

Metric No. 3.3.2

Number of research papers per teachers in the Journals notified on UGC website during the last five years



Laxminarayan Institute of Technology, Nagpur
Self-Study Report



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Professor (Dr.) Raju B. Mankar
M. Tech, Ph. D., Fellow DAAD Germany
Director

PUBLICATIONS OF FACULTY IN LAST FIVE YEARS

Sr. No.	Name of the Faculty	2020-2021	2019-2020	2018-2019	2017-2018	2016-2017
<i>Department of Chemical Engineering</i>						
1	Dr. R.B. Mankar	0	0	1	0	1
2	Dr. B. A. Bhanvase	5	9	5	11	11
3	Mr. S. L. Pandharipande	1	6	2	8	10
4	Dr. R. P. Ugwekar	3	1	0	1	2
5	Dr. S. P. Shirsat	0	0	0	2	0
6	Mr. R. P. Birmod	0	1	0	1	0
7	Dr. S. N. Joglekar	2	0	0	0	0
<i>Department of Food Technology</i>						
1	Dr. M.G. Bhotnange	0	1	1	0	1
2	Dr. S.V. Karadbhaje	0	4	3	3	1
3	Dr. (Mrs.) S. D. Deshmukh	0	1	2	1	2
<i>Department of Oil, Fats & Surfactants Technology</i>						
1	Dr. V. Y. Karadbhaje	0	1	6	10	2
<i>Department of Petrochemical Technology</i>						
1	Dr. G. M. Deshmukh	0	0	0	0	3
2	Dr. V. N. Ganvir	0	0	0	0	2
3	Mr. A. C. Shende	0	0	0	0	1
4	Mr. A. J. Agrawal	0	0	0	3	0
<i>Department of Pulp & Paper Technology</i>						
1	Dr. J. B. Bhasarkar	4	0	0	0	0
<i>Department of Surface Coating Technology</i>						
1	Dr. G. P. Lakhawat	1	0	0	0	2
<i>Department of Chemical Technology</i>						
1	Dr. S. M. Wagh	0	2	1	0	0
<i>Department of General Engineering</i>						
1	Dr. P. N. Belkhode	0	1	3	3	0
2	Dr. (Mrs.) P.J. Giri	0	0	1	0	0
<i>Department of Chemistry</i>						
1	Dr. (Mrs.) P. S. Agrawal	3	2	1	5	1
2	Dr. N.T. Khaty	2	1	0	0	0
3	Dr. S. U. Meshram	1	1	0	0	0
4	Dr. Asar Ahmed	1	0	0	0	1
<i>Department of Physics</i>						
1	Dr.(Mrs.) S. A. Pande	2	3	2	3	3
2	Dr. N. M. Patil	4	0	2	0	1
3	Dr. Vijay Pawade	3	2	2	5	3
4	Dr.(Mrs) N. T. Kalyani	4	4	3	8	4
<i>Department of Mathematics</i>						
1	Dr. S. P. Dautpure	0	0	0	0	1
2	Dr. S. D. Warbhe	2	1	1	3	1

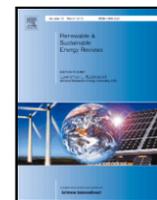
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Performance evaluation of nanofluids in solar thermal and solar photovoltaic systems: A comprehensive review

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ABSTRACT

Nanofluids, due to their superior thermal properties, have immense applications in heat transfer process. In view of this, nanofluids, as working fluids in solar thermal systems, have gained importance. This review emphasizes the properties of nanofluids for solar thermal applications as well as typical nanomaterials and analyses experimental and numerical investigations on solar thermal systems utilizing nanofluids along with typical experimental setups and calculation methods used for determination of the performance of nanofluids in the same. The effect of nanoparticles concentration, flowrate, ambient temperature, solar intensity and inlet temperature on the solar thermal system performance utilizing nanofluids is also discussed. Further, challenges occurring during application of nanofluids in solar thermal systems are specified along with recommendations for scaling up of nanofluid-based solar thermal systems.

List of abbreviations

CFD	Computational fluid dynamics
CNT	Carbon nanotubes
CTAB	Cetyl Trimethyl Ammonium Bromide
DASC	Direct absorption solar collector
DI	Deionized water
EG	Ethylene glycol
ETSC	Evacuated tube solar collector
FEM	Finite element methods
FPSC	Flat plate solar collector
FVM	Finite volume method
IR	Infrared
LSPR	Localised Surface Plasmon Resonance
MWCNT	Multi-walled Carbon Nanotubes
PTC	Parabolic trough collector
PV	Photovoltaic
PVT	Photovoltaic-thermal
SDBS	Sodium Do-decyl Benzene Sulphonate
SPR	Surface Plasmon Resonance
SWCNT	Single-walled Carbon Nanotubes
VEROS	Vacuum Evaporation onto a Running oil substrate

Nomenclature

A_b	Basin effective area (m^2)
A_c	solar collector surface area (m^2)
β	Temperature coefficient (K^{-1})
C_p	heat capacity of working fluid (J/kgK)
$C_{p,bf}$	Specific heat of base fluid (J/kgK)
$C_{p,np}$	Specific heat of nanoparticles (J/kgK)
d	diameter of nanoparticles (nm)
E_c	Total absorbed energy by PV cells (W)
E_e	Solar energy converted into electrical energy by PV cells (W)
E_{th}	Useful thermal energy (W)
E_{XDest}	Exergy due to destruction (W)
$E_{XElectrical}$	Electrical exergy (W)
E_{XHeat}	Exergy related to heat from solar radiation (W)
E_{XIn}	Irradiance exergy (W)
$E_{XMass,in}$	Exergy due to flow at inlet (W)
$E_{XMass,out}$	Exergy due to flow at outlet (W)
E_{XOut}	Exergy output (W)

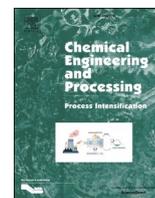
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Textile Industry Wastewater Treatment by Cavitation Combined with Fenton and Ceramic Nanofiltration Membrane

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Intensification
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ABSTRACT

This work first time reports the intensification of real wastewater treatment by combination of hydrodynamic cavitation (HC), Fenton reagent, and membrane separation. In this work, a micro-porous ceramic membrane was used for the preparation of nano-porous catalytic membrane reactor. Initially, the aluminium boehmite sol has been synthesized and coated onto the tube side of the ceramic membrane by wet impregnation technique. A layer by layer technique was adopted for the wet impregnation of boehmite sol onto the ceramic membrane. After achieving a desired number of layers coating onto the ceramic membrane, a prepared catalyst sol was further used for coating. The dried boehmite powder was characterized using X-ray diffractometer and particle size distribution analysis. Mercury intrusion porosimetry (MIP) technique was used to identify the pore size distribution of modified ceramic membrane. The modified ceramic membrane was used in conjunction with HC for industrial dye wastewater treatment. The impact of process parameter such as cavitation unit (orifice) inlet pressure, intensifying chemical additive like Fenton reagent, and H₂O₂ dosage was investigated. HC along with intensifying chemical additives H₂O₂ and Fenton reagent improved the organic pollutants removal from textile industry wastewater

1. Introduction

A huge quantity of water is used by many chemical firms, including dyes, textiles, paper, and laundry and release a significant quantity of colored wastewater as a discharge into the environment. The liquid discharges of textile plants are often composed of high color, mineral salts, surfactants, and several other chemical additives such as lubricating agents and foam reducers etc. [1]. Before wastewater is released into the ecosystem, it is important to remove the contaminants from it due to considerable restrictions by the pollution control bodies of the government. To achieve the goal of zero liquid discharge, the advanced treatment methods must be developed. Since traditional wastewater treatment methods are inefficient, advanced oxidation processes (AOPs), especially the Fenton and cavitation processes, have been identified as a promising treatment method for destroying persistent organic pollutants in water. Advanced separation methods for eliminating organic/inorganic pollutants from water using polymer membranes, such as nanofiltration (NF) and reverse osmosis (RO), are widely

being employed in the colored and other wastewater treatment and reuse [2–5]. Long et al. [6] have studied the application of nanofiltration membranes by the film casting strategy for effective removal of dyes/salts from textile wastewater. Gunawan et al. [7] demonstrated the cross-linked nanofiltration membrane by m-phenylenediamine for dye removal from textile wastewater. Sutedja et al. [8] have studied the polysulfone thin film composite nanofiltration membranes for removal of textile dyes wastewater. Febrianto et al. [9] developed and demonstrated a polyetherimide nanofiltration membranes modified by interfacial polymerization for treatment of textile dyes wastewater. Meltem et al. [10] have studied the nanofiltration membranes for salt and dye filtration. In this work, authors were investigated the different properties on the performances of the membrane. Venkata Swamy et al. [11] studied the treatment of biscuit industrial effluent using thin film composite nanofiltration membranes. Nguyen et al. [12] have studied the treatment of synthetic and industrial dye baths using nanofiltration membrane. Authors were studied the influence of temperature on rejection and membrane fouling. Ahmed et al. [13] have investigated

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Synthesis, analysis, and application of lactide-based polyester as coating with improved mechanical and rheological behavior

Rushikesh S. Chanpurkar, Gajanan P. Lakhawat, Ruta D. Khonde

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Abstract Lactide-based polyester resin was synthesized from diethylene glycol and phthalic anhydride with 20, 30, and 40% lactide compositions. The lactide was prepared from lactic acid and the polyester resin was functionalized with carbon-carbon crosslinking by polycondensation reaction. The purpose of this investigation was to enhance the properties such as thermal, mechanical, and rheological behavior of polyester resin synthesized using lactide. The resin was also characterized for acid values, hydroxyl values, and bio-based content. The bio-based content varied from 76 to 92% for variable composition of lactide in the resin. Acid value confirmed the formation of polyester resin and the hydroxyl value indicated the occurrence of crosslinking. The flow viscosity is an important characteristic of resins that are intended to be used as matrix in composite applications, and it was measured at different stress levels at varied temperatures. The performance of a mild steel specimen coated with the synthesized polyester was evaluated for mechanical properties such as tensile strength, impact resistance, flexibility, scratch resistance, and adhesion test. It revealed that lactide-based polyester resin had better mechanical, rheological, and anticorrosive properties than simple polyester resins.

Keywords Polyester, Polycondensation, Hydroxyl values, Bio-based content, Anticorrosive

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Introduction

Polymeric materials currently play a significant role in everyday life due to their unique range of properties compared to other conventional materials. Polymers offer many advantages, such as durability, lightness, resilience to corrosion, ease of processing, high productivity, low cost, and environmental aspects, which determine their importance to society and enable greater extent of industrial development. Several developments have been explored for the synthesis of new bio-based thermoset resins due to the exploitation and the complicated nature of conventional polymeric materials. During synthesis, the bio-based resins need to be crosslinked, which requires the starting materials to contain reactive groups in the molecules.^{1,2} In this paper, bio-based thermoset resins are synthesized from lactic acid, involving modification by introduction of reactive groups in the lactic acid polymer chains. These resins are comparable to commercial unsaturated polyester resin, vinyl ester, and epoxy resins based on their structures and curing mechanism.³

Lactic acid (2-hydroxypropanoic acid), also called milk acid, is a widely occurring carboxylic acid. Lactic acid can be produced by either chemical or biotechnological process. Lactide is a cyclic di-ester of lactic acid. Lactide has several advantages such as its eco-friendly nature, biocompatibility, excellent processability, and good energy savings compared to conventional polymers. It also decreases volatile organic compounds (VOC) upon its addition in polyester resin due to its biological property. Lactide-based thermoset coating can be prepared by introducing reactive groups into lactide and by polymerization process. A research group⁴ developed polyester resins for coating cans with the property of best adhesion to metal substrates, with chemical resistance and elasticity. Other researchers investigated the utilization, analysis, and aging of composites of unsaturated polyester resins with micro-



Sugarcane valorization: selection of process routes based on sustainability index

Saurabh N. Joglekar¹ · Gauri Dalwankar¹ · Nishat Qureshi¹ · Sachin A. Mandavgane²

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Abstract

Increasing awareness about sustainability has compelled the recent researchers to explore different methods for evaluation. Conventionally the sustainability of a process was majorly dependent on the economics feasibility. Recently need of incorporation of environmental and social concerns in overall sustainability assessment has been realized. Authors in their prior work has published a framework for performing sustainability assessment of biomass processing enterprises. The present work is on selection of sugarcane valorization pathways based on the sustainability index using the same framework. Six alternative routes are compared based on their economic, environment and social criteria. Life cycle assessment of each process is performed as per ISO 14040/44 to evaluate the environmental criteria. Integrated method of value function (MIVES) is used for consolidation of different indicators and criteria. Amongst the process alternatives considered for assessment, 1G2G ethanol route is observed to have highest sustainability index (0.864) owing to relatively lower environmental impact whereas first generation butanol production route (1GRS) had the least sustainability index of 0.090 on account of decreased yield and less products. Sensitivity analysis performed on the model showed no significant change in the ranking of the alternatives.

Keywords Life cycle assessment · Sustainability index · Multicriteria decision · Route selection

Introduction

Sugarcane, a crop cultivated in tropical and subtropical ecological zones in India, is a major source of sugar, bioenergy, and bio-ethanol in the domestic and international market.

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India is second highest producer of sugarcane after Brazil cultivating on 2.57% of total cultivated area (Sindhu et al. 2016). The sugarcane cultivation and sugar industry in India plays a vital role towards socio-economic development in the rural areas by mobilizing rural resources and generating higher income and employment opportunities. Sugarcane processing industries is estimated to produce direct employment to 6 million farmers and around 0.5 million of skilled and unskilled industrial workers (Narayanan et al. 2019).

To strengthen the complete utilization of sugarcane, different biorefinery approaches have been proposed. The basic sugarcane biorefinery involves the production of sugar, electricity and ethanol. However, with the recent advancement in technology, a sugarcane biorefinery that integrates the first and second generation ethanol along with other products such as butanol and acetone has been proposed by (Pereira et al. 2015). Apart from the production of bioethanol, Elias Martinez-Hernandez et al suggested various alternative processing strategies for sugarcane bagasse to obtain products such as furfural, xylitol, enzymes, fertilizers, boards, and proteins (Eliche-Quesada et al. 2012). Researchers across the globe has been experimenting and modeling various sugarcane bagasse valorization routes with a view to



E-waste recycling practices: a review on environmental concerns, remediation and technological developments with a focus on printed circuit boards

Saurabh P. Tembhare¹ · Bharat A. Bhanvase¹ · Divya P. Barai¹ · Sanjay J. Dhoble²

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Abstract

Decrease in life span of electronic devices and consumer's urge to use advanced technology leads to obsolescence of such devices, resulting in electronic waste generation. The technology for e-waste components recycling has made great progress. However, due to growing environmental concern, there is a need to find alternatives for conventional e-waste recycling methods to achieve a safer environment. Rapid surge in e-waste generation is a matter of concern due to elevated levels of heavy metals and persistent organic pollutants (POPs) in air, soil and water caused by informal recycling practices. Moreover, recycling of printed circuit board (PCB), a major part of electronic waste, in order to recover metals, results in release of waste acid leach water, if untreated, which contain heavy metals like Pb, Cr, Ni, etc. This has given rise to the development of several remediation techniques for soil- and water-like phytoremediation, soil washing, bioremediation, and application of nanoparticles, which have been compared and reviewed in this paper along with their limitations for application at larger scale for real-contaminated soil. This review focuses on the existing remediation techniques and their limitations to decrease environmental hazards caused by the release of various pollutants through e-waste recycling.

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ANN-based modelling of peppermint flavour encapsulation process with ultrasound approach

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[Water Environment Research / Early View](#)

REVIEW

A review of graphene-TiO₂ and graphene-ZnO nanocomposite photocatalysts for wastewater treatment

Kunal G. Thakre, Divya P. Barai, Bharat A. Bhanvase 

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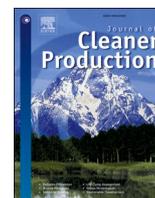
Citations: 1

Abstract

Technologies for wastewater remediation have been growing ever since the environmental and health concern is realized. Development of nanomaterials has enabled mankind to have different methods to treat the various kinds of inorganic and organic pollutants present in wastewater from many resources. Among the many materials, semiconductor materials have found many environmental applications due to their outstanding photocatalytic activities. TiO₂ and ZnO are more effectively used as photocatalyst or adsorbents in the withdrawal of inorganic as well as organic wastes from the wastewater. On the other hand, graphene is tremendously being investigated for applications in environmental remediation in view of the superior physical, optical, thermal, and electronic properties of graphene nanocomposites. In this work, graphene-TiO₂ and graphene-ZnO nanocomposites have been reviewed for photocatalytic wastewater treatment. The various preparation techniques of these nanocomposites have been discussed. Also, different design strategies for graphene-based photocatalyst have been revealed. These nanocomposites exhibit promising applications in most of the water purification processes which are reviewed in this work. Along with this, the development of these nanocomposites using biomass-derived graphene has also been introduced.

Practitioner Points

Graphene-TiO₂ and graphene-ZnO nanocomposites are effective for wastewater treatment through photocatalysis.



Bismuth titanate based photocatalysts for degradation of persistent organic compounds in wastewater: A comprehensive review on synthesis methods, performance as photocatalyst and challenges

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Visible-light photocatalyst
Persistent organic compounds
Wastewater treatment

ABSTRACT

Bismuth-based nanocomposites have tremendous applications in wastewater treatment and air purification. Various bismuth-based nanocomposites have been developed and investigated, out of which, bismuth titanates have been explored a lot for their environmental applications. They are aurivillius type of compounds belonging to the family of layered perovskites. Bismuth titanates and their nanocomposites possess the ability to degrade persistent organic pollutants, present in water and wastewater, including various dyes (rhodamine blue, methyl orange, congo red, methylene blue, malachite green, brilliant red, acid orange, acid blue), organic compounds (phenol, methanol, formic acid, salicylic acid, p-chlorophenol), pharmaceutical compounds (sulpha methoxazole, ciprofloxacin, tetracycline, carbamazepine, gatifloxacin, 17 β -Estradiol) etc. In this review, the various synthesis methods of bismuth titanates are discussed. This work reviews characterization and applications of Bi₂Ti₂O₇, Bi₄Ti₃O₁₂, Bi₂Ti₄O₁₁, Bi₈Ti₄O₁₄, Bi₂₀TiO₃₂ etc. For environmental remediation. Usage of these nanomaterials are in the form of slurry or immobilized system. However, future perspectives involving more research related to the development of novel bismuth-based nanocomposite materials with superior photocatalytic properties, easy recoverability, and practicability for real systems. Further, challenges related to fabrication of pure bismuth titanates, morphology and development of bismuth titanate photocatalyst are also stated. Some novel bismuth titanate nanocomposite photocatalysts including fiber-based photocatalyst, photocatalytic membrane, floating photocatalyst etc. are also discussed.

1. Introduction

Water crisis and pollution are closely related due to the water reservoirs getting polluted by various human activities. The toxic pollutants present in polluted water seriously affect human health, environment, and, in turn, the economy. This demands urgent attention for the development of technology for treatment of wastewater so that it could be reused, thereby reducing the burden on environment (Fawell and Nieuwenhuijsen, 2003; Nathan and Scobell, 2012; Schwarzenbach et al., 2010; Vörösmarty et al., 2010). Several researchers have tested and developed various wastewater treatment methods to combat the problem of water pollution (Bhanvase et al., 2021). Due to various problems and challenges of conventionally existing water treatment methods, new treatment processes involving novel nanomaterials are being explored (Abouzeid et al., 2019; Barac et al., 2004; Di Paola et al., 2012; Oliveros et al., 1997; Pandey et al., 2017; Radjenovic and Sedlak, 2015; Saini

et al., 2019; L. Wang et al., 2019a). Photocatalysis is considered as one such green, cost effective and suitable method for treating organic pollutants present in wastewater (Bhaskar Bethi et al., 2016b; Bhanvase et al., 2017; Deshmukh et al., 2020; Kale et al., 2020; R. Kumar et al., 2021; Meshram et al., 2017; Potle et al., 2020; Shende et al., 2018). Photocatalysis, also referred to as an advanced oxidation process, is initiated by an incident radiation of appropriate wavelength on a photoactive material (Bethi et al., 2019; Bhaskar Bethi et al., 2016a; Kumar et al., 2018). In view of this, many researchers developed different types of photocatalyst materials which are active under ultraviolet, visible and near infrared radiations (Banerjee et al., 2014; Dal Santo and Naldoni, 2018; Dong et al., 2015; Kodarkar et al., 2021; Pawar and Lee, 2015; L. Wang et al., 2019b). Photocatalysis is also seen as an effective method for inactivation of micro-organisms and viruses due to mild reaction conditions (Habibi-Yangjeh et al., 2020). Graphitic carbon nitride has found immense application in photocatalysis (Akhundi et al., 2020;

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Comparison of different concrete compositions based on sustainability score

Saurabh Shinkhede, Vasudha Katare, Saurabh Joglekar, Mangesh Madurwar & Sachin Mandavgane

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Web-analogues one-dimensional iron hydroxide@cadmium hydroxide nanostructure: electrochemical supercapacitor

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ABSTRACT

One-dimensional iron hydroxide@cadmium hydroxide nanostructures have been prepared by sequentially converting cadmium hydroxide into iron hydroxide via simple and cost-effective cation exchange reaction based on solubility product to design electrochemical supercapacitive electrode. Surface architecture of iron hydroxide@cadmium hydroxide nanostructures in the form of core-shell enables easy and effective electrochemical reactions which have been studied via electrochemical cyclic voltammetry and charge-discharge studies. Interestingly, iron hydroxide@cadmium hydroxide electrode exhibits specific capacitance of 368 F g^{-1} at current density of 0.5 A g^{-1} along with electrochemical impedance analysis. Capacitance retention performed at the scan rate of 50 mV s^{-1} for 5000 cycles results in 52% capacity of its initial.

1 Introduction

Supercapacitor possesses the distinctive capability of higher power densities and longer cycle life than batteries for numerous applications such as power sources in mobile electronic devices as well as in

next-generation electric vehicles. Due to the growing demands for the advancement of supercapacitive energy storage devices with high power and energy densities, various electrode materials with high capacitance have been explored [1, 2]. It is extreme important to develop electrode material with

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Appraisal of Structural, Thermal, and Optical Properties of Novel Bluish-Violet Light-Emitting Cyclometallated Iridium (III) (Cl-H-DPQ)2Ir(acac) Complex for OLED Devices

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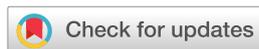
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Exploration of photophysical behavior of RE(TTA)₃ dpphen molecular complexes doped in PMMA and PS matrices

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ABSTRACT

This paper put forward the synthesis and photophysical characterization of hybrid organic rare earth complexes namely RE(TTA)₃dpphen (RE = Eu/Eu_{0.5}Sm_{0.5}/Sm; Eu: Europium, Sm: Samarium, TTA: 2-Thenoyltrifluoroacetone, dpphen: 4, 7- diphenyl, 1, 10-phennathroline) doped in polymethylmethacrylate (PMMA) and polystyrene (PS) at different weight percentage. Photoluminescence (PL) spectra of RE(TTA)₃dpphen blended films in PMMA and PS portrayed strong emission in the orange/orange-red region of visible spectrum. The absorption spectra of solvated matrices show two peaks corresponding to $\pi \rightarrow \pi^*$ (in the range of 240–275 nm) and $n \rightarrow \pi^*$ (in the range of 370–390 nm) optical transitions in the range of and respectively. Bathochromic (red) shift in the peak position was observed in solvated films in formic acid as compared to that in dichloromethane. The energy band gap of the films solvated in dichloromethane and formic acid was found to be in the range of 3.16–3.20 eV. PL spectra of the solvated films in dichloromethane showed emission in the red region of visible spectrum while the emission is in blue region for the films solvated in formic acid. CIE diagram of the blended films in solid state and solid state proves the potential of the synthesized complexes as strong contenders with novel feature of tunable emission with the change in media from basic to acidic. These investigations portrayed the potential of blended films as a emissive medium for OLEDs and flat panel displays and solid state lighting.

1. Introduction

The evolving optoelectronics industry mandates for the agile lighting sources that are thin and lighter, cost effective and offer greater efficiency. In contemporary years, OLEDs grasped much scientific curiosity due to their versatile applications in full-color displays with major refinements of earlier findings [1–4]. However, the synthesis of an appropriate blend of red, green and blue (RGB) displays is still a task due to the fact that the full color displays require pure hues. As human is less sensitive to red region of visible spectrum, filtering is highly pre-requisite in order to sharpen the emission peaking wavelength. Use of hybrid organic rare earth complexes in the display technology gained momentum as they proffer good flexibility, better solubility in most of the organic solvents, due to which thickness of the deposition on the substrate can be controlled in an effective way [5]. Especially, europium and samarium β -diketonates have virtuous luminescent properties due to their inimitable electronic structure, the antenna effect of the ligands [6–9].

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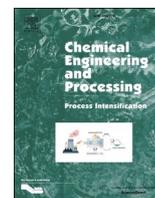
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Ultrasound assisted one step in-situ preparation and characterization of rGO-WO₃ nanocomposite for degradation of organic dyes

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ABSTRACT

The present work focuses on preparation of reduced graphene oxide-WO₃ (rGO/WO₃) nanocomposite using ultrasound assisted method. It is expected that the intense environment created by ultrasound will help reduce particle size of WO₃ deposited on the graphene oxide nanosheets. Successful formation of rGO/WO₃ nanocomposite was confirmed with the use of different characterization techniques. The use of ultrasound in the preparation of nanocomposites plays very important role in its formation. The rGO/WO₃ nanocomposites prepared by varying reaction conditions like type of sonication, sonication time, concentration of acidic medium, and initial quantity of graphene oxide (GO) were further used in methylene blue (MB) dye degradation experiments to study the effect of various preparation conditions. rGO/WO₃ nanocomposite photocatalyst prepared using low HCl concentration (3.0 M), bath sonication (75 min sonication time) and 40 mg GO loading in nanocomposite exhibited maximum degradation of MB dye (81.56%). Further, this nanocomposite photocatalyst was used to investigate magnitude of degradation of various dyes which revealed that the degradation rate follows the order as crystal violet > methylene blue > brilliant green.

1. Introduction

Environmental pollution and energy crisis are major problems in the modern era of science and technology. New clean and green routes for synthesis and development of materials with much effective processes can offer a better solutions to the environmental pollution issues [1,2]. WO₃ (band gap in the range 2.4 to 2.8 eV) is a metal oxide of tungsten and an *n*-type semiconductor material [3] that has potential applications in the field of photo degradation of organic dyes due to its non-toxicity, low band gap and significant photo-activity. The combination of WO₃ nanoparticles with rGO forming rGO/WO₃ nanocomposites have shown great efficiency for photo dye degradation application compared to neat WO₃ nanoparticles [2,4,5]. Also, doping of graphene nanosheets with various metal oxides enhances the effectiveness of metal oxide materials towards their targeted applications. For the same, metal oxides like SnO₂ [6,7], CeO₂ [8], CuO [9,10], TiO₂ [11,12], ZnO [13–15] etc. were tested for their different applications such as gas sensing, photo catalysis, and other applications. However, WO₃ suffers from higher recombination rate of electron-hole and has slow charge transfer leading to limited degradation of the pollutants [2]. Several modifications have been tried by researchers to overcome this problem. One option is to incorporate

WO₃ nanoparticles with graphene or rGO, which has exceptionally higher surface area and excellent electronic and physico-chemical properties. Also, graphene or rGO has excellent electron mobility and therefore has superior electron transfer rate, thus suppressing the recombination of electron-hole pair [16–18]. Therefore, the use of graphene or rGO in the rGO/WO₃ nanocomposite acts as a co-photocatalyst with improved adsorption capacity, extended visible light absorption, and enhanced photocatalytic degradation of the targeted pollutant. Also, the amount of graphene in the prepared nanocomposite is considered to have significant effect on the performance of such graphene-based nanocomposites for degradation application.

Further, the method used for preparation of rGO-WO₃ nanocomposites with desirable morphology plays very important role in various applications like photocatalysis, gas sensors and for altering electrochemical properties of the materials. Generally, preparation of WO₃ nanoparticles and rGO-WO₃ nanocomposites relatively takes more time with the use of solvothermal [19–21] and hydrothermal [2,22,23] routes. Formation of different nanostructures such as moonflowers [24], nanorods [2], nanolamelle [23] has been reported with the use of hydrothermal route and solvothermal routes of synthesis. The ultrasound assisted technique is a new emerging process for synthesis of

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The influence of annealing temperature on the structure and optical properties of Gd₂Zr₂O₇ nanostructures prepared by chemical bath deposition method



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ABSTRACT

Gadolinium zirconate (Gd₂Zr₂O₇) powders were prepared for the first time using chemical bath deposition (CBD) method. In this study, the chemical bath deposition (CBD) method was employed due to its simplicity, cheap, low temperature, versatile and it gives better homogeneity. The effect of annealing temperature (T_a) on the thermal, structural, morphological, and optical properties were investigated. Thermogravimetric analysis (TGA) and differential thermogravimetric analysis (DTGA) showed that the material is thermally stable between 400 and 900 °C. The X-ray diffraction (XRD) results confirmed the cubic Gd₂Zr₂O₇ phase with hexagonal ZnO secondary peaks. Scanning electron microscopy (SEM) results revealed the transformation of irregular particles to hexagonal-like structure shape with an increase in T_a. Energy dispersive x-ray spectroscopy (EDS) analysis confirmed the presence of the expected elements. Transmission electron microscopy (TEM) confirmed the nano-nature of the prepared powders. Ultraviolet-visible spectroscopy (UV-Vis) spectra showed a slightly red shift with an increase in T_a. The photoluminescence (PL) results revealed that the emission intensity and peak position in UV region highly depends on the T_a. It was also noted that both secondary peaks from hexagonal ZnO and T_a regulates the defects emission. The international illumination (CIE) color chromaticity showed that the color shifts from blue to yellow-greenish with an increase in T_a. The approach in the present study opened a new way to tune band gap and luminescence intensity of Gd₂Zr₂O₇.

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1. Introduction

Due to their superior electrical, chemical and mechanical characteristics, nano range metal oxides (MO) have drawn great interest to the researchers around the world. In technological applications, MO are used in the fabrication of microelectronic circuits, sensors, piezoelectric devices, solar cells, coatings for the passivation of surfaces against corrosion, luminescence and as catalysts [1–5]. MO

nanoparticles can display unique physical and chemical properties due to their limited size and a high density of corner or edge surface sites. At the nanoscale, physical, chemical and biological properties differ from the properties of individual atoms and molecules of the bulk matter. Therefore, it provides opportunity to develop new classes of advanced materials which meet the demands from high-tech applications [6–10]. Development of MO nanoparticles with improved properties has been studied with much success in several areas such as synthesis and surface science [11–17]. Advancement in nanotechnology has led to the production of nanosized MO which has been widely used as luminescent materials [4,5,14].

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Effect of NaCl and KCl on volumetric and acoustic behavior of aqueous Creatinine Hydrochloride solutions at $T = (288.15\text{--}318.15)$ K



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ABSTRACT

Systematic measurements of density and speed of sound of Creatinine Hydrochloride in aqueous and in aqueous solutions of $0.06 \text{ mol}\cdot\text{kg}^{-1}$ NaCl/KCl and $0.1 \text{ mol}\cdot\text{kg}^{-1}$ NaCl/KCl were carried out at $T = (288.15\text{--}318.15)$ K within the concentration range of $(0.03 \text{ to } 0.1) \text{ mol}\cdot\text{kg}^{-1}$. All the measurements were performed for density and speed of sound simultaneously on Anton Paar DSA 5000 M. The density (ρ) and speed of sound (u) were employed to calculate the various derived parameters such as apparent molar volume of solute (V_ϕ), limiting apparent molar volume of solute (V_ϕ^0), limiting apparent molar expansivity (E_ϕ^0), thermal expansion coefficient (α'), isentropic compressibility (κ_s), apparent molar isentropic compressibility ($K_{s,\phi}$), limiting apparent molar compressibility ($K_{s,\phi}^0$). The trends of variation of experimental and computed parameters have been discussed in terms of hydrophilic-ionic group interactions and hydrophilic-hydrophilic interactions operative in the systems.

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1. Introduction

Creatinine also known as Creatine Anhydride is formed as a breakdown product of Creatine. Creatine Phosphate is a high energy compound in muscles with a high Phosphate transfer potential. The enzyme Creatine Kinase catalyzes the transfer of Phosphate from Creatine Phosphate to ADP to form ATP and generate Creatine. This Creatine is broken down to Creatinine to be eliminated from body through urine, a renal function. Level of Creatinine in blood is thus an indicator of kidney/renal function. Increased level of Creatinine in blood is indicative of kidney nephron damage [1]. Creatinine Hydrochloride is a salt of Creatinine and is known to inhibit the bacterial infections [2]. Creatinine Hydrochloride (2-Amino-1-methyl-2-imidazolin-4-one hydrochloride) is a molecule having a number of functional groups with potential for Hydrogen-bonding associations. In fact, it contains three Nitrogen and one Oxygen atoms. Nitrogen as well as Oxygen atoms are highly electronegative and have one lone pair of electrons each. So, when Creatinine HCl is dissolved in water the probability of forming Hydrogen bond with water is very high

and it can form a Hydrogen bonded structure with water. Moreover, it is the only Creatinine Hydrochloride that inhibits bacterial infections and not the Creatinine or Creatine monohydrates [2]. Due to presence of two Hydrogen bond donors and one Hydrogen bond acceptor, it was felt interesting to study the solvation behavior of Creatinine Hydrochloride in electrolytic media.

Various enzymatic and chemical reactions in the body occur in the aqueous media therefore studies on the physicochemical properties of molecules in aqueous solution provide useful information which is important to understand complex mechanism of molecular interactions. Volumetric and acoustic properties are very useful in understanding molecular interactions.

Sodium and Potassium are the primary positive ions in blood plasma and extracellular fluids. Sodium and Potassium ions help in maintaining the osmoregulation in the human cells and also responsible for the flow of electrical signals inside the body. Sodium Chloride is an electrolyte that regulates the amount of water in body and also plays a part in nerve impulses and muscle contractions. Potassium is a very significant body mineral, important to both cellular and electrical function. The Sodium-Potassium pump is an important contributor to action potential produced by nerve cells. Although, there are some important studies reported in the literature in electrolytic media like Sodium and

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Investigation on thermophysical properties, convective heat transfer and performance evaluation of ultrasonically synthesized Ag-doped TiO₂ hybrid nanoparticles based highly stable nanofluid in a minichannel

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Hybrid nanofluid
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ABSTRACT

Ag-doped TiO₂ hybrid nanoparticles have been synthesized by ultrasonic-assisted method for nanofluid application for heat transfer in minichannel heat exchanger at constant wall temperature condition. Prepared nanoparticles were dispersed in water by ultrasonication to form an extremely stable nanofluid. Thermal conductivity of the nanofluid was found to be 1.84 W/mK at 45 °C for nanofluid concentration of 0.25 vol%. The overall heat transfer coefficient increased from 1211.71 to 2727.38 W/m²K as the nanofluid concentration increased from 0.01 vol% to 0.1 vol% at Reynolds number of 3480 ± 3. A new correlation for Nusselt number has been proposed. The pressure drop and friction factor of the nanofluids were also advantageously lesser than that of water. The overall performance of the Ag-doped TiO₂ hybrid nanoparticles based nanofluid was assessed by comparing the heat transfer with the pumping power and by determining the entropy generation and thus the Bejan number.

1. Introduction

Novel nanometer-sized particles have gained great interest for preparation of dispersions in different kinds of basefluids for analyzing their heat transfer properties. The term 'nanofluid' is a name given to a two-phase mixture consisting of dispersed particulate solid phase and a base liquid phase. Nanoparticles can be fine metallic or non-metallic particles of size in the nanometer range i.e., below 100 nm. The idea of nanofluid was first introduced by Choi in year 1995 [1]. There are various metal-based and metal oxide-based nanomaterials that have been used for synthesis of nanofluids [2–6]. A number of studies have also confirmed potential of nanocomposite materials for nanofluid applications [7–9]. Also, since the discovery of graphene, graphene-based materials have also been used widely for nanofluid applications [10–13]. The broad range of research studies about nanofluids has advocated their use in heat transfer applications. As nanotechnology is integrated into various technological areas, applications of nanofluids in car engine cooling [14,15], solar thermal systems [16–18], transformer cooling systems [19,20], oil drilling [21,22], refrigeration [23,24], electronic cooling systems [25,26], medical sciences [27,28] etc. have risen up. Increasing demand for high performance devices require efficient heat rejection systems which largely depends on newer

innovations in thermal management [29]. Common mechanisms responsible for superior heat transfer include high thermal conductivity, Brownian motion of nanoparticles and thermophoresis effect [30–32]. Similarly, different geometries of heat exchanger have also been utilized to extend the study further [33–35].

High heat transfer area is a key solution to improve heat transfer. Minichannels are found to have a significant effect on heat transfer augmentation due to the large surface area to volume ratio possessed by them. Due to the advancement in miniaturization systems, minichannel heat exchangers have gained a lot of interest in the recent years. Fundamental numerical studies related to the flow patterns and heat transfer in tiny flow channels are eminent [36]. And along with this, application of nanofluids in minichannel heat sinks have also been studied experimentally as well as numerically in various geometries in the view to provide solutions for enhancement in heat transfer in them [37–42].

Hybrid nanofluids are a class of nanofluids which contain two or more types of nanoparticles or nanocomposites of two or more types of materials out of which at least one is in nanoscale. In this type of fluids, the advantages of different nanomaterials can be realized, thereby obtaining synergy between the components present in the fluid. For instance, Hamid et al. [43] found that the ratio (TiO₂:SiO₂) of 40:60 and 80:20 of mixture of TiO₂ nanoparticles (average diameter of 50 nm) and

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Membrane Disruption Potential of Doped Cuprous Oxide Nanoparticles Against bla_{NDM-1} and mcr-1 Positive Colistin Resistant *E. coli*

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Abstract

Bacterial resistance against the last-resort antibiotic “colistin” is a growing problem worldwide. Novel strategies in the field of nanotechnology for the development of suitable antibacterial drug with minimal toxicities are need of the time. Here we synthesized, Cu₂O nanoparticles (Cu₂O-NPs) doped with 5% Zn metal ions by adopting solution-phase method using hydrazine reduction in aqueous medium. Antibacterial assays showed a promising activity against colistin-resistant *Escherichia coli* isolates. Leakage assay, propidium iodide uptake assay, EtBr uptake assay, and LIVE/DEAD® BacLight™ assay showed membrane damaging activity of Cu₂O-NPs. Imaging by scanning electron microscopy of NP-treated bacterial cells confirmed membrane damaging potential of used Cu₂O-NPs. Toxicity assessment by cell viability assay showed no cytotoxic activity to the HEK cell line. In conclusion, our results suggest that Cu₂O-NPs doped with 5% Zn may exert their antimicrobial action by disruption of the bacterial cell membrane and probably generating reactive oxygen species (ROS). We suggest that Cu₂O-NPs doped with 5% Zn can be used as effective antibacterial agent.

Keywords Cu₂O nanoparticles · Colistin · *E. coli* · Antibacterial resistance

1 Introduction

Rise in nosocomial infections and spread of antibiotic resistance might leave only few antibiotics like “colistin” for treatment of infections of Gram-negative bacteria [1]. World Health Organization (WHO) has designated colistin as only drug available for treating severe bacterial infections in critically ill patients [2]. But global increase of carbapenem-resistant *Enterobacteriaceae* (CRE) infection and the overuse of colistin have increased an inevitable risk of developing colistin resistance [3]. Colistin resistance (Col-R) occurs mostly by a chromosomal

mutation leading to alteration in mechanism of lipid A modification [4]. That reduces the net negative charge of bacterium membrane and the binding affinity of colistin to them, thus reducing the efficacy of the drug. Several reports of mcr-1 gene mediated Col-R have been published from different parts of the world including Africa, Asia, USA, and Europe [5, 6]. Till date, nine variants (mcr-1 to mcr-9) have been reported [4], which suggests rapid spread of Col-R strains. Therefore, development of alternative therapeutics for Col-R as well as carbapenem-resistant isolates is need of the time.

Several nanoparticles have been used as an alternative therapy against such superbugs including cuprous oxide (Cu₂O) [7]. Cu₂O has concerned a great deal of interest as it offers many advantages over other materials. It is non-toxic, low-cost material, easily available, and has high optical absorption coefficient. This makes Cu₂O suitable for various kind of applications [8, 9]. Including, used as a potential anti-bacterial and anti-fungal agent [7]. Therefore, we decided to evaluate zinc-doped Cu₂O in the nanoscale form for its Col-R antibacterial property.

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Synthesis, characterization and heat transfer study of reduced graphene oxide-Al₂O₃ nanocomposite based nanofluids: Investigation on thermal conductivity and rheology

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ABSTRACT

Investigation of thermophysical properties of reduced graphene oxide-Al₂O₃ (rGO-Al₂O₃) nanocomposite based nanofluid along with convective heat transfer study and associated pressure drop has been done in the present work. Formation of the rGO-Al₂O₃ nanocomposite was confirmed with the help of various characterization techniques like UV/Vis, XRD, FTIR, Raman spectroscopy, TEM, Elemental mapping and XPS analysis. Thermal conductivity at different temperatures of various volume % (0.01–0.1%) of the prepared rGO-Al₂O₃ nanofluid was measured by dispersing and ultrasonating the nanocomposite in deionized water. Thermal conductivity increased with increase in temperature as well as concentration of the rGO-Al₂O₃ nanofluid. These nanofluids exhibited non-Newtonian behavior as found from their rheological study. Different viscosity models also were employed to predict the viscosity at a range of applied shear rate (0–2000 s⁻¹). Convective heat transfer study at a wall condition of constant heat flux was done at different concentration and Reynolds number of the rGO-Al₂O₃ nanofluid. Maximum value of heat transfer coefficient of 5461.602 W/m²°C was achieved at the exit of test section by using 0.05 vol.% rGO-Al₂O₃ nanofluid flowing at Reynolds number of 7510.

1. Introduction

Since the discovery of Maxwell [1], that suspension of solid particles in liquids can help increase liquid thermal conductivity, many scientists have struggled in their experiments to augment the thermal transport properties of the several conventional fluids by incorporation of solid particles into it. It was later found by Das et al. [2] that the addition of large-sized particles in fluids present many inherent disadvantages like clogging, erosion, settling, high pumping power requirements etc. Due to all these reasons, Choi and Eastman [3] invented ‘nanofluids’ which are dispersions of solids that have size that is measured in nanometers into the base liquids. They found that these fluids containing nanometer-sized particles can overcome all the disadvantages possessed by the fluids containing micrometer-sized particles. Thus, nanofluids have recently gained much importance due to the outstanding thermal transport properties that they provide [4–10].

Al₂O₃ nanoparticles based nanofluids have been widely studied by many researchers for different applications, for example, as a car

radiator coolant [11,12], in electronics cooling [13,14], in solar thermal systems [15–17] and in other industrial cooling applications [18]. There also have been experimental as well as numerical investigations on Al₂O₃ (alumina) nanoparticles based nanofluid convective heat transfer. Heris et al. [19] experimentally investigated heat transfer provided by Al₂O₃/water nanofluid in circular tube at laminar conditions and found an increase in heat transfer coefficient in comparison with base fluid. Heyhat et al. [20] investigated Al₂O₃ nanofluid (water-based) and found a 32 % increment in heat transfer coefficient exhibited by a nanofluid at 2% concentration by volume. They also found a large pressure drop increment of about 5.7 times higher shown by 2 vol.% nanofluid concentration than that shown by water. Bianco et al. [21] performed a numerical investigation on turbulent convective heat transfer using Al₂O₃-based nanofluids flowing in circular tubes which can be utilized for thermal optimization of flow of nanofluids inside the tube at constant wall temperature conditions. Ghanbarpour et al. [22] found out that the rise in viscosity is much more than that in thermal conductivity for Al₂O₃ based nanofluids. Performance of Al₂O₃/water nanofluids in a

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Artificial neural network for prediction of thermal conductivity of rGO–metal oxide nanocomposite-based nanofluids

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Abstract

A four-input artificial neural network (ANN) model has been presented for the prediction of thermal conductivity of rGO–metal oxide nanocomposite-based nanofluids. For this, data of five types of water-based nanofluids containing rGO–metal oxide nanocomposites particles were used from the available literature. The four-input variables considered were molecular weight of nanocomposite, average particle size of nanocomposites, concentration, and temperature of nanofluid which exhibited thermal conductivity of the nanofluids as output. Using the same architecture, two ANN models were developed, one using a total of 185 data points and the other by dividing the data points in two sets (training and testing). The model agreed well with the experimental data and exhibited an R^2 value of 0.956 for the testing data set. Also, the magnitude of deviation of the predicted thermal conductivity for all the data points was very less with an average residual of ± 0.048 W/mK.

Keywords Artificial neural network · Nanofluid · Thermal conductivity · rGO–metal oxide nanocomposites

1 Introduction

Heat transfer, being a major factor in industrial as well as domestic processes, its intensification has always been paid high attention by researchers working in various fields. Generation and storage of heat energy involve great expense and so proper use without any wastage is always required. Numerous types of heat transfer intensification process developments have been reported through the years since the need of energy conservation is realized. A basic technique for enhancing the process of transfer of heat commonly involves increasing the surface area or modifying the flow channel geometry. Usage of fluids having high thermal conductivity values is also great alternatives to expensive surface modification techniques. Nanofluids, as developed by Choi and Eastman [1], find tremendous applications in heat transfer due to their enhanced thermal conductivity because of the presence of solid nanoparticles.

These fluids contain solid particles of sizes in the range of nanometers (0–100 nm). They were developed based on the fact that, solids have higher thermal conductivity than the liquids, helps in increase in the thermal conductivity of the liquids when dispersed in them [2]. Nanomaterials including metals and metal oxides were widely utilized for the preparation of nanofluids [3–5]. Individual thermal properties, sizes, shapes, preparation techniques are the some of the variables that determine the thermal conductivity of the prepared nanofluids [6]. In view of several attractive properties of nanofluids, they find application for heat transfer in automobile radiators [7, 8], industrial cooling towers [9], refrigeration systems [10], solar thermal systems [11, 12], etc.

With the technological advancement in the field of nanoscience, various types of nanomaterials with outstanding thermal properties have been developed by many researchers. Among them, graphene is found to be the superior-most having highest thermal conductivity measured approximately as 5000 W/mK [13]. Researchers all around the world made use of graphene and its derivatives for preparing nanofluids that have amazing thermal transport properties [14–16]. Graphene derivatives-based nanofluids have found immense applications in various

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Intensified Hydrodynamic Cavitation-Based Process for the Production of Liquid Emulsion Membrane (LEM) for the Extraction of Chromium(VI) Ions

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Abstract

The present work deals with the production of liquid emulsion membrane (LEM) accomplished by applying hydrodynamic cavitation-based process for the extraction of Chromium(VI) from wastewater. Aliquat 336 was used as the carrier during membrane transport. Diesel and Span 80 were used as diluent and emulsifier, respectively. NaOH (as a stripping agent in the internal phase) was used in emulsion preparation with the use of orifice (1 mm diameter)-based hydrodynamic cavitation process. Chromium(VI) removal from heavy metal-containing water was examined with the influence of LEM production time, amount of carrier, surfactant concentration, treat ratio (which is the ratio of feed phase to emulsion membrane phase) and type of diluent. The LEM synthesized using hydrodynamic cavitation process showed the possibility of complete removal of Chromium(VI) from the feed phase containing heavy metals, i.e. Chromium(VI). The optimal conditions were observed to be 2 min emulsification time, 1.00% carrier concentration, 3% surfactant concentration and treat ratio of 1:05. Therefore, the application of hydrodynamic cavitation for the production of LEM with excellent stability can be considered as a novel process for the extraction of Chromium(VI) from wastewater.

Article Highlights

- Efficient preparation of ELM with Aliquat 336 using hydrodynamic cavitation.
- 97.86% extraction of Cr(VI) in 10 min with prepared LEM by hydrodynamic cavitation.
- Intensified interfacial mass transfer area of LEM prepared by hydrodynamic cavitation.
- Intensified extraction of Chromium(VI) from the feed phase.

Keywords LEM · Hydrodynamic cavitation · Emulsification time · Chromium(VI) · Extraction

Introduction

Wastewater generated from numerous process industries like electroplating, leather tanning, textile, steel, and mining is found to contain heavy metals (Vetrimurugan et al. 2017). Release of these heavy metals in water bodies has adverse effects on the environment. Heavy metals are highly toxic to all living organisms and inhibit various biological processes occurring in the water (Sandrin and Maier 2003). Amongst the various heavy metals, chromium is predominantly found to be present in trivalent Cr(III) and hexavalent Cr(VI) oxidation states. Cr(VI) is proved to be more poisonous because of its strong oxidizing nature (Goyal et al.

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Kinetic modelling and process engineering aspects of biodesulfurization of liquid fuels: Review and analysis

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Biodesulfurization
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ABSTRACT

Biodesulfurization has been explored (as alternative to hydrodesulfurization) for deep desulfurization of liquid fuels. Previous lab-scale research has demonstrated efficacy of numerous microbial strains for desulfurization of heavy sulfur residues (basically benzothiophenes and their derivatives) in liquid fuels. This review has attempted to present an analysis of biodesulfurization literature from engineering perspective. Numerous kinetic models reported in literature are reviewed after grouping them in four categories on the basis of their approaches and features. Basic equations of these models and the biophysical insights provided by them are analyzed. The merits and limitations of these models from perspective of design of large-scale processes are identified. Process engineering issues of biodesulfurization with different reactor types and free/immobilized microbial cultures have been discussed for batch/continuous mode. Finally, an approximate analysis of sizing of the process for large-scale application is given with possible solutions in terms of improved biocatalyst and process intensification tools.

1. Introduction

Vehicular exhausts have been the largest contributors to the environmental pollution in recent years. In addition to particulate matter (free carbon) and greenhouse gas of CO₂, the two other major pollutants are sulfur and nitrogen oxides (SO_x and NO_x) gases. SO_x and NO_x emissions essentially arise due to the combustion of sulfur and nitrogen compounds present in petrol and diesel (Fang, 2004). As far as liquid transportation fuels, viz. petrol and diesel, are concerned, the predominant form of sulfur is thiophene. Dibenzothiophene and its alkylated derivatives are the most common organic sulfur compounds found in diesel fractions. Crude oil may contain sulfur in the range of 0.03 to 7.89% w/w (Gary et al., 2007). In view of enormous exhausts of SO_x and NO_x gases to the atmosphere, and their adverse effects on the ecology (such as acid rain) as well as on the human health, strict restrictions have been imposed worldwide on sulfur content of liquid fuels (Koch et al., 1996). Current EU legislation has prescribed sulfur levels in diesel to be ≤50 ppm, while Environmental Protection Agency (EPA) of the USA has restricted the maximum allowable sulfur content in diesel to be 15 ppm. In order to meet those stringent specifications of sulfur content in transportation fuels, new and effective technologies are being

developed.

Conventionally, the sulfur in crude oil is reduced by catalytic hydrodesulfurization. However, this technology is inefficient in achieving deep desulfurization (to the prescribed levels of ≤50 ppm), as the benzothiophenes, dibenzothiophenes, their alkyl substituted derivatives, and other abundant polyaromatic and heterocyclic sulfur compounds have very low reactivity towards the hydrodesulfurization. The alternative desulfurization processes for the deep desulfurization of liquid fuels are: (1) adsorptive desulfurization, (2) extractive desulfurization and (3) oxidative desulfurization. However, none of these processes have been commercialised. Adsorptive desulfurization has problem of sulfur selectivity. Moreover, effective separation and regeneration of solid adsorbent from the crude oil has operational issues. Coupling of solvent extraction with oxidative desulfurization is more effective technique of sulfur removal. In oxidative desulfurization, the divalent sulfur is oxidised to sulfones through electrophilic addition reaction of oxygen atoms with hexavalent and octavalent sulfur. The resulting sulfones can be easily extracted from the oil with common solvents such as methanol or DMF. Typically, peracids are used as an oxidant in the oxidative desulfurization process. Although the oxidative desulfurization process is relatively less energy intensive, high

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Photocatalytic Degradation of Sugar and Distillery Industry Effluent

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Abstract In the present study, photocatalytic degradation of recalcitrant pollutants present in the sugar and distillery industry was investigated using TiO_2 as photocatalysts. The efficiency of degradation was quantified by several parameters such as the effect of varying pH, initial concentration, catalyst loading, and UV light intensity. The degradation was measured in terms of COD reduction using Titrimetric, Mid-Level method for sugar, and distillery industry wastewater. It was observed that in comparison with UV/ TiO_2 system exhibited a higher rate of COD degradation. The degradation was found to follow pseudo-first-order kinetics. On optimization of various parameters, it was found that TiO_2 (Degussacp-225) could bring about COD reduction within 6 h for an initial concentration of 2000 ppm of the COD and a catalyst loading of 1 g/L. Increment in UV exposure intensity further enhanced the degradation rate.

Keywords Photocatalysis · Sugar and distillery industry effluent, TiO_2 · Kinetic analysis · UV light intensity

Introduction

Water contamination is a major issue faced by the various chemical industries nowadays. It is known that water contributes to approximately 65% of human body weight [1]. There are extremely limited resources of fresh water for human and industrial use. Thus, the recycling and conservation of water have great importance nowadays. Industrial effluent or wastewater, which may contain highly recalcitrant compounds, needs special treatment before it can be disposed or recycled in the system [2]. The changing environmental norms make the existing system ineffective in terms of the desired effluent quality and cost of the process. There are three methods of wastewater treatment that commercially used such as, Physical treatment method, Biological treatment method, and Chemical treatment method [3]. The sugar and distillery effluent are one of the major sources of water pollution. These effluents contain a huge quantity of biodegradable and non-biodegradable high organic matter such as COD, BOD_5 , and biopolymeric materials such as fatty acids, starch, cellulose. [4, 5]. The high amount of BOD (7000–15,000 mg/dm³) is mainly responsible for higher biodegradable organic matter present in effluent; however, the higher amount of COD (20,000–150,000 mg/dm³) is triggered by the presence of both biodegradable and non-biodegradable organic matter in sugar and distillery effluent [6]. The amount of COD and BOD of both effluent mainly depends on the type of raw material used in the process to produce ethanol. The various raw materials have been utilized for the production of ethanol and sugar such as, fruits, grain, sugarcane, and molasses [7]. Sugar and distillery effluent also comprises a significant quantity of contaminated organic load and several of which are intractable combinations unsafe to the ecosystem [8, 9].

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Adsorptive degradation of hexavalent chromium from aqueous solution using coconut shell as a green adsorbent

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Abstract

The present study aimed to remove the heavy metal compounds present in wastewater. In this study, we used hexavalent chromium Cr (VI) as a heavy metal compound, and coconut shell was used as a promising green bio-sorbent to remove Cr (VI) from wastewater. Coconut shells are readily available and are termed as waste materials. Various parameters such as contact time, pH of the solution, initial Cr (VI) concentration, and amount of coconut shell were studied. The adsorption data were fitted with various isotherm models. The Langmuir and Freundlich isotherm models were the best fit for the experimental data, and the maximum adsorption capacity was found to be 16.39 and 12.19 mg/g, respectively. Kinetic and thermodynamic studies were performed to assess the feasibility of the process. The pseudo-second-order kinetic model is also signified that the Cr (VI) adsorbent capacity was due to particle diffusion. To identify the morphological properties of the adsorbent various analysis such as Scanning Electron microscope (SEM) and BET surface area were performed. The experimental results and rate of adsorption, and the adsorption process was found to be feasible and endothermic in nature.

KEYWORDS

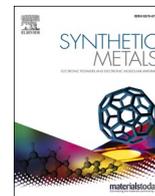
adsorption, adsorption isotherm, adsorption kinetics, coconut shell, hexavalent chromium, wastewater

1 | INTRODUCTION

The discharge of heavy metal ions from industrial effluent is the most challenging nowadays due to the unwanted bioaccumulation of these ions in humans and plants.¹ Industrial processes, like electroplating, wood protection, and leather tanning, etc. are significant contributors of chromium contaminants in the effluent, and which lead to harm to the environment.² Chromium is generally identified in two oxidation states in an aqueous medium, that is, Cr (III) and Cr (VI). Out of these, Cr (VI) is highly toxic, which hampers the environment and has been classified as a carcinogenic agent and mutagenic.^{3,4} However, trivalent chromium (Cr (III)) is necessary for humans life and is very low toxic in nature.⁵ Due to its carcinogenic nature, it causes skin irritation and further leads to lung cancer.

Hexavalent chromium can be identified in the form of HCrO_4^- , $\text{Cr}_2\text{O}_7^{2-}$, and CrO_4^{2-} based on the concentration and pH of the reaction mixture.⁶ As per the current Central Pollution Control Board (CPCB), India regulation, the maximum allowable limit of Cr (VI) concentration in the wastewater ranges from 0.01 to 5 ppm. It is necessary to remove or degrade Cr (VI) from wastewater using an efficient method to meet the CPCB regulation.

Various methods such as advanced oxidation processes (AOPs), enzymatic or microbial assisted,^{7,8} ion exchange,⁹ reverse osmosis,¹⁰ solvent extraction,¹¹ and chemical/physical adsorption processes are employed for the effective removal of Cr (VI). However, most of these methods have not been commercialized owing to their limitations and high operating costs. Biosorption process is one of the cost-effective method that has been emerged as an alternative method for the



Research Paper

Prototype symmetric configured MWCNTs/Fe₂O₃ based solid-state supercapacitor

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ARTICLE INFO

Keywords:

MWCNT/Fe₂O₃

PVA-LiCl gel electrolyte

Solid-state symmetric supercapacitor

ABSTRACT

Prototype solid-state symmetric supercapacitor (SSS) device has been designed by using two MWCNT/Fe₂O₃ electrodes assembled through polyvinyl alcohol-lithium chloride gel electrolyte as mediator onto flexible stainless steel substrate. Through electrochemical investigation as-fabricated device demonstrated 70.16 F g⁻¹ of specific capacitance with remarkable 9.74 W h kg⁻¹ specific energy and 487 W kg⁻¹ specific power at current density of 0.57 A g⁻¹. Assembled device delivers an outstanding volumetric energy of 24.36 mW h cm⁻³ compensating volumetric power of 1218 mW cm⁻³ at a current density of 1.42 mA cm⁻³. The cycle repeatability test of MWCNTs/Fe₂O₃ SSS device exhibited capacitance retention of 75% for 1500 cycles.

1. Introduction

Supercapacitor's research and development has boosted rapidly in diverse fields including portable electronics, transportation, military and aerospace by providing substantially advanced energy density compared to conventional capacitors [1]. Small, thin, lightweight and flexible solid-state devices maintain a high-quality performance with an inimitable set of features inclusive of higher power density, extravagant charge-discharge rate capability and remarkable cycle permanency under continuous mechanical deformation such as folding, bending and stretching [2]. Traditional liquid electrolyte based supercapacitor exhibit key shortcomings in practical application as encapsulation is the prime requirement against the embedded toxic electrolyte for technological application to prevent its leak [3]. In addition, inappropriate shape of traditional supercapacitors reveals several significant disadvantages for their employment in feasible applications. In particular, same electrode materials exhibiting the same specific capacitance in same electrolyte is used to fabricate symmetric supercapacitor which could simplify cell packing process. To design high-performance supercapacitors, porous carbon material with a variety of faradaic-active species, specific morphologies, compositions and structures have aroused scientific and technological interest [4–7].

Wide spread materials have been explored as electrode towards

solid-state symmetric supercapacitor devices, among which the hybrid electrode material consist of carbon nanotube coated metal oxide permit to perform the faradic and non-faradic mechanisms for charge storage [8,9]. Inclusion of higher valence states available with iron (0, 2+ and 3+), enriched redox chemical kinetics (Fe⁰/Fe²⁺, Fe⁰/Fe³⁺, Fe⁰/Fe³⁺, etc.), widen working potential in negative region, less poisonous and more eco-friendly nature as compared to other transition metal oxides, iron oxide and iron based oxides/hydroxides have been emerging as a promising material for supercapacitor applications[10].

Our earlier report emphasis the liquid-state configured supercapacitive electrode based on Fe₂O₃ material anchored onto high surface area MWCNTs thin film [11] and its electrochemical comparative investigation with individual MWCNTs and Fe₂O₃ electrodes. Liquid-state electrochemical supercapacitor suffers through evaporation of solvent, leakage problem due to imperfect sealing and reaction between used electrolytes with the substrate and hence, affects the long life period. Hence, state of art has been explored to design prototype complete solid-state supercapacitor in symmetric configured mode by using two MWCNTs/Fe₂O₃ electrodes sandwiching with the aid of polymer-conducting gel electrolyte as mediator where polymer can act as a dielectric and conducting electrolyte can act as a conducting matrix embedded between non-conducting dielectric matrix. Hence, supercapacitive performance has been explored for designed prototype

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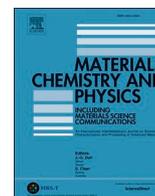
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Synthesis and characterization of europium doped zinc selenide thin films prepared by photo-assisted chemical bath technique for luminescence application

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HIGHLIGHTS

- ZnSe:*x*% Eu³⁺ (0 ≤ *x* ≤ 2.0) thin films were deposited on glass slide at 80 °C for 2 h.
- Photo-assisted chemical bath technique was used for the deposition.
- The films were annealed in air at temperatures at 250 °C for 3 h.
- The films were of single wurtzite structure with no impurity phases.
- Blue colour emission was observed with potential application in luminescent devices.

ARTICLE INFO

Keywords:

ZnSe:Eu³⁺

Photo-assisted chemical bath deposition

Thin films

Luminescence

ABSTRACT

ZnSe:*x*% Eu³⁺ (0 ≤ *x* ≤ 2.0) thin films were deposited using the photo-assisted chemical bath technique. All the films samples revealed wurtzite phase and the diffraction peak intensities decreased with increased Eu³⁺ concentration, due to loss of crystallinity. Raman spectroscopy revealed two optical phonon peaks due to first and second order longitudinal modes. The films morphological transformed from flakes to spherical grains with an increased Eu³⁺ concentration. The presence of the anticipated elements was confirmed by energy dispersive X-ray spectroscopy. Atomic force microscopy showed an increase in surface roughness with increased Eu³⁺ concentration, which however decreased at *x* = 2.0%. The ultraviolet–visible spectroscopy results showed increased band gap energy with an increase in Eu³⁺ concentration. There was a blue shift in the transmittance edge with respect to the undoped sample due to the decrease in crystallite size. The undoped sample showed four luminescence peaks, which are due to the band-to-band and defects within the host material. Although there was no evidence of emission from the Eu³⁺ ions, increasing the Eu³⁺ doping concentration resulted in enhancement of the emission peak intensities. Chromaticity analysis showed that the blue emission color is not significantly influenced by the Eu³⁺ concentration.

1. Introduction

Zinc selenide (ZnSe) is one of the mostly studied II-VI group

chalcogenide compounds due to its high optical transparency, wide emission spectrum, and chemical and thermal stability [1–3]. These properties have made ZnSe an excellent candidate in light emitting

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Investigations on optical properties of $\text{Eu}_{0.5}\text{Sm}_{0.5}(\text{TTA})_3\text{tppo}$ hybrid organic complexes molecularly doped in PMMA and PS matrices

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Abstract

An attempt has been made to synthesize orange-red light emitting rare earth doped polymer matrices $\text{Eu}_{0.5}\text{Sm}_{0.5}(\text{TTA})_3\text{tppo}$ (Eu = Europium, Sm = Samarium, TTA = ThenoylTrifluoroacetone, tppo = TriphenylPhosphine oxide) hybrid organic complex by solution technique. Blended thin films were made by molecularly doping the complex in Polymethylmetacrylate (PMMA) and Polystyrene (PS) polymers at different weight percentage (5%, 10%). These films were solvated in basic and acidic media so as to explore the effect of solvent on its luminescence properties. UV-Visible absorption spectra of these solvated films portrays two peaks corresponding to π to π^* and n to π^* optical transitions in the range of 240-275 nm and 370- 390 nm in basic medium. Energy band gap of these thin films in basic media was found between 3.16 eV to 3.20 eV whereas 3.12 eV to 3.22 eV in acidic media. Photoluminescence spectra of all the films in dichloromethane showed an intense peak at 614 nm, where as in formic acid, the same was found to be 475 nm, which falls in orange-red and blue region of visible spectrum, respectively. CIE coordinates of these solvated films in various solvents and at different weight percentage reveals tunable orange-

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Investigation of the effect of temperature on aggregation behaviour and thermodynamic properties of Ornithine monohydrochloride in aqueous and aqueous dextrose and urea solutions

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Compressibility

ABSTRACT

In this communication for the first time, we report the density (ρ) and speed of sound (u) of aqueous solution of Ornithine monohydrochloride (Ornithine-HCl) and Ornithine monohydrochloride (Ornithine-HCl) in aqueous 0.06 mol·kg⁻¹ urea and aqueous 0.06 mol·kg⁻¹ dextrose at $T = (288.15, 293.15, 298.15, 303.15, 308.15, 313.15 \text{ and } 318.15) \text{ K}$ within the concentration range of (0.02 to 0.2) mol·kg⁻¹. From the experimental data of density (ρ) and speed of sound (u) the various derived parameters such as apparent molar volume of solute (V_ϕ), limiting apparent molar volume of solute (V_ϕ^0), limiting apparent molar volume of transfer ($\Delta_{tr}V_\phi^0$), limiting apparent molar expansivity (E_ϕ^0), thermal expansion coefficient (α^*), second derivative of limiting apparent molar volume ($\partial^2 V_\phi^0 / \partial T^2$), isentropic compressibility κ_s , apparent molar compression ($K_{S,\phi}$), limiting apparent molar compression of solute ($K_{S,\phi}^0$), apparent molar isentropic compression of transfer ($\Delta_{tr}K_{S,\phi}^0$) and hydration number (n_H) have been calculated.

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1. Introduction

Ornithine monohydrochloride is a salt of ornithine. Ornithine is not an amino acid coded by DNA. However, in urea cycle ornithine is produced along with arginine. L-ornithine has an antifatigue effect in increasing the efficiency of energy consumption and promoting the excretion of ammonia [1]. To treat cirrhosis, a stable salt of ornithine (L-Ornithine L-aspartate LOLA) and aspartic acid are used. The interactions of amino acids with aqueous solution of urea play a very important role in understanding the thermodynamic behavior of biochemical processes in the living cell. Urea is used to control the amino acid concentration and detoxification. Urea is produced in the liver and is a metabolite (breakdown product) of amino acids [2–4].

Similarly, simple saccharides have received considerable attention for their ability to protect biological macromolecule [5]. The solute–solvent interactions have large effect on the structure and properties of carbohydrates which are very important for some

physiological process. The studies on carbohydrate–protein interactions are very important in the field of immunology, biosynthesis, pharmacology and medicine [6–10]. Dextrose is one of the simplest carbohydrates and a major component of intracellular fluid. Designing drugs which can bind to carbohydrates may block the ability of bacteria and viruses to invade host cell [11,12]. Thus, it is interesting to study the volumetric and acoustic properties of Ornithine-HCl in aqueous glucose and urea solution. Moreover, dextrose behaves as structure maker in aqueous systems and urea solutions behaves as structure breaker in aqueous system, therefore, it was interesting to investigate the interaction of ornithine monohydrochloride in both the types of co-solutes. As evident, the physicochemical properties play a pivotal role in interpreting the intermolecular interactions in the mixed components. In order to gain insight into such interactions volumetric and acoustic study of Ornithine-HCl in aqueous solution of dextrose and urea was carried out.

In this communication, we report the results for density (ρ) and speed of sound (u) of aqueous solution of Ornithine-HCl and Ornithine-HCl in aqueous 0.06 mol·kg⁻¹ urea and in aqueous 0.06 mol·kg⁻¹ dextrose at $T = (288.15, 293.15, 298.15, 303.15,$

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A review on solid base heterogeneous catalysts: preparation, characterization and applications

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ABSTRACT

The development of suitable catalysts that have high activity, abundant efficiency, and easy recovery as well as lesser ecological contamination suitable for various industrial processes is the rising area concerning green chemical processes. In recent times, solid heterogeneous catalysts with several industrial applications have attracted widespread attention because of characteristics like simple synthesis processes, even pore size distribution, large specific surface area, and high alkalinity. Solid base catalysts include metal oxides, zeolites, supported alkali metal compounds, clay minerals, waste solid base catalysts, mesoporous solid base catalysts, etc. They can be synthesized by using precipitation, co-precipitation, sol-gel, hydrothermal, impregnation, vapor phase deposition, and sonochemical methods which are thoroughly discussed in this paper. There has been tremendous development in characterization techniques for the solid base catalysts such as Fourier transform infrared spectroscopy, X-ray diffraction, X-ray photoelectron spectroscopy, scanning electron microscopy, transmission electron microscopy, Energy dispersive spectroscopy, Brunauer-Emmett-Teller technique, Barrett-Joyner-Halenda method, etc. which are briefly explored. Various industrial processes catalyzed by solid base catalysts dehydration, condensation, isomerization, alkylation, polymerization, hydrogenation, esterification, and amination are also discussed in this paper.

KEYWORDS

Solid base catalysts; industrial processes; characterization technique; heterogeneous catalysts; isomerization; esterification

Introduction

Catalyst can be defined as a chemical compound that accelerates or decelerates the reaction rate and remains unchanged at the end of reaction. It alters the activation energy of the chemical reaction without affecting thermodynamic equilibrium. The catalyst can be used only for those reactions that are thermodynamically feasible, i.e., reactions with negative Gibbs free energy change at reactions conditions. In multiple reactions, catalyst can be selectively chosen to affect, rather augment the rate of desirable reaction. These concepts are applicable for any type of catalytic reaction, whether it is a homogenous, heterogeneous or an enzymatic reaction.

A catalyst helps increase the rate of completion of chemical equilibrium even if it is present in small quantities without undergoing chemical

transformation itself. It stimulates various chemical reactions. Catalysts used in different processes can be classified into two types, namely solid acid catalyst or solid base catalyst. Acid base interactions among reactants and catalysts initiate the chemical reactions. The catalyst acts as an acid and base toward the reactants in acid and base catalyzed reactions simultaneously. Many materials, if properly pretreated, are accepted as solid base catalysts. Presence of CO₂, O₂, water, etc., on the surfaces of basic materials weakened the activity of the catalyst. This is because catalysts were pretreated generally at low temperatures. For solid base catalysts, it is extremely essential to pre-treat the catalysts at elevated temperatures which result in removal of CO₂, O₂, water, etc. from the surfaces so as to flaunt basic properties and stimulate base

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[Luminescence / Early View](#)

SPECIAL ISSUE ARTICLE

Investigations on optical properties of $\text{Eu}_{0.5}\text{Sm}_{0.5}(\text{TTA})_3\text{tppo}$ hybrid organic complexes molecularly doped in PMMA and PS matrices

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Abstract

An attempt has been made to synthesize orange-red light-emitting rare earth-doped polymer matrices $\text{Eu}_{0.5}\text{Sm}_{0.5}(\text{TTA})_3\text{tppo}$ (Eu = europium, Sm = samarium, TTA = thenoyltrifluoroacetone, tppo = triphenylphosphine oxide) hybrid organic complex by solution technique. Blended thin films were made by molecularly doping the complex in polymethylmethacrylate (PMMA) and polystyrene (PS) polymers at different weight percentages (5%, 10%). These films were solvated in basic and acidic media to explore the effect of solvent on its luminescence properties. UV-visible absorption spectra of these solvated films portray two peaks corresponding to $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$ optical transitions in the range 240–275 nm and 370–390 nm in basic medium. Energy band gap of these thin films in basic medium was found between 3.16 eV to 3.20 eV and 3.12 eV to 3.22 eV in acidic medium. Photoluminescence spectra of all films in dichloromethane showed an intense peak at 614 nm, whereas in formic acid, the same were found at 475 nm, which fell in the orange-red and blue region of the visible spectrum, respectively. CIE coordinates of these solvated films in various solvents and at different weight percentages revealed tunable orange-red to blue light emission with change in polarity of the solvent. Therefore the synthesized complexes blended in the polymers can be shaped into flexible films for fabrication of organic light-emitting diodes (OLEDs) with consistent results, proving their prospect as colour tunable light emissive materials for OLED devices, lasers, displays, and solid-state lighting.

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Original research article

Kinetics of ferroelectric domains investigated by etching technique in Al-doped KNbO₃ single crystal

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ARTICLE INFO

Keywords:

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ABSTRACT

A single crystal sample of Al-doped Potassium Niobate (KNbO₃) [KN] was produced using a high-temperature flux technique. The fully grown sample of Al-doped Potassium Niobate (Al: KNbO₃) crystals were subjected to domain studies. The cleavage face of ferroelectric Al-doped potassium niobate (KN) crystals has been with chemically etching by methanol (CH₃OH) and Nitric acid (HNO₃). The domain structure of single crystal KN within the orthorhombic ferroelectric section at temperature is investigated by Trinocular microscopes. 60, 90°, and 180° ferroelectric domains show constant interaction and orientation on the grown surface of the crystal. The most aim of this study to investigate the orientation, formations, and motion of the domains after the etching.

1. Introduction

Ferroelectric materials are the major and hefty classifications of electronic materials due to their properties of spontaneous polarization in response to the external electric field. The potassium niobate KNbO₃ [KN] single crystals have gained significant attention due to their ferroelectric characteristics and other suitable applications in non-linear optics, phase hologram storage, piezoelectric instruments, and many more [1]. The KN is the only ferroelectric material that undergoes a similar order of phase transitions as the well-studied BaTiO₃, though the transitions in KN are moved to higher temperatures and show more marked structures of first-order transitions than those in BaTiO₃ [2]. Ferroelectrics materials were the perovskite-type structure, KN, which is expected to exhibit semiconductive properties and its physical characteristics could be influenced by doping [3,4].

Hooton and Merz [5] were initially initiate the etching technique for the nucleation of a site in BaTiO₃. They found that BaTiO₃ single crystals show a dissimilar pattern with relevancy the polar axis, the positive finish of the electrical polarization etches abundant quicker than the negative one. A valuable new tool for the investigation of ferroelectric domains so became on the market. A good range of later investigations in BaTiO₃, TGS, Rochelle salt, etc. are found to possess utilized a technique to check the pure mathematics of domain arrangement in these crystals. Miller and Savage additionally used the technique in conjunction with electrical fields and ascertained the motion of domain walls [6,7]. When the crystal surface is inscribed with the associate in an etchant, then it's going to reveal new domain formations, impurity dipoles, and sites of dislocations. Generally, etch pits are situated at the sites of impurity dipoles. Additionally, because the serial etching is distributed, data would be on the domains on, however, the dislocations, besides as domain walls, exist within the bulk crystal. The chemical etching was adopted in the present work to study the kinematics of domain walls in the crystal surface.

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Fertilizing Potential of Urine in Agriculture

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Abstract This paper aims to devise an alternative low-cost optimized solution of using urine as a fertilizer. Urine bio-waste from humans and livestock has unrealized potential and can increase the yield of crops if used correctly. For *Triticum aestivum* (Common wheat), 30% of urine can be potent in promoting growth. A comparative assessment was conducted to validate the applicability of the proposed method. Several plant growth parameters like chlorophyll content, average leaf length, and percentage germination were evaluated to reach the optimized urine dosage for enhanced plant growth. The study also provides a schematic model for an economically feasible waste collection system that can treat the urine and produce easy-to-use fertilizer using the proposed method.

Keywords NPK · Waste collection · Fertilizer · Urine

Introduction

Rising food demand is the result of the growing world population and chemical fertilizers are essential to meet this demand. The major nutrients available in the fertilizer market consist of nitrogen (N), phosphorus (P), and potassium (K). Human defecation in the agriculture sector is being utilized since time immemorial. The upbringing of chemical fertilizers in the sector has neglected the scope of usage of natural waste, in the hope of higher crop yield.

Pollution in water bodies near crop fields is making the soil unfit for agriculture due to an increase in alkalinity over a period, which takes place due to the careless use of such highly soluble fertilizers [1, 2]. However, the chemical fertilizers are not readily available in remote villages and are neither economical. The soil conditions and yield are deeply affected by the use of chemical fertilizers. For healthy plant growth, large amounts of nitrogen and phosphorous are necessary. The chemical composition of the chemical fertilizers is the same as that produced by the body. The plants need ammonia and nitrogen released by the urea in soil for proper growth.

The problem of communicable diseases is created in unhygienic situations due to the social stigma and the practice of open defecation in India [3]. The issues related to proper drainage and treatment of human waste are prominent in remote places. Urine is considered to be beneficial as it contains major nutrients for plant growth similar to chemical fertilizers [4, 5]. Urine contains N in the form of soluble urea. Its effectiveness in plant growth has been studied extensively [6–8]. If fertilization by urine is carried out correctly, with respect to its amount, urine nitrogen has the same agricultural values as commercially produced mineral fertilizers [9]. It has been observed for some plant species like Barley that the intake of phosphorus from urine was much better than that from mineral fertilizers [9]. The major component in domestic wastewater is urine and treating it by suitable chemicals can prove to be an attractive and sustainable approach. In a study, it was found that urine contains a greater part of the total nutrients found in sewage [6]. 1.5% volume of the sewage had 60% K, 55% P and 80% N. Countries like Nigeria, Germany, Sweden, Switzerland, and South Africa has studied the use of urine in agriculture and has stated that the fertilizing power of urine is comparable to chemical

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Impact of COVID-19 : A mathematical model

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Abstract

In the present scenario, the whole world struggling with COVID-19 which affects highly transmittable and pathogenic viral infection that rose by a newly discovered coronavirus and believed to be originated in China. The more serious effects of the virus occur for the people who are under medical problems as diabetes, chronic respiratory diseases, cancer, and cardiovascular diseases also in older persons. Because of the unavailability of proper vaccine, medical facility and medical experts the current situation becomes worst and uncontrollable for many countries. Hence, in order to overcome and reduce the spread of infection there is a necessity to prepare the predictive mathematical model due to prevention factor and suitability conditions. Enlightened by the coronavirus, the present study deals

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Nucleation and evaporation of new domains under the influence of successive electric field in Al-doped KNbO₃ single crystal

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ABSTRACT

Photographic proof of domain wall nucleation was originated on the surface of Al-doped KNbO₃ single crystal. For the photographic proof, experiment were performed using a trinocular microscopy technique. Nucleation and evaporation of 60° and 90° domain were conducted under the applied electric field at room temperature which is consistent to the elastic theory of dislocation. An attempt was made by the dislocation model to clarify that the nucleation and evaporation of the domain walls was dependent on impurity dipoles. The appearance of nucleation and evaporation of domains under the influence of electric fields was interestingly studied in domain engineering.

1 Introduction

Ferroelectric material is a vigorous electronic material in optical and electronic industries [1]. Potassium niobate (KNbO₃) crystal received considerable attention for its several applications as a ferroelectric and photorefractive material, from educational and commercial viewpoints [2]. KNbO₃ (KN) is a well-known perovskite oxide with the structural formula ABO₃ (A: Alkaline earth element B: transition metal element) where Nb resides in the octahedron surrounded by 6 O atoms [3]. These perovskite ABO₃ were studied and found to have excellent electrochemical and thermoelectric properties in different metal oxides [4, 5]. A phase transition of ferroelectric material is the main phenomena behind KN single crystal. The performance of KN ferroelectric phase

transition is very much similar to BaTiO₃ [6]. Earlier studies have shown that the photorefractive properties can be improved by doping Al to KN single crystal [7].

Several studies were performed to analyse the composition, nucleation and sideways motion of domains, domain imperfection interactions and impurity dipole interactions [8]. These studies were based on Potnis et al.'s admirable analysis of the production of ferroelectric domain and domain microscopic methods [9]. At present, various advanced methods such as AFM, SEM, TEM, XRD and SHGM are practiced. A substantial research on domain morphology was made available through the use of a simple metallurgical reflective microscope and probably by domain wall nucleation tools [10, 11].

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FRACTIONAL HEAT CONDUCTION IN A RECTANGULAR PLATE WITH BENDING MOMENTS

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Abstract. In this research work, we consider a thin, simply supported rectangular plate defined as $0 \leq x \leq a$, $0 \leq y \leq b$, $0 \leq z \leq c$ and determine the thermal stresses by using a thermal bending moment with the help of a time dependent fractional derivative. The constant temperature is prescribed on the surface $y = 0$ and other surfaces are maintained at zero temperature. A powerful technique of integral transform is used to find the analytical solution of initial-boundary value problem of a thin rectangular plate. The numerical result of temperature distribution, thermal deflection and thermal stress component are computed and represented graphically for a copper plate.

MSC 2010: 33E12, 44A99, 35R11, 26A33

Keywords: Mittag-Leffler function, integral transform, fractional partial differential equation, fractional derivatives and integrals

1. Introduction

Thermal stress analysis of a rectangular plate and its thermal stress intensity factor for a compressive stress field have been discussed by Tanigawa and Komatsubara [1]. Gogulwar and Deshmukh [2] studied thermal stresses in a rectangular plate due to partially distributed heat supply. Kulkarni and Deshmukh [3] deals with the realistic problem of the quasi-static thermal stresses in a rectangular plate subjected to constant heat supply on the extreme edges ($x = a, y = b$), whereas the initial edges ($x = 0, y = 0$) are thermally insulated. Deshmukh et al. [4] discussed thermal stresses in a simply supported plate with thermal bending moments with a heat source.

Fractional-order differential equations have been the forefront of research due to their applications in many real-life problems of fluid mechanics, viscoelasticity, biology, physics, and engineering. It is a well-known fact that the integer-order differential operator is a local operator but the fractional-order differential operator is non-local. Therefore, the next state of a system depends not only upon its current



Investigation on preparation of graphene oxide-CuO nanocomposite based nanofluids with the aid of ultrasound assisted method for intensified heat transfer properties

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HIGHLIGHTS

- Sonochemical method for preparation of finely dispersed GO-CuO nanocomposite.
- Enhanced $k_{nanofluid}$ and $h_{nanofluid}$ with uniform dispersed CuO on GO nanosheets.
- GO-CuO nanocomposite based nanofluid show non-Newtonian rheological behaviour.
- New correlations for thermal conductivity, viscosity and Nu for GO-CuO nanofluid.

ARTICLE INFO

Keywords:

GO-CuO nanocomposite based nanofluid
Ultrasound
Thermal conductivity
Nusselt number
Friction factor

ABSTRACT

Investigation on the ultrasonic-assisted synthesis of graphene oxide-CuO (GO-CuO) nanocomposite and its nanofluid was accomplished in this work for intensified heat transfer properties. The successful formation of the GO-CuO nanocomposite has been confirmed with UV/vis spectroscopic analysis, x-ray diffraction (XRD), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR) and energy dispersive X-ray spectroscopy (EDX) analysis. The thermal properties like thermal conductivity of the prepared GO-CuO nanocomposite based nanofluids were measured and found to be increasing with the concentration and temperature. For the case of 0.03 vol% nanofluid, it was observed to be 1.046 W/mK at 33 °C. The method of ultrasound assisted was proved to be beneficial in enhancing the thermal properties of the GO-CuO nanocomposite and then the prepared nanofluids. Rheological studies of the GO-CuO nanocomposite based nanofluid proved their non-Newtonian behavior. Further, investigation on the convective heat transfer was accomplished using the GO-CuO nanocomposite based nanofluid. Heat transfer coefficient was found to be 1474.99 W/m²K at the exit of the flow channel for 0.03 vol% GO-CuO nanocomposite based nanofluid at Reynolds number of 940. Finally, various correlations for thermal conductivity, viscosity and Nusselt number for GO-CuO nanocomposite based nanofluid have been proposed in this work.

1. Introduction

Nanofluids, as discovered in the Argonne National Laboratory by Choi [1] have recently caught attention of the researchers striving to find out energy efficient systems. Nanofluids are pseudo-homogeneous suspensions containing nanometer-sized particles suspended in conventional liquids called the basefluids. It has come into existence as a result of higher thermal conductivity possessed by the solids that help in increasing thermal properties of liquids when dispersed in it as found

out by Maxwell [2]. The augmented thermal conductivity values of these nanofluids make them applicable as an alternative to fluids like water, ethylene glycol etc. which are the common conventional heat transfer fluids. There have been many findings on how heat transfer in any equipment can be enhanced by use of different techniques like vibration, extended surfaces, using electrical fields etc. [3]. The use of nanofluids instead of conventional fluids which are being used for the heat transfer applications has proven to be one of the efficient heat transfer methods.

There are various applications of nanofluids which are still being

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Diffusion Kinetics of Vitamin B₁₂ from Alginate and Poly(vinyl acetate) Based Gel Scaffolds for Targeted Drug Delivery

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ABSTRACT

The research described here probed the thermodynamics and kinetics of Vitamin B₁₂ release from two types of polymeric gel scaffolds for targeted drug delivery applications. The polymeric gel scaffolds were successfully prepared from sodium alginate and polyvinyl acetate (PVA) using crosslinking and casting mechanisms, respectively. Vitamin B₁₂ was effectively blended into the polymeric gel scaffolds during their synthesis processes. The release of Vitamin B₁₂ from the polymeric gel scaffolds was characterized by immersing the scaffolds in a brine solution at various temperatures (25 °C, 32 °C and 37 °C) and, simultaneously, the transient concentrations were measured using a UV visible spectrophotometer. The sodium alginate gel scaffolds exhibited a more rapid release of Vitamin B₁₂ as compared to the PVA gel scaffolds. The Vitamin B₁₂ release kinetics from the alginate and PVA scaffolds were characterized by fitting the experimental data with various diffusion kinetic models. The Vitamin B₁₂ release from the alginate gel scaffolds followed the Peppas-Sahlin model, whereas releases from the PVA gel scaffolds were fitted to the Hopfenberg model. The diffusion coefficients for the alginate scaffolds with respect to the three temperatures were found to be 15.72 m²/s, 17.17 m²/s and 18.58 m²/s respectively whereas the diffusion coefficients for the PVA scaffolds with respect to the three temperatures were found to be 0.23 m²/s, 0.29 m²/s and 0.32 m²/s respectively. The activation energies (E_a) for the two types of polymeric scaffolds were calculated using the Stannett equation and found to be 10.38 kJ.mol⁻¹ and 20.47 kJ.mol⁻¹ for the alginate and PVA scaffolds, respectively, for all three temperatures.

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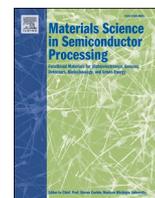
alginate; kinetic release profile; PVA; scaffold; Vitamin B₁₂

Introduction

Gel scaffolds are used extensively now-a-days to provide controlled drug administration into the human body. The effectiveness of drug release from the gel scaffold and its dissolution in the body is of great concern.^[1,2] The use of natural and synthetic biopolymers for the fabrication of gel scaffolds is well known, where the biocompatibility and the biodegradability are important requirements.^[3] Natural and synthetic biopolymers have been used to fabricate hydrogel films that can hold a significant volume of drug

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Phase transformation on zinc selenide thin films deposited by photo-assisted chemical bath method: The effect of annealing temperature

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ABSTRACT

Zinc selenide (ZnSe) thin films have been deposited on glass substrates via photo-assisted chemical bath deposition technique. The films were annealed at different temperatures 100, 150, 200, 250, 300, 350 and 400 °C in air for 2 h and were characterized using different techniques. The glancing incidence X-ray diffraction (GIXRD) showed that the as-deposited sample and films annealed from 100 to 200 °C contained secondary peaks due to combine effects of ZnSe and unreacted Zn and Se. The films annealed at 250 and 300 °C showed pure hexagonal ZnSe phase while those annealed at 350 and 400 °C changed to hexagonal ZnO. The estimated crystallite sizes were found to decrease in size with increased annealing temperature. The change in phase was also observed in Raman spectroscopy, scanning electron microscopy and UV-visible spectroscopy. Atomic force micrographs showed decrease in surface roughness with an increase in the annealing temperature. Energy band gap increased with annealing temperature. Three emission bands due to band-edge and defect levels were observed in the photoluminescence spectroscopy. The lifetime decay did not show any ordered dependence on the annealing temperature. The sample annealed at 250 °C was considered because its parameters such as the diffraction angle, lattice constants and energy band gap were closest to the bulk ZnSe. The Commission Internationale de L'Eclairage showed blue emission color with color purity between 56 and 97%. The films especially 250 °C sample was recommended for lighting applications.

1. Introduction

Zinc selenide (ZnSe) is a binary semiconductor material of the II – VI family [1]. There are many interesting properties of ZnSe that have attracted the attention of researchers over the years. It is chemically inert, non-hygroscopic, theoretically dense, high transmittance to infrared, has a high resistance to thermal shock and is stable in virtually all environments [2,3]. These properties make ZnSe a material of choice for use in solid state lighting such as light emitting diodes and also in optoelectronic devices such as lenses, windows, output couplers and beam expanders in biomedical and industrial applications [4]. The wide band gap (2.7 eV at room temperature) [5] and large exciton binding energy (21 meV) [4,6] have boosted the application of this binary semiconductor as a replacement for cadmium sulfide (CdS) as a buffer

layer material in copper indium gallium selenide (CIGS) based solar cell because it offers a better lattice matching with the CIGS absorber layer than the CdS [7]. The structural, morphological and optical characteristics of ZnSe have been known to be influenced by many factors such as synthesis temperature [8–12], synthesis methods [13], solution pH [14], precursors concentration [14,15], solvents [16] and annealing temperature (AT) [17]. There are however limited reports on the effects of AT on the characteristics of ZnSe thin films. Kumaresan et al. [18] used zinc sulfate, sodium selenite and selenous acid to deposit cubic phase structure ZnSe thin films on indium tin oxide doped substrate via photochemical deposition. The samples were annealed at 300 and 400 °C and showed that the AT changed the as-deposited (room temperature (RT)) amorphous samples to polycrystalline films. Ashraf et al. [19] investigated the effect of AT on thermal evaporation deposited ZnSe thin

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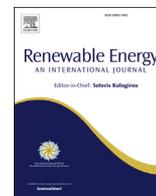
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Performance analysis of gas diffusion electrode with varying platinum loading under different oxidant condition

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ABSTRACT

In the last decades, fuel cells are exceptionally capable and environmentally responsive energy exchange devices and have received great attention for the energy investigation. The components of fuel cells and its fabrication techniques essentially affect the performance of fuel cell. The gas diffusion electrode (GDE) is considered to be one of the key components of PEMFC. In the present work, hot pressing technique has been used for the fabrication of GDEs and were studied in detail. The catalyst loadings of 0.25, 0.5 and 2 mgPt/cm² with different charging of carbon were layered on the surface of GDL opposite the membrane and its performance are correlated by using two different oxidants i.e. air and oxygen. The fuel cell performances have been compared by using performance curve at different cell stack temperature. The optimum catalyst loading for highest current density and power density was found to be 0.25 mgPt/cm² on anode side and 0.5 mgPt/cm² on cathode side. Surface quality of these GDLs have been investigated with the help of scanning electron microscopic (SEM) analysis by performing top surface and cross-sectional scan and confirms the effectiveness of hot-pressing method for better quality catalyst.

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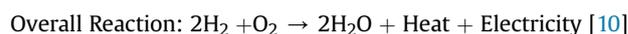
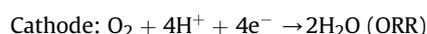
1. Introduction

In the recent years' researchers have paid more attention towards PEMFC as a replacement for the traditional internal combustion engines [1] PEMFC is considered to be alternative solution for resolving the problems which are related to the worldwide energy reserves and environmental issues arising out of usage of petroleum in conveyance system and electrical energy production [2,3]. PEMFCs are remarkably a better choice in establishing environment friendly and economical due to their advantages in the utilization of energy supply in transport as well as stationary and mobile application. Further membrane electrode assembly is the important element of the PEMFC [4]. Therefore, it is essential to explore the various attempts for the improvements of fuel cell components [5]. In general, PEM fuel cell stack consists of two end plates which compresses nine-layer in the assembly. This nine layers' assembly consists of two gold plated copper current collector plates, followed by two monopolar plates made up of graphite material grooved with particular flow pattern onto it.

These end plates and monopolar plate compresses five-layer membrane electrode assembly (MEA). MEA of PEM consist proton conducting polymer like Nafion which is catalyst layers (supported/unsupported platinum) and gas diffusion layers (GDL) usually made up of carbon paper [6–8].

Basic functioning of PEMFC is hydrogen gas enters at anode and air/oxygen enters at cathode. At anode due to proton exchange membrane only protons enter into the membrane from hydrogen side of the cell. Electrons moves in the outside path, producing current from the cell. On cathode sideway of the cell, these hydrogen protons and electrons reacts with oxygen to create water, which is discarded as waste; oxygen supplied in pure form or separated in the end specifically from air [9].

The electrochemical reaction is as follows



Various work reported utilizes Pt supported on carbon photo-catalyst in MEA assembly [7,11]. Further, MEA is a heart of fuel cell.

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Investigation on the thermal conductivity and convective heat transfer enhancement in helical coiled heat exchanger using ultrasonically prepared rGO–TiO₂ nanocomposite-based nanofluids

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ABSTRACT

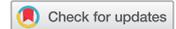
This work deals with sonochemical synthesis of finely dispersed reduced graphene oxide–TiO₂ (rGO/TiO₂) nanocomposites with successful immobilisation of TiO₂ nanoparticles on rGO. Structural and morphological analysis of prepared rGO/TiO₂ nanocomposite was done with the use of UV/VIS, TEM, XRD and FTIR analysis that confirms the formation of finely dispersed rGO/TiO₂ nanocomposite. A helical coiled heat exchanger was used for examining convective heat transfer enhancement exhibited by the prepared rGO/TiO₂ nanocomposite-based nanofluid. Thermal conductivity enhancement of rGO/TiO₂ nanocomposite-based nanofluids with the nanocomposite loading of 0.1–0.5 volume % in water was investigated. An investigation on improvement in the heat transfer coefficient was carried out at different loading of rGO/TiO₂ nanocomposite in base fluid at various Reynolds number values. Percentage enhancement in the heat transfer coefficient was around 35.7% for 0.25 volume % concentration of rGO/TiO₂ nanocomposite in base fluid.

KEYWORDS

rGO/TiO₂ nanocomposite-based nanofluids; ultrasound; helical coiled heat exchanger; thermal conductivity; heat transfer coefficient

Nomenclature

A_x	Inside surface area of copper coil at x
C_{pnf}	Heat Capacity of rGO/TiO ₂ nanocomposite-based nanofluid
D	Inner diameter of helical coil tube
D_c	Helix diameter
h_{avg}	Average heat transfer coefficient
$hi(coil)$	Heat transfer coefficient estimated with helical coil
$hi(straight)$	Heat transfer coefficient estimated in straight tube
k	Thermal conductivity of the nanofluid
m	Mass flow rate of nanofluid (kg/s)
$q_s(x)$	Heat flux
$T_b(x)$	Fluid bulk temperature at a distance “ x ” from the inlet
$T_c(x)$	Copper tube wall temperature at a distance x from the inlet
T_{bi}	Inlet temperature of bulk fluid
T_{bo}	outlet temperature bulk fluid



Effect of methyl alcohol and nitric acid as an etchant on the motions of ferroelectric domains in Al-doped KNbO₃ single crystal

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ABSTRACT

The domain structure of the single crystal KNbO₃ (KN) in the orthorhombic ferroelectrics phase at room temperature is investigated using optical and trinocular microscope. The cleavage face of ferroelectric Al-doped KN crystals was chemically etched using CH₃OH (Methanol). At room temperature and before etching, the 60°, 90° domains were observed on the crystal surface. A dislocation model is proposed to explain the nucleation and evaporation of the domain wall under the influence of the electric field, which can be used to study the changes in motion of ferroelectric domains. After etching with HNO₃ (Nitric acid) and applying an electric field, the 180° domains were observed.

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Trinocular microscopy;
single crystal; domain
structure

1. Introduction

Ferroelectric materials were used in the form of thin film, single crystal and bulk ceramic for various applications [1]. In the last two decades, lead-free ferroelectric have come to dominant due to environmental protection concerns [2]. KNbO₃ (KN) is a material with a wide variety of ferroelectric properties and applications such as miniature capacitors, ferroelectric RAM, electro-optical applications [3,4], etc. Ferroelectric potassium niobate KN is a typical representative of the perovskite crystal family with the general formula ABO₃ [5]. Potassium niobate has an orthorhombic symmetry at room temperature and undergoes phase transitions at -10°C, 225°C and 425°C from rhombohedral-, orthorhombic- and tetragonal-cubic, respectively. The lattice parameters of KNbO₃ (Potassium niobate) single crystals are $a = 5.695 \text{ \AA}$, $b = 3.973 \text{ \AA}$ and $c = 5.721 \text{ \AA}$ [6,7]. It is well known that domain structure is very common in ferroelectric crystals, such as KN, due to the local variation of an electric field when cooling from the melting temperature in the growth process [8]. Mishra and Ingle showed that impurities play a significant role in domain formation in KN single crystal. In the mechanism of domain-wall nucleation, impurities play an important role to nucleate the microdomain around the crystal. The mechanism is operative both at the Curie transition and when switching under externally applied dc electric field [9].

The properties of crystals are strongly affected by the technique of crystal growth as well as by adding external impurities, i.e. dopants. Doping may cause the colouration of crystals during the generation of both point defects and changes in dielectric properties [10]. An aluminium doped KN (Al: KN) single crystal was grown using the flux method. Because the doping of Al³⁺ ions in the crystal nucleation occurred under the influence of the doping ions, the domain walls in the Al-doped KN crystal in most cases are easier to move and grow than in the undoped KN crystals [11]. Since the nucleation process also depends on strain and defects, the domain pattern does not always correspond to the absolute

minimum free energy and is only metastable. It is also possible that domains have stabilisation effects. Therefore, it is difficult to completely eliminate these domains during the growing process. The complicated domain structure is unique to ferroelectric crystals such as Al: KN and other similar crystals allows these crystals to have excellent photorefractive properties. Study of domain structure is very important not only for eliminating these properties but also for the implication of possible future applications [12].

The etching study provides core understanding of the surface at a microscopic level. It aids in exploring the quality of the surface and the 0-D point defects, 1-D line defects, 2-D planar defects and 3-D bulk defects which include various impurities, voids, defects, cracks, pores, grain boundaries and phase boundaries, etc. [13–16]. When the crystal surface is etched with an etchant, it may reveal new domain formations, impurity dipoles and sites of dislocations. Generally, etch pits are located at the sites of impurity dipoles. In addition, as successive etching is carried out, information is available regarding how the dislocations and domain walls exist in the bulk crystal.

In the present investigation, the etching technique was used as a complement to optical studies. Thin crystal flakes [17,18] were used. As previously mentioned, the polar axis lies in the pseudocubic (001) plane of a plate at 45°. The effect of etching on the formation of a domain in Al-doped KN single crystal has been reported.

2. Experimental studies

2.1 Growth and methods of observation

Single KN crystals were grown using a technique developed through the flux method. The crystals showed smooth cleavage along the pseudocubic (001) plane, and therefore, thin crystal flakes were smoothly cut without disturbing the domain structure of the crystals. Crystal flakes of about 0.3 mm in thickness that showed less complicated domain structures were selected for the study. A detailed analysis of



REVIEW ARTICLE

Starburst pamam dendrimers: Synthetic approaches, surface modifications, and biomedical applications



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KEYWORDS

PAMAM;
Supramolecular dendrimer;
Synthesis;
Biomedical application;
Nanotherapeutics;
Cytotoxicity

Abstract Dendrimers are having novel three dimensional, synthetic hyperbranched, nano-polymeric structure. Among all of the dendrimers, Poly-amidoamine (PAMAM) dendrimer are used enormously applying materials in supramolecular chemistry. This review described the structure, characteristic, synthesis, toxicity, and surface modification of PAMAM dendrimer. Various strategies in supramolecular chemistry of PAMAM for synthesizing it at commercial and laboratory scales along with their limitations and applications has also discussed. When compared to other nano polymers, the characteristics of supramolecular PAMAM dendrimers in nanopolymer science has shown significant achievement in transporting drugs for molecular targeted therapy, particularly in host–guest reaction. It also finds its applications in gene transfer devices and imaging

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Sonochemical preparation of rGO-SnO₂ nanocomposite and its nanofluids: Characterization, thermal conductivity, rheological and convective heat transfer investigation

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Viscosity
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ABSTRACT

In the present study, rGO-SnO₂ nanocomposite of different rGO:SnO₂ ratio (1:7, 1:8 and 1:10 on mass basis) was synthesized using ultrasonic assisted method. The nanofluid prepared with the use of the rGO-SnO₂ nanocomposite dispersed in water was investigated at lab-scale for its application for convective heat transfer using a heat exchanger consisting of a straight tube. The successful formation of the rGO-SnO₂ nanocomposite particles was proved through UV/vis spectrophotometry, XRD, Raman spectroscopy and TEM analysis. Further, rGO-SnO₂ nanocomposite based nanofluids were prepared using distilled water as the basefluid, varying its volumetric concentration (0.01 to 0.1%). The rGO-SnO₂ nanocomposite based nanofluid with 0.07 vol.% concentration (1:7 ratio) exhibited 102.97% enhancement in thermal conductivity at 40°C. Further, rheology of the prepared nanofluids was studied at various concentrations and temperatures. It has been found that the prepared nanofluid exhibits non-Newtonian rheological behaviour. The obtained experimental data were tested with the available viscosity models to find the one that predicts the experimental to an acceptable degree. The influence of volume percent of rGO-SnO₂ nanocomposite and Reynolds number over the heat transfer coefficient presented by nanofluid was investigated and was found to be increasing with an increase in the volume % of rGO-SnO₂ nanocomposite in it and also with rise in Reynolds number. A 0.01 vol. % rGO-SnO₂ nanocomposite based nanofluid with 1:7 rGO-SnO₂ mass ratio showed 3671.19 W/m²K heat transfer coefficient at a Reynolds number of 7510 at the exit of the test section. Various other equations and analogies were tested so as to find the one that satisfactorily predicts the experimental Nusselt number.

1. Introduction

The fact that ‘smaller is better’ has been attracting much attention and has given rise to the field of nanotechnology in this ever progressing technical world. It is an amazing concept that takes part in wide range of applications. Nanofluid as developed by Choi [1], is an offspring of the field of nanotechnology, and since then has been very popular amongst the researchers working in the areas of process intensification.

From an industrial point of view, heating and cooling processes with enhanced rate of transfer of heat is found to be one of the greatest challenges. There are many fields such as the automobile industries, air conditioning systems, nuclear reactors, microelectronics devices and large scale industrial process equipments where heat transfer is very essential and increasing their heat transfer efficiency becomes very important. Conventional techniques of increasing heat transfer in these

applications include increasing the available heat transfer area, thus raising the cost requirements. Another technique is to use heat transfer fluids that act as mediums to carry heat along with them. The greater its ability to carry heat, the more heat transfer it can provide. This ability of a material to transfer heat is governed by its thermal conductivity. Previously, heat transfer fluids like water, ethylene glycol etc. were in use. These conventional heat transfer fluids were known to possess relatively lower thermal conductivity which could be greatly enhanced by dispersing solid nanoparticles within them [2]. Since then, several researchers studied the performance of millimeter or micrometer-sized particles suspended in basefluids and reported several problems such as settling down rapidly, erosion of heat transfer device, clogging of the flow channel and higher pressure drop [3]. Due these reasons, alternatives for the millimeter- or micrometer-sized particles based fluids were explored and eventually Choi [1] became the first one to introduce a suspension of nanometer-sized particles in a base fluid which

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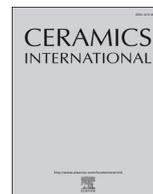
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Sonochemical preparation and characterization of rGO/SnO₂ nanocomposite: Electrochemical and gas sensing performance

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Supercapacitors

ABSTRACT

The present investigation deals with solution-based sonochemical production of graphene oxide (GO) and reduced graphene oxide-SnO₂ (rGO/SnO₂) nanocomposite. These rGO/SnO₂ nanocomposites were analysed with XRD, TEM, FTIR and UV/visible techniques. While synthesizing rGO/SnO₂ nanocomposites, use of the ultrasound generated cavitation events which has evidently improved the uniform deposition of SnO₂ on graphene nanosheets. These rGO/SnO₂ nanocomposites were explored for their potential electrochemical as well as gas sensing applications. The cyclic voltammetry (CV) studies revealed a good electrochemical performance of rGO/SnO₂ nanocomposite with a specific capacitance of 35 F/g. Further, the influence of NO₂ gas concentration was investigated on rGO/SnO₂ nanocomposite based sensor at various temperatures. The nanocomposite displayed the highest response of 99.9% with a very short response time of 14 s for 100 ppm concentration of NO₂ gas at 150 °C. These sonochemically derived rGO/SnO₂ nanocomposite based sensor showed excellent performance towards NO₂ gas compared to other selected gases under the same conditions.

1. Introduction

The burning of various fuels and motor vehicle exhaust contain many toxic and harmful gases, which primarily have NO₂ gas. Prolong exposure of NO₂ gas could result in several respiratory problems like cough, wheezing, reduced lung function and increased asthma attack etc., these problems could also recur at the lower concentration on NO₂ [1]. Therefore, its selective detection at low concentration is very much essential. Currently, there are several problems with sensing materials in terms of sensitivity, high-temperature operation, reversibility, poor selectivity, high material and fabrication costs [2–4]. Further, supercapacitors are finding interesting usage in portable electronic devices due to their significant features like high power density, extended cycle life and short charge-discharge time [5,6]. The active materials used for the preparation of electrodes of the supercapacitors are based on metal oxides [7,8].

For these applications, the transition metal oxides like SnO₂ are less expensive alternative but suffer from its low electrical conductivity [7]. SnO₂ is a distinctive n-type metal oxide and have been used in several applications in combination with various other nanostructures [9–11].

The performance of these metal oxides like SnO₂ can be enhanced with its deposition on selected carbon nanostructure like graphene [12]. With the loading of SnO₂ nanoparticles on graphene sheets, the problems mentioned above can be addressed successfully. This can be realised owing to the high surface area, more interfacial contacts present in the 2D structure of graphene, and also due to higher charge carrier mobility [13–15]. Further, reduced graphene oxide (rGO) showed better performance in term of conductivity as compared to graphene oxide (GO), which is attributed to reduced oxygen functionalities in the rGO compared to GO.

The uniform deposition of SnO₂ nanoparticles on rGO nanosheet is utmost important. Therefore, the application of ultrasound in the preparation of rGO/SnO₂ nanocomposite promotes the uniform deposition of SnO₂ nanoparticles on rGO nanosheets without any agglomeration [16,17]. Therefore, in the present work ultrasound-assisted production of rGO/SnO₂ nanocomposite was accomplished, which substantially enhances the deposition of SnO₂ nanoparticles on rGO nanosheets. During ultrasonic irradiation, ultrasound waves get passed through the reaction medium; due to this, the formation of several microbubbles takes places. These microbubbles collapse after its growth in a very

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Field dependent study on formation of ferroelectric domain in KNbO₃ single crystal

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Abstract: The study of ferroelectric domains is essential for understanding the orientation of electric dipoles. This orientation of electric dipole shows the defect and impurities formation in a ferroelectric single crystal. Domain study is important for studying formations of defects and movement of dipoles in Al-doped KNbO₃ single crystal. The Al-doped KNbO₃ ferroelectric Single-crystal prepared using flux methods; then it chemically etched using methyl alcohol and nitric acid as an etchant. The electric field of 50 V/cm, 60 V/cm, and 70 V/cm was applied to the doped crystal. The variations of domain structure after the applying electric field are observed using the Trinocular microscopy method

Keywords: Domain Impurities: KNbO₃: Electric Field

1. Introduction

The ferroelectric material is a crucial part of the perovskite family of the materials [1]. These devices mainly include memory devices, sensors, electro-optics, and LASER. Simultaneously ferroelectric materials are also used in pyroelectric and piezoelectric devices. A lot of modification has been done on ferroelectric materials [2]. Various scientists worldwide and studies have done a broad review about its dielectric properties, hysteresis loop, and mainly domain research. Many ferroelectric materials are currently available for analysis; they mainly include PbTiO₃, BaTiO₃, and PbZr/TiO₃ materials and have undergone many modifications [3]. Among these, on KNbO₃ [KN] materials, Korde and Patil et al. has done a lot of work in their lab. The different dopants in KN materials such as aluminum (Al) and ferrous (Fe) are used for doping. This doping combination changes the properties of these crystals [3–5].

KN Materials is a perovskite structure element. KN and BaTiO₃ have many similarities; both at room temperature in a single crystal shows orthorhombic phase [6]. As it has different doping adds, its structural properties change. KN single crystal has another important stuff in that it shows phase transition [7]. Phase transitions mean its phase changes at different temperatures, due to which the structure of KN changes, which is very important for practicing dielectric properties and study its hysteresis loop [4]. Formations of hysteresis loop are the main parameter to check the ferroelectric properties of materials. In KN well saturated rectangular hysteresis loop has formed the shape of hysteresis loop were changed by adding different dopant. Also, the parameter value of hysteresis loops such as spontaneous polarization, remnant polarization, and coercive were altered by dopant change [8].

Domain engineering is the main field of science that studies the orientations and formations of ferroelectric domains. The ferroelectric domains are a crucial part of ferroelectric to understand the various structural behavior defects and imperfections produced in the ferroelectric crystals[9]. This article studies the electric field's effects on the ferroelectric domains in various doped KN single crystals.

2. Experimental Studies

2.1. Crystal growth

The KN single crystal has been prepared using the flux method. Al and Fe doping was used while preparing the KN crystal. While preparing, the crystal K₂CO₃ and Nb₂O₅ powder were taken in the ratio of 1.2:1, and it was mixed. Afterward, this mixture was taken in the mortar and crushed for 5 to 6 hours and made into a fine powder. The same finely mixed powder Fe and Al are doped with suitable concentration. In the last, this doped composite powder is placed in a platinum crucible, and this platinum crucible is placed in a programmable furnace. This program runs continuously for eight days and comes with different steps: heating, cooling, soaking and reheating, recooling, and resoaking. In this way, this doped powder is heated up to its highest temperature of 1100°C, and finally, doped KN single crystal was prepared [10].

2.2. Methods of Microscopy

To study the domain properties of crystal; the most important instrument for the observations of domains is microscope. Different microscopes like atomic force microscopy (AFM), Scanning probe electron microscopy are

Silver doped micro porous Zeolitic materials for antimicrobial applications

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ABSTRACT

In association with upcoming energy demand and fossil fuel crises fastidiously in India; Co-firing i.e. combustion of coal and biomass (rice husk) is gaining considerable attention. The leftover during the process is termed as composite ash consisting amorphous silica as major component. As reputable, Zeolites or Molecular sieves are crystalline hydrated alumino-silicate resin historically known for its unique permeable bare bones which is also an overruling material as ion exchanger, adsorbent and catalyst in chemical reaction. Synthesis of MS-4A from composite ash, silver doping, its physicochemical and analytical characterizations as well as antimicrobial activity are reported in this paper.

For silver doping aimed at MS 4A, ion exchange was found to be predominant method reported in literature. Antimicrobial activity of silver doped sample was experimentally justified against gram-negative bacteria. The current paper also deals with the way to methodize formation of MS 4A by amalgamating waste aluminium scrap extricate tuned with sodium silicate extracted using ash followed by hydrothermal crystallization. Fair amount of hydrogen gas liberated in the process can be a gainful utility in other chemical industries.

Keywords: Composite ash, MS 4A, Silver, Antimicrobial, Waste

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I. INTRODUCTION

Due to constantly mounting population of our country, there is amplified call for energy. Excessive amount of coal is burned for satisfying necessity of the energy. The amount of an ash generated by coal-based thermal power plants has been swelling at a disturbing rate throughout the world [1]. The current grade of coal used in combustion is producing nearly 40-45% ash ensuing generation of 169.25 million tons averagely in year 2018[2]. It has been also observed that the fly ash generates as a result of coal firing is polluting three major sectors of environment (air, water and land) predominantly hence reflected as ironic source of pollution. To resolve this issue, it has been proposed to produce energy economically using biomass resources [3-4]. Numerous forms of biomass such as wheat, sugarcane, corn, eucalyptus etc. are currently obtainable in our country. India being second largest manufacturer of rice paddies globally, the ample and

ease in availability of rice husk makes it an appropriate biomass for co-firing [5]. Also, the calorific value of rice husk is nearly two third that of coal and hence mini thermal power plants have already been started in various states of India such as Chhattisgarh and Utter Pradesh producing nearly 8 to 15 MW energy [6]. The ash generated from these power plants is termed as Composite Ash (CA) as it is an outcome of co-firing of coal and biomass. On stuffing the composition of this ash, it was found that it contained silica about 85-90% in amorphous form which is easier to disintegrate. Hence composite ash was identified as a major source of silica as well as of sodium silicate which is the key material for Zeolites or Molecular Sieves.

Zeolites or MS 4A with tangled micro porosity have been studied as a prominent class of industrial porous materials [7]. MS 4A are noted for their liability toward their ion exchange and reversible dehydration. They have framework

A Review on Graphene Derivatives-Based Nanofluids: Investigation on Properties and Heat Transfer Characteristics

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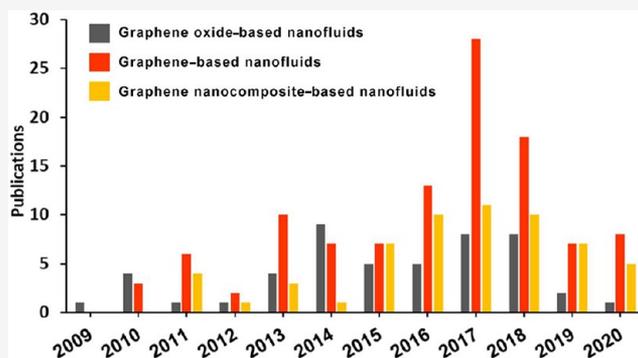
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ABSTRACT: The fact that some solid materials with suitable phases possess higher thermal conductivity than liquids gave rise to their utilization in heat transfer processes. Fluids that contain nanoparticles of any conducting solid material that enhance the thermal conductivity of the conventional heat transfer fluids are known as nanofluids. Ever since graphene has been known for its high thermal conductivity, it has found applications in nanofluids. There are many investigations on enhancement of thermal conductivity using graphene derivatives-based nanofluids. Graphene can form composites with metal, metal oxides, polymers, and other carbon forms. Nanohybrids of graphene derivatives and other conducting materials can enhance the heat transfer properties of fluids. This review presents an in-depth discussion of the studies done on graphene derivatives (like graphene oxide)-based and graphene nanocomposite-based nanofluids and their preparation methods, properties, and applications. Although there have been many studies on the thermal properties of graphene oxide-, graphene-, and graphene nanocomposite-based nanofluids, there still remains a wide scope for further discoveries.



1. INTRODUCTION

Heat transfer for the purpose of process fluid heating or cooling and energy recovery is crucially involved in many industrial processes. A little enhancement in heat transfer can make huge cost and energy savings. Thus, there is always a need for the emergence of new technologies in order to increase the efficiency of heat transfer. There are many heat transfer fluids used in process industries. But they do not seem to be very effective due to their low thermal conductivities. In comparison with liquids, solids have a better thermal conductivity. It was first studied by Maxwell¹ that suspension of solids in liquids showed higher thermal conductivity. But these solids were micro- or macro-sized and thus presented many disadvantages like rapid settling, erosion of equipments and pipelines, clogging of flow channels, and increased pressure drop. Since the realization of this, fluids containing dispersed nanometer-sized solid particles were invented by Choi and Eastman² and termed as “nanofluids”. These nanofluids have higher thermal conductivity than conventional fluids and thus help in enhancing heat transfer. The synergistic effect caused by the fluidity due to the liquid phase and the higher thermal properties due to the solid phase possibly can be the main reason behind the enhanced properties possessed by the nanofluids. Synergistic effect refers to the combined influence of the fluid and the solid phases of the nanofluid. The fluid phase, due to its flow properties, has inherent thermal transport mechanism due to its movement. This fluid carries the solids which have inherent high thermal conductance. Both

these properties of the individual phases complement each other and thus exhibit synergistic effect. No doubt this synergy is one of the possible mechanisms for thermal conductivity enhancement in nanofluids, but there are many such phenomena that take place simultaneously within the nanofluid which are mostly stated in several available reports. These mechanisms include the Brownian motion, thermophoresis, formation of clusters of nanoparticles, formation of liquid nanolayer over the nanoparticle, ballistic transport and nonlocal effects, and near-field radiation. Among these, Brownian motion and the thermophoresis effect contribute the most, followed by formation of nanoparticle clusters and nanolayers. Brownian motion is nothing but the nanoparticles motion in a random direction that gives rise to development of tiny convection currents so as to dissipate the energy within the nanofluid. Similar to Brownian motion, another mechanism that gives rise to development of convection currents is the movement of the nanoparticles due to temperature differences. A rise in temperature raises the energy around the nanoparticles and thus induces their motion from locations

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Process development and life cycle assessment of pomegranate biorefinery

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Abstract

According to the global survey, Iran, China, India, and USA are leading producers of pomegranate. Among them, India tops the chart as the highest producer of pomegranate, cultivating 1.14 million tons per annum. Peels cover 50% weight of whole pomegranate fruit and are mostly discarded as waste. This enormous peel waste has innumerable health benefits. Pomegranate peel (PP) constitutes various antioxidants, anthocyanins, and polyphenols such as ellagic acid, pectin, gallic acid, and many others which can be extracted. A detailed process for sequential extraction, with zero discharge, of such valuable chemicals from biorefinery point of view is developed in this study. Major products considered for extraction include ellagic acid (EA), lignin, and pectin. Also, the total phenolic content (TPC) and total reducing sugar (TRS) content are found in the intermediate stages. The percent yield of the products EA, lignin, and pectin is 10%, 13%, and 19% with respect to the weight of pomegranate peels (PP) processed. For the first time, a sequential extraction of products with its detailed process flow diagram, process inventory, and life cycle assessment (LCA) of PP biorefinery is presented. The global warming potential of the PP biorefinery is found to be 4505.8 kg CO₂ eq. per ton of PP processed. The intense hydrolysis step contributed majorly to the overall GWP indicator.

Keywords Biorefinery · Pomegranate · Life cycle assessment · Process development · Ellagic acid · Pectin · Lignin

Introduction

The antioxidant properties of pomegranate fruit are known globally which lead to its increasing demand all over the world. Fifteen lakh tons of pomegranate is produced as of November 2018 (Water Watch Numerical). India is a leading country in the production of pomegranate, followed by Iran,

China, and USA (Chandra et al. 2010). The overall production of pomegranate in India is around 1.14 million tons (Jadhav, 2007). A whole pomegranate fruit weighs about 250–300 g, of which the peel covers the 50% weight of fruit and the remaining comprises of seeds and arils (Jalal et al. 2018). Thus, cultivating 1.14 million tons of pomegranate leads to humongous production of waste pomegranate peels (PP). These waste PP have numerous health benefits.

The PP are studied as a potential bioresource for various valuable products (Pathak et al. 2017). Waste PP are rich in phenolic, pectin, and sugar content with varying quantities of 10–20%, 20–25%, and 30–35% respectively (Talekar et al. 2018). PP are rich source of phenolics and flavonoids (e.g., kaempferol, quercetin, luteolin, and proanthocyanidin), complex polysaccharides, hydrolysable tannins (ellagitannin, punicalin, punicalagin, and pedunculagin), proanthocyanidin compounds, and minerals, mainly K, Ca, N, P, Na, Mg, Fe, Cu, and Zn (Pathak et al. 2017). Phenolic compounds extracted from PP exert beneficial effects such as anticancer, antioxidant, prebiotic activities, anti-atherosclerosis, and anti-inflammatory (Gullon et al., 2016). There are different routes of sequential extraction of valuable products from PP and each route needs to be assessed from sustainability point of view.

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Thermodynamic Studies of Creatinine Solvation in Aqueous Dextrose and Urea

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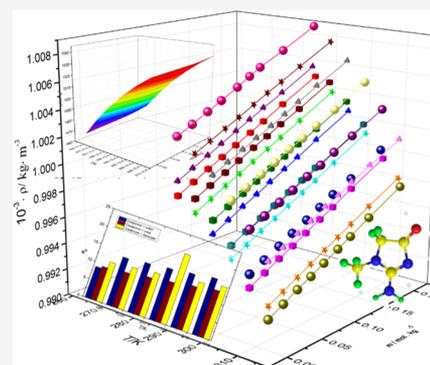


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Supporting Information

ABSTRACT: The interactions of the drug in aqueous media are associated with many thermodynamic changes. To understand these thermodynamic changes, systematic measurements of density and speed of sound of creatinine in aqueous and in aqueous solutions of 0.06 mol·kg⁻¹ urea and 0.06 mol·kg⁻¹ dextrose were carried out at $T = 288.15\text{--}313.15$ K within the concentration range of 0.02–0.2 mol·kg⁻¹. All measurements were performed for the density (ρ) and speed of sound (u) on Anton Paar DSA 5000M instrument. Further, the density data was employed to calculate the apparent molar volume of solute (V_{ϕ}) and apparent molar volume of transfer ($\Delta_{tr}V_{\phi}^0$).



1. INTRODUCTION

Creatinine is the eliminating product of renal secretion and byproduct of muscle metabolism produced by kidneys. Creatinine itself is a product via a biological system involving creatine, phosphocreatine, which is also known as creatine phosphate. Glycoamine is synthesized in the kidney from amino acids, and then creatine is synthesized in liver from the methylation of glycoamine.¹ The knowledge of kinetics of elimination of drugs is the basis to devise rational dosage regimens and modifications of dosage for the need of individuals. The elimination of creatinine is the sum total of metabolic inactivation and excretion. The clearance of creatinine represents the volume of the plasma from which the drug is removed in unit time.² The rate of elimination is directly proportional to the drug concentration, and its rate remains constant per unit time.

Ali and co-workers³ have presented the volumetric behavior and group contributions of amino acids at different temperatures. Nain⁴ studied the effect of arabinose/glucose/sucrose on L-phenylalanine at different temperatures (298.15–318.15 K). Riyazuddeen and Usmani⁵ discussed the volumetric, viscometric, and acoustic properties of L-proline with glucose and sucrose solutions at $T = 298.15\text{--}323.15$ K. Shekari and co-workers⁶ studied the volumetric behavior of ionic liquids in the aqueous D-glucose solutions. Lou and Lin discussed the transfer properties of amino acids in an aqueous glucose solution.⁷ Nain and co-workers⁸ measured the density, sound velocity, and viscosity of L-histidine in aqueous glucose solutions at different temperatures. Palani and Geetha⁹ studied the acoustic and thermodynamic properties of L-serine, L-glutamine, and L-asparagine in an aqueous glucose solution at 298.15 K. Li and co-

workers¹⁰ have reported the volumetric behavior of glycine, alanine, and serine in aqueous glucose solutions at 298.15 K. Banipal et al.¹¹ studied the acoustic behavior of some amino acids in aqueous sodium chloride and glucose solutions.

Urea is involved in various biological processes and acts as a protein denaturing agent.^{12,13} Osmolytes stabilize proteins by modifying their properties and interact with macromolecules directly. The change of structure and hydrodynamics of the solvent in presence of urea plays a vital role in understanding the denaturation of protein.¹⁴

Detailed literature survey reveals that volumetric and acoustic properties of creatinine in an aqueous solution of dextrose and urea are scarce. So, it was thought interesting to study volumetric and acoustic properties of creatinine in aqueous and aqueous dextrose and urea solutions.

In the present work, systematic measurements of density (ρ) and speed of sound (u) of an aqueous solution of creatinine and creatinine in 0.06 mol·kg⁻¹ aqueous urea and 0.06 mol·kg⁻¹ aqueous dextrose solutions at $T = 288.15, 293.15, 298.15, 303.15, 308.15,$ and 313.15 K within the concentration range of 0.02–0.2 mol·kg⁻¹ have been carried out.

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Investigation on liquid emulsion membrane (LEM) prepared with hydrodynamic cavitation process for cobalt (II) extraction from wastewater

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ABSTRACT

In the present work, the preparation of liquid emulsion membrane (LEM) considering Aliquat 336 as a carrier was accomplished first time with the use of hydrodynamic cavitation (orifice based) process. The other components/ingredients used for the preparation of LEM were kerosene (diluent), span 80 (emulsifier) and NaOH which was used as a stripping agent in the internal phase. The extraction process of cobalt (II) from wastewater was investigated using the LEM prepared with the orifice plates having diameter equal to 1 mm and 5 mm. Further, the influence of various elected parameters like processing time, orifice diameter, carrier concentration and external feed phase to emulsion membrane phase ratio (i.e. treat ratio) on extraction efficiency of cobalt (II) from the feed phase have been examined and reported. The obtained results confirmed the possibility of 100% extraction of cobalt (II) using hydrodynamically prepared LEM from the aqueous feed phase which contains 100 ppm cobalt (II). The % extraction efficiency of cobalt increases with the carrier concentration and also with LEM prepared in hydrodynamic cavitation for various cavitation time up to certain limit. Further, the concentration of span 80 has been established to be adequate for the stability of the LEM throughout the cobalt (II) extraction process. In the present work, the effectiveness of hydrodynamic cavitation based process for the preparation of stable LEM with an application in the separation of cobalt (II) from the aqueous feed phase has been established.

1. Introduction

The toxic heavy metals like aluminum, mercury, chromium, iron, cobalt, nickel, zinc, copper, etc. [1] based wastewater is being generated in various metallurgical industries, coal and mining, leaching solution etc. These heavy metals potentially affect the living organism and inhibits various biological processes affecting the biodegradation of the various pollutants present in the wastewater [2,3]. Out of which cobalt (II) has various health ill effect like asthmas, damage the heart and thyroid and also it causes the genetic changes in the living organisms. It is being used in various drugs and has applications in paint and ceramic industries as a catalyst, alloy industries, batteries and nuclear applications [4]. Therefore, in view of its applicability in various industries and due to its environmental concern, it is essential to separate and recover the cobalt from the wastewater generated. The several processes have been proposed in the literature for the removal of cobalt (II) which includes precipitation [5], ion-exchange [6], adsorption [7], Nano-filtration [8], bisorption [9] and solvent extraction [10] etc. However, as per their report, these processes are neither effective nor economical.

Which triggered the researchers for development of new energy efficient, low cost and time saving processes like liquid membranes [11].

LEM based approaches are being depicted to be efficient compared to other liquid membrane processes like bulk liquid membrane (BLM) and supported liquid membrane (SLM) [12,13]. It is attributed to accomplishment of extraction and stripping processes in a single unit operation leading to cost effective process. Liquid emulsion membrane process showed effective separation of various pollutants like acids/base, phenolic compounds, metal ions, hydrocarbons and inorganic compounds [14–18] which is attributed to higher mass transfer rates due to higher interfacial area [19]. The main feature of the LEM is the use of organic compound as an extractant or carrier. Ionic liquids, like Aliquat 336, are considered to be green compounds for the removal of heavy metals from aqueous medium [20]. Further kerosene has been reported to be hydrophobic material and have better stability compared to other organic materials due to its less transport in aqueous medium [21]. Sulaiman et al. [22] have effectively prepared emulsion liquid membrane for the recovery of the nanosized silver from wash water and reported 99.89% recovery of nanosized silver with the use of ionic

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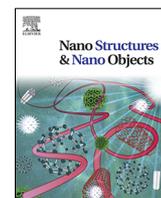
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Prospective of nanotechnology in degradation of waste water: A new challenges



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ABSTRACT

In the current scenario, the conservation of environment is an urge. Among various environmental hazards, the knocking area is waste water treatment. Scientists are constantly engaged in finding the advanced technology with high proficiency and low investment. One such technique called as nanotechnology has interesting application in the field of waste water treatment. However, information accessible is restricted. The present text reviews the application of various nano-materials for wastewater treatment techniques. The five main classes includes: First, Nano adsorbents like metal oxides, applied usually for removal of heavy metals. Second, nanomaterials of carbon used for effective adsorption and conduction process. Third, graphene-based nanoparticles for environmental remediation. Fourth, nanotubes have been used for effective removal of pollutants by means of, hybrid Nano membranes, Nano fibers and carbon nanotube membranes. Fifth is recyclable nano composites, mats, beads in water decontamination. Finally, some zero valent Nano sized metals showing strong adsorption capability and operational simplicity.

This paper discusses the application of nanomaterials in wastewater treatment. Such nanomaterial's which affordable, eco-friendly are, and efficiently work at large scale is the need of hour.

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Original research article

Sonochemical preparation of multifunctional rGO-ZnS-TiO₂ ternary nanocomposite and its application for CV dye removal

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ABSTRACT

This work deals with the conventional and sonochemical preparation of reduced graphene oxide-ZnS-TiO₂ (rGO-ZnS-TiO₂) ternary multifunctional nanocomposite and its application for crystal violet dye (CV) dye removal. The prepared nanocomposite samples have been thoroughly characterized using various techniques and confirms its successful formation. The efficacy of the synthesized multifunctional nanocomposite was investigated as an adsorbent as well as photocatalyst for the removal of crystal violet dye from wastewater. The experimental results indicated that the nanocomposites exhibited superior adsorption compared to its photocatalytic activity. Almost 97 % CV dye was removed by adsorption and photodegradation at temperature of 35 °C with initial dye concentration of 50 ppm and nanocomposite dose of 0.4 g/L.

1. Introduction

The sectors like dyeing, textile, tannery and the paint industries generate wastewater streams containing hazardous dyes. Dyes can lead to hazardous by-products when they are subjected to processes like oxidation, hydrolysis etc. in the wastewater phase [1]. These dye molecules and formed by-products are extremely poisonous, carcinogenic, mutagenic and allergenic to human being and other animals [2]. Thus, it becomes imperative to treat dye containing wastewater prior to it being released into the receiving body of water. Different treatment processes like adsorption [3], and photocatalytic degradation [4] are extensively used for removing dyes from wastewater. Photocatalytic degradation using TiO₂ has received lot of attention of numerous investigators due to its exceptional properties however; it is suffering from objectionable recombination of electrons and holes and having lower effectiveness under visible light for waste water remediation [5]. Numerous approaches have been used to resolve these issues and one of the methods is doping of TiO₂ to extend its absorption threshold.

Transition metal sulphides like ZnS and CdS widely studied for their photocatalytic capabilities are comparable to TiO₂ [6]. Similar to TiO₂, ZnS nanoparticles also suffer from the disadvantage of rapid recombination of photo-generated electron and hole pairs and the aggregation of nanoparticles that significantly limits its outstanding photoelectric properties. Also, compared with the performance of individual TiO₂ or ZnS, the photocatalytic activity of ZnS/TiO₂ composite can be substantially enhanced due to the quantum confinement effects [7]. The combination of ZnS with TiO₂ supported on a conductive support like graphene (which has larger specific surface area, outstanding electronic transport property and higher chemical stability) can prove to be effective photocatalyst for the treatment of wastewater [8].

For the preparation of nanostructures such as transition metals having higher surface area, oxides and colloids, the use of

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Original research article

Sonochemical preparation of ternary rGO-ZnO-TiO₂ nanocomposite photocatalyst for efficient degradation of crystal violet dye

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ABSTRACT

In the present work, conventional and sonochemical production of ternary reduced graphene oxide (rGO)-ZnO-TiO₂ nanocomposite photocatalyst was accomplished. XRD patterns of ternary nanocomposite indicated that it contained a combination of anatase and rutile phases of TiO₂ nanoparticles deposited over rGO sheet. TEM images revealed that ZnO and TiO₂ nanoparticles were evenly distributed on graphene sheet due to application of ultrasound. The photocatalytic degradation of crystal violet (CV) dye was performed to assess the photocatalytic activity of the sonochemically as well as conventionally prepared ternary nanocomposite. The beneficial effects of ultrasound were evident from the results as the nanocomposite synthesized using ultrasound assisted approach exhibited higher photocatalytic activity against the conventionally prepared nanocomposite.

1. Introduction

The two semiconductor materials ZnO and TiO₂ having similar band gap energies (approximately 3.2 eV) are vastly investigated because of their high activities, size-tunable physicochemical properties, safe nature, cost effectiveness and ecological features for photo-degradation of various organic contaminants like detergents, dyes and pesticides in water [1]. Also, they have immense photocatalytic efficiency in the presence of UV light irradiation because of their excellent oxidising and reducing potential due to the photo-generated electrons and holes [2,3]. As the photocatalytic action is strongly reliant on the generation of electron-hole pairs, the coupling of ZnO and TiO₂ exhibits synergistic separation of electron-hole pair under UV light irradiation and therefore a greater photocatalytic activity [4]. At the same time, it is observed that these photo-generated charge carriers recombine and there is also an electron transfer that occurs within both ZnO and TiO₂ that decreases their photocatalytic performance [5,6]. Owing to similar band gap energies and photocatalytic mechanism of both TiO₂ and ZnO, both of them can be suitably coupled and hence ZnO/TiO₂ composite nanoparticles are being considered as an encouraging photocatalyst [7].

Graphene has appealed ample attention pertaining to its huge specific surface area, exceptional electronic transport property and high chemical stability [8]. An exceptional electrical conductivity of graphene makes it appropriate for photo-generated electrons to transfer from semiconductor materials, consequently augmenting the process of degradation [9]. Thus, addition of nano-sized carbon

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Original research article

TL -OSL properties of nanosized $\text{BaMg}_2\text{Al}_6\text{Si}_9\text{O}_{30}:\text{Ce}^{3+} / \text{Dy}^{3+}$ phosphor

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Optical properties
Radiation interaction
Defect

ABSTRACT

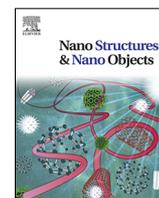
In this article we have reported $\text{Ce}^{3+} / \text{Dy}^{3+}$ activated $\text{BaMg}_2\text{Al}_6\text{Si}_9\text{O}_{30}$ nanosized phosphor synthesized by the combustion method. Prepared phosphors was initially irradiated by Sr-Y90 β -emitting source and then it was used for the Thermoluminescence- Optically Stimulated Luminescence (TL-OSL) measurement. Here, $\text{BaMg}_2\text{Al}_6\text{Si}_9\text{O}_{30}:\text{Ce}^{3+} / \text{Dy}^{3+}$ phosphor exhibits an isolated broad TL glow curve at around 201^o C. And further, it was well resolved into two sub-bands to estimate the trap depth and TL parameters of the individual glow curve. Along with this, we have carried out the OSL measurement of $\text{BaMg}_2\text{Al}_6\text{Si}_9\text{O}_{30}:0.1\text{Ce}^{3+}, \text{yDy}^{3+}$ phosphor which is well fitted into third order exponential. The micro and nanostructure of the phosphors product has been confirmed from SEM, TEM analysis. Again the phase purity of the materials was confirmed by XRD, which has hexagonal structure. Also diffraction pattern of the prepared phosphor is indexed well using theoretical tools of XRD. Hence from the investigation of TL-OSL properties, it is seen that synthesized thermoluminescent materials may be a promising candidate for the irradiation of foods and seeds.

1. Introduction

Thermoluminescence is a thermally stimulated emission of light from a solid luminescent material when it absorbs energy from ionizing radiation. Such type of phenomenon is very much useful for detection or measurement of absorbed radiation in many fields for ex-dating of archeological specimens and as well as to identify the defects in solids. Therefore this physical property of materials is purely crystalline in nature and also have the capability to emit light when it is heated and latter irradiated. The light emitted by the TL materials is proportional to the dose received, hence this is the fundamental phenomenon of ionizing radiation dosimetry. Therefore, TL materials gives an information about energy deposited by the ionizing radiation in a particular medium (Azorín,1990). Such materials emits light in natural post-irradiation where the electrons come back to the ground state after a long time, therefore, this effect called as fading and it depends on the intrinsic properties of the material. Currently, RE (Rare-earth) doped phosphor materials play an important role in the fields of basic and applied research, such as nuclear power plants, personal and environmental monitoring of radiation and geological dating etc. Doping of suitable rare earth ions in thermoluminescence materials may vary the TL features as well as the dosage rate [1]. Recently many rare earth doped phosphor host has been studied and proposed for the TLD application which includes, sulfate, borates, aluminate, silicates, phosphate etc. Among them very few reports are available on rare

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Ultrasound assisted preparation of rGO/TiO₂ nanocomposite for effective photocatalytic degradation of methylene blue under sunlight

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ABSTRACT

In the present work, well known Hummers–Offeman method was employed for production of graphene oxide (GO) and in-situ deposition of TiO₂ nanoparticles on prepared GO in presence of ultrasonic irradiations to get reduced graphene oxide–TiO₂ (rGO/TiO₂) nanocomposite. The structural and morphological analysis of synthesized photocatalysts was accomplished with UV–Vis, XRD, FT-IR, Raman Spectra, EDAX, XPS and TEM analysis. The absorption peak at 234 nm shows redshift to 285 nm which confirms the reduction of GO to rGO. XRD analysis of the prepared composite confirmed the presence of the combination of anatase and rutile phases of TiO₂. TEM images revealed that large amount of round-shaped TiO₂ nanoparticles in size range of 3 to 5 nm were consistently deposited on the rGO sheet due to ultrasonic irradiations. Further, effectiveness of the prepared nanocomposite as a photocatalyst was examined with the decolourization of methylene blue (MB) dye in sun light. The effect of catalyst loading and pH on MB dye degradation was examined. The results indicated that the percent degradation of selected MB dye enhanced at higher catalyst loading and also a higher pH favoured the degradation. The maximum MB dye degradation was observed to be 91.3% within 30 min for pH value of 13.2 and photocatalyst dosage of 2 g/L. Further, the kinetic studies established the pseudo first-order reaction kinetics for the photocatalytic decolourization/degradation of MB dye.

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1. Introduction

Graphene is a hexagonal lattice having *sp*²-bonded carbon atoms and is stable under ambient conditions. Graphene has got exceptional thermal, electrical, mechanical and optical properties and is particularly important for applications in electronics, materials science and condensed-matter physics [1]. Additionally, graphene exhibits semimetal behaviour because of small overlap between the valence and conduction bands. The composite materials based on graphene find uses in varied fields such as drug delivery, nanoelectronic devices, catalysis, biomaterials etc. [2]. The production of graphene is easier and it can be produced from natural graphite which is inexpensive through GO [3,4]. Titanium dioxide (TiO₂), a semiconductor photocatalyst, is an important material in material chemistry. Owing to the properties like suitable band gap energy, strong oxidizing power, durability against photo and chemical corrosion, chemical inertness, electronic and

optical properties TiO₂ has been extensively examined [5–7]. On account of its high efficiency and high stability it is extensively used in various applications like hydrogen production [8], gas sensors [9], heterogeneous photocatalysis [10] and dye-sensitized solar cells [11]. Apart from this, it is also used for paints, filter materials, cosmetics, anti-reflection films, electronic paper etc. [12,13]. Moreover, titanium dioxide can be easily produced and used. It efficiently catalyses reactions, is cheap and does not pose any risk to the environment or humans [14]. Further, it has been extensively used in wastewater treatment as a photocatalyst. However, TiO₂ has the disadvantage that it is active in UV irradiation, whereas the quantity of UV radiations is only 5% of the solar spectrum. In addition, the recombination rate of electrons and holes is higher in case of TiO₂. Therefore, it has less photocatalytic activity under visible sunlight, which necessitates the development of new photocatalyst materials delivering high reactivity in visible light ($\lambda > 400$ nm) that covers maximum percentage of the solar spectrum [15].

Further, the photoreactivity of TiO₂ is extremely labile and blending with other mineral and organic materials, modifications

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Intensified Thermal Conductivity and Convective Heat Transfer of Ultrasonically Prepared CuO-Polyaniline Nanocomposite Based Nanofluids in Helical Coil Heat Exchanger

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Abstract

In this study, investigation of convective heat transfer enhancement with the use of CuO-polyaniline (CuO-PANI) nanocomposite based nanofluid inside vertical helically coiled tube heat exchanger was carried out experimentally. In these experiments, the effects of different parameters such as Reynolds number and volume % of CuO-PANI nanocomposite in nanofluid on the heat transfer coefficient of base fluid have been studied. In order to study the effect of CuO-PANI nanocomposite based nanofluid on heat transfer, CuO nanoparticles loaded in PANI were synthesized in the presence of ultrasound assisted environment at different loading concentration of CuO nanoparticles (1, 3 and 5 wt.%). Then the nanofluids were prepared at different concentrations of CuO-PANI nanocomposite using water as a base fluid. The 1 wt.% CuO-PANI nanocomposite was selected for the heat transfer study for nanofluid concentration in the range of 0.05 to 0.3 volume % and Reynolds number range of was 1080 to 2160 (± 5). Around 37 % enhancement in the heat transfer coefficient was observed for 0.2 volume % of 1 wt.% CuO-PANI nanocomposite in the base fluid. In addition, significant enhancement in the heat transfer coefficient was observed with an increase in the Reynolds number and percentage loading of CuO nanoparticle in polyaniline (PANI).

Keywords

CuO-PANI nanocomposite based nanofluid, helical coil tube heat exchanger, CuO loading, ultrasound, heat transfer coefficient

1 Introduction

The need of efficient heat transfer has always been a serious matter as far as process cost is concerned. There are many fields where heat transfer is essential right from a car radiator to spacecraft thermal applications, from air-conditioning systems to nuclear reactors and from small electronic devices to large industrial process equipments. These applications utilize different kind of heat transfer devices that provide varying degrees of heat transfer. Simple modifications like vibration of heating surface, injection and suction of fluids, application of electrical and magnetic fields in these devices to increase the heat transfer have been studied by several researchers [1]. Also, the use of conventional heat transfer fluids like water, ethylene glycol etc. does not seem to be offering high heat transfer. Thus, there arose a need of using solid particles dispersed in base fluids to increase the thermal conductivity of the base fluids due to the fact that solids have higher

thermal conductivity than liquids. Many research groups made use of solid particles dispersed in liquids but were discontent with the results. This was reported to be happening due to various disadvantages like settling, erosion, clogging, increased pressure drop etc. exhibited by the micrometer-sized particles due to their large size [2]. This was again overcome by introducing nanometer-sized particles into base fluids as invented by Choi [3] and named as 'Nanofluids'. Nanofluids are uniform suspensions of nanoparticles in various kinds of base fluids. They have been used to enhance the thermal conductivity and in convective heat transfer studies by many researchers [4-8]. There are many fields where nanofluids find applications which include automobile radiator [9, 10], solar applications [11-13], electronic applications [14, 15], biomedical applications [16, 17], industrial cooling applications [18, 19], anti-bacterial applications [20-22], targeted drug



Preparation and thermal conductivity investigation of reduced graphene oxide-ZnO nanocomposite-based nanofluid synthesised by ultrasound-assisted method

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ABSTRACT

Preparation of water-based nanofluid containing reduced graphene oxide-zinc oxide (rGO-ZnO) nanocomposite particles synthesised by ultrasonic-assisted method has been carried out in this work. Energy-dispersive X-ray spectroscopy, transmission electron microscopy, Fourier transform infrared spectroscopy, X-ray photoelectron spectroscopy and Raman spectroscopy were used to confirm the successful formation of the nanocomposite. The reduction of GO and attachment of the ZnO nanoparticles to it was evident from all the characterisation techniques. For 0.1 vol.% of rGO-ZnO nanocomposite-based nanofluid, the thermal conductivity was found to be 2.95 W/mK at 50°C. It further increased with increase in temperature and concentration of the nanofluid, for which a new correlation has been proposed, which can satisfactorily predict the behaviour. Also, comparison of thermal conductivity of rGO-ZnO nanocomposite-based nanofluid with nanofluids containing rGO, ZnO nanoparticles and other rGO-based nanocomposite particles has been done. This study suggests a possible application of the rGO-ZnO nanocomposite-based nanofluid for various heat transfer applications.

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1. Introduction

A process that has efficient heat transfer systems can prove to be helpful in conserving thermal energy, thus contributing to the environment. Such processes can be smallscale, i.e. domestic, as well as largescale, i.e. industrial. Increase in heat transfer area, application of vibration or magnetic field are some of the basic methods that are used to augment heat transfer. All these efforts are undertaken by having energy conservation and consequently sustainable development as the prime aim. Since the last two decades, nanofluids have connected nanotechnology and chemical engineering and have become a great alternative for enhancement of processes of heat transfer due to their superior thermal transport properties. It was due to the findings of Maxwell [1], that the solids having higher thermal conductivity than liquids can help increase the thermal conductivity of the liquids, which gave an impetus to the development of nanoscale solid particle-based liquids. This was first done by Choi and Eastman [2] in 1995, and they named it as nanofluids. As there were a lot of disadvantages by dispersing microscale solid particles into liquids [3], development of nanoparticle-based fluids was given more importance, and since then a lot of advancement in characterisation as well as investigation of optimum set of properties of such fluids that can exhibit maximum enhancement in thermal conductivity has taken place.

Scientists all over the world have been involved in synthesising and studying nanofluids in various heat transfer applications [4,5]. Also, there are various types of nanomaterials that are used for preparing nanofluids that are carbon based [6,7], metal based [8,9], metal-oxide based [10,11] and polymer based [12,13] and their nanocomposites as well [14–17].

The process of synthesis of the nanomaterials also tends to affect their properties [18]. Thus, selection of an appropriate process of synthesis is also very crucial. Cavitation has proved to be one of the most efficient methods for bottom-up synthesis of nanoparticles [19]. Many researchers have successfully prepared nanoscale solid particles having very less size [19–21]. The process of cavitation can be typically classified into hydrodynamic cavitation and ultrasonic cavitation. It involves the formation of cavities which are small bubbles due to sudden and localised changes in pressure within the fluid medium. These bubbles grow in size, and finally they collapse after a certain increase in size is attained. This process of collapse of the bubbles produces localised harsh temperature and pressure conditions which are nearly 5000 K and 1000 atm which help in reaction as well as maintenance of the reduced particle size of the solid by preventing agglomeration and thus producing nanometre-sized particles [19].

ZnO nanoparticles have been investigated by many researchers for their application in nanofluids using different base fluids [22–25]. Among these, Radkar et al. [25] have utilised ultrasonic as well as hydrodynamic cavitation for synthesis of ZnO nanoparticles and preparation of ZnO/water nanofluid, respectively. With these methods, they achieved a particle size of 9–15 nm and were successful in enhancing thermal conductivity of water, thus augmenting the Nusselt number by 18.6% using 0.5 vol.% nanofluid concentration for convective heat transfer in helical coiled tube.

Graphene, as one of the highest conducting materials, has caught the attention of researchers involved in developing



RESEARCH ARTICLE

Intense green-, red-emitting Tb³⁺, Tb³⁺/Bi³⁺-doped and Sm³⁺, Sm³⁺/La³⁺-doped Ca₂Al₂SiO₇ phosphors

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Abstract

This paper focuses on an optical study of a Tb³⁺/Bi³⁺-doped and Sm³⁺/La³⁺-doped Ca₂Al₂SiO₇ phosphor synthesized using combustion methods. Here, Ca₂Al₂SiO₇:Sm³⁺ showed a red emission band under visible light excitation but, when it co-doped with La³⁺ ions, the emission intensity was further enhanced. Ca₂Al₂SiO₇:Tb³⁺ shows the characteristic green emission band under near-ultraviolet light excitation wavelengths, co-doping with Bi³⁺ ions produced enhanced photoluminescence intensity with better colour tunable properties. The phosphor exhibited better phase purity and crystallinity, confirmed by X-ray diffraction. Binding energies of Ca(2p), Al(2p), Si(2p), O(1s) were studied using X-ray photoelectron spectroscopy. The reported phosphor may be a promising visible light excited red phosphor for light-emitting diodes and energy conversion devices.

KEYWORDS

Ln³⁺ ions, combustion synthesis, X-ray diffraction, X-ray photoelectron spectroscopy, transmission electron microscopy photoluminescence

1 | INTRODUCTION

Due to the vast increase in demand for energy from industry and for households and commercial purposes, the level of power generated based on coal and fossil fuel technologies is growing rapidly and hence the levels of CO₂ and other harmful gases in our environment are increasing. This increase has a detrimental effect on human health and the health of other living animals due to changes in water, soil and air qualities. Many research groups and organizations are making increased efforts to develop both environmentally friendly energy generation and energy-saving technologies for the sustainable development of mankind. Many existing technologies developed by scientists have been proposed and proven in practice to have the capacity to produce new and renewable sources of energy generation that are based on geothermal energy, wind energy, solar energy, and hydrothermal energy etc.^[1] These natural resources are available depending on the geographical and geological resources of each country. Of the different natural resources, the Sun is the main contributor to life on Earth and development of the global environment. Natural sunlight is available everywhere and in larger amounts in most countries when

compared with other resources. Therefore solar photovoltaic technology is the best alternative for energy generation, as it uses a green and non-polluting source.^[2] We should not only think about environmentally friendly sources of energy, but also focus on energy-saving technologies. In the area of power generation and utilization, some energy is used for indoor or outdoor lighting, and for decoration etc. Therefore there is a second challenge to develop low-cost, non-toxic, energy-saving products that are environmentally sustainable. Compared with lighting devices used over the past few decades such as incandescent or compact fluorescent lamps (CFL), light-emitting diodes (LED) are an emerging lighting source for the 21st century based on their special merits of long operating lifetime, energy-saving potential, high brightness, and much reduced toxicity compared with incandescent or fluorescent light sources.^[3] Therefore, indirectly, they help to control the level of greenhouse gases in the atmosphere due to their energy-saving capabilities. LEDs have many advantages and are a much safer alternative to current lighting devices used at commercial and industrial levels.^[4-6] White LEDs (wLED) are made using two methods: (1) by combining near-ultraviolet (NUV) LED chips with RGB phosphors; and (2) by combining blue and yellow phosphors and



Research article

Intensification of the degradation of Acid RED-18 using hydrodynamic cavitation

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ABSTRACT

In this work degradation of Acid Red-18 (AR-18) was examined in the hydrodynamic cavitation reactor. Orifice plates with different holes geometry are used to determine the optimum plate to carry out the degradation based on cavitation number. The obtained optimum orifice plate is used as a cavitating device on varying parameters like initial AR-18 concentrations, pH, temperatures, and operating pressures of the reactor. A photocatalyst (TiO₂) was prepared by the sol-gel method and used in combination with H₂O₂ to intensify the degradation of AR-18. The obtained optimum condition of hydrodynamic cavitation was again used in the ultrasonic cavitation reactor for the comparison. Hydrodynamic cavitation (orifice) given the highest degradation as compared to Hydrodynamic cavitation (Venturi) and Ultrasonic Cavitation with and without the use of TiO₂. At TiO₂(300 mg/L) dose, 88.1%, 70.4% and 64.8% degradation is obtained in HC-O, HC-V and UC reactor at initial AR-18 concentration (15 ppm), pH (3), Operating temperature (35 °C), and H₂O₂(300 mg/L). Hence the use of an advanced oxidation process can be successfully used with hydrodynamic cavitation to intensify the degradation of Acid Red-18 under the controlled operating parameters.

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1. Introduction

In the world, around thousand of types of dyes are produced, whose amount is in tons per year. Azo dyes are mostly used in the textile industry and to add the colors in solvents, inks, varnishes, paints, varnishes, paper, wood, plastic, leather, rubber, foods, drugs, and cosmetics [1,2]. These industries are consuming water for the different processes which produces a large quantity of wastewater with a dye concentration in the range of 10–200 mg/L [3,4]. The effluent containing dye may have some components which will be toxic, carcinogenic and mutagenic to aquatic life [5]. The treatment like adsorption, biological degradation and chlorination are not much effective to degrade these compounds from wastewater. Therefore, the degradation of azo dyes with the help of AOPs can be effectively carried out [6–8]. Wastewater generated from the

textile dyeing industry contains unreacted dyes and supplementary [9]. Wastewater released by the textile industry is characterized by its color, dynamic pH, high chemical oxygen demand (COD) which affect human health and ecosystems [10,11]. The dyes present in the wastewater is chemically stable, it is not easily removed by traditional methods like flocculation, precipitation, reverse osmosis and adsorption [12]. In AOPs generated hydroxyl free radicals oxidizes organic or inorganic pollutants present in wastewater. These Hydroxyl radicals have more oxidation potential. Hence OH radicals react quickly with most organic compounds [13,14]. A heterogeneous type of photocatalyst is a new technology heading towards the mineralization organic pollutants. TiO₂ is one of the famous semiconductor photocatalysts for degrading dye present in wastewater due to its strong oxidizing power [15].

The traditional methods are not able to degrade the dye molecules chemically present in the wastewater [16]. Hence, it is required to find an effective treatment technology for the degradation of the complex and non-biodegradable compound. For this purpose, AOPs have emerged in the 20th century. In AOPs hydroxyl radicals are generated to complete the oxidization of dyes [17]. Some literature has revealed that a combination of different AOPs is

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Treatment of fish processing industry wastewater using hydrodynamic cavitation reactor with biodegradability improvement

Prashant Dhanke and Sameer Wagh

ABSTRACT

Water generated from the fish processing industry is contaminated with organic matter. This Organic matter present in wastewater increases the Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). A new technology, Hydrodynamic cavitation (HC) is used to deal with this wastewater produced in fish processing plants. The orifice plate is used in the HC reactor to generate a cavitation effect. The intensification of this technique was carried out with the help of hydrogen peroxide (H_2O_2) and TiO_2 . The treatment of this wastewater is reported in terms of percent degradation in BOD and COD and in Biodegradability index (BI). Operating parameters like inlet pressure, pH, operating temperature and H_2O_2 doses were used to find the optimum condition. 15 g/L of H_2O_2 gave 69.5% reduction of COD in the 120 min of treatment that also increases BI value to 0.93 at inlet pressure 8 bar, Plate-5, temperature (30 °C), and pH 4. In Ultrasonic cavitation (UC) reactor, COD reduction is 68.7% without TiO_2 and with TiO_2 is 71.2%. Also, this HC and UC reactor reduced CFU count to a great extent at the same operating conditions.

Key words | biodegradability index, chemical oxygen demand, fish processing industry wastewater, hydrodynamic cavitation

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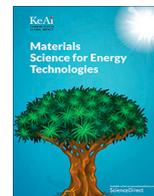
INTRODUCTION

Wastewaters of fish processing industries are the big sources of coastal environmental pollution. The discharge of fish processing industries will constitute biohazard to human beings and other living organisms in the ecology (Sankpal & Naikwade 2012; Dhanke *et al.* 2018). Fish processing operations generate wastewater containing different contaminants which are in soluble, colloidal, and particulate forms. The intensity of the contamination depends on the specific operations like washing, filleting, cutting, cleaning and thawing (Sunny & Mathai 2013). The treatment operation is difficult due to the high amount of organic matter with some amount of oil and grease. Degradation of organic matter of this wastewater is carried out when it is conventionally submitted to biological treatments (Sunny & Mathai 2013). Fish processing involves removing unwanted parts like head and viscera removal. During this process, an effluent mainly contaminated with salt, blood and fish waste that cannot be used as food. In the washing process of fish, water consumption is used in the ratio of 1:1 but it can be double to ensure the washing process. In a further

process like cooking and cooling of the fish produces water which contains a high concentration of organic material and fats (Cristovao *et al.* 2012). Hence this fish processing methods increases the organic matter in outlet water. Organic matter present in wastewater increases the Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Organic Carbon (TOC).

The canning industry is also the main segment of the fish processing industry at the international level. High COD in the range of $21,821 \pm 176$ mg/L, BOD 19,200 mg/L and microorganisms are due to the organic substances like blood, soluble protein, and fish oil present in FPIW (Cristovao *et al.* 2012). Most of the fish processing plants generate wastewater about $14,300$ m³ daily. This produced wastewater when passing through households through surface gives smell and unaesthetic. It contained mainly suspended solid, sulfide, nitrogen, phosphate (Priambodo *et al.* 2011). Generally the treatment like chemical coagulation, flocculation, and sedimentation processes is used. In the next stage of treatment, the effluent could involve

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Judd-Ofelt analysis on pH sensitive Eu(tta)₃bipy and Eu(dmh)₃phen hybrid organic complexes in various organic solvents for solution processed OLEDs

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ABSTRACT

Extremely luminescent Eu(tta)₃bipy and Eu(dmh)₃phen complexes were synthesized by encapsulating the lanthano-ion Eu(III) with β-diketonates ligands (tta: thenoyltrifluoroacetone and dmh: 2,6-dimethyl-3,5-heptanedione) and neutral ligands (bipy: 2,2' bipyridine and phen: 1,10 phenanthroline) so as to investigate their photo physical parameters in various organic solvents. Various UV-absorbance based transition parameters, Stokes shift and its dependence on solvent polarity were explored by Lippert-Mataga plot. Judd-Ofelt emissive parameters Ω₂ and Ω₄ (pH: ranging from 6.0 to 8.0) and photoluminescence quantum yield (PLQY) were calculated in different organic solvents. These architeched complexes, when dissolved in different organic solvents maintained their emission in reddish-orange region, irrespective of polarity of solvents. Photometric parameters-CIE coordinates, dominant wavelength, color purity and Color correlated temperature (CCT) were determined. These results reflect their versatility in the manufacture of solution processed electroluminescent devices such as OLEDs, flat panel displays and solid state lighting technology, wherever reddish-orange emission is highly essential.

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1. Introduction

Owing to the brilliant luminescence characteristics such as fine emission lines in the visible range, narrow full width half maxima (FWHM), antenna effect and chelating effect, europium complexes with TTA as primary ligand and 1, 10-Phenanthroline and 2,2'-bipyridine are extensively probed [1–3]. In view of these fascinating properties and potential applications of lanthanides, we propose to synthesize europium thenoyltrifluoroacetone complex with 2,2'-bipyridine: Eu(tta)₃bipy and europium 2,6 dimethyl 3,5 heptanedione complex with 1,10-phenanthroline: Eu(dmh)₃phen. As discussed in our previous research [4,5], a simpler and economical OLED fabrication process involves the solution processing techniques such as spin coating or ink jet techniques [6], in which the solvated organic solvent is sprayed on the substrate and then

solvent is evaporated to obtain a coating of organic material. When a luminescent complex is dissolved in organic solvent, innumerable interactions operate in solutions. The modifications induced by a solvent in the electronic spectra of molecules can offer information on the local electric field acting on the spectrally active molecule [7–12]. The intensity and position of the absorption spectra support modifications when the spectrally active molecules are dissolved in different organic solvents. Hence the choice of solvent is significant due to the fact that the electronic absorption and emission spectra of organic molecules are usually modified in solvation processes [13]. In the present study, UV-visible absorption and photoluminescence spectra enables us to determine various parameters such as energy gap, Stokes shift as well as photoluminescence quantum yield (PLQY), which provide vital information for the stability of the complex using polarity approach by employing polar protic (acetic acid) to non polar (toluene) range of solvents.

2. Experimental

2.1. Chemicals and reagents

Starting materials used for the synthesis of Eu(tta)₃bipy and Eu(dmh)₃ phen complexes are europium chloride hexahydrate

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Vanadium oxide anchored MWCNTs nanostructure for superior symmetric electrochemical supercapacitors

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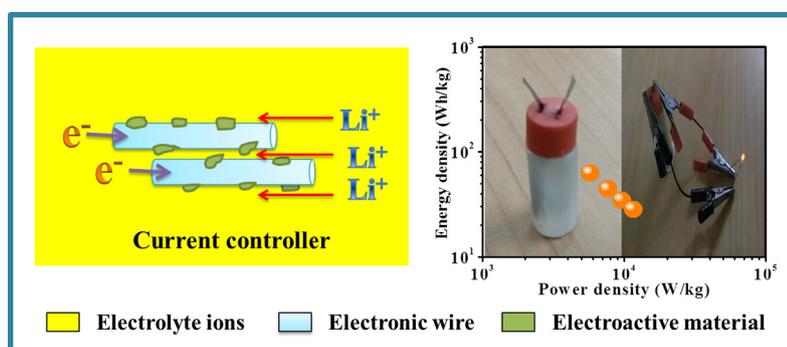
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HIGHLIGHTS

- Complete symmetric supercapacitor device with a wide voltage frame of 2 V.
- Highest recordable specific capacitance of 569.7 F/g at 2 mV/s scan rate.
- Remarkable energy density of 62 Wh/kg and power density of 11.5 kW/kg with capacitive retention of 89.2 % for 4000 cycles.
- Glowing of red LED shows the practical aspect of device.

GRAPHICAL ABSTRACT



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ABSTRACT

Proper selection of electrode material with sensible scheme is definitely significant to dodge commercial obstacles of supercapacitors. This challenge has been addressed by engineering prototype symmetric supercapacitor (SSC) device fabricated with enhanced supercapacitive vanadium (V) oxide integrated multi-walled carbon nanotubes (MWCNTs) composite as electrode material with Li-ion associating LiClO_4 electrolyte. The V_2O_5 /MWCNTs composite with nanoscale architecture has been synthesized with inexpensive and simple chemical bath deposition (CBD) method. The cyclic voltammetry of SSC device has exhibited the involvement of electrochemically active reversible redox process in the composite. The specific capacitance of 569.7 F/g at scan rate of 2 mV/s including excellent electrochemical stability of 89.2% at 4000 CV cycles have been achieved with operating potential window of 2 V. Furthermore, the device exhibits excellent energy density of 62 Wh/kg and exceptional power density of 11.5 kW/kg. The low resistive factors have driven the device towards the potential application as glowing of red LED for 10 s.

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1. Introduction

Due to energy snags, unfathomable efforts have been made to design novel supercapacitors (SCs), which have been measured as potential energy storage solutions due to their necessary assets of pronounced power density (ten times greater than orthodox batteries), quick charge/discharge, exceptional lifetime, light weight and compact size

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A high performance biological degradation of trimethylamine: Experimental study and mathematical modeling

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Shock loads
Response surface method and artificial neural network

ABSTRACT

A bench scale Biotrickling filter (BTF) packed with polyurethane foam seeded with potential TMA degrading bacterial strains (*Agromyces* and *Ochrobactrum* sp.) was tested to eliminate TMA from ambient air. BTF was functioned constantly for a period of 125 days at retention time of 180 s and 90 s corresponding to the different loading rate of 14.4–232 g m⁻³ h⁻¹. The maximum elimination capacity attained in the study was 160 g m⁻³ h⁻¹ with the removal efficiency above 95%. Low, medium and high shock loads of higher concentration were applied to the BTF during the operational period. The BTF has recuperated its performance after each shock loads which shows its good resilience capacity. The performance of the BTF was modeled first time using RSM and ANN algorithm to predict the outlet concentration, elimination capacity and removal efficiency of TMA. Both the algorithm can efficiently be employed to model the BTF performance for degrading TMA.

1. Introduction

Trimethylamine i.e. (CH₃)₃N is among the main source of odor discharged from several industrial units and is difficult to eradicate [1]. The common sources of gaseous Trimethylamine (TMA) are fishmeal processing plants [2,3] wastewater treatment plants [4], waste landfills, hog manure, and livestock farms [5,6]. TMA is a colorless gas with a low threshold limit and is potentially toxic to human health and considered carcinogenic [7,8]. TMA has been distressing the environment by subsidizing to the greenhouse effect, eutrophication and acid rain [9–11]. Therefore, TMA emission from various sources must be reduced up to reasonable limits for the betterment of the environment and human health. In recent times, biological treatment has been established as an effective and robust technology for eradicating various odorous gases and pollutants. Biological treatments have been highly efficient, economical and eco-friendly options for the removal of low concentration of gaseous pollutants, which are broken down to simple and non-toxic form [12]. The key component in the biotreatment procedure is the employment of microbial flora [13]. Several studies have been reported to show an effective removal of TMA with the use of

bacterial species viz *Curvibacter* sp, *Sphingobacterium* sp. [3], *Paracoccus* sp. [14], and *Aminobacter* [15]. The metabolic pathway of TMA degradation involves its mineralization to dimethylamine (DMA), which further is mineralized to monomethylamine (MMA) and finally into Ammonia [14]. Once the system was established, the most significant phase in a treatment procedure is modeling to establish the proficiency of the system. The treatment system models can be developed in a deductive manner or by statistical modeling. Developing such models require a precise assessment of certain factors which are required to resolve the understanding of the complex mechanism. Likewise, during the process optimization, a single parameter is changed at a time and keeping the other parameters constant. This procedure is not only a long process which also not describes the effect of other parameters in the operation and the interactions among them. The precise assessment of certain parameters includes intricate practical services and skill, the lack of which hampers the model's accuracy and confines its performance and consistency. In the present study, biotrickling filter was employed with *Ochrobactrum* and *Agromyces* sp. derived from the sludge of Indian Oil Corporation Limited (IOCL), Assam. The microbial culture was found to be highly efficient in the mineralization of TMA and its

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Ultrasound assisted encapsulation of peppermint flavor in gum Arabic: Study of process parameters

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Abstract

In the present study, ultrasound assisted encapsulation of peppermint flavor (core material) in gum Arabic (GA; wall material) was carried out in the presence of Tween 80 surfactant. It is well known that the intense environment generated due to cavity collapse in the presence of ultrasonic irradiations help in the preparation of fine emulsion which enhances the encapsulation efficiency of flavor. In this work, the use of ultrasound during encapsulation of peppermint flavor in GA, enhances the encapsulation efficiency to 87%. The effect of various parameters such as flavor concentration, GA concentration, and inlet temperature and feed rate during spray drying on encapsulation efficiency, product yield and particle size was studied. Also, the encapsulation of peppermint flavor in GA was confirmed using Fourier-transform infrared spectroscopy (FTIR) analysis. The particles size of obtained nanoparticles after spray drying is in the range of 45.2–255.7 nm. This encapsulation process is believed to enhance the shelf life and stability of flavors that may be protected from outside environment by reducing its reactivity.

Practical applications

Components of the peppermint flavor are first of all mono and sesquiterpene hydrocarbons and their oxygenated derivatives, and also phenylpropanoids. These are volatile substances sensitive to oxygen, light, moisture, and heat. Stability and shelf life of peppermint flavor will be lower when it is in liquid state because it is very sensitive to outside environment. This ultrasound assisted encapsulation process improves the processing time and encapsulation efficiency in lesser time which improves its stability and shelf life. Upon investigation of effect of direct exposure of peppermint oil to acoustic cavitation with bath and probe type and obtained FTIR patterns, its properties were found to be unaffected with acoustic cavitation. Further, in the present work, the effect of ultrasonication is little after encapsulation of peppermint flavor in gum Arabic wall material. Further the produced encapsulated materials are having uniform particle size distribution which can be prepared at industrial scale.

1 | INTRODUCTION

In the recent years, essential oils like rosemary, oregano, thyme, and peppermint obtained from various natural sources are being used as

efficient additives for food preservation due to their antimicrobial properties toward several foodborne pathogens (Burt, 2004). Peppermint oil is obtained from the leaves of the perennial herb, *Mentha piperita* L. and *Mentha arvensis* var. *piperascens* a member of the



Ultrasound assisted preparation and characterization of Ag supported on ZnO nanoparticles for visible light degradation of methylene blue dye

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ABSTRACT

The present work reports sonochemical preparation of zinc oxide (ZnO) and silver decorated ZnO (9 wt%) with the use of zinc acetate, silver nitrate and sodium carbonate as precursors in 60 min duration. The resulted ZnO and silver decorated ZnO nanoparticles were characterized with SEM, FE-SEM, FTIR, XRD and UV-Vis techniques. XRD analysis reveals hexagonal quartzite crystalline phase of ZnO with highest purity. The doping of silver differs the ionic radii of the elements and that produces the strain in Ag-ZnO nanocomposites. The average crystallite size of ZnO and Ag-ZnO estimated to be 17.53 and 18.73 nm, respectively with the use of XRD analysis. The lattice parameters, crystallite size and unit cell volume was observed to be increased with the loading of Ag on ZnO nanoparticles during its preparation with the aid of ultrasonic irradiations. The observed lesser size of nanoparticles and nanocomposites is due to the use of ultrasonic irradiations. Photocatalytic properties of ZnO and Ag-ZnO (doped) nanocomposite was examined for the degradation of methylene blue (MB) dye in aqueous solution under solar light irradiations. Influence of the initial dye concentration, catalyst loading, pH, and temperature on the degradation of MB dye was investigated and optimized conditions were obtained. Furthermore, a relative study of photocatalytic properties of ZnO and Silver doped ZnO nanocomposites prepared by conventional and sonication method was accomplished and the results were discussed. A maximum degradation of MB dyes was achieved (~96.2%) under optimized conditions for Ag doped ZnO nanocomposite prepared by ultrasound assisted method.

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1. Introduction

Recently, due to an extensive progress occurred in industries and supported with the enhanced human population, the extent of the pollutants released in the water bodies has been increased. Organic and toxic pollutants present in the water causes great concern. Therefore, the application of “green” technique like photocatalysis has been accomplished for the efficient removal of toxic chemicals available in water and is of a great interest for the researchers. The practice of heterogeneous photocatalysts in wastewater treatment has fascinated extensive consideration [1–3]. Amongst various semiconductors, and as compared to TiO₂, zinc oxide has been broadly applied as a photocatalyst, because of its nontoxic nature, excellent chemical stability, lower cost and significant usefulness in the photocatalytic degradation of various organic dyes pollutants and therefore widely examined [4–7]. Further, ZnO is considered to be an effective photocatalyst in comparison to TiO₂, though both have similar band gap and photocatalytic mechanism [8].

In the recent years, the preparation of functionalized photocatalysts is one of the most prime research areas. For the preparation of nanostructured materials, several available conventional techniques like co-precipitation [9–13], sol-gel process [14–16], chemical vapour deposition [17], thermal decomposition [18,19], hydrothermal synthesis [20,21], solid-state reaction [22], spray pyrolysis [23], vapour-liquid-solid method [24] and microemulsion precipitation [25–27] etc. have been used. Even though numerous wet chemical processes have been followed in various investigations, ultrasonication process has been used for the preparation of such tailored nanoparticles [28–39]. The sonochemical method is established to be highly effective method for the metal ions doping and is responsible for tailored photocatalytic efficiency of the prepared photocatalyst [40–49]. The conventional method of preparation has extended the reaction times usually in the range of 24 to 48 h and includes multiple steps in its preparation. Synthesis process of Ag doped ZnO nanoparticles plays a significant role in the governing size, morphology and properties of prepared nanocomposite through dispersion method and using ultrasonication [50]. The ultrasound assisted method for the preparation of various nanomaterials have been extensively used to prepare the novel nanomaterials with diverse characteristics, as this method can yield nanoparticles with smaller size and controlled shape [28–39]. The use of ultrasonication

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Accepted Article

Title: Facile SILAR processed Bi₂S₃:PbS solid solution on MWCNTs for high-performance electrochemical supercapacitor

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Hydrodynamic, Mass Transfer and RTD Studies of Fluid Flow in a Spiral Microreactor

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Abstract In this article, the spiral microreactor made of copper tube with *U*-junction, mixing region, was used to study the reactor performance on sodium hydroxide-*n*-butyl acetate system. The internal diameter of microreactor is 1.5 mm and length is 2 m. The performance of spiral microreactor was studied considering hydrodynamic flow, mass transfer characteristics, RTD and computational analysis of fluid flow using *n*-butyl acetate and sodium hydroxide system. Pressure drop was estimated in spiral geometry using dean number and compared with simulation results for laminar flow. The volumetric mass transfer coefficient obtained was in the range of 0.02–0.37 s⁻¹. The dispersion number calculated from the RTD study was equal to 0.0526 indicating the plug flow conditions.

Keywords Spiral microreactor · *U*-junction · Hydrodynamics · Mass transfer characteristics · RTD

Introduction

Microreactor is one of the efficient tools for optimizing reactor design for continuous flow synthesis of chemicals, nanoparticles, organic compounds and industrial pharmaceutical products. The characteristic microscale leads to higher volume-to-surface ratio, higher overall heat transfer

coefficients and the minimum mass transfer pathway [1, 2]. It is essential to develop novel microreactors with controlled characteristics to get new reaction pathways in continuous flow chemical manufacturing [3]. In order to scale up of continuous flow microreactor, it is very much essential to first understand the factors that are associated with it, such as effect on mass transfer rate by changing in configuration, hydrodynamics of flow, residence time distribution and flow regimes, which depends on geometry and mixing pattern of a microreactor. Burns and Ramshaw [4] have obtained mass transfer performance data for acetic acid extraction from kerosene that was performed by using chip-based design of glass microreactor of width 380 μm per channel. The obtained data were compared with other inter-phase contacting techniques. Further, Burns and Ramshaw [4] have concluded that for 15% acetic acid extraction, the value of F_o (Fourier number) obtained is 0.02 and for 62% extraction, F_o obtained is 0.30 [4]. Yue et al. [5] have also explored hydrodynamics and mass transfer characteristics experimentally for a rectangular microchannel oriented horizontally having a hydraulic diameter of 667 μm. The reported volumetric mass transfer coefficient was 21 s⁻¹, and interfacial area was 9000 m²/m³ [5]. To obtain volumetric mass transfer coefficients, the saponification method was successfully adopted by researchers Ghaini et al. [6] and Plouffe et al. [7].

There are many reports on glass microreactor, stainless steel and other materials. The reason to use copper material in microreactor is because of ease of fabrication of microreactor using copper materials rather than the steel or silicon. The copper tubes are available at low cost, and making *U*-junction is also very easy as compared to stainless steel tubes and other materials. So, an attempt was made to study the performance of copper microreactor for the reaction. While the reaction was carried out at room

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Journal Pre-proofs

Investigations on RE(TTA)₃tppo (RE=Eu/Sm/Eu_{0.5}Sm_{0.5}) rare earth β-diketonate complexes for OLEDs and solid state lighting

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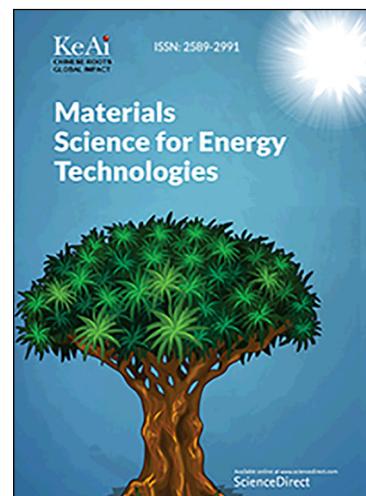
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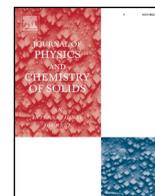
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Synthesis and characterization of green-light emitting (pbi-Cl)₂Ir(acac) complex



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ABSTRACT

This work reports the design, synthesis and characterization of the (pbi-Cl)₂Ir(acac) [pbi-Cl:2-(4-chlorophenyl)-1-phenyl-1H-benzimidazole, Ir: Iridium, acac: acetyl acetone] complex by Suzuki coupling reaction. X-ray diffraction disclosed its amorphous nature, Fourier transform infra-red spectra and nuclear magnetic resonance confirmed its structural formation, and scanning electron microscopy revealed highly agglomerated polygonal morphology. Thermo-gravimetric analysis and differential thermal analysis disclosed high thermal stability to about 307.40 °C. Absorption spectra of the solvated (pbi-Cl)₂Ir(acac) complex showed intense absorption bands in the ultraviolet region with optical band gap of 3.0 and 3.70 eV in acetic acid and chloroform, respectively. Oscillator strength of the (pbi-Cl)₂Ir(acac) complex in chloroform and acetic acid was in the range of 0.1146–0.543 and 0.0086–0.1530, respectively. The photoluminescence spectra of the (pbi-Cl)₂Ir(acac) complex in solid state exhibited intense green emission, peaking at 543 nm under excitation wavelength of 380 nm, and in acetic acid and chloroform it peaked at λ_{emi} = 513 and 538 nm, respectively. Commission International de l'Eclairage coordinates and phosphorescent quantum yield showed that the (pbi-Cl)₂Ir(acac) complex has potential as a green-light emitter in electroluminescent devices.

1. Introduction

Solid state lighting is envisioned as a vital and up-coming lighting technology with potential to fundamentally amend and progress the current lighting system. There is a need to focus on vigorous research by designing new materials that provide economical and hassle-free production and thermo-electrochemical stability using existing light-emitting technology [1–4]. Efficiency and stability are the two imperatives for organic materials, and dictate the performance of organic light-emitting diodes (OLEDs) [5,6]. The third-row transition metal complexes, particularly of Ir(III), have the ability to achieve nearly 100% internal quantum efficiency and high phosphorescence efficiency at room temperature because both singlet and triplet excitons can be harvested [7–12] and hence proffer significant benefits as light emissive complexes in OLEDs [13–16]. The OLEDs based on Ir(III) complexes show relatively good electro-phosphorescence with external quantum efficiency of about 27% [9]. The optical properties of Ir(III) complexes depend on the highest occupied molecular orbital (HOMO), considered to be metal centered, and the lowest unoccupied molecular orbital, located at heterocyclic rings of the cyclometallated ligands [17]. In the present study, Ir complexes possessing two types of ligands –cyclometallated ligand (main) and ancillary ligand

(secondary) [18–20] were designed and the structural, thermal and photo-physical properties explored. A benzimidazole-type cyclometallated ligand [21] containing an aromatic heterocyclic segment was selected as the main ligand because it has the ability to inject or transport the electrons. However, it cannot be used directly as an emissive layer due to its poor luminescence [22,23]. To be used as an emissive layer would require its conjugation length to be appropriately increased to shift the spectrum to the visible region, HOMO energy level to be raised in and so increase injection efficiency, and electron injection characteristics to remain unchanged [24–30].

2. Experimental

All reagents and solvents of analytical reagent grade were used as received without further purification.

2.1. Synthesis of the Ir(III) complex

Suzuki coupling reaction was employed for synthesis of the (pbi-Cl)₂Ir(acac) complex [pbi-Cl, 2-(4-chlorophenyl)-1-phenyl-1H-benzimidazole; acac, acetyl acetone] because complexes synthesized in this

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Transient thermal stresses due to axisymmetric heat supply in a semi-infinite thick circular plate

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Abstract

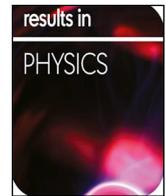
The present paper deals with the determination of thermal stresses in a semi-infinite thick circular plate of a finite length and infinite extent subjected to an axisymmetric heat supply. A thick circular plate is considered having constant initial temperature and arbitrary heat flux is applied on the upper and lower face. The governing heat conduction equation has been solved by using integral transform technique. The results are obtained in terms of Bessel's function. The thermoelastic behavior has been computed numerically and illustrated graphically for a steel plate.

Keywords: Heat Conduction; Michell's function; Thermal Stresses; Thick Plate; Goodier's thermoelastic potential; Thermoelasticity

MSC 2010 No.: 30E25, 35K05, 44A10, 74F05, 35A22

1. Introduction

Nowacki (1957) has determined steady state thermal stresses in a circular plate subjected to an axisymmetric temperature distribution on the upper face with zero temperature on the lower face



Comprehensive study on photophysical properties of Eu(TTA)₃bipy phosphor molecularly doped in PMMA and PS matrices

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ABSTRACT

Successful synthesis of the most studied europium activated β -diketonate red light emitting complex Eu(TTA)₃bipy in which 2,2' bipyridine is used as a synergistic ligand has been demonstrated. This complex is incorporated into Polymethylmethacrylate (PMMA) and Polystyrene (PS) at 10 and 25 wt% to check its compatibility with polymers. The photophysical properties of molecularly doped blended thin films were characterized by UV–visible absorption spectra and photoluminescence (PL) spectra in the solid state as well as by dissolving them in different organic solvents such as chloroform, tetrahydrofuran (THF), toluene (basic) and acetic acid (acidic). From the results of UV–vis absorption spectra, probability transition parameters were calculated. Thin films illustrated red emission, always peaking at 614 nm when excited at 380 nm, irrespective of solid state or solvated state. Comparison of optical intensities of the doped thin films dissolved in chloroform for different wt % and the pure complex in the same solvent reveals enhancement in PL intensity in the doped thin films rather than in pure complex. Relative intensity ratio (R-values) for different wt% of doping in PMMA and PS matrix were found to be in the range of 13.0–14.3. CIE coordinates of Eu(TTA)₃bipy in PMMA and PS for 10 and 25 wt% in solid state were found to be (0.66, 0.34) and (0.66, 0.33), whereas in solvated state the same was found to be (0.67, 0.32) and (0.66, 0.34), respectively, clearly indicating unique emission wavelength. These results dictate that the blended films are more economical as compared to the pure Eu(TTA)₃bipy, proving its great potential as strong red light emitting phosphor for the fabrication of optoelectronic devices such as OLEDs, flat panel displays by solution processing techniques.

Introduction

The cutting edge research in the field of lighting technology is the desire towards declining energy consumption and propelling pollution free solid-state lighting with organic light emitting diode (OLED) technology. OLEDs employ novel fabricating technologies that proffer considerable improvements in efficiency as well as the prospect to lighten the world with its staring designs and paper thin wall window display panels, which could go with the rapidly changing designs. However, there lie significant challenges to the designers of lighting industry to cope up with the users' expectations that OLED technology is energy efficient, eco-friendly and more advanced than the standard lighting sources. Owing to these challenges, the combination of rare earth ions in polymers has become a great deal of interest in the field of material research [1–4] globally. The most important reasons are (i) the enhanced luminescence and (ii) easy method of processing of such

combination [5]. The technological advances have been limited by the effect of concentration quenching (occurs at quite higher concentration of doping) when rare earth ions are doped in inorganic crystals for glass [6]. Such limitation can be overcome by enveloping the rare earth ion in the organic ligand, which provides the complex the ability to merge in the organic polymer matrix [7–9]. As far as red emissive materials are concerned, rare earth europium (Eu³⁺) and samarium (Sm³⁺) are widely used as effective ions for red light emission in OLEDs because of their colour purity. The rare earth complexes in coordination with chelating oxygen ligands like β -diketonates offers good stability and narrow emission bandwidth with enhanced luminescence efficiency and quality of colour emission [10–16]. The organic ligands have ability to strongly absorb the light and transfer this energy to the central metal ion through antenna effect [17]. Many red OLED devices using rare earth β -diketonates complexes have been reported [18–23]. Their reports revealed that organic materials have numerous

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Optimisation of Reaction Time and Methanol Consumption for Esterification of Palm Fatty Acids and its Kinetic Study

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Abstract : Palm fatty acids are chosen for esterification . The esterified oil is obtained in the presence of fatty acids and methanol. Various parameters are considered for the esterification of fatty acids. Amount of methanol has added in different molar ratio and vigorous stirring was employed at constant temperature. The heating schedule of complete reaction system is differed. These parameters lead effects in the product formation and its purity.

The esterification reaction of FFAs in the esterified production from PFAD in batch reactor system employing methane sulphonic acid as the catalyst has been studied. The optimum condition was observed at 14 hours has been studied , the amount of methanol added was 180gm , catalyst concentration of 1-2%(w/w) , stirring rate 400 rpm , and at reaction temperature of 60 – 75 °C . At the optimum condition , the achieved conversion of FFAs was found to be 99.17%. A kinetic model for the esterification of FFAs was established using the second – order homogeneous kinetic model involving the rate of mass transfer.

Keywords: esterification, optimisation, conversion, mechanism, kinetics.

Broad Initiatives

Esterified oil from non-petroleum is a wide area of research. Vegetable oils and other minor oils are one of the renewable form of resources which can be utilised for various commercial commodities.

Palm fruit are handled during harvesting and transportation , normal bruising occurs causing the fat in the fruit to start degrading . The longer it takes for the fruit to be transported, processed and refined into palm oil , the larger part of the fats degrade. When palm oil is being refined into food grade oil, these degraded fats, free fatty acids are removed by distilling to improve taste , odour and colour of the oil, as well as increase its shelf life.

Palm fatty Acid Distillate (PFAD) consists of these degraded fats that are undesired for food production and need to be removed during the palm oil refining process before the oil meets the food industry's quality standards. The annual production of PFAD totals approx. 2.5Mt as refining of palm oil generally yields approx..4-5% of PFAD as a processing residue (Informa Economics 2016).

Prajakt S Charhate *et al* /International Journal of ChemTech Research, 2019,12(2): 06-14.

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Refractance Window Drying: An Innovative Drying Technique for Heat Sensitive Product

S. V. Karadbhajne, V.M. Thakare, N.B. Kardile, S.M. Thakre

Abstract: A unit operation in which moisture is evaporated from the material to make the product shelf stable by applying heat is known as drying. During drying of fruits and vegetables, it loses most of the essential phytochemicals due to the application of heat, as they are sensitive to heat. Refractance Window (RW) drying is a novel drying technology for converting puree and slices of fruits and vegetables and the biomaterials into powder, flakes, or sheet and value added products without losing essential heat sensitive nutritional components. It is relatively new drying technique which belongs to the fourth generation of drying techniques. RW drying is included in film (thin) drying technologies having high transfer rates of heat and mass which fastened the drying rate relatively with low temperature of product to give better quality product. It also provides advantages in terms of energy consumption, impact on environment, dehydration cost, safety, and productivity.

Keywords: biomaterials, quality, Refractance window dryer, shelf stable.

I. INTRODUCTION

The process of removal of moisture from the product by the application of heat is known as drying. Drying is carried out to halt or slow down the growth of spoilage causing microorganisms and at the same time occurrence of deteriorative chemical reactions [11]. The process of drying also provides advantages in terms of minimizing storage, transportation and packaging cost of the product. It is a complex process that involves transfer of heat and mass as well as various rate processes, chemical or physical transformations that may cause changes in the quality of product and mechanisms of transfer of heat and mass. Physical changes that can occur during drying are puffing, shrinkage glass transition and crystallization. In certain cases, desirable or undesirable chemical or biochemical reactions may take place which leads to changes in colour, texture, odour or other properties of the solid product [3]

Dried fruits, vegetables and many other ingredients are being used widely in many food industries, which demands raw materials with good quality. In drying of heat sensitive fruits and vegetables maintaining quality parameters such as colour,

aromas and nutrients has always been a challenging task and today's consumer demands dried product with high quality that encourage developers to develop improved and innovative drying techniques which gives better result in terms of energy consumption, product quality, impact on environment, dehydration cost, safety and productivity [8].

Refractance window drying is a recently developed non-thermal drying technology among them to dry products including heat sensitive purees, and slices of fruits and vegetables, manufacturing meat powder and it can also be used in an algae, pharmaceuticals, nutraceutical, cosmetics and pigment handling industries where it has found several application [12]. It can be used to encapsulate the microorganism probiotic with proper survival of the microorganism in the food product [21]. It is relatively new drying technique which belongs to the fourth generation of drying techniques. It was patented by Richard Magoon (1986) was developed by MCD Technologies, Inc. (Tacoma, WA) [15]. It is a modular technology and 5 models are available up till now. The important characteristics of Refractance window drying technique are low product temperature and short drying time. Moisture in the product is removed by using thermal energy which is transferred from hot water through the belt above the hot water tank to remove moisture in the product [8] and ambient air above the product remove the evaporated moisture from the product by convective heat transfer.

The main advantages of this advanced drying technology are low drying cost due to working at lower temperature and atmospheric pressure, short drying time and low product temperature during drying, as well as cross contamination are avoided as it is an indirect contact drying technique which produces dried product of high quality. The dryer is mechanically simple; consume low energy, and relatively inexpensive. Drawbacks of RW dryer are its modest throughput, it is intended primarily to dry liquids, it is inconvenient in handling powder with high sugar content (stickiness) and high cost as compared to the drum and spray drying [17, 20].

The aim of this study is to give detailed description of film dryers or Refractance type drying of heat sensitive product which can be used for design and development. It also gives information about benefits of using Refractance window drying including colour retention, microbial reduction, and preservation of essential phytochemical and less energy consumption as compare to spray drying and freeze drying [25].

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Theoretical and Experimental Desalination Using Ultrasound Assisted PVDF Membrane in Direct Contact Membrane Distillation

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Abstract: Desalination by the direct contact membrane distillation (DCMD) for prepared saline water and Ambazari lake water sample was investigated. The self-prepared ultrasound assisted polyvinylidene fluoride (PVDF) membrane by wet phase inversion method exhibited effects on membrane contact angle, pore size, and porosity and investigated performance of DCMD. Membrane properties are characterized and employed in theoretical model with assumptions for water vapor transport in the transition region. It is observed that similar pattern obtained for permeate flux from experimental results and simulated results for transition region. Effects of operating parameter on permeate flux also simulated and compared with experimental data. For this work mathematical models developed and simulated in Polymath. PVDF membrane exhibited its characteristics like contact angle, pore size and flux enhancement may be due to ultrasound assisted polymer solution preparation for membrane casting.

Index Terms: desalination, hydrophobic membrane, PVDF, membrane distillation, ultrasonication

I. INTRODUCTION

About 70% portion of the Earth's is covered with 97.5 % salt water and remaining in glaciers form water. From whole water present on Earth's surface only 0.3% can be useful for human activity. Water plays vital role in any countries economic development [2]. But agricultural and industrial development of many developing countries causes 70 to 80% water pollution [3]. India is second largest populated country after China contributing 20 % of world population. Population growth of India demands nutritional food along with good quality drinking water, which needs more water. This leads India towards disaster shortly. All Indian water bodies within and near population centers are now grossly polluted with organic and hazardous pollutants released from domestic, industries and natural sources. Other than domestic sewage and industrial wastewater, there is another factor effects on water quality depletion; large number of idol immersion in water bodies due to use of heavy metals during idol sculpturing in the form of paints causes increase of heavy metal level than desirable level.

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In the membrane separation process membrane plays vital role; to meet demand of membrane characteristics, preparation and application of hydrophobic membrane have become a recent trend in membrane science [4-6]. The hydrophobic characteristic of the membrane is very important for membrane distillation; membrane with low hydrophobicity enhances membrane pore wetting so reduces rejection rate and permeate flux [7]. PVDF membrane came into focus due to excellent chemical and mechanical properties [8]. However, membrane distillation (MD) is not fully accepted at industrial level. MD has different configurations; DCMD is commonly used MD configuration considered in this study. MD works on basic principle of transportation of water vapor from hot side fluid to cold side fluid of membrane due to vapor pressure difference on two sides of membrane. So many attempts have been observed in literature based on three regimes during membrane distillation. In this work we prepared novel ultrasound assisted hydrophobic PVDF membrane with phase inversion method and transition model used to check and correlate experimental and simulated data from model. Numerical iterative technique has been used to solve the set of nonlinear equations of flat sheet DCMD process for desalination. Validity of model is evaluated by comparing with obtained experimental results.

II. MODEL DESCRIPTION

D is a nonisothermal thermally driven process in which vapor molecules transfers from feed solution i.e. hot solution to permeate side, where cold liquid or gas may present to condense vapor molecules transferred through microporous hydrophobic membrane. DCMD represents complex heat transfer mechanism due to simultaneous heat transfer and mass transfer. Due to simultaneous heat transfer and mass transfer; mass transfer shows effect on heat transfer coefficient and its flux in feed and permeate side.

Due to simple configuration of DCMD, most of the modeling approach for MD process has been shown towards DCMD. Whatever models developed till now days depends on measuring the resistance of mass and heat transfer in the MD process. Heat balance is applied to predict membrane interface surface temperature in DCMD.

After evaporation of water molecule in water vapor from feed solution transfers through membrane pores by mass transfer mechanisms; Knudsen diffusion, Poiseuille flow, molecular diffusion, transition flow and surface diffusion in DCMD.

MWCNT REINFORCED COMMERCIAL EPOXY RESIN COATING FOR ROBUST HYDROPHOBIC COATING

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ABSTRACT: Robust superhydrophobic coating was prepared by reinforcing bisphenol A diglycidyl ether (BADGE) epoxy resin with functionalized multi-walled carbon nanotubes (MWCNT). 0.1, 0.3 and 0.5 % of functionalized MWCNT in epoxy resin were coated on stainless steel. Functionalized MWCNTs improved the interfacial bonding between the nanotubes and epoxy resin. Field Emission Scanning Electron Microscope (FESEM) images confirmed the superior dispersion of MWCNT in the epoxy matrix. The dispersion of functionalized MWCNT reinforced epoxy composite was studied by X-ray diffraction. Coated panel were kept in water for the period of 3 and 7 days for fouling studies. The study of hydrophobicity and changes after keeping panels in water did by using contact angle test. The effect of percentage of functionalized MWCNT in epoxy resin on hydrophobicity of coating was discussed in detail.

KEYWORDS: Contact angle, Epoxy resin, Functionalized multi walled carbon nanotubes, Superhydrophobic surface.

1. INTRODUCTION

Polymer-based superhydrophobic surfaces and coatings have recently attracted a tremendous amount of attention with extraordinary water repellency. The Superhydrophobic surface has been used to describe a surface that exhibits contact angles of greater than 150° [1]. This kind of surfaces have attracted tremendous attention due to their broad applications in scientific and industrial applications, such as self-cleaning [2-5], anti-fouling and anti-scaling [6-8], anti-icing [9, 10], oil-water separation [11, 12], drag reduction [13, 14], medical applications, transparency and anti- reflection [14] and others.

Epoxy resin is one of the best choices for designing superhydrophobic coating due to its versatility and practical characteristics such as robust physical, chemical, and mechanical properties, safety, heat absorbance, high bonding strength and low costs [15-16]. Good compatibility of epoxy resin with hard as well as soft surfaces gives high versatility for the applications in advanced functional materials [17].

A large number of studies have been done to design superhydrophobic surface by using graphene. The carbon nanotubes in coating gives structural integrity as well as superhydrophobicity even after exposure to extreme thermal stresses and have excellent thermal and electrical properties [18]. MWCNT composite film provides a superhydrophobic coating with high contact angle values and high adhesion force for stainless steel [19]. In the

Studies on Packaging Material and Shelf Life Estimation of Ready to Use Indian Curry Base

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Abstract - The static gravimetric method, along with the different salt solutions was used in a range of water activity of 0.50-0.90 at 37.8° C and 75 % RH to obtain the isotherm of the product. The isotherm obtained at 37.8° C was desorption J shaped curve represented as type III isotherm. The Equilibrium Moisture Content (EMC) was used to evaluate the shelf life of curry base at 37.8° C and 25° C and at 75 % RH. The shelf life of the product was studied by calculating Half Value Period (HVP) of the product which was packed in laminates for storage at 37.8° C and 25° C and 75 % RH. The product contained 36.62 % moisture content, 4.51 % volatile oil content and the peroxide value remained unchanged. As per HVP (150 and 188 days), shelf life of 212 and 262 days was estimated at respective temperatures and relative humidity.

Keywords: Sorption isotherm, Curry Base, HVP, shelf life, (k) packaging material constant.

1. INTRODUCTION

Convenience food, or tertiary processed food, is food that is commercially prepared (often through processing) to optimize ease of consumption. Products designated as convenience food are often sold as hot, ready-to-eat dishes; as room-temperature, shelf-stable products; or as refrigerated or frozen food products that require minimal preparation. Convenience or instant food is the order of the day especially amongst the urban population. They are hard pressed for time and are willing to pay for good quality convenience food. Changing lifestyles and overall increase in the standard of living have witnessed substantial increase in demand for such items.

Curry base is a new type of convenience food. Curry base has been used in cooking for vegetarian and non-vegetarian recipes. The curry base is generally prepared as paste which is composed of spice such as onion, ground nut, ginger, garlic, dry mango powder,

turmeric powder, chilli and its powder, cumin seeds, coconut, poppy seeds, cardamom, cinnamon, coriander seeds, etc. and makhana flour as a binding agent. Curry base preparation is pre-processing prior to main curry processing. It normally took 1 to 2 hrs for small serving preparation whereas 5 to 6 hrs when been done for large processing. The short shelf life of paste is generally due to the microbiological spoilage from moulds (Supachai Pisuchpen, 2008). To improve the consistency and body forming of the product, it is made by mixing it with makhana flour as a binding agent. The mix contains around 34 % moisture and 31% oil content. In addition, the water activity of mix is around 0.85-0.90 at its initial moisture content (Supachai Pisuchpen, 2008). Moisture content in food is one of the predominant factor affects the physical, chemical, microbial and sensory properties which are the key properties for consumers and shelf life (Robertson, 1993). The shelf life of the food can be predicted by the mass transfer characteristics of the package-product system (Supachai Pisuchpen, 2008). Winks weight equilibrium method (S. Ranganna, 1986) was used to determine the equilibrium moisture content of the product at 37.8° C and 50% to 90 % RH. The estimation of the shelf life of packaged food was done by using relation of half value period (Oswin, 1945) at 25 ° C and 37.8 ° C and at 75 % RH.

The objectives of this study were (i) to determine the equilibrium moisture content and (ii) to establish the shelf life of the packaged product.

2. Experimental

2.1 Materials

The materials used for the preparation of the mix were ginger, garlic, onion, groundnut, dalia, chilli and its powder, coconut, turmeric, salt, dry mango powder,

Extraction & Characterization of Pectin from Mixed Fruit Peels Waste

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Abstract – Fruit and vegetable peels are considered agro waste and are thrown into the environment instead of being used as a source of nutrient, supplement or antimicrobial agent. Various studies conducted on peels revealed the presence of these useful constituents, which can be used for various purposes. Present work addresses to this issue partially & attempts in separation of pectin from combined fruits peels mixture like apple, pineapple, orange, sweet lime, and pomegranate. Experimental studies are conducted for combinations of fruit peels waste & the FTIR of the samples A-1, OLP-1, APO-1 have been carried out. From the comparison of the spectrogram, it can be observed that the wavenumbers are in agreement with each other and with that reported in literature for pectin. The percentage of pectin isolated is observed to be in A-1 (0.05%), APO-1(14%), OLP-1 (12%). Thus, it can be concluded of various combination of fruit peels tried in the present work that a good amount of pectin can be isolated effectively.

Key Words: mixed fruit peels waste, pectin extraction, orange peel, apple peel, pineapple peel, pomegranate peel, lime peel

1. INTRODUCTION

India is the second largest fruit producer in the world after China as per the report of the ministry of horticulture and produced 82.631 million tons of fruits in 2014-15, while China tops the list with 154.364 million tons. The current apple production in India is around 20 lakh tons per year and is predominantly grown in Jammu and Kashmir, Himachal Pradesh and Uttarakhand. India produces 29 lakh tons of excellent quality oranges per year mostly in the central part of India. Around 1415 thousand ton per year of Pineapple is grown in almost entire north east region whereas production of Citrus limetta, also known as mousambi, is around 3251.68 tons per year. Production of Pomegranate is around 743 thousand tons per year & Maharashtra is leading producer of it followed by Karnataka, Andhra Pradesh, Gujarat and Tamil Nadu.

Fruit and vegetable peels are considered agro waste and are thrown into the environment instead of being used as a source of nutrient, supplement or antimicrobial agent. Various studies conducted on peels revealed the presence of these useful constituents, which can be used for various purposes. By-products and waste materials if discarded without processing have detrimental impact on environment & affects economic, and social sectors. The fruit waste is one of the major concerns contributing to global environmental burden. While some of the agricultural wastes can be used as animal feed or fertilizer; waste such as pulp & peel can be treated for value added products such as pectin, essential oils, lignin & cellulosic constituents.

Presently many cities have adopted segregation of dried and green waste material, however these may not lead to value addition to the waste. The Present work addresses to this issue partially & attempts in separation of pectin from combined fruits peels mixture like apple, pineapple, orange, sweet lime, and pomegranate.

2. LITERATURE SURVEY

An outline of the summary of published papers on related theme is given below:

The paper titled [1] "Separation of oil and pectin from orange peel and study of effect of pH of extracting medium on the yield of pectin" discusses about an orange specifically, the sweet orange (citrus sinensis (L.)) which is the most commonly grown tree fruit in the world. Orange trees are widely cultivated in tropical and subtropical climates for the sweet fruit, which is peeled or cut and eaten whole, or processed to extract orange juice and also fragrant peel. The orange processing industry can get a complete makeover if due importance is given for separation of useful ingredient from orange peel. The outcome of this work highlighted that sweet orange peels are good source of orange oil and pectin and does have the potential to become important raw material for food processing industries. Two methods namely simple distillation and leaching have been explored for separation of oil from peels. It is found from the experimental observation that the orange peel source gives higher yield than leaching residue when orange oil is extracted using simple distillation

Novel layer-by-layer casting of Chitosan-Alginate edible films

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ABSTRACT

In recent years, there has been remarkable development in edible films and coatings using biopolymers. Edible packaging is usually prepared with natural polymers that are non-toxic, biodegradable & readily available. The advantages such as biodegradability, non-toxicity and improved shelf life have caused edible packaging used widely in food industry. Edible films are synthesized either by direct casting or layer by layer assembly using polysaccharides such as chitosan, sodium alginate, carboxymethyl cellulose, starch, pectin etc. Chitosan based film have tendency to form gel solution when comes in contact with moisture whereas alginate-based films have zero water resistance. The novel feature of the present work is that, it addresses to the experimental studies on layer by layer casting of chitosan and alginate, using glycerol as a plasticizer. Film samples are analyzed for the GSM, functional group presence & water resistance. Based on the observations, result and discussion it can be concluded that, the novel method of the present work involving layer by layer casting of chitosan and alginate have successfully resulted in films with better moisture resistance.

Keywords – Chitosan-Alginate composite film, Edible film, layer by layer, moisture resistance

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I. INTRODUCTION

The growing environmental concerns regarding non-biodegradable plastic packaging materials have increased interest in the use of biodegradable alternatives from renewable sources. In recent years, there has been remarkable development in an edible film and coatings using bio-polymers.[1] An edible packaging film is a continuous layer of edible material formed on, placed on or between the food components. Edible packaging is usually prepared with natural polymers that are non-toxic, biodegradable & readily available. The film forming matrix, solvent, plasticizer and other additives are food grade component. The advantages such as biodegradability, non-toxicity and improved shelf life have caused edible packaging used widely in the food industry. Edible films are synthesized either by direct casting or layer by layer assembly using polysaccharides such as chitosan, sodium alginate, carboxymethyl cellulose, starch, pectin etc., Chitosan is a cationic polysaccharide isolated from chitin. It consists of β -1,4-linked polymer of glucosamine (2-amino-2-deoxy- β -D-glucose). It imparts antibacterial property to the packaging film. Alginate is sodium salt of alginic acid, with block copolymer of β -D-mannuronic acid (M) and α -L-guluronic acid (G), and is isolated from brown seaweed.[2] It forms strong, translucent, glossy

films. The mechanical strength of the edible film can be improved by using plasticizers as an additive. The present work addresses to the experimental study on alternate layer by layer casting of chitosan and alginate films using glycerol as a plasticizer.

II. LITERATURE REVIEW

The outline of literature survey conducted is given below;

P.K.Dutta et.al, highlighted various preparative methods and antimicrobial activity including the mechanism of antimicrobial action of chitosan-based films by incorporating garlic oil. Chitosan films are prepared by solution cast method. Garlic oil enhances antimicrobial activity of chitosan film and had little effect on mechanical and physical properties of chitosan films.[3]

F. Karimnezhad, V. Razavilar et.al conducted experimental studies on the antimicrobial effects of chitosan-based edible film containing T. ammi essential oil on shelf-life of chicken meat. Chitosan solution was prepared by dissolving chitosan powder in an aqueous acetic acid. T. ammi essential oil was added to homogeneous solution. Tween 80 was used as plasticizer. The pH was maintained at 5.8 using NaOH solution. After drying the films at room temperature for at least 36 h, they were peeled from the plates. All meat samples were surrounded and packaged using the prepared

Chitosan Gelatin Multi-layered Biodegradable Films For Wrapping Food Materials

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Abstract: : The development of edible films based on polysaccharides and proteins has brought a significant increase in their applications and in extending shelf life of fruit and vegetables. The composite film of such biopolymers is effective for improving the physical properties of edible films; however, film performance can be reduced if there is a lack of careful consideration of the compatibility of these blended components. The present work addresses to the experimental study on multilayer casting of chitosan and gelatin films and investigate comparative study of chitosan, Gelatin, chitosan-gelatin blends and multi-layered edible films. Film samples are analysed for thickness, functional group presence and water solubility. In order to evaluate the potential application of the prepared films in food packaging, the shelf life of the milk bread wrapped with films was studied. Based on the observations, result and discussion it can be concluded that, the present work involving multilayer casting of chitosan and gelatin have successfully resulted in films with better moisture and water solubility resistance along with good strength and show antimicrobial performance against *E. coli* , *L. mono-cytogenes*.

Key Words: Biodegradable, Chitosan-gelatin films, Edible, Food packaging, Shelf life, Water solubility.

1. INTRODUCTION:

The environmental impact of non-biodegradable packaging waste material is of increasing global concern & it is a necessity of the hour to develop eco friendly packing materials.[1] The development of edible films based on polysaccharides and proteins is one such initiative & has brought a significant increase in their applications by extending shelf life of fruit and vegetables. Edible coatings and films can provide a protective layer around food product. Film-forming polysaccharide materials include starch & its derivatives, cellulose derivatives, alginate, carrageenan, pectin, chitosan etc. Proteins that have received great attention for their capability of forming edible films and coatings include corn zein, wheat gluten, soy protein, whey protein, casein, collagen/gelatin, pea protein, rice bran protein, cottonseed protein, peanut protein, and keratin [2]. Plasticizers used for edible films and coatings include sucrose, glycerol, sorbitol, propylene glycol, polyethylene glycol, fatty acids, and monoglycerides. [3] Edible films containing proteins and polysaccharides as the film matrix materials typically utilize the distinct functional characteristics of each film forming component. The composite film of such biopolymers is effective for improving the physical properties of edible films; however, film performance can be reduced if there is a lack of careful consideration of the compatibility of these blended components. The incorporation of polysaccharides into globular protein matrices may extend the functional properties of these ingredients.[4][5] Among these biopolymers, chitosan and gelatin have attracted increased attention since derived films and coating

improve the food quality & shelf life of the protected food due to their adequate mechanical & excellent gas barrier properties.[6] The advantages such as biodegradability, non-toxicity and improved shelf life have caused edible packaging used widely in the food industry. Chitosan is one of the versatile functional polysaccharides comprising β -1,4-linked polymer of glucosamine (2-amino-2-deoxy- β -D-glucose)[7] Gelatin has good film forming property. However, the poor mechanical, thermal & barrier properties in comparison to conventional plastics are the major disadvantages to use gelatin as food packaging material. Edible films of protein show satisfactory gas barrier & mechanical properties. In general, blending of these two different biopolymers may optimize the physico-chemical and barrier properties of the gelatin based films for food applications.[8] Edible films produced from denatured proteins have the potential for decreased moisture and gas permeability and solubility and improved mechanical properties, thereby enhancing their potential use as packaging materials.[9]

2. LITERATURE REVIEW:

Gelatin films, with high puncture strength, low puncture deformation, and high water vapor permeability, prepared from bovine and porcine skin have been reported.[10][11] Simon-Lukasik and Ludescher studied oxygen permeability through gelatin films, also the functional and thermal properties of edible films made from blends of gelatin and starches have been studied.[12] It can form films and coating with good optical properties and act as bio-packaging materials. [13] Composite films of chitosan and gelatin

Novel Method of Lignin Separation from Almond Shells Applying Multiple Contacts

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Abstract - Almond shell is the name given to the ligneous material forming the thick endocarp or husk of the almond tree fruit. Lignin is the second most abundant natural polymer next to cellulose. Its complex structure helps it to function like adhesive that binds cellulose and hemicelluloses. The present work addresses to the isolation of lignin from almond shells. A novel method that includes different solvents in combination of multiple stage contacting in a reflux setup has been used. The solvents included ethanol-water (60:40 v/v) and 3% NaOH. The FTIR analysis of the samples L1, L21, L22 and L32 have been carried out. The spectrogram of these samples is compared with that of lignin isolated from almond shells and reported in literature. From the comparison, it can be observed that the wavenumbers are in agreement with each other and with that reported in literature. The percentage yield of lignin isolated is observed to be 5.89%, 16.54%, 28.33% respectively for single stage contacting using EtOH-H₂O, two stage contacting with EtOH-H₂O at 1st stage & 3% NaOH solution at 2nd stage and two stage contacting using 3% NaOH solution at both stages respectively. Thus, it can be concluded that of the various combinations tried in the present work, two stage extraction employing 3% NaOH solution in each stage using reflux setup resulted in better yield.

Key Words: Novel lignin isolation technique, lignin isolation, almond shells, multistage contacting, 3%NaOH solution

1. INTRODUCTION

Almond fruit consists of three or correctly four portions: kernel or meat, middle shell, outer green shell cover or almond hull and a thin leathery layer known as brown skin of meat or seed coat. The nutritional importance of almond fruit is related to its kernel. Other parts of fruit such as shells and hulls were used as livestock feed and burned as fuel. In the past decades, different phenolic compounds were characterised and identified in almond seed extract and its skin, shell and hull as almond by-products. In addition, poly-phenols are abundant micronutrients in the human diet, and evidence for their role in the prevention of degenerative diseases such as cancer and cardiovascular diseases is emerging. The health effects of poly-phenols depend on the amount consumed and on their bioavailability. [1]

Almond shell is the name given to the ligneous material forming the thick endocarp or husk of the almond tree fruit. When the fruit is processed to obtain the edible seeds, big ligneous fragments are separated. These materials remain available as a waste product for which no important industrial use has been developed, so they are normally incinerated or dumped without control. Almond shells can be ground up and used as bedding for garden planters and landscape material similar to wood chips. Almond shells are most commonly sold to co-generation plants to be used as a fuel source. They are robust and rigid in nature. This nature of shells indicates presence of lignin and cellulose.

2. LITERATURE SURVEY

Pure cellulose crystals had been successfully extracted by Najeh Maaloul, Rim Ben Arfi, Manuel Rendueles, Achraf Ghorbal, Mario Diaz from Tunisian almond shells using a combination of chemical treatments, such as alkaline treatment, bleaching, and sulphuric acid hydrolysis. The hydrolysis products of cellulose crystals without further dialysis had been thoroughly characterized. In this work, the chemical analysis of the raw materials revealed interesting levels of α -Cellulose (29.9 wt%) and lignin content (30.1 wt%). Before the extraction of cellulose, dried almond shell was milled and screened to select the fraction of the particles that were below 60 mesh. The crushed plants fibers were dewaxed with a mixture of chloroform and absolute ethanol (2:1 ratio, v/v) under a mechanical stirring for 24h. Then, the fibers were washed with distilled water until filtrate pH was neutral and dried. Dried product was treated in 4 wt% NaOH solutions at 80-90°C for 2h to remove hemicelluloses with residual starch and pectin. This alkali treatment was conducted two times, and after each treatment, the fibers were filtered and washed with distilled water to remove the alkali-soluble components. Lignin in the fibers plants was removed by a sodium hypochlorite solution 2.5 wt% at 70°C for 1h under mechanical stirring and was repeating two times. The bleached fibers were subsequently filtered, washed with distilled water, and air dried. Bleaching treatment was used to facilitate the removal of the majority of the residual lignin content. [2]

Design of Table Top Electrocoagulation Unit for Remediation of Wastewater from Paper Industry

Table Top Electrocoagulation Unit for Wastewater Treatment

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Abstract:- The water pollution caused by organic and inorganic compounds is a global problem originated by natural or anthropogenic sources; particularly the effluent generated by paper and pulp industries. This paper highlights the usage of mobile electro coagulation as one of the efficient and inexpensive remedy for treatment of water and wastewater. The effluent source from the paper industries usually have severe pollutant load that may exceed the TSS value 1000 ppm, TDS of 5000 ppm and COD up to 20,000 ppm carrying pungent odor and color. The table top design of Electrocoagulation unit for the aforesaid treatment consists of iron/ aluminum as sacrificial anode with rotational facility. Special emphasis has been focused to investigate the optimum operational conditions viz. effect of pH, contact time and selectivity of electrode for maximum removal efficacy. The proposed research work clearly reveals the impact of the gyration of electrodes which facilitates the intimacy between the metal cations with the effluent, results in significant reduction in pollution load. Using the aforesaid mechanism under optimum conditions; color, odor, TSS, TDS and COD removal has been noted up to 95%, 100%, 95%, 49% and 71% respectively.

Keywords: Coagulation; effluent; electrodes; wastewater.

1. INTRODUCTION

At the turn of the last century, it was estimated that about one-sixth of the total world's population are supplied with polluted water. The right of all people to access suitable water supplies must thus be seen as a global challenge, the solution of which is dependent on the formulation and implementation of sustainable water management strategies [1]. In this new era, sustainability is the main factor to encounter the challenges of depletion of our reserves and environmental upsets. Effluents of paper industries contain highly toxic compounds and organic bio-refractory compounds which accounts for high COD, BOD, TDS and TSS along with pungent odor and color [3]. Pulp and Paper industries have been responsible for important technical and socio-economic impacts in a country. They are distinguished contributors of pollutants to the environment in the form of

black liquor. Lignin in black liquor contributes to more than 50% of the total COD load [3,4]. It harms fish, wildlife and contaminates the food chain if poured down a storm drain. Water usage is high in Paper Industries, based on type of paper produced and its cost of processing and supplying. However, it is highest in specialty paper mills and it varies from 370-1220 m³/ton of paper [5, 6]. The global best specific water consumption is 28.66 m³/ton of paper. This large gap is because of use of conventional manufacturing and treatment technologies and less water management practices by industries. In comparison with international standards Indian Paper industry uses 200% more water, 10% more chemicals and about 30% excess raw material and energy [7]. It has often observed that water is the most misused commodity in the industry. The mini paper mills having capacities below 30 TPD (tones per day) accounts for nearly 20% of total production in the country. The entire black liquor is discharged as pulp wash water in small mills as it is not economic to go for chemical recovery. Pollution load from small mills is therefore nearly equal to that of big mills.

In recent years, variety of novel processes for efficient and adequate treatment of industrial effluent with relatively low operating costs has been explored due to strict environmental regulations [8,9]. Electrocoagulation process has been attracted a great attention for treatments of industrial wastewater such as pulp and paper mill and rayon pulp mill [10]. Literature reports state that attempts were made to increase the efficiency of the process by making use of punched or oscillating electrodes [11].

1.1. Description of Technology

Industrial wastewater is in possession of impurities including colloidal particles and dissolved organic substances. The finely dispersed colloids or suspended solids are usually repelled by their outer layer of negative electrical charges and maintain the colloidal nature until treated by flocculants/coagulants for their removal [12]. This article

Optimization of Fin Spacing of Vertical Plate Fin Heat Sink in Natural Convection

D.D.Palande, A.M.Mahalle, N.C.Ghughe, P.N.Belkhode

Abstract: Heat sinks are frequently used in the cooling of electrical and electronics devices. If the heat sink has very close fin spacing, it increases the surface area but reduces the heat transfer coefficient. On the other hand, if the heat sink has wide fin spacing, it reduces the surface area but increases the heat transfer coefficient. Therefore, there is a need to optimize the fin spacing that enhances the heat transfer from the heat sink. A properly selected heat sink may reduce the operating temperature and reduce the risk of failure of components. A steady state natural convective heat transfer from aluminum plate fin heat sink was examined experimentally. The length and thickness of the fin were kept constant while the height was varied from 5mm to 25mm and the spacing varied between 5.5mm to 17mm. After experimentation, it was observed that fin spacing plays an important role than any other geometrical parameters. Response surface methodology is used for optimization of fin spacing. It is observed that the optimum fin spacing of the heat sink is 8.28mm. The error analysis is done with the help of ANOVA and flow visualization was done using CFD.

Keywords: Natural convection, fin spacing, Response Surface Methodology.

I. INTRODUCTION

Many researchers have worked on fin geometry to improve the heat transfer. Still more efforts are needed in order to understand the complete behavior of geometry variation and its effect on heat transfer and fluid flow application. The selection of a particular heat sink depends on the required thermal performance and application. Among the literature, the most common studied heat sink was the rectangular heat sink because of simplicity in manufacture. B. Yazicioglu, H. Yuncu [1] experimentally investigated natural convection heat transfer from vertical fin arrays by changing the fin height, fin spacing and base to ambient temperature difference. The study shows that fin spacing is playing a major role than any other geometrical parameter. Yüncü and Güvenc [2] concluded that fin spacing was the most important parameter in the thermal performance of fin arrays and an optimum fin spacing can be found for every fin height, for a given base-to-ambient temperature difference. R. Arularasan and R. Velraj [3] carried out the modeling and simulation of parallel plate heat sink by using computational fluid dynamics package. The result shows that, 20 numbers of fins with 30mm fin height and 7.5mm base

Height gives lower thermal resistance and higher heat transfer compared to all other geometries. S. Manivannan, S. Prasanna Devi, et al. [4] Taguchi's design of experiments was performed by using Minitab software. The factors to be considered for optimization are length and width of the heat sink, fin height, base height, number of fins, and fin thickness. They also carried out ANOVA test for finding out the contribution of various parameters. Ko-Ta Chiang et al. [5] using RSM analyzed the results showing that design parameters, such as height and diameter of pin-fin and width of pitch are the significant influence factors to minimize thermal resistance and pressure drop. R. Senthilkumar, et al. [6] analyzed natural convective heat transfer of nanocoated aluminum fins using Taguchi method. They found 5% more fin efficiency for coated aluminum surface. D.D.Palande, A.M.Mahalle [7] has experimentally investigated different heat sinks. It is concluded that fin spacing is a significant parameter for better heat transfer.

II. EXPERIMENTAL SETUP AND EXPERIMENTATION

An experimental setup is designed and fabricated to investigate the enhancement in heat transfer in natural convection using plate fin heat sink. To ensure natural convection, a large enclosure is required to be made symmetrical about a vertical plane. It is required to heat the plate arrangement to obtain the natural convection effects by using suitable heating arrangement. The experimental evaluation of the results requires temperature measurements at several locations on the heat sink and also temperature of the surrounding. The enclosure is open from top and bottom. A schematic view of the experimental set-up is shown in figure 1.

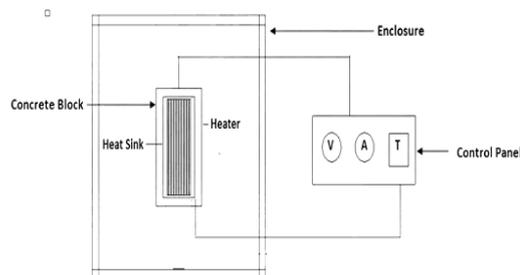


Fig. 1. Experimental setup

For all Aluminum plate heat sink 2.5 mm thickness and 200 mm length and 75 mm width were fixed while the fin height varies from 5mm to 25mm and fin spacing varies from 5.5 to 17mm.

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ABSTRACT

In the recent times, cellulosic derivatives and lignin have become important materials in various industries. One of the sources, the Jackfruit peel, remains one of the lesser explored renewable alternatives to extract cellulose and lignin constituents. Jackfruit peels are usually discarded off as waste, which can be utilised to produce valuable entities. Hence it is substantial to find out the approximate content of cellulosic constituents and lignin in the jackfruit peel and to isolate them. The present work summarises isolation of cellulosic components and lignin using chemical treatment in a reflux setup under moderate conditions of temperature and pressure along with a thorough analysis of the isolated constituents for functional group presence using FTIR spectroscopy.

KEYWORDS: jackfruit peel, cellulosic constituents, lignin, isolation.

1. INTRODUCTION

Jackfruit (*artocarpus heterophyllus*) is one of the popular fruits in India, where the total area under cultivation for this fruit is about 13,460 ha. Around 1.4 million tones in India every year. It is the largest tree-borne fruit. It reaches up to 55kg in weight, 90 cm in length and 50 cm diameter. They are mostly found in tropical lowlands and utilized majorly in South Asia.

In India, even after the utilization of jackfruit produced, the resulting wastage is worth crores of rupees. The major ingredients present in jackfruit are starch, cellulose, hemi-cellulose etc. whereas the other components like lignin, pectin, protein and moisture are also present.

A typical partial composition of jackfruit peel is given in table below.

Table 1 composition of jackfruit peel

PARAMETERS	WEIGHT (%)
CELLULOSE	27.75 ± 0.06
PECTIN	7.52 ± 0.12
STARCH	4.12 ± 0.02
PROTEIN	6.27 ± 0.03
MOISTURE CONTENT	12.98 ± 0.42

Cellulose is an organic compound with formula $(C_6H_{10}O_5)_n$ & is an important structural component of cell walls present in green plants. It is the most abundant organic polymer on earth. It is a linear polymer composed of single sugar molecule unit adjoined by β -1-4 glycosidic oxygen linkages. This polymer has versatile uses in textile cosmetic and pharmaceuticals industries.

Advances in Low Temperature Processing

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Abstract --- Food is preserved by various methods such as high temperature processing (heating, blanching), low temperature processing (freezing) or by using chemicals. This paper reviews about novel technologies applied to low temperature freezing process like pulsed electric field treatment, high pressure processing, ultra sound freezing, ultra rapid freezing and pressure shift freezing. Low temperature freezing changes water (present in food) into ice in the number of crystals. Due to applied pressure, electric current and voltage small ice crystals are formed which are uniformly distributed to whole food. Hence, foods shelf life increases. Colour, texture, structure, taste, appearance and quality attributes are better preserved in freezing. Low temperature processing offers several advantages such as preservation of color, flavor, texture, appearance and volatile retention, modification of sensory qualities and inhibition of bacterial growth. Novel technologies applied to thawing like high voltage electric field thawing, radio frequency thawing and ultra sound assisted thawing have also explained. Thawing is process of conversion of frozen ice into liquid i.e. frozen ice crystals into water. Heat is supplied to frozen food which converts frozen food into unfrozen. Hence, these novel technologies have become beneficial in terms of preserving food and quality attributes & sensory characteristics.

Keywords — Pulsed electric field treatment, high pressure processing, ultra sound freezing, ultra rapid freezing, pressure shift freezing, high voltage electric field thawing, radio frequency thawing and ultra sound assisted thawing.

I. INTRODUCTION

Spoilage occurs due to chemical, biological, physical and enzymatic activities in the food that cause rancidity/poisoning. Due to which, food industries commenced use of preservatives such as salt, sugar, vinegar, benzoates, nitrites, sulphites and sorbates which is the easiest, simplest and commonly used methods for food preservation [Z.I.M. Sharif et al., 2017]. Another techniques for preservation [Z.I.M. Sharif et al., 2017] such as heating, drying, pickling, smoking, freezing, edible coating or high pressure processing [Navin k. Rastogi, 2013] have also been

practiced to preserve food. These preservation techniques increases foods shelf life, maintain its nutritive value, stabilizes quality and preserve taste, colour & flavour [Z.I.M. Sharif et al., 2017].

Freezing is the widely used and common technique of preservation which not only maintains its nutritive value but also retains its sensory attributes [Xinfeng Cheng et al., 2015, Xiao-fei wu et Al., 2016]. Previously freezing was practiced in meat, fish, fruits and vegetables, and other animal industry [S. Oranusi et al., 2014]. In the recent times, low temperature process or freezing has become the main technique of preservation to maintain the characteristics of frozen foods in industry [Lina Cheng et al., 2015]. Since freezing is not a perfect technique of preservation as deterioration may occur due to development of random ice crystals. Large size of crystals leads to loss in protein content, lipid oxidation, and loss of moisture, texture, colour and tenderness [Arpassorn Sirijariyawat et al., 2012].

Micro organisms during freezing are not killed. Their activity gets diminish. [Z.I.M. Sharif et al., 2017]. Freezing preserves the food by inhibiting the growth of microorganism or by halting their enzymatic activity [Paul Dawson et al., 2018]. In freezing, pathogens needs water to grow that turns into ice crystals which inhibits their activity so they don't get multiply [S. Oranusi et al., 2014].

Freezing makes the food of better quality by maximizing its shelf life. Some methods like air freezing, cryogenic freezing, immersion freezing and their advanced collaboration are widely used in the frozen food or freezing industry to obtain superlative freezing rate for products [Bing Li et al., 2002]. Freezing rate is the rate of development of ice crystal in frozen food. Rapid and high freezing rate produces small intracellular ice crystal and slow freezing rate produces large ice crystals [Bing Li et al., 2002]. A large ice crystal destroys some qualities like appearance, texture, sensory properties and nutritional value of food [Paul Dawson et al., 2018]. Although, higher freezing rates maintains structural value and reduces the chemical activity in food [Paul Dawson et al., 2018].

Effect of Temperature and hypertonic solution Concentration on Mass Transfer Kinetics of Plum During Osmotic Dehydration

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Abstract

In this research work mass transfer kinetics of plum (*P. Domestica*) during osmotic dehydration was carried out at three different temperature and hypertonic solution concentration with 0.5% salt and 0.25% citric acid for colour retention. Main objectives of this research work were to examine the effect of temperature and hypertonic solution concentration on mass transfer kinetics of plum. The most important kinetics parameters are WL, WR, SG and osmotic dehydration efficiency indicators (RWL and RSG) was calculated. It was found that 50^oC temperature, 75^oB hypertonic solution concentration with 0.5% salt and 0.25% citric acid gives satisfactory results of WL, WR and SG.

Keywords: Hypertonic Solution, Concentration, Kinetics, dehydration

I. INTRODUCTION

Osmotic dehydration was first introduced by Ponting (1973), for dehydration of fruits and vegetables. Osmotic dehydration is achieved by the pressure difference (chemical potential) between food material (hypotonic solution) and concentrated osmotic solution (hypertonic solution) (Sugar syrup). It is also consider as a pretreatment of food which are going to freezing, air drying and other drying treatments with quality improvement of them by partial water loss and solid gain. This is also Osmotic dehydration reduces moisture content up to 30-50% (Josephine Selvi. N. etal, 2014). Osmoactive substance should be edible, non-toxic, and inert to food materials and produce the acceptable taste. Sugar (for fruits) and salt (NaCl) (vegetables, fish, meat and cheese). Mixture of osmoactive substances are also used to obtain higher ratio of water loss and solid gain. Salt (NaCl) shows synergetic effect on fruits.

In this present research work, osmotic dehydration was applied to plum (*Prunus domestica*) because it is highly perishable fruit and not available throughout the year. Thus, its preservation is necessary. Further, it has been chosen because it

provide vitamin C, antioxidants, phenolic content which are helpful to human nutrition as well as treatment of some diseases (leucorrhea, irregular menstruation, miscarriage) (Preeti Birwal and et al, 2017).

Considering the importance of osmotic dehydration pre-treatments for food preservation applications in food industry various model development was carried out which simply provide the information related to dehydration process. To fulfill this aim lewis model, hederson model, logarithmic model and parabolic model was used to define the relationship between water loss (WL), solid gain (SG) and weight reduction (WR). These models are further used to study the regression analysis.

Several research works were carried out osmotic dehydration kinetics of fruits and process influencing on process kinetics of slice and dice fruits. The present research was conducted to study influence of operating parameters like temperature and concentration of hypertonic solution on high moisture content whole fruit like plum. The study was aimed to predict the influence of temperature and concentration of hypertonic solution on the osmotic dehydration kinetic parameters like water loss (WL), solid gain (SG) and weight reduction (WR).

II MATERIALS AND METHODS

A. Sample Prepration

Fresh fully ripened plums (*Prunus domestica*) with dark red outer skin were procured from market. The fruits were washing with chlorinated water to ensure removal of surface adherents. Further blanching (100^oC was carried out for removal of tissue gases, inactivation of enzymes, softening of tissue and to facilitation of osmosis by rupturing the cell wall. The retention of colour was done by addition of 1% citric acid and 0.5% salt (NaCl) in combination during blanching.



Preparation of sugar-free multigrain biscuits

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Abstract

Multigrain sugar free biscuits were developed using whole wheat, soya and finger millet flour and by incorporating various levels of sucralose and stevia as substitute of sugar. The incorporation of 3% sucralose or 0.1% stevia as a substitute of 40% sugar in the formulation of biscuits made with wheat, soya and ragi flour was acceptable. No remarkable change in colour of low-calorie biscuits was observed in both cases of sucralose and stevia. The diameter of biscuits was decreased but the thickness was increased. With increase in level of both the sweeteners, hardness of biscuits was observed to be decreased than that of control sample. From the sensory analysis of data, it was observed that the overall acceptability of control biscuits was more than the biscuits made with sucralose and stevia. Thus, these low-calorie biscuits made with multigrain flour and artificial sweeteners were found to be suitable for diabetic patient only.

Keywords: multigrain, sugar-free, sucralose, stevia

1. Introduction

In recent studies, the daily routine diet of the human being is inappropriate. Obesity and diabetes have been considered as the common risk due to inappropriate diet. Changes in the quality, quantity, and source of food consumed along with a high level of mental stress and inactive lifestyle have led to an increase in these non-communicable diseases. The recent published IDF Diabetes Atlas [30] reports that there are 425 million people living with diabetes in the world and it is expected that it may rise to 629 million in 2045. There is a vital fact that lifestyle modification (unhealthy diet rich in calories and saturated fat, physical inactivity) has a sustained effect in expanding these diseases. In order to limit the frequency of diabetes, it is suggested to reduce the calorie intake through sugars and saturated fatty acids.

The food business has targeted on the assembly of low-fat/low-calorie foods in response to public interest. Biscuits are the foremost well-liked bakeshop things attributable to their high nutritious value, ready-to-eat nature, and simple accessibility in numerous shapes and sizes at an affordable price. Diabetic friendly biscuits ready by incorporation of non-nutritive sweeteners are getting popular recently. High-intensity sweeteners (HIS) and low-calorie sweeteners are employed in the formulation of reduced-in sugar or sugar-free product, together with cookies. Although these compounds might give calories, they're used at an awfully low concentration creating their caloric contribution negligible. Additionally, to provide no calories, these sweeteners are thought-about safe for diabetics (ADA, 2004) and are non-cariogenic. Limitations that exist once victimization HIS in cookies embrace no Maillard browning, no effect on water activity, no role in product structure and problem in dispersing the ingredient within the product. Further, some HIS shows bitter and/or lingering sweet aftertastes and are heat sensitive.

Sucralose is that the 1st non-calorie sweetener made of natural sucrose. Sucralose is 600 times sweeter than sugar and this sweetness is due to structure of the sucralose molecule in which 3 hydrogen atoms of sucrose are replaced by 3 chlorine atoms. In step with Deutsch and Hansch, the generation of a sweet style comes from the hydrophobic bonding from one space on a molecule with electronic bonding from another space [32] extremely intense sweeteners are a lot of hydrophobic and so produce to multiply absorption to the taste buds, in distinction to a lot of deliquescent easy sugars. Sucralose is originally approved in North American country on September 5, 1991. Associated Food and Drug Administration (FDA) defines an ADI (acceptable daily intake) for sucralose of five mg/kg weight. It is stable below heat and over a broad varies of pH condition and hence used in baking. The sucralose with 0.05% combination employed in place of 30% sugar in biscuit formulation and it ascertained that sweetness of the sugar-replaced biscuits was acceptable [26].

Another sort of sweetener may be a natural sweetener plant called "stevia", "sweet weed", "sweet leaf", "sweet herb" and "honey leaf" that is calculable to be 200-300 times sweeter than sugar [31]. It offers sweetness precisely like sugar with lesser calorie and don't show any aspect effects when consumption on human health. Stevia leaves have sensory and purposeful properties higher to those of the many different high-potency sweeteners and is probably going to become a serious supply of natural sweetener for the budding food market. The only species is that the Stevia rebaudiana Bertoni that is adopted as a sweetener around the world. It comes from two primary steviol glycosides – stevioside and rebaudioside. Rebaudioside is that the sweetest (350-450 times the sweetness of table sugar) and least bitter a region of the leaf, whereas stevioside (250-300 times the sweetness of table sugar) has that bitter memory

RESEARCH PAPER

Development and Characterization of Novel Guava Chips Using Vacuum Frying Technique

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ABSTRACT

The objective of this study was to develop guava chips applying vacuum frying technique. Guava slices were vacuum fried at 85°C for 55 minutes, at 100°C for 50 minutes and 110°C for 40 minutes at 9 kPa pressure. The prepared chips were analyzed for quality attributes such as oil content, ascorbic acid content, total phenolic content, crude fibre, colour, texture, browning index. The guava chips fried at 85°C and 9 kPa pressure for 55 min demonstrated maximum acceptability to consumer panellists with 8.2 score on nine-point hedonic scale. The composition of vacuum fried guava chips showed 18.66% oil, 27.1% crude fibre, 5120 mg/100gm total phenolic content and 448.36mg /100gm ascorbic acid. The colour values L*, a* and b* were 79.62, 1.74 and 20.95, respectively. The resistance force required to break chips was 1051 gm and fracturability 32.75 mm. The vacuum frying can be better alternative to produce guava chips with high nutritional values and desired quality attributes.

Keywords: Vacuum frying, guava chips, ascorbic acid, crude fibre, browning index

Frying is one of the oldest and most popular cooking method used by society (Varela and Bender, 1988). The fried products are sterile, dried and showed longer shelf-life. Recent trend of consumers towards healthier and low-fat products demonstrated the need to produce novel snacks with good sensory properties. Frying methods such as pressure frying, microwave frying, vacuum frying and radiant frying are studied for reduction in oil uptake by fried products and degradation of frying oil. Pressure frying has proven effective in reducing the cooking time and better textured products. However, this process is limited to meat, fish and poultry products (Das *et al.* 2013) juiciness of pressure fried chicken products was superior ($p \leq 0.05$). Microwave frying has the advantages of decreased processing time and oil uptake but the major challenges are non-uniform heating and deterioration of oil at high temperatures

(Oztop *et al.* 2007). Studies on radiant frying, reported their foods to be tougher, drier in mouth feel, and slight resemblance to deep fat fried food (Pankaj and Keener, 2017). Vacuum frying represents the latest and effective preservation method applied to fruits and vegetables to produce snacks with better sensory and nutritional qualities. The frying process is usually carried out under pressure below the atmospheric level, lowering the boiling point of water and thus, significantly reducing the frying temperature (Garayo and Moreira, 2002). The low temperature and negligible exposure to oxygen in the vacuum frying provides several benefits, like nutrient preservation (Da Silva and Moreira, 2008), oil quality protection (Shyu *et al.* 2005), reduction of acrylamide content (Granda *et al.* 2004), retention of natural colour and flavours with lower moisture content. Thus, it is appropriate for high sugar content



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Reddish orange to blue tunable emission from rare earth β -diketonate $\text{Eu}(\text{TTA})_3$ dpphen complex for solid state lighting applications

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Abstract

This work reports synthesis and characterization of novel $\text{Eu}(\text{TTA})_3$ dpphen (Eu-Europium, TTA- 2-Thenoyltrifluoroacetone, dpphen-4,7-diphenyl,1,10-phenanthroline) complex which has potential to tune its emission from reddish-orange to blue colour. Its crystalline nature was revealed by X-ray diffractogram while, the structure formation and [molecular bonding](#) of the complex was declared by FTIR spectra. TGA/DTA analysis divulges high thermal stability. [UV-visible absorption spectra](#) of the complex in various solvents show two distinct peaks referring to the $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$ [optical transitions](#) in the [rare earth ions](#) and β -diketonate moieties. Also, various optical transition parameters were evaluated from these results. Under excitation wavelength of 380 nm, the complex in solid state illustrates characteristic reddish-orange light emission registered at 613 nm with narrow full width at half maxima, attributed to f-f transition of central Eu^{3+} ions. However, solvated complex in various [organic solvents](#) such as [chloroform](#), [dichloromethane](#) and [toluene](#) revealed a red shift by 1 nm with intense sharp emission, peaking at 614 nm. Conversely, solvated complex in [acetic and formic](#)

FEEDBACK 

RESEARCH ARTICLE

Ultrasound assisted synthesis of $\text{CaF}_2:\text{Eu}^{3+}$ phosphor nanoparticles

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Abstract

In this work, the optical and structural properties of ultrasonically prepared $\text{CaF}_2:\text{Eu}^{3+}$ nanoparticles have been reported. Ultrasonically prepared $\text{CaF}_2:\text{Eu}^{3+}$ phosphor shows orange, red emission bands at 591 nm and 612 nm, respectively, when it is excited by 394 light-emitting diode (LED) excitation wavelengths. Further phosphor materials are well characterized by X-ray diffraction (XRD), Fourier transform infrared (FTIR) spectroscopy and transmission electron microscopy (TEM) techniques to confirm the phase purity, metal oxygen (MO) bonding and crystallites size of the materials. Here synthesized materials show a tube-like structure under 100 nm resolution and 0.1 mol% is the best doping value of the europium ion (Eu^{3+}) in calcium fluoride (CaF_2) that shows highest intensity when prepared with an ultrasound assisted method.

KEYWORDS
 CaF_2 , phosphor, TEM, ultrasound, XRD
1 | INTRODUCTION

Currently, the demand for natural and renewable sources of energy generation has increased tremendously with increasing demand for eco-friendly materials to protect the environment everywhere. Thus, for the development of low cost non-toxic materials, scientists have paid great attention on the green synthesis techniques for the preparation of several kinds of hybrid and oxide based materials which are useful in energy devices. In the past few years synthesis methods such as solid-state diffusion, precipitation, sol-gel, hydrothermal, sonochemical, etc. have been extensively used for the development of metal oxide material in microscale and nanoscale range. Among these methods, solid-state techniques require high temperature and higher reaction time to achieve the desired phase of materials than other conventional techniques particularly for the synthesis of some types of oxides based materials.^[1-5] During these type of reactions, some gaseous by-products such as nitrogen (N_2) and carbon dioxide (CO_2) are being liberated. Whereas the precipitation techniques are simple and easy for the preparation of nitrate- and sulphate-based

compounds that are well dissolved in solvent. However, low temperatures are required for precipitation, but high temperature sintering is required to release the earlier mentioned gaseous product in the precipitation. Another widely used and simple technique is the sol-gel method, which is popular for the preparation of nanomaterials. However, it involves some kind of acidic product during the synthesis process. Thus, it has been observed that these earlier mentioned synthesis methods cannot fall under the scope of green synthesis routes for the development of environmentally sustainable products of various shape and size. It is well known that calcium fluoride (CaF_2) material has a wide band gap (12.1 eV)^[6] and is optically active having outstanding optical properties. Further, CaF_2 material exhibits unique physical and chemical properties.^[7-9] Pure CaF_2 is a natural form of fluorite and is an example of an optically stimulated luminescence material.^[10] The doping of europium ion (Eu^{3+}) into CaF_2 host lattice shows colour tuning properties. In recent years several research articles have been published on the synthesis techniques and corresponding properties of the $\text{CaF}_2:\text{Eu}^{3+}$ phosphor.^[11-18] In the conventional method of the synthesis of



Functionalization, Uptake and Release Studies of Active Molecules Using Halloysite Nanocontainers

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Abstract Halloysite nanotubes are inorganic clay minerals of kaolin group. Halloysite possess unique morphology, chemical composition, cation exchange capacity and charge properties making them ideal candidate for various industrial application. In the present study, an attempt was made to functionalize the exterior surface of halloysite nanocontainer. The surface of halloysite nanocontainer was modified using tetrabutylammonium chloride (TBAC). Further an attempt was made to employ these functionalized nanocontainers to uptake and release the active molecule (dye Acid Red1). TBAC-modified nanocontainer indicated higher adsorption capacity of 4.54 mg/g as compared to unmodified nanocontainer (3.08 mg/g). The release behaviour of active molecule from loaded nanocontainers was found with change in pH and temperature. Since the loading characteristics of functionalized nanocontainers were found to be adsorption dependent, parameters such as effect of time, loading, pH, initial concentration were studied for analysing the loading

characteristics. The dye release from 0.5 g dye-loaded TBAC-modified nanocontainers at pH 11 and at 32 °C was found to be 92%. Lastly, the release readings were analysed for the best fit (97%) using permeation kinetic model (Peppas's model).

Keywords Halloysite · Nanocontainers · Functionalization · Controlled release · Active molecule

Abbreviation

AR	Acid Red 1 (dye)
CH ₃ COOH	Acetic acid
CH ₃ COONa	Sodium acetate
DI	Deionized water
HCl	Hydrochloric acid
HDTMA	Hexadecyltrimethylammonium bromide
HNT	Halloysite nanotubes
Na ₂ HPO ₄	Disodium hydrogen phosphate
NaCl	Sodium chloride
NaH ₂ PO ₄	Monosodium phosphate
TBAC	Tetrabutylammonium chloride

Symbol

C_0	Initial solution concentration in ppm
C_e	Solution concentration at equilibrium in ppm
C_{ed}	Equilibrium concentration of the dye in the solution in (mg/L)
k_{ad1}	Rate constant of pseudo-first-order adsorption (min^{-1})
k_{ad2}	Rate constant of pseudo-second-order adsorption ($\text{g mg}^{-1} \text{min}^{-1}$)
K_f and n	Physical constants of the Freundlich adsorption isotherm
k_r	Release rate constant
M	Mass of nanocontainers in g

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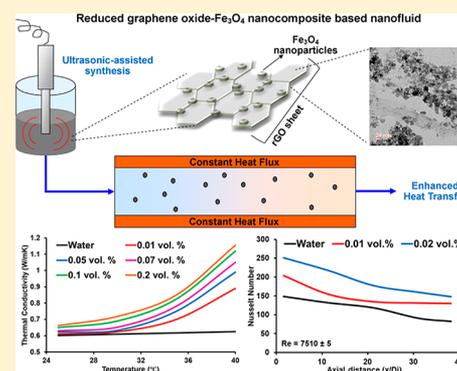
Reduced Graphene Oxide-Fe₃O₄ Nanocomposite Based Nanofluids: Study on Ultrasonic Assisted Synthesis, Thermal Conductivity, Rheology, and Convective Heat Transfer

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ABSTRACT: The present work deals with the preparation of reduced graphene oxide-Fe₃O₄ (rGO-Fe₃O₄) nanocomposite and its nanofluid by an ultrasound assisted method for convective heat transfer study. Formation of the rGO-Fe₃O₄ nanocomposite with a uniform distribution of smaller sized (10–20 nm) Fe₃O₄ nanoparticles on graphene nanosheets was confirmed from UV/vis, transmission electron microscopy, Raman, X-ray diffraction, and X-ray photoelectron spectroscopy analysis. Thermal conductivity of prepared rGO-Fe₃O₄ nanocomposite based nanofluids with the aid of ultrasound showed an 83.44% enhancement for 0.2 vol % concentration of the rGO-Fe₃O₄ nanocomposite at 40 °C. Rheological study revealed non-Newtonian behavior of the nanofluids. Various viscosity models were used to predict the behavior of rGO-Fe₃O₄ nanocomposite based nanofluids. The estimated heat transfer coefficient with the use of 0.02 vol % rGO-Fe₃O₄ nanofluid at the exit of the test section was 4289.5 W/m²·K for the Reynolds number equal to 7510 ± 5. A new correlation for the estimation of Nusselt number has been proposed for the rGO-Fe₃O₄ nanofluid which fits the experimental data very well.



1. INTRODUCTION

Heat transfer improvement has become a major area of interest in order to conserve energy. Use of conventional heat transfer fluids such as water, ethylene glycol, oil, etc., does not give a satisfactory heat transfer rate. Increasing the thermal conductivity of the base fluids used in industries can prove to be an effective way of enhancing the heat transfer. Dispersions of solid particles in base fluids are found to have a higher thermal conductivity than the base fluid.¹ Macro- or micron-sized particles have been dispersed in base fluids but due to many disadvantages such as clogging, settling, abrasion of surfaces, and increase in pressure drop, these dispersions are found to be uneconomical at large scale. Choi and Eastman² have named fluids containing nanosized solid particles as “nanofluids” which have superior thermal properties due to their better stability.

Many researchers have investigated the heat transfer properties of nanofluids containing different metal oxide nanoparticles.^{3–8} Fe₃O₄ is found to be an interesting material to be used in nanofluid applications as it has good thermal and magnetic properties and is also low cost and environmentally safe.^{9–12} The main disadvantage is that the Fe₃O₄ nanoparticles tend to agglomerate. This can be avoided if these particles are loaded onto a surface like graphene thus avoiding contact of individual particles and therefore their agglomeration. So, a nanocomposite of magnetite, i.e., Fe₃O₄, with some other material can be formed. Nanocomposites are particles

composed of two or more materials among which one is in nanoscale.

Since Geim and Novoselov¹³ discovered graphene, there have been many studies reported on the applications of graphene due to its high thermal conductivity.¹⁴ Graphene is a 2D carbon structure that has sp²-hybridization. The sheets of graphene have strong out-of-plane bonds, and therefore, graphene tends to agglomerate by sheet stacking. Graphene oxide is an oxidized form of graphene which has comparatively lower thermal conductivity than graphene. It is commonly synthesized using Hummers’ method as it is the fastest and simplest method.¹⁵ Due to the repulsive forces exerted by the oxygen functionalities present on the surface of graphene oxide, it has lower chances of stacking and thus agglomerating. There are studies on the thermal conductivity enhancement of nanofluids containing nanocomposites of graphene and metal oxides.^{16–18} Many researchers have synthesized nanocomposites of graphene and magnetite for various applications like in dye removal systems,^{19–21} lithium ion batteries,^{22–24} adsorbent materials,²⁵ magnetic resonance imaging,²⁶ electromagnetic interference shielding,^{27,28} supercapacitors,²⁹ desalination,³⁰ targeted drug delivery,³¹ and H₂O₂ biosensors.³²

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Original Article

Development of mathematical model and artificial neural network simulation to predict the performance of manual loading operation of underground mines



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ABSTRACT

The paper illustrates the formulation of mathematical model for manual work such as loading operations at underground mines of manganese ore. The recent manual loading operation is having less production with large amount of human energy consumption. The variable responsible for the performance of manual loading operation has been identified to formulate the mathematical model. The indices of mathematical model indicate variables responsible for increasing the production and minimize human energy consumption. The field data based modeling has been achieved based on the field data for the three dependent π terms time, human energy and productivity. The validation of field data base model is not in close proximity due to the complex phenomenon involving non-linear kinematics, therefore it becomes necessary to formulate artificial neural network simulation of the observed data.

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1. Introduction

Manual loading operations in many of the mines are practicing manual loading for the excavated ore. Worker loads the ore into baskets with shovel and the other carries this to the chute and dumps into it. The ore is dumped into trolleys through chute which is hauled by battery operated locomotives else dumped into a dump truck [1]. The parameters

related to the manual loading operation have been known to increase the production and save the human energy in the present method. Mathematical model is formed for manual loading operation for increasing the productivity and optimizes human energy. This mathematical model based on dependent and independent variables can be studied for enhancing the productivity and human energy conservation.

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Ultrasound assisted preparation, characterization and adsorption study of ternary chitosan-ZnO-TiO₂ nanocomposite: Advantage over conventional method

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ARTICLE INFO

Keywords:

CTS-ZnO-TiO₂ ternary nanocomposite
Ultrasound
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ABSTRACT

In the present work, the synthesis of ternary chitosan/zinc oxide/titanium dioxide (CTS-ZnO-TiO₂) nanocomposite was carried out with the use of mechanical stirring (conventional) and ultrasound assisted method. The characterization of prepared CTS-ZnO-TiO₂ adsorbent was carried out using XRD, TEM, FTIR and the results of these analysis methods proved the successful preparation of ternary nanocomposite. Crystal violet (CV) dye was used as a pollutant to observe the adsorption ability of the prepared nanocomposite and the nanocomposite prepared by ultrasonic-assisted method proved to be a better adsorbent. The CV dye adsorption was significant for CTS-ZnO-TiO₂ nanocomposite synthesized with the use of ultrasound assisted method compared to that prepared by conventional method. It is due to the physical effects of the ultrasonic irradiations due to which formation of finely dispersed nanocomposite takes place than that by conventional method. For batch adsorption the effect of various operating parameters such as initial dye concentration, time, temperature and adsorbent dose has been evaluated. The obtained data were processed using isotherm models, adsorption kinetics and the thermodynamic behavior of the cationic dye adsorption was also studied. The isotherm data was correlated reasonably well by the Temkin adsorption isotherm. Pseudo-second-order kinetic model provided a better correlation for the experimental data compared to pseudo first order, Elovich model and power function kinetics model. Thermodynamic parameters for adsorption indicated that the dye adsorption was spontaneous and endothermic in nature.

1. Introduction

Tremendous volumes of colored waste water are generated in textile, leather, paint, cosmetic etc. industries causing eternal damage to the water resources [1]. Wastewater released from dye production and application industries are responsible for water pollution. Untreated disposal of the colored water into receiving water body causes damage to aquatic life and human bodies [2]. Due to high toxicity of dyes at low concentrations they must be treated before being discharged into the receiving body of waters. Therefore, environmental legislation has imposed severe limits on the concentrations of the discharged effluents from dyestuff manufacturing and textile industries [3]. The non-biodegradable nature of dyes and their stability towards oxidizing agents obscure the selection of appropriate method for their removal [4]. Various physical, chemical and biological treatment methods like, filtration, oxidation, ozonation, adsorption, biosorption, photocatalysis,

electrochemical treatment and membranes [5,6] have been used for the treatment of the dye bearing effluents. Adsorption is a most widely used physicochemical wastewater treatment method found to be effective for the treatment of the colored wastewater [7,8] producing high quality treated effluents which can be re-used [3]. Researchers around the globe are constantly working on the development of novel, effective and low cost adsorbents. Natural biopolymer chitosan (CTS) of glucosamine is obtained by deacetylation of chitin derived from crab, shrimp etc. [9,10]. CTS has higher adsorption capacity for diverse dyes owing to the presence of amino and hydroxyl groups in the structure, which are potential adsorption sites. The main advantages of chitosan are its low cost and availability [11,12]. However, there are certain disadvantages of CTS such as weak mechanical strength, dissolution in acidic solutions, and leaching of organics like carbohydrates, are serious when raw chitosan is used. These drawbacks limit the applications of CTS for treatment of waste streams. Hence efforts have been focused

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Prediction and Identification of Sensitive Parameters for Flood Management Using Regression Analysis: Case Study of PENCH Dam

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Abstract Flood management is an extremely essential consequence in the world; closing conditions of reservoir largely affect the water release decision to control flood downstream. This paper focuses on the mapping of entire reservoir operation scenario using 19 assorted independent variables and further does include with predictive analytics for five dependent variables. Multivariate regression analysis is used in coordination with cross-checking of data sets using various statistical measures. 2295 sample reading of reservoir operation is considered to formulate mathematical models, and its statistical interpretation is also presented. Overall, five mathematical models are presented; all models fitted well with coefficient of correlation in the range of 0.946–0.967. Most influential (Sensitive) variables are sought out from the mathematical models to formulate future strategy of flood management.

Keywords Multiple regression · Predictive analytics · Conditional probability · Coefficient of determination

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Introduction

Most of the studies related to reservoir operation for flood control often based on forecasted or time series analysis based data sets. Various evidences are available for flood management also based on these data sets. Modeling is extensively for flood control for various reservoirs in the recent past. Most predominant modeling techniques used are: artificial neural network, soft computing techniques, genetic algorithms as well as assorted traditional optimization techniques also. Unfettered streams in New Mexico were analyzed for the approximation of 4-day, 3-year low-flow frequency at ungaged sites using regression equations. Two regression equation was formulated for estimation of the 4-day, 3-year (4Q3) low-flow frequency at ungaged sites [1]. Normal probability plot (Q–Q plot), standardized residuals versus standardized predicted values plot, and standardized residuals versus observation order plot are a standard representation of the regression model [2]. Sensitivity analysis is the study to check the influence of the input variable on the output variable either quantitatively or qualitatively. In linear regression modeling, natural sensitivity indices are represented by regression coefficients. For multidisciplinary and multifaceted problem, sensitivity analysis provides requisite facet. Sensitivity analysis using linear regression model is useful for decision makers to control hydrological system [3].

Prediction of daily pan evaporation depths from climatic data was carried out using multiple least-squares regression (MLR), principal components regression (PCR) and partial least-squares (PLS) regression. More or less analogous prediction exactitudes were obtained by all three approaches [4]. Pennsylvania and contiguous states were used as a study area to devise regression equations for estimation of flood flow using peak flow data from 322 gauging stations.



Domain imaging in Fe-doped KNbO₃ single crystal via trinocular microscopy and scanning electron microscopy

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HIGHLIGHTS

- Flux method is used to prepare sample of Fe-doped KNbO₃ single crystal.
- Domain walls are observed by using Trinocular microscope.
- Conclusive evidence has been obtained through a simple etch pit technique.
- Using Scanning Electron Microscopy, 'herringbone' type domains are observed.

ARTICLE INFO

Keywords:

Single crystal
Trinocular microscopy
Etching technique
Domain wall

ABSTRACT

Trinocular microscopy with a high spatial resolution is a promising technique for studying the surface morphology of materials. The cleavage face of ferroelectric Fe-doped K niobate (KNbO₃) crystals was chemically etched by using HNO₃. Trinocular microscopy was used to study the surface morphology of the grown ferroelectric KNbO₃ single crystals. The grown surface of the crystal with a 60° domain wall revealed the same interaction and orientations. The results indicate that the type of domain walls that occur in ferroelectric crystals depend on the symmetry of both the nonferroelectric and ferroelectric phases of the crystal.

1. Introduction

Potassium niobate (KN; chemical formula: KNbO₃) is a ferroelectric perovskite oxide that has the potential to replace lead-based perovskites in various applications. The analysis of the mechanical properties of KN [1] revealed that KN is a perovskite-type ferroelectric–ceramic material [2]. At temperatures higher than 435 °C [3], KN has a cubic structure and is not ferroelectric. KN undergoes two phase transformations between 435 °C and room temperature. It first transforms to a tetragonal structure and then to an orthorhombic structure [4]. At temperatures lower than –10 °C, KN has a rhombohedral structure [5]. These different structures result from the displacements of the oxygen octahedra and Nb atoms [6] and cause polarity and ferroelectric behaviour. The offset of the phase change direction in the tetragonal structure is in the [001] direction. In the orthorhombic structure, the offset is in the [011] direction, and in the rhombohedral structure, the offset is in the [111] direction [7]. The peculiar properties of KNbO₃ single crystals include the occurrence of phase transitions, a high dielectric constant, the formation of a hysteresis loop, and the formation of domains [8]. The formation of domain walls and the surface morphology of crystals was

studied using various optical instruments [9].

In the past decade, domain engineering, which is mainly based on ferroelectrics, has attracted considerable attention and has been widely studied. The studied phenomena include the fabrication and application of periodically inverted domain structures [10]. Meanwhile, imaging domain structure in ferroelectric materials can be achieved through many techniques including optical microscopy with polarized light, scanning probe microscopy (piezoresponse force microscopy, PFM), scanning second harmonic generation, transmission electron microscopy (TEM), and even scanning electron microscopy (SEM), among others [11,12]. Some of these techniques, such as polarized optical microscopy and scanning second harmonic generation are well suited to bulk ceramics and single crystals where domain sizes may be much larger than the wavelength of the imaging light. It would be advantageous to have an imaging technique that can provide high-resolution domain structure characterization and orientations information [13].

In this work, trinocular microscopy is applied to observe the ferroelectric domain walls, by using etching technique. This method can be used to acquire the information of domain structure on the surface of the crystals. It also used to study the different orientations of the

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Synthesis, structural, dielectric and domain properties of Al-doped KNbO₃ single crystal

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Abstract

Single-crystal samples of Al-doped potassium niobate (KNbO₃) [KN] were synthesized by a high-temperature flux technique. X-ray diffraction analysis of the crystal suggests that a single phase with an orthorhombic structure was formed. The dielectric studies of the KN single crystal as a function of temperature (from 30 to 500 °C) show that the compounds underwent a phase transition, which was confirmed by thermal analysis of the DTA curve. The measured loss tangent of the crystal, which is in good agreement with the dielectric studies. The ferroelectric property of the crystal was confirmed by studying the hysteresis loop. In this study, several parameters, like the coercive field and spontaneous polarization, were measured and calculated. The domain study was carried out using a trinocular microscope, which reported the formation of the 60° domain line and dislocation etch pits. The effects of the electric field on the domain of the Al-doped KN single crystal were discussed.

1 Introduction

Ferroelectric materials are used in the formation of thin films, single crystals, and bulk ceramics for different applications [1]. Growing a single crystal is important for studying the optical, nonlinear optical, and dielectric properties of the single crystal; for this reason, various techniques have been applied to get large, high-quality single crystals [2]. Potassium niobate KNbO₃ (KN) is a well-known, lead-free ferroelectric material grown by using flux methods [3, 4]. It is difficult to grow bulk single KN crystals from melting due to KN's incongruent melting and the double solid-state phase transformation properties; its cubic structure is above 435 °C, tetragonal below it, and then at 225 °C it becomes orthorhombic [5]. Recently, however, the KN crystal has been a focus of growing interest for ferroelectric applications due to its peculiar properties, including the occurrence of phase transitions, a high dielectric constant, the formation of a hysteresis loop, and the formation of domains [6]. In the past decade, domain engineering, which is mainly based on ferroelectrics, has attracted considerable attention and has been widely studied [7].

Doping with various metal oxides has been an effective approach to improve the properties. Generally, doping could be in the bismuth oxide layer or in perovskite-like units (A or B sites) [8]. Millan et al. reported the substitution of Pb²⁺ in (Bi₂O₃)²⁺ layers by other cations, such as Sb³⁺, Sn²⁺ or Te⁴⁺, within the perovskite-like units; partial substitution of strontium ions by bismuth ions increased the Curie temperature and improve the dielectric properties of KN [9]. In a present study the lead free complex perovskite, KN single crystals are very promising materials for electronic devices and applications such as capacitors, actuators, sensors, transducers [10]. Therefore, it is of special interest due to very large electro-optic properties and good dielectric properties [11]. These properties have been studied by using different impurities such as (Al, Fe, Cu, Co, Mn) [12]. As the role of impurities in ferroelectric crystals is increasingly being realized, they affect the vital parameter like domain structure and phase transition temperature, of particular importance that impurities can convert non ferroelectric crystal in to ferroelectric under suitable condition [6]. It is thus obvious that these impurities develop a strong large distance cooperative interaction in the structure. In this article, we attempt to investigate examine the effect of Al₂O₃ doping on perovskite KNbO₃ structure, dielectric, ferroelectric and domain properties of KN single crystal.

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First report on solution processed α -Ce₂S₃ rectangular microrods: An efficient energy storage supercapacitive electrode

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Mathematical Modelling of Liner Piston Maintenance Activity using Field Data to Minimize Overhauling Time and Human Energy Consumption

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Abstract Field data based model is proposed to reduce the overhauling time and human energy consumed in liner piston maintenance activity so as to increase the productivity of liner piston maintenance activity. The independent variables affecting the phenomenon such as anthropometric parameters of workers (Eastman Kodak Co. Ltd in Section VIA Appendix-A: Anthropometric Data. Ergonomic Design for People at Work, Van Nostrans Reinhold, New York, 1), workers parameters, specification of liner piston data, specification of tools used in liner piston maintenance activity, specification of solvents, axial clearance of big end bearing and bolt elongation, workstation data (Eastman Kodak Co. Ltd in Work Place Ergonomic Design for People at Work, Van Nostrans Reinhold, New York, 2) and extraneous variables, namely, temperature, humidity at workplace, illumination at workplace and noise at workplace (Eastman Kodak Co. Ltd in Chapter V Environment Ergonomic Design for People at Work, Van Nostrans Reinhold, New York, 3) are taken into account. The model is formulated for dependent variables of liner piston maintenance activity to minimize the overhauling time and human energy consumption so as to improve the productivity of liner piston maintenance activity. The developed model can predict the performance of liner piston maintenance activity which involves man and machine system (Schenck in Theories of Engineering Experimentation, McGraw Hill, New York 4). The model is then optimized by

optimization technique and the sensitivity analysis of the model has also been estimated.

Keywords Modelling · Liner piston · Maintenance · Sensitivity · Optimization

Introduction

Railway diesel loco shed has aimed to a specific of repair and maintenance work of ZDM diesel loco motives which includes preventive maintenance schedule along with the condition based maintenance schedule. During the maintenance work in diesel loco shed there is a higher probability of hazards in the areas including engine block, cylinder head, under frame, fuel injection pump, machines and equipments used during the maintenance work which may result in loss of man hours and trained man power which may directly affect the productivity of liner piston maintenance activity. Further, loco shed workers have to work in humid, poorly illuminated and noisy environment. So due to this present maintenance method, the productivity of liner piston maintenance activity affects adversely and requirement of human energy and time required is substantial. Liner piston maintenance activity is performed by three workers for duration of 8 h shift with a small break. The liner piston maintenance activity consists of dismantling of big end nuts (12 numbers) connected to connecting rod and liner piston assembly by 41 mm socket tool. Then de-carburizing of six liners in BDC position of piston is done by scrapping plate. Cleaning of liner connecting rod and piston is done by kerosene and emery paper. Lab testing is done for piston and connecting rod to check out cracks and defects. Measurement of liner diameter is done by suito stand and piston ring gap (1 to 1.5 mm) in liner is checked by filler gauge. Assembly

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Bubble size prediction in gas–solid fluidized beds using genetic programming

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The hydrodynamics of a gas–solid fluidized bed (FB) is affected by the bubble diameter, which in turn strongly influences the performance of a fluidized bed reactor (FBR). Thus, determining the bubble diameter accurately is of crucial importance in the design and operation of an FBR. Various equations are available for calculating the bubble diameter in an FBR. It has been found in this study that these models show a large variation while predicting the experimentally measured bubble diameters. Accordingly, the present study proposes a new equation for computing the bubble diameter in a fluidized bed. This equation has been developed using an efficient, yet infrequently employed computational intelligence (CI)-based data-driven modelling method termed genetic programming (GP). The prediction and generalization performance of the GP-based equation has been compared with that of a number of currently available equations for computing the bubble diameter in a fluidized bed and the results obtained show a good performance by the newly developed equation.

Keywords: Bubble diameter, bubble motion, fluidized bed, genetic programming.

FLUIDIZED bed reactors (FBRs) are widely used in petroleum, chemical, food, metallurgical, pharmaceutical and power generation industries¹. The design of gas–solid fluidized reactors requires an understanding of the size and behaviour of bubbles therein. Despite widespread use of FBRs, their scale-up still depends on the empirical methods owing to the complicated nature of gas–solid flows inside the reactor. The formation and travel of bubbles play a crucial role in the hydrodynamic study of a fluidized bed. Specifically, the size of a bubble decides the homogeneity, heterogeneity and slug formation in a fluidized bed. There are four stages of bubble motion: formation of bubble, its detachment from the orifice, travel in the bed and finally bursting. Harrison and Leung², and Zenz³ proposed equations for the formation of a bubble at the orifice. Bubble detachment time was studied^{3–6} to

propose equations for its prediction. A number of equations have also been proposed for determining the bubble diameter while the bubble is in motion, as a function of the particle diameter and density, bed geometry, type of distributor and gas velocity.

Previous work

Major studies concerning the bubble travel are described here. A number of studies have proposed equations to model the bubble dynamics^{7–21}. As suggested by Patil *et al.*²², the Darton's model is based on the bubbles tending to rise in preferred paths and that the distance travelled by the two neighbouring bubbles before coalescence is proportional to their lateral separation. Farshi *et al.*²³ studied and compared the performance of a number of equations with the experimental data and found that the equation by Rowe¹⁵ fitted their experimental data the best. In the pilot scale study, the corresponding experimental data were well predicted by the equations of Rowe¹⁵ and Darton *et al.*⁸. In a gas–solid bubbling fluidized bed, Farshi *et al.*²³ suggested that the equations by Mori and Wen¹⁶ and Rowe¹⁵ possess a good bubble diameter predicting ability. Hilligard and Werther⁷ performed experiments using quartz sand particles belonging to the Geldart's Group B of 480 μm size and density equal to 2640 kg/m^3 . On the basis of these experiments, they proposed a relation for calculating the bubble diameter of the Geldart Group D particles.

The two commonly used variables in all the equations for calculating the bubble diameter are, the ratio of injection velocity (U) to minimum fluidization velocity (U_{mf}) and the bed height (h) of the bubble above the distributor (Table 1). The equations proposed^{11,17} show that the diameter of the bubble (D_b) is proportional to the particle diameter (d_p), whereas Park *et al.*¹³ reported D_b to be proportional to $(d_p^{1.5})$. Similarly, D_b is shown to be dependent on the density of the material^{11,17}.

The present study focuses on the behaviour of the bubble diameter since the hydrodynamics of a bubbling fluidized bed strongly depends on the bubble characteristics. Owing to the variations found in the predictions of

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RESEARCH ARTICLE

Synthesis and characterization of a green-light-emitting (pbi-Br)₂Ir (acac) metal complex for OLEDs

Neha Khotele, N. Thejo Kalyani ✉, S.J. Dhoble

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Abstract

We designed and synthesized a 2-(4-bromophenyl)-1-phenyl-1H-benzimidazole (pbi-Br) ligand, which was then employed to create an innovative phosphorescent cyclometallated iridium(III) (pbi-Br)₂Ir(acac) metal complex with acetyl acetone as an ancillary ligand using the Suzuki coupling reaction. The complex was then characterized by X-ray diffraction (XRD), Fourier transform infrared (FTIR) spectra and thermogravimetric analysis (TGA)/differential thermal analysis (DTA) for structural and thermal analysis, respectively. XRD confirmed its amorphous nature and the FTIR spectrum revealed the molecular structure confirmation of the metal complex. The TGA/DTA curve disclosed its thermal stability up to 310°C. Ultraviolet (UV)-vis absorption and photoluminescence (PL) spectra were measured to explore the photo-physical properties of the (pbi-Br)₂Ir(acac) complex in basic and acidic media respectively. With the variation in solvent from acidic to basic media, optical absorption peaks blue shifted with variation in optical densities. These results facilitated the calculation of various photo-physical parameters. When excited at 379 nm in the solid state, the synthesized complex gave out a green light emission, peaking at $\lambda_{\text{emi}} = 552$ nm. Staggering differences in optical density were observed in the PL spectra of the solvated complex. A Stokes' shift of 7140.45 cm⁻¹ and 7364.94 cm⁻¹ was observed when the complex was solvated in acetic acid and chloroform, respectively. Hence the synthesized iridium metal complex can be considered as promising green emissive material for optoelectronic applications.

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Optical properties of $\text{Ln}^{2+,3+}$ ($\text{Ln} = \text{Eu}^{2+}, \text{Ce}^{3+}, \text{Dy}^{3+}$ and $\text{Ce}^{3+}/\text{Dy}^{3+}$) doped $\text{BaMg}_2\text{Al}_6\text{Si}_9\text{O}_{30}$ nanophosphor

M. M. Kolte¹ · V. B. Pawade² · L. F. Koao³ · S. J. Dhoble⁴

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Abstract

This paper presents the synthesis and characterization of novel Eu^{2+} , Ce^{3+} , and Dy^{3+} doped $\text{BaMg}_2\text{Al}_6\text{Si}_9\text{O}_{30}$ nanophosphors by combustion method at 550 °C. Eu^{2+} and Ce^{3+} ions show the broadband emission assigned due to the 5d–4f transition. Whereas, Dy^{3+} activated $\text{BaMg}_2\text{Al}_6\text{Si}_9\text{O}_{30}$ nanophosphor shows the characteristic emission bands due to f–f transition respectively. From the observed excitation and emission bands of donor and acceptor, we have studied the critical distance of energy transfer (ET) in $\text{Ce}^{3+}/\text{Dy}^{3+}$ ions. Further, the phosphor was well characterized by XRD, SEM, TEM for the confirmation of phase purity, surface morphology and crystallite size respectively. The band gap of the material is measured from the diffuse reflectance spectra. From emission characteristics, it is seen that the prepared nanophosphor may be a promising candidate for solid-state lighting.

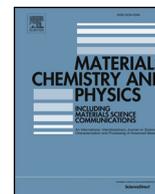
1 Introduction

Recently, the study of high efficient aluminosilicate phosphors has been receiving a lot of attention because these phosphor materials play a key role in the lighting and display devices. Therefore, it is an urgent demand to develop high efficient phosphors fit for application in white-light-emitting diodes (WLEDs) which can be the promising candidate for next-generation solid-state lighting [1, 2]. Nowadays, rare earth doped nanomaterials have received a lot of interest due to their high surface to volume ratio and quantum confinement effect [3]. Optical properties of nanomaterials in the form of nanoparticles, nanorods, nanowires, nanotubes as well as colloidal or bulk nanocrystals are of interest not only for basic research but also for interesting application [4–7]. There are different applications of nanomaterials from

those of the bulk materials. More efforts have been given on the development nanomaterials which have been applied in many areas like hybrid solar cells [8], transparent conductive films [9], gas sensors [10] and nanophosphors for solid-state lighting especially used in light-emitting diodes (LEDs) [11]. Rare earth activated inorganic materials are regarded as important photoluminescent materials for their extensive applications in display devices. Their emission originates from the different activators such as cerium [12], europium [13] and dysprosium [14] are slightly affected by the host material due to crystal field splitting. Rare earth elements are mostly used as luminescence sources in inorganic matrixes to obtain phosphors. Recently, there are few commercial phosphors such as Ce^{3+} doped YAG [15], $\text{Li-}\alpha\text{-SiAlON:Eu}^{2+}$ [16], $\text{Ca-}\alpha\text{-SiAlON:Eu}^{2+}$ [17] and $\text{Ba}_3\text{MgSi}_2\text{O}_8\text{:Eu}^{2+}$ [18] reported. These RE ions are generally used and studied many times due to their 5d–4f broad and f–f sharp emission bands. These emissions are either parity allowed or forbidden that depends on the RE emission characteristics and transitions. Also, morphology and crystallites size and the band gap of the phosphor materials play the important role during the device fabrication [19, 20]. Therefore this article gives a brief information about the luminescence properties and energy transfer study in $\text{Ln}^{2+,3+}$ doped $\text{BaMg}_2\text{Al}_6\text{Si}_9\text{O}_{30}$ nano phosphor for their application in solid state lighting devices.

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Sonochemical synthesis, characterization and sorption study of Kaolin-Chitosan-TiO₂ ternary nanocomposite: Advantage over conventional method

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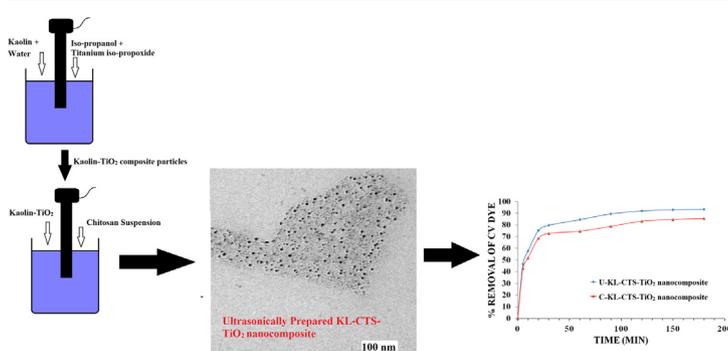
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HIGHLIGHTS

- Preparation of KL-CTS-TiO₂ nanocomposite using ultrasound assisted method.
- KL-CTS-TiO₂ nanocomposite prepared by ultrasonication is superior.
- Effect of various parameters on CV dye adsorption is reported.
- Pseudo second order kinetic model show better fit compared to other kinetic models.

GRAPHICAL ABSTRACT



ARTICLE INFO

Keywords:

KL-CTS-TiO₂ nanocomposite
Ultrasound
TEM
Adsorption isotherm
Kinetic model

ABSTRACT

The present study deals with the successful preparation of kaolin/chitosan/titanium dioxide (KL-CTS-TiO₂) ternary hybrid nanocomposite adsorbent using conventional and ultrasound assisted method synthesis. The particle size (observed from TEM image) of TiO₂ nanoparticles dispersed in the nanocomposite was found to be around 5 nm for U-KL-CTS-TiO₂ nanocomposite (ultrasonically prepared), which is lesser compared to conventionally prepared nanocomposite. The average particle size of U-KL-CTS-TiO₂ nanocomposite was observed to be 293 nm which is very less compared to C-KL-CTS-TiO₂ nanocomposite (prepared by conventional method) that is 439 nm. The BET surface area of U-KL-CTS-TiO₂ nanocomposite was found to be 116.5 m²/g which is significantly higher than the C-KL-CTS-TiO₂ nanocomposite (4.95 m²/g). In batch adsorption experiments the effect of initial dye concentration, time, temperature, and adsorbent dose was studied and equilibrium data, adsorption kinetics and adsorption isotherms parameters are reported. The adsorption equilibrium data was best fitted by Freundlich isotherm compared to the Langmuir and Temkin model for U-KL-CTS-TiO₂ and C-KL-CTS-TiO₂ nanocomposite. The % removal of CV dye for 2 g/L loading of U-KL-CTS-TiO₂ and C-KL-CTS-TiO₂ nanocomposite was found to be 93.30% and 85.49%, respectively. The higher adsorption in the case of U-KL-CTS-TiO₂ nanocomposite is attributed to the physical effects of ultrasound which are responsible for the preparation of finely dispersed KL-CTS-TiO₂ nanocomposite compared to conventional method. Finely dispersed KL-CTS-TiO₂ nanocomposite provides more sites for the adsorption which in turn enhances the adsorption capacity of CV dye on ultrasonically prepared KL-CTS-TiO₂ nanocomposite.

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Original research article

Colour tunable emission from $\text{Eu}_{0.5}\text{Sm}_{0.5}(\text{TTA})_3$ dpphen β -diketonate hybrid organic complex in various organic solvents

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ARTICLE INFO

Keywords:

$\text{Sm}_{0.5}\text{Eu}_{0.5}(\text{TTA})_3\text{dpphen}$
tunable emission
CIE coordinates
CCT
OLEDs
flat panel displays
solid state lighting

ABSTRACT

We propose the synthesis and characterization of an orange-red light emitting binuclear Samarium and Europium β -diketonate complex ($\text{Sm}_{0.5}\text{Eu}_{0.5}(\text{TTA})_3\text{dpphen}$) [Sm: Samarium, Eu: Europium, TTA: Thenoyl Trifluoro Acetone, dpphen: bathophenanthroline] by cost effective precipitation technique at pH 7.0, maintaining the stoichiometric ratio by mole percentage. The XRD spectrum reveals low crystallinity of the complex and FTIR spectra confirms the structure formation of the complex. Thermogram unveils the thermal stability of the complex as 273.76 °C, while DTA reveals a peak at 507.66 °C, corresponding to the melting point of the complex. UV-Visible absorption spectra of the solvated complex in different basic solvents registers wide band absorption spectra with two sets of peaks, one peaking in the range of 249 - 314 nm and 379-386 nm. PL spectra of the complex in solid state and in solvated state reveal tunable emission from 614 nm to 443 nm when excited at 385 nm. Various photo physical parameters such as absorbance, optical band gap, Stokes shift, radiative life time, CIE and CCT were evaluated. These results proved that the synthesized complex have potential as tunable orange-red to blue emissive material for OLED devices, flat panel displays and solid state lighting.

1. Introduction

Owing to the versatile advantages of using rare earths as emissive centers in OLEDs, a range of red emissive materials have been designed, synthesized and evaluated [1–3]. This is due to their superior characteristic features such as (i) sharp emission from electronic transitions within the 4f subshells due to the effective shielding by the overlying 5s and 5p orbitals [4], (ii) possibility of enhancing the efficiency of the OLEDs as both singlet and triplet excitons can transfer their energy to the rare earth ions [5] and (iii) highly monochromatic clear emission [6]. When organic β -diketonate ligands are added to these rare earths, they result in rare earth diketonates hybrid organic complexes and yield unique and promising fluorescence properties. These ligands have a superior feature such as (i) absorbing energy from the external environment and transferring it to the central rare earth ions such as Eu(III), Sm(III), thereby enhancing the luminescent intensity of the complex. Among many, $[\text{RE}^{3+}(\text{TTA})_3\text{phen}]$; $\text{RE}^{3+} = \text{Sm}$ and Eu) complexes have attracted a lot of attention because of their high fluorescence emission efficiency [7]. These complexes find versatile applications in lasers [8], electroluminescent (EL) materials for OLED large-area flat panel displays [9], solid state lighting and many more, due to numerous advantages like easy synthesis, elevated quantum efficiency, quick response, elevated contrast flexibility and lighter weight. In spite of these progresses, immense confront in this field is the comprehension of a competent pure red light emitting device

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Phosphate removal from industrial wastewater effluent using modified coal fly ash

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ABSTRACT

Phosphate in a water act as a primary nutrient for the algae and water bodies present in that water. This present phosphate is also responsible for the excess growth of algae through eutrophication in stationary water. High level of phosphate reduces the oxygen present in the water. Reduced oxygen is indirectly harmful to aquatic life present in the water. Excessive growth of algae can be reduced by removing the phosphate from water. Coal based fly ash (CFA) using adsorption method proved itself best technique for the removal of phosphate from water. Oxides of aluminum iron and calcium in CFA is responsible for the phosphate adsorption from water. In this research work laboratory scale experiments were carried out using (CFA) and Modified coal based fly ash (MCFA). An effect of adsorbent concentration, contact time, pH and temperature were investigated for the phosphate removal from water.

Keywords: Modified coal fly ash; Phosphate; Adsorption isotherm; Adsorbent

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Development of gluten free biscuits and evaluation of functional properties of composite flour

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Abstract

Gluten free biscuits, also suitable during fasting were developed utilizing different levels of water chestnut and makhana powders. Four types of formulations of biscuits were prepared with water chest nut and makhana flour. The water chestnut flour for biscuits was substituted with makhana flour in four different levels 40, 30, 20, and 10%. Biscuits were developed using creamery method and evaluated for physical properties, proximate composition, sensory characteristics and storability at room temperature. The spread ratio was found to increase from 8.4 to 11.25 with decrease in addition of makhana flour from 40 to 10%. Textural measurements showed that breaking hardness and fracturability biscuit was increased with decrease in addition of makhana powder in flour blends. The functional properties of composite flours such as swelling power and solubility, foaming capacity and stability, bulk density, least gelation concentration, water absorption power and oil absorption power get varied with percentage of flour blends. Sensory data indicated that maximum overall acceptability scores for biscuits developed using 90:10 parts of water chestnut and makhana powders in flour blend.

Keywords: water chestnut flour, makhana flour, spread ratio, texture, hardness

1. Introduction

Biscuit is the one of the oldest bakery snack item, consumed by all age groups regularly. Biscuit industry in India is expected to grow at a rate of 15 to 17% in coming years. Biscuits, which are one of the most commonly, accepted snack foods may be considered as one of the good supplementary food for distributing to the undernourished children through developmental agencies (Jha, 2014) [6].

Biscuits are typically round cakes of bread that are leavened with baking powder, baking soda or sometimes yeast. It may also refer to a cookie or cracker. They are mostly sweet and in history they were used by travelers as they were long-lasting foods and easy to carry. It is made with different kind of flour, butter, sugar and other ingredients. It is often served with tea; coffee etc. It is a snack which is widely acceptable by all age groups and easy to carry while traveling (Mehta & M, 2014) [8].

Gluten free biscuit was prepared by using water chestnut flour and makhana flour. Products made from chestnut characterized with two specific advantages: source of essential fatty acids and gluten free content (Nafisa & Hegazy, 2014) [10]. Popped makhana flour may possibly serve as a useful alternative in nutritious food products and could improve the physico-chemical, functional and sensory characteristics of products. Incorporating popped makhana flour (10-40%) in cookie formulation and examines the proximate, physical, color, textural and sensory properties of cookies (Kumar & I.S., 2015) [7].

Gluten free biscuit was useful for people suffering from celiac disease. Celiac disease, a disease caused by an immune disorder which is also known as gluten sensitive enteropathy, occurs in people who have a genetic problem with gluten when they eat it (Chopin Technologies). Increasing numbers of scientists in the medical field acknowledge the existence of this autoimmune enteropathy

that is the result of permanent gluten intolerance (Mert, 2014) [9].

Overall, composites flour was a good new approach to utilizing uncommon food products as the application of composite flour produced products with different characteristics and quality (Noorfarahzilal, 2014) [11].

2. Materials and Methods

The study was conducted in the laboratory of the Department of Food Technology, Laxminarayan Institute of Technology, and Nagpur.

2.1 Materials

The raw materials used for the production of gluten –free cookies: water chestnut flour, makhana flour, sugar and fat have been purchased from M/s Bapat Mega Mart Nagpur. Lab grade ammonium bi-carbonate, sodium bicarbonate, baking soda, sodium Metabisulphite and glycerol monostearate were used from food laboratory of LIT Nagpur.

2.2 Formulation

Four flour blends, prepared using water chestnut and makhana powder are given in Table 1.

Biscuit dough was prepared and sheeted to a thickness of about 4.5 mm approximately, cut into round shape of 45 mm diameter, transferred to baking tray and baked at 180 °C for 15 min. The biscuits, after attaining the room temperature were packed in LDPE bags and evaluated for all different quality parameters.

2.3 Physical Properties

Expansion in diameter and thickness gives spread ratio of biscuit; diameter and thickness before and after baking were also recorded. Spread ratio of biscuit samples was calculated

Synthesis of Carbon Aerogel From Waste Newspaper

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Abstract

Carbon aerogel are porous carbon materials with high surface areas, relative low electrical resistance, hydrophobicity & oleophilicity. The present work addresses to the synthesis of carbon aerogel (CA) from waste newspaper. Experimental runs have been conducted using waste newspaper & the carbon aerogel sample have been synthesized & characterized for the property that includes apparent density, hydrophobicity, oleophilicity & functional group presence. The synthesised samples of carbon aerogel exhibited weight in the range of 0.16 gm-1.23 gm. and density as 169.7653 mg/cm³ to 248.58 mg/cm³. Based on the observation, the hydrophobicity measured by angle made by water droplet is obtained as 130⁰ this is indicative that the obtained hydrophobicity is close to the super hydrophobicity . Similarly the oleophilicity i.e. oil absorption capacity is estimated to be 125 to 150 %. The FTIR analysis is supportive of the claim that other than carbon groups are eliminated from the CA samples. Hence the present work has successfully demonstrated the synthesis of CA from waste newspaper with good characteristic features.

Keywords: Carbon Aerogel, Hydrophobicity, Oleophilicity, light weight& Waste newspaper

1. Introduction

Aerogels, as 3D porous solid materials, have been attracted significant attention because of their intriguing properties, such as developed porosity, high surface area, low density and multi-branched network structure. Among the diverse aerogels, biomass-derived carbon aerogels have become a promising candidate in many applications, including adsorbent materials and electrode materials. These can be ascribed to the biomass-derived carbon aerogels possess environmental friendliness, reasonable electrical conductivity, chemical stability and low prices properties [1]

1.2 Applications

1.2.1 In mitigating organic pollution: With the rapid increasing exploitation, transportation and storage of oils and toxic chemical spills/leaks accidents have resulted in severe energy, environmental, and ecological problems all around the world. Among the existing strategies used for oil recovery currently, sorption is considered as an economical choice because of its simplicity and high efficiency. Carbon nanotubes and spongy grapheme aerogel used as oil sorbents have been extensively investigated because they have three-dimensional (3D) structures and outstanding physical properties (eg.

Synthesis of Superabsorbing Polymers from Orange Peels

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Abstract

The Super Absorbing Polymers (SAPs) are the special type of polymeric substances which can absorb and retain large quantities of water with respect to its own dry mass. The present work deals with the preparation of SAPs from orange peels which could be used as a water retaining agent in the agricultural and other applications. Orange peels being a naturally occurring material, the SAPs produced from its peels will be biodegradable and non-toxic in nature. Moreover, as the orange peel is a waste product of the juice & fruit industry, the SAPs produced from its peels will be cheap & economical as compared to those made commercially. The present work is divided into: Extraction of oil, Pectin Separation & Preparation of SAPs. Experimental runs were carried out & the sample synthesized was analyzed for various properties using FTIR spectroscopy, UV spectroscopy and an Absorptivity test. Based on the observations, results & conclusions, it can be said that the sample synthesized was able to absorb 20–25 times of water relative to its own dry weight. The FTIR & UV analysis tests have also supported the claims of formation of cross-linked polymers. The present work has successfully demonstrated synthesis of SAPs from agro-based waste material such as orange peels.

Keywords: Super Absorbing Polymers (SAPs), Emulsion polymerization, Water retention, Crosslinking, Orange peels, Pectin separation.

1. Introduction

The Super Absorbing Polymers (SAPs) are the special type of polymeric substances which can absorb and retain large quantities of water with respect to its own mass. The SAPs commonly known as Hydrogels, when immersed in a liquid they turn into a gel like substance by absorbing large quantities of water. The commercial SAPs can absorb 300-1000 times of water relative to their own dry weight. The structure of SAPs consists of a net like structure which is formed by the cross-linking of the polymeric chains which prevents the SAPs from dissolution. By the presence of ionic functional groups and hydrogen bonding along the polymeric structure, the water molecules gets absorbed and retained. Most of commercially produced SAPs are synthesized by polymerizing Acrylic acid, Acrylonitrile, etc. But the SAPs produced from them are toxic & synthetic in nature. Recently many researchers have been working for the development of biopolymers as an alternative to the synthetic polymers used in our daily life. The advantage of the use of these naturally occurring polymers against the synthetic polymers is that they are cheap, biodegradable & non-toxic. The present work deals with the preparation of SAPs from orange peels which could be used as a water retaining agent in the agricultural and other applications.



Optimum Choice of the Front Suspension of an Automobile

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Abstract. The paper details the optimum choice of the front suspension of an automobile. The influence of suspension on the steering geometry is studied by considering the various combinations of joints at the four-bar mechanism of the front suspension. The purpose of the suspension is to make the job easier for the tires and give a predictable behavior so that the driver will have control of the car. The most common suspension used is double wishbone. The performance of the steering geometry depends upon the performance of various steering parameters such as kingpin angle, caster angle, camber angle, toe in and out and scrub radius. This steering geometry depends upon the position of kingpin axis an imaginary line passing through the knuckle pin. The steering geometry is a function of vehicle speed, link lengths, and road condition. The selection of the optimum choice of the suspension makes the benefit the comfort for driving and controlling the vehicle conditions.

Keywords: suspension, steering geometry, front suspension, optimum, mechanism.

1 Introduction

The suspension of the front wheels is more complicated than the suspension of the rear wheels. This is because the front wheels move up and down. Front suspension changes the orientation of wheel with respect to the road, affecting the steering behavior and tire. The most common suspension used is double wishbone. As this suspension locates the wheels and controls the geometry of their movement, over bumps. Unequal length wishbones are preferred because they separate the effects of the springs more effectively and controls wheel movement better. The upper wishbone is shorter than the lower one for superior camber control. Therefore, it is also called as SLA which stands for Short Long Arm. It is easily recognized that an SLA suspension is a three-dimensional four bar mechanism [1–2].

Ball joints provide key pivot points in the front independent suspension set up. In operation the swiveling action of the ball joints allows the wheel and spindle assemblies to be turned left or right and to move up and down with changes in road surface geometry. Four control arms are connected with spherical joints, lower ones and upper ones [3]. The other ends of these control arms are connected to the vehicle frame via revolute joints. Various types of mechanisms with two spherical pairs along with revolute pairs and cylindrical pairs were formed by changing the position of various joints [4].

These mechanisms are analyzed for the optimum choice of a front suspension. It also presents the steering geometry parameters along with the measuring techniques. This exercise can be looked upon as a type synthesis of suspension mechanism [5].

2 Research Methodology

2.1 Steering geometry parameters

Presently steering geometry parameters kingpin inclination angle, caster angle, camber angle, toe angle are measured using alignment equipment, caster / camber gauge, a set of turntable and bubble gauges. The steering wheel should be centered while measuring the steering performance. Turn the steering wheel completely to the right then turn the wheel completely to the left and count the number of turns of the steering wheel. After following the complete procedure steering geometry performance parameters are measured and adjusted.

On the basis of six included angles of the 3D front suspension mechanism, one at each revolute joints and two at each spherical joints of this four bar chain, the position of kingpin axis is determined. Steering performance depends on the position of a kingpin axis. Depending on the position of the kingpin axis, caster angle, camber angle, kingpin angle, and toe angle of the four-wheel vehicle are decided.

AN EFFICACY OF MULTI-FUNCTIONAL LIQUID BIOFERTILIZERS

ON MANDARIN ORANGES: FIELD EXPERIMENT RESULTS

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ABSTRACT

The present investigation entitled “Studies on liquid biofertilization of soil and its impact on growth, quality and productivity of mandarin oranges was conducted in a well established mandarin orange orchard with 5 years old orange trees planted at 6 x 6 m spacing having uniform growth and productivity at Dhapewada Farm, Maharashtra, India during 2016-2018. The results revealed that, there were significant variations in growth and yield of sweet orange due to application liquid biofertilizer formulation (Acetobacter, Azotobacter Psudeomonas, Trichoderma, Frateuria). Field trials revealed a significant increase in height of the plant (5.5-26%), stem diameter (5.3 - 25.7%), weight of fruit (9.6 - 36.5%) and a number of fruits (7.0 - 29.7%) using formulation T-5 in comparison to T-1 during the year 2016-18.

KEYWORDS: Mandarin Orange & Liquid Biofertilizer

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INTRODUCTION

The changing paradigm towards agriculture has necessitated that horticultural sector may be looked as an enterprise for providing the livelihood security to the farmers globally. Diversification in cultivation of horticultural crops will not only ensure sustained income to the farmer, but will also generate the employment in the rural as well as urban sectors. India has a unique climatic advantage that makes it the world's second largest producer of fruits 88819 MT with a productivity of 13.97 tonnes per hectare. Among fruits, citrus is an important crop and occupies an area of about 987,000 ha with production of 12181 thousand tones (Anonymous, 2015). Sweet orange is important fruit crop. India endowed with varied agro climatic condition where wide range of citrus species can be grown on a commercial scale (Shyam Singh et al., 1996). Fertilizer is one of the major inputs in citrus farming contributing about 1/3rd of the cost of cultivation and responsible to maintain soil fertility, crop yield, fruit quality, tolerance to pests, diseases and other stresses (Srivastava and Singh 2003d). However, large scale use of chemical fertilizers causes problems of ground water and environmental pollution through leaching of volatization, respectively. The disproportionate use of fertilizer has widened the soil imbalance in terms of the NPK ratio (Dheware & Waghmare, 2009). It has now been realized that the use of chemical fertilizers must be replaced with more economic, renewable and environmental friendly biofertilizers.

Biofertilizer is a substance containing living microorganisms, which, when applied to seeds, plant

Fractional order theory of thermal deflection to a 2D problem for a thin circular plate with instantaneous heat source

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Abstract

In this work, a quasi-static uncoupled theory of thermal deflection based on time fractional heat conduction equation is studied in a thin circular plate with internal heat source, whose lower surface is at zero temperature whereas the upper surface is insulated and subjected to constant temperature on the curved surface. Integral transform techniques including Mittag-Leffler functions are used to solve the problem. Numerical results for temperature distribution and thermal deflection are computed and represented graphically for copper material.

Keywords: Quasi-static; thermoelectricity; fractional order; integral transform; thermal deflection; Mittag-Leffler function.

1. Introduction

In the recent past, a lot of applications were found for fractional calculus in various engineering disciplines such as proportional-integral-derivative (PID) controllers, signal processing, fluid mechanics, viscoelasticity, mathematical biology, and electrochemistry. This has led to research in the area of non-integer calculus. The idea of fractional-order calculus is appealing but poses a serious challenge when one embarks on a journey to know the physical interpretations. Podlubny [1] gave the geometric interpretation of fractional integration as “Shadows on the walls” and its physical interpretation is “Shadows of the past.” The most important advantage of using fractional-order differential equations is their nonlocal property. This is more realistic, and an important reason why fractional calculus has gained popularity.

The classical theory of thermoelasticity has aroused much interest in recent times due to its numerous applications in engineering discipline such as nuclear reactor design, high energy particle accelerators, geothermal engineering, advanced aircraft structure design, etc. The heat conduction of classical coupled theory of thermoelasticity is parabolic in nature and hence predicts infinite speed of propagation of heat waves. Clearly, this contradicts the physical observations. Hence, several non-classical theories such as, Lord-Shulman theory [7], Green Lindsay theory [5] have been proposed, in which the Fourier law and the parabolic heat conduction equation are replaced by more complicated equations, which are hyperbolic in nature predicting finite wave propagation.

Effect of Hydrocolloids on Oil Uptake in Bhature

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Abstract

The amount of oil may be reduced by victimization hydrocolloids for the preparation of bhature. Bhature square measure the favored food made up of the refined flour that is that the deep-fried product that absorbs high quantity of oil throughout sauteing. result of hydrocolloids on reduction of oil in bhature throughout deep fat sauteing was studied. Hydrocolloids at zero.5–1.5% (on the premise of refined flour and semolina) were screened for his or her ability to cut back oil uptake in bhature. it had been determined that there was important decrease in oil uptake with increase in level of all hydrocolloids. The study disclosed that gum acacia and carrageenin at one.5% level considerably reduced the oil content in bhature to seventy six.7% and 76.47% severally as compared to any or all alternative hydrocolloids and their concentration levels. Hence, bhature with low oil and higher acceptance is ready for health cautious shoppers World Health Organization demands low fatty foods.

Keywords: hydrocolloids, bhature, deep fat frying, oil uptake

1. Introduction

Frying could be a common cookery technique of food preparation having fascinating product characteristics. it's a unit operation that will increase the taste property of food. cooked foods square measure currently standard for his or her distinct flavour, texture, look and crisp mouth feel. Deep-fat sauteing involves immersion of food in hot edible oil to cook it to a crisp golden color that is allotted at a temperature higher than the boiling purpose of water for a given amount of your time. the method involves each mass transfer, primarily described by water loss and oil uptake, and warmth transfer. throughout deep fat sauteing crust formation and browning happens giving the merchandise a beautiful golden look and crisp mouth feel (Annapure et al., 1998). The soft and wet interior and porous crisp crust makes food delicious (Mellema 2003). Deep fat sauteing of varied forms of foods coated with batter could be a standard cookery procedure in several countries (Kimber and Holding, 1987), whereby the warmth is transferred from oil to the merchandise, water is gaseous and oil is absorbed. The oil uptake and its distribution within the deep-fried product is principally close to the surface i.e.

crust (Varela, 1988). the amount of oil uptake is directly proportional to the extent of wet removed (Gamble and Rice, 1988). there's intensive use of hydrocolloids in varied dough mixes to reinforce quality attributes and shelf-life (Saha and Bhattacharya, 2010). within the previous study on oil reduction victimization many hydrocolloids pulverised polyose (Annapure et al. 1999 and Mallikarjunan et al. 1997), HPMC, CMC, guar gum, xanthan gum (Sakhale et. al., 2011), pectin, metal alginate (Holikar et al. 2005 and Khalil 1999) were studied. Hydrocolloids square measure applied in 2 ways in which within the deep-fried merchandise either within the kind of solution to create edible film on the surface of food material to be deep-fried or they're additional on to the batter together of the ingredient (Varella, 2011). Bhature is one among the samples of deep sauteing product. it's dish from geographic region preparation. Bhature square measure technically quite as same as poori. Bhatura is sometimes accompanied with chole. Bhature square measure the popular food made up of the refined flour that is that the deep-fried product that absorb high quantity of oil throughout sauteing. Bhature square measure created by refined flour,



Antioxidants: Activity determination and Identification

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Abstract

Antioxidants are gaining tremendous importance in our daily lives. These components intent to neutralize the free radicals formed in the body which are capable of damaging the body. Natural antioxidants added to foods may have a physiological impact on human health, particularly because they may reduce the risk of illnesses or they promote the delay of damaging free radicals effect, like cardiovascular diseases, intestinal cancer or infections symptoms. Synthetic antioxidants are often added to foods to retard oxidation and extend a helping hand in increasing shelf life. A variety of methods are used for determination of antioxidant activity. With the technological advances, identification of antioxidants is not a big deal. In the present article the various methods for antioxidant activity determination and for identification of antioxidants are discussed.

Keywords: antioxidants, free radicals, antioxidant activity, identification, oxidation

1. Introduction

Human body can be regarded as a complex system composed of natural enzymatic and non-enzymatic antioxidant defenses that strive to protect the body against damage caused due to free radicals or reactive oxygen species (ROS) and other oxidants. Free radicals are found to be major causative factors for the occurrences of many diseases like cancer and also for aging. Antioxidants provide protection against the damage caused by free radicals [1]. Antioxidants are compounds that are capable of delaying or inhibiting the oxidation processes which occur under the influence of atmospheric oxygen or reactive oxygen species. Oxidation process normally occur in foods as well as in human body and the antioxidants serve as a defense mechanism against damage caused due to oxidation process. They are used for the stabilization of polymeric products, of petrochemicals, foodstuffs, cosmetics and pharmaceuticals.

There is a growing interest of scientists in the concept of 'synergism' i.e. A combination of antioxidants may be more effective rather than providing single entities. Antioxidants may contribute on a greater scale in improving the quality of life by preventing or postponing the occurrences of diseases. Due to this contribution incorporation and intake of antioxidants is considered to be of significance today and thus they are gaining a lot of importance in the field of healthcare and food industries [2].

Antioxidant activity can be termed as the ability to inhibit the process of oxidation. A good number of abstracts and research articles published, so far, for evaluating antioxidant activity of various samples of research interest were studied where 407 methods were come across, which were repeated from 29 different methods. These were classified as *In vitro* and *In vivo* methods and those are described and discussed below in this review article. Various methods are used to investigate the antioxidant property of samples (diets, plant extracts, commercial antioxidants etc.) [3]. This review article

aims to accumulate commonly used methods that are used to evaluate the antioxidant property of various samples.

Antioxidant activity should not be concluded based on a single antioxidant test model. Several *In vitro* test procedures are carried out for evaluating antioxidant activities with the samples of interest. Another factor is that antioxidant test models vary in different respects. Therefore, it is difficult to compare fully one method to other one. Researcher has to critically verify methods of analysis before adopting them for his/her research purpose. Method for determining antioxidants should be adopted as per the suitability of researcher and availability of the materials [3].

2. Antioxidants

The basic concepts regarding antioxidants, free radicals and oxidative stress are discussed in our article, (Antioxidants: Extraction and application in food industry) [4]. Antioxidants are compounds of many different chemical forms, grouped together as they are capable of compensating the ill effects of free radicals and oxidation reactions in the food system and the human body. An antioxidant can be defined as: "any substance that, when present in low concentrations compared to that of an oxidizable substrate, delays or inhibits the oxidation of that substrate". Antioxidants were found attractive by the researchers as they were capable of inhibiting rancidity in oils and fats. Dietary sources like fruits, vegetables, tea, etc. are rich in antioxidants [4]. As the food industry, today is very much concerned with the incorporation of antioxidants in various food products newer techniques for the extraction, identification, purification, and recovery of antioxidants continue to emerge. With the development of these techniques, antioxidants have found many applications in the food industry today. The methods of antioxidant activity determination and identification are discussed further.

A PILOT SCALE PROCESS FOR THE PRODUCTION OF HIGH SHELF LIFE MULTI-FUNCTIONAL LIQUID BIOFERTILIZERS

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ABSTRACT

The mass production of liquid biofertilizers on the industrial scale with high cell viability and shelf life is still in infancy. Cost effective pilot scale (50l) process developed at purti enterprises, nagpur exhibits a high viability for azotobacter (1 x 10¹⁵), acetobacter (1 x 10¹⁵), psudeomonas (1 x 10¹⁸), frateuria (1 x 10¹⁷), bacillus (1 x 10¹⁷), trichoderma (2 x 10⁹). The liquid biofertilizers were kept at room (28 ± 2°C) for shelf-life study. Liquid biofertilizers showed a significantly high viable count after storage of one to one and half year.

KEYWORDS: Alternative Agriculture, High Cell Viability, High Shelf Life & Liquid Bio Fertilizers

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INTRODUCTION

Liquid Bio fertilizers

The liquid biofertilizers are believed to be the best alternative to synthetic fertilizers and conventional carrier based biofertilizers in the modern agriculture due to their high moisture retaining ability, longer shelf life than carrier based biofertilizers, better survival on the seed and nodulation, ease of handling, storage and transportation all favouring sustainable agricultural system of high productivity. They are the microbial preparations containing specific beneficial microorganisms which are capable of fixing or solubilizing or mobilizing plant nutrients by their biological activity (Pindi & Satyanarayana, 2012)..

Mass Production of High Cell Viability

The agricultural benefits possible from the use of selected liquid biofertilizers can be realised only when farmers obtain high quality inoculants on their legume seeds or soil before planting. Technology on growing rhizobia, preparing inoculants with suitable carrier materials, and distributing viable inoculants to farmers is essential. The most important constraint for adoption of liquid bio fertilizers was identified as the number of viable cells in the product. The production process of the inoculum is key to a final high-quality product (Bashan et al. 2014), since there is a direct relationship between the population density of mother culture and the quality of the final products (Stephens and Rask 2000). Hence, the increasing need for environmental friendly agricultural practices is driving the manufacturer to develop processes with high cell viability using the low cost medium. Related to the number of inoculant cells in carriers, the growing medium used to cultivate the microbial cells plays a very important role. For mass production of microbial cells of inoculant, the medium should be able to support



Antioxidants: Extraction and application in food industry

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Abstract

A class of various compounds, 'antioxidants' are the ones which possess an ability to protect the human body against the deleterious effects of oxidation reactions. The concept of good health and well-being revolves around the fact of maintaining a balance of antioxidants and reactive oxygen species (ROS) in the human body. Antioxidants provide protection against the free radicals responsible for cell damage which otherwise are accumulated and leads to a pathological condition known as 'oxidative stress' and is a causative factor for cancer. Formation of free radicals is an inevitable phenomenon but their neutralization by antioxidants is indispensable for the body. Antioxidants are like bodyguards which prevent our body from damage and diseases and have a wide range of applications. In this review, the concept of antioxidants, identification, extraction and their specific applications in the food industry will be covered.

Keywords: antioxidants, oxidative stress, free radicals, ROS

1. Introduction

Oxygen, no doubt is an essential component of living. Proper utilization of oxygen is needed in the production of energy through the metabolism of nutrient components of food. Thus, oxygen is regarded as a pre-requisite for the survival of living beings. On the other hand, it is hard to believe that oxygen, a crucial element for life may have pernicious effects on the human body under certain conditions. A number of chemical reactions continue to occur in the human body responsible for its proper maintenance and metabolism. Oxygen play an extremely important role in the occurrences of these reactions. Oxidation and reduction reactions are of significance among the commonly occurring natural chemical reactions. Both of these reactions occur simultaneously. Oxidation cannot occur without reduction and vice versa. Oxidation reactions are thus the basis of survival for living beings and these reactions are inevitable. Several cellular functions are impossible without oxidation reactions. Oxidation also occurs in food which is mainly responsible for quality, flavor and texture loss of food product and rancidity of fats and oils.

Free radicals formed during the metabolic processes or from the external sources are capable of carrying out chain reactions and causing cellular damage. Environmental agents also initiate free radical generation. The toxicity of lead, pesticides, cadmium, ionizing radiation, alcohol, cigarette smoke, UV light, and pollution may all be due to their free radical initiating capability. Reactive oxygen species is a collective term that includes all reactive forms of oxygen, including both oxygen radicals and several non-radical oxidizing agents that participate in the initiation and/or propagation of chain reaction^[1].

Oxidative stress is defined as a pathological condition caused

due to the accumulation of free radicals in the body. It is an indicator that the free radicals present in the body are not effectively neutralized by the antioxidants. Oxidative stress is the main causative factor of various diseases, aging and cell damage. Occurrences of oxidative reactions, formation of free radicals and ROS in the human body and food systems no doubt is an inevitable phenomenon but their neutralization by the antioxidants is extremely important as they may further lead to cellular damage in case of the human body and may carry out some undesirable changes in the food product with regards to its flavor, texture and organoleptic properties thus rendering it unacceptable by consumers^[2].

Antioxidants are a class of chemical compounds that have an ability to stabilize the free radicals by donating their free electrons and thus combat the ill effects of oxidative reactions. They play a vital role in the neutralization of free radicals and contributes much to the health and well-being of an individual and in maintaining the acceptability of a food product. The food industry is majorly concerned with the neutralization of free radicals by incorporating antioxidants in a food product and also has an emphasis on the development of newer products which will extend a helping hand towards the stabilization of free radicals in the body when consumed. Polyphenolic and flavonoid compounds are a major class of antioxidants. As the food industry, today is very much concerned with the incorporation of antioxidants in various food products newer techniques for the extraction, identification, purification, and recovery of antioxidants continue to emerge. With the development of these techniques, antioxidants have found many applications in the food industry today which will be covered further.

MODIFICATION OF KUSUM OIL, ISOLATION OF KEY FATTY ACIDS AND PREPARATION OF COSMETICS

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Abstract - With the increasing modernization, people are becoming more health conscious. This has led to the increasing importance of Cosmetology in today's world. However, the normal cosmetic products are prepared using mineral oils having petroleum origin, which is non-biodegradable and contributes to toxic organics to the environment. The purpose of this research is to produce a range of cosmetic products using Kusum Oil, which is renewable and eco-friendly raw material. Various cosmetics products such as moisturizing lotions, shaving creams and hair conditioners can be prepared using Kusum oil. It has emerged as a very effective ingredient in the preparation of the various cosmetic products. The various physicochemical analyses was carried out with the prepared formulations which gave excellent results. The details regarding the same are available in the further contents of this paper.

Key Words: Non-traditional Oils, Kusum Oil, Eco-friendly, Cosmetic Products

1. INTRODUCTION

Out of 250000 trees known species only 4500 species, are being examined for oil all over the world. India possesses about 100 non-edible oil bearing seeds. Many of these species are not cultivated, but they grow in the wild. Out of 100 species, only 10 species have attracted the attention of technologists for commercial use, some of which are Mahua, Sal, Neem, Karanja, Jatropha and, Kusum.

Table -1: Estimated total potential of minor oil seeds of tree origin

Sr. No	Variety of Minor Oil Seeds	Seed Potential (in tonnes)	Oil Yield (in %)	Oil Potential (in tonnes)	Nature of Oil
01.	Sal	5,54,000	12.3	6,88,000	Hard
02.	Mahua	4,90,000	35	1,71,000	Hard
03.	Neem	4,18,000	20	83,600	Semi-hard
04.	Kusum	90,000	33	30,000	Semi-hard

Table - 2: Total Utilization of Minor Oil Seeds

Sr. No	Variety of Minor Oil Seeds	Seeds (in tonnes)	Oil (in tonnes)
01.	Sal	2,00,000	20,000
02.	Mahua	71,426	25,000
03.	Neem	25,000	3,125
04.	Kusum	9,900	8,000

Kusum is a dry forest tree which serves as a host for lac insects. Its oil content ranges from 50-62%. Oil is extracted by pressing the seeds in an expeller, which can yield 36% of the oil. This oil is yellowish white to yellowish brown in colour. It is a semi-solid fat having a faint odour of bitter almond. It is composed of 37% glycerol esters. Since it has 91% of fatty acids, it can be used for the preparation of soft soaps which produce more lather. It can be used for the treatment of itches, aches and skin diseases. It also serves as illuminant, lubricant and hair oil. It has a cleansing effect on the scalp. It has the ability to improve the Spreadability as well as the shelf life of the final products.

Table - 3: Physico-chemical Characteristics of Kusum Oil

Characteristics	Values
Specific Gravity (32°C)	0.9099
Refractive Index (40°C)	1.46107
Acid Value	31.3
Saponification Value	234.3
Iodine Value	60.2
Unsaponifiables (%)	2.1
Acetyl Value	4.0
Hehner Value	88.7

Table - 4: Fatty acid composition of Kusum Oil

Fatty Acid	% Composition
Oleic Acid	43
Arachidic Acid	21
Eicosenoic Acid	15
Palmitic Acid	8
Linoleic Acid	4.5
Stearic Acid	1-2
Behenic Acid	1-2
Erucic Acid	1-2

SYNTHESIS ON RICE BRAN FATTY ACID GEL, IT'S BEHAVIOUR IN VARIOUS COSMETIC: A CASE STUDY

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Abstract - The Rice Bran Fatty Acid wax is natural derivative obtained during extraction of rice bran oil. It is widely used in industrial application i.e. in preparation of cosmetics industry. The aim of study was to investigate process of synthesis and utilisation of Rice Bran Fatty acid because of its good consistency emollience and gelling property, as formulation in lipsticks lip care etc .it is a good moisturising agent also. Rice Bran Fatty Acid wax is good in keeping skin soft and moisturised .some experimental was carried out to make different cosmetic products to observe their Physico chemicals properties. Mostly it is in the field of cosmetics preparation such as face cream, skin cream

Key Words: Cosmetic Products, Rice Bran Fatty Acid Rice Bran Oil, Consistency

1. INTRODUCTION

Rice Bran Fatty Acid Wax is said to be most abundantly available-product, which is derived from crude Rice bran oil. It is obtained from outer brown layer of rice extracted from husk usually balance fatty acid. There is large amount fatty acid and wax present in mixture. The oil is removed to obtained fatty acid and wax. This can be used in cosmetic. It has emollience property and gelling agent .it can be used to make lip care, skin cream, and face cream, conditioning agent. It's also gives good spread ability and softness to skin when applied on skin .it particularly rich in essential fatty acid and vitamins. In addition to that, it is found to be safe ingredients and can be used in cosmetics product to improve skin texture, maintain Ph when applied considered as natural substances. Rice bran fatty acid has smoothing properties huge application in cosmetics and chemical industry. The world production of vegetables wax is evaluated 16,000 tons per year, about half of this quality is carnuba wax. The production of other plants waxes is relatively smaller.

Table 1: Rice producing states

SR NO	STATE/UT	RICE (Th.Tonnes)	AREA	AVERAGE YIELD
1	West Bengal	14711	5386	2731.38
2	Uttar Pradesh	12221	3809	2082.36
3	Andra pradesh+Telangana	11565	2894	3036.35
4	punjab	11107	4166.28	3837.94
5	Orissa	8286	3268	1988.84
6	Bihar	6377	3808.5	1951.40
7	Chattisgarh	6021	1829.98	1581.00
8	Tamilnadu	5839	2278	3190.75
9	Assam	4863	1278	2134.77
10	Haryana	4006	1387	3112.67

Table 2: Chemicals Composition of Rice Bran oil

COMPOSITION	PERCENTAGE%
Triacylglycerol	80.5
Free Fatty Acid	6.8
Diacylglycerol	4.8
Monoacylglycerol	1.7
Oryzanol	2.0
Phosphatides	1.3
Wax	2.9



Replacement of fat, salt, and sugar: Need of an hour for food industries

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Abstract

The escalating concern of consumers towards the consumption of healthy food and leading a healthy lifestyle has encouraged the food industry to develop and market food products manufactured by considering the health aspect of the consumers. Health consciousness these days has become a trend. Excess weight is considered to be a key factor associated with the diseases like CVD, Hypertension, and Diabetes etc. Fats, salt, and sugar no doubt are the principal ingredients in the majority of food preparations worldwide. They play a major role in flavor development and preservation. People desire to replace these ingredients without compromising the flavor and taste. Developing replacement strategies and creating replacers of these ingredients is a major challenge before the food industries. This review article has a focus on the replacement strategies of fat, salt, and sugars in foods and the use of analogs for replacement of these ingredients.

Keywords: analogs, fat, salt, sugar, health consciousness

1. Introduction

Statistical surveys are performed regularly by the World Health Organization in order to check the health and well-being of people and estimate the number of deaths and patients affected due to various diseases every year. The results of the statistical surveys over years has shown a continuous increase in the number of people affected and the deaths caused due to diseases like hypertension, diabetes, CVD etc. A majority of people all over the world have fallen prey to these diseases. The main factors responsible for this condition today is the modernized lifestyle (more a sedentary one), lack of exercise, adoption of fast food culture and mainly an improper diet loaded with fat, salt and sugar. The development of Hypertension is usually linked to the consumption of salt similarly diabetes is associated with sugar consumption and CVD to the consumption of fats.

The Food Safety and Standards Authority of India (FSSAI) has recently launched a campaign, 'Eat right movement', at a national level which focusses on reducing the content and intake of fat, salt and sugar on everyday basis and at an industrial level, thus making the food more nutritious and combat the ill effects of excessive consumption of fat, salt and sugar. This campaign is a collective effort to encourage people in making safe, healthy and nutritious food choices. As a part of this campaign, citizens are empowered to make the right food choices and food business operators are requested to reformulate their products, provide accurate nutritional information to consumers and make an investment in healthy food.

The analogs of these ingredients extend a helping hand towards the minimized use of these ingredients and ultimately contributes to minimizing the occurrences and exercise control

over these diseases. Moreover, these analogs have proven to be beneficial for consumers with a desire to cut off the calories from their diet without compromising the flavor and quality of the food product. Food analogs may be referred to as 'engineered food'. A food manufactured with a view of replacing the traditional ingredients. They are manufactured food product or ingredient intended to mimic or replicate the characteristics of a particular food. They must possess the characteristics equal to or higher than that of the original food which it is intended to replace.

They are designed with a basic objective of replacing the food ingredients, to save money, change the nutritive value of food, improve the performance of foods and compounds, provide an option for replacing the foods that are restricted for health reasons, religious views and provides an attractive option for the health-conscious consumers. Some of the examples of food analogs are Texturized vegetable protein from soybean used as a meat analog, Meat analog like (Tofu, Quorn), Artificial sweeteners (Saccharin, Aspartame, Sucralose), Fat replacers (Olestra, Caprenin), Salt substitutes (Potassium chloride), Gums etc.

Some of the advantages of this technology are that it provides benefits of low-fat reduced calorie options, keep prices of other food products reasonable, and provides more options for people with heart diseases, food allergies, and diabetes. Certain disadvantages of food analogs are firstly they are not natural, the manufacturing cost may be expensive which ultimately leads to the increased cost of the final product and may withdraw the consumer's interest to purchase them. However, it cannot replace all the traditional foods in the diet and their use may tempt some people to avoid eating a variety of foods. Food analogs have gained increased consumer

MODIFICATION AND UTILIZATION OF RICE BRAN FATTY ACID IN COSMETICS

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ABSTRACT:

The field of cosmetics is gaining huge importance in the present days. The conventional methods of preparations need some modification in order to fulfill the requirements of the society. Waxes have always been a primary ingredient of the cosmetic preparations. Natural and synthetic waxes are used since a long period of time. This study aims to investigate the modification of rice bran fatty acid and its usage in cosmetics preparations. Rice bran gel is a by-product generated during the refining of rice bran fatty acid. In this work Rice bran gel was purified processed and was analyzed for its physico-chemical properties further based on these properties it was utilized in preparing various skin care products. Natural and synthetic waxes are used since long period of time. But studies reveals that's natural waxes provide a latter emollient effect as contrasted to synthetic waxes. One such natural product is rice bran gel.

KEYWORDS: Rice Bran fatty Acid, Rice Bran Gel, Emulsion, Natural Cosmetics

INTRODUCTION:

Rice bran oil is an unique vegetable oil produced from the outer brown layer of rice which is commonly known as rice bran are removed during the processing and polishing of rice in milling industry. Besides having an about ideally balanced fatty acid profile, it is splendid in actual anti-oxidants. A numeral of controlled systematic studies conducted in India & abroad compromise considerably acknowledged the improved on cholesterol lowering properties of rice bran oil as contrasted to other conventional vegetable oils. White rice is polished to remove the excess bran layers and achieve desired degree of whiteness. The hull of rice and the rice bran are generated as the by-product of the rice milling industry.^{1,2}

Rice bran wax is obtained from natural source. That natural sources *Oryza-Sativa*- family Gramine. And it is abundantly available. It is significant result of the rice bran oil industry. The wax is reported to be chiefly Melissly cerotate.

Rice bran wax has been historically old in a large strain of cosmetics. The rice bran wax is moderately despicable in priced as compared to imported materials. It is an ordinary hard, crystalline vegetable expand obtained from rice husk. It is having peak melting point of 77-86 degree Celsius. It consists of exceedingly prolonged chain saturated C46-C62 esters additionally recognized as policosanols, from C20-C36 fatty acids. Rice bran wax expand in nature contains phospholipids. There phytosterols (healthy arrange steroids) and squalane which moisturizing and has antioxidant properties.

According to the prescriptions of FDA, rice-bran wax is a refined wax from rice-bran meetings the following specifications: m.p. 75 - 80°C, max. Free fatty acids content 10 per cent, max. Iodine number 20, saponification number 75~12t. Based on the data published in literature and on the results of my own investigations the proposed quality prescriptions for rice-bran wax may be summarized in the following: color yellowish-white, iodine number 4-20, acid number 5-20, saponification value 80-120, non-saponifiable matter 52 - 58 per cent, m.p. 78-82.

The purified rice-bran wax has similar properties of carnauba wax. This means, that the potential field of use of the rice-bran wax is very wide. As a potential replacement for carnauba wax, rice-bran wax may moreover be a "melting point booster" for other waxes. It may be utilize in different polishing emulsions, as a constituent of shoe creams and as components or coating for candy, chewing gum and fruits and in various cosmetics. To estimate the marketability of a new outcome result is very difficult.

CHEMICAL REACTION ENGINEERING ON ISOMERIZATION OF OLEIC ACID: CLAY CATALYST

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ABSTRACT

Isomerization reaction was carried out and was studied in detail. Porous Clay is the catalyst for isomerization of oleic acid .The reaction kinetics are estimated for 5wt% catalyst concentrations, temperature was from 260⁰C to 280⁰C .The reaction was carried out for several duration of hours and product was obtained as iso-oleic acid (IOA) along with dimer as simultaneous product. Kinetic studies based on rate data is proposed based on multiple reactions. Residence time distribution for reactant is plotted for F curve and E curve. Yield and conversion has determined **50.5258%** and **66.309%** respectively.

KEYWORDS: iso-oleic acid, isomerization kinetics, residence time distribution

INTRODUCTION

Oleic acids are mono unsaturated compound commercial known as cis – 18 octadecanoic acid having a polar carboxylic acid head group and an alkyl chain.

Oleic acid as its sodium salt is a major component of soap as an emulsifying agent . It is also used as an emollient [1]. Small amounts of oleic acid are used as an emulsifying agent or products[2].

This straight chain naturally occurring compound and its isomers for many beneficiaries and to obtain much desired properties into products which could not be fulfilled by oleic acid.

Hence an isomer named , Iso-oleic acids are branched compounds that are non-toxic and biodegradable in nature. They are predominantly used in cosmetics because of their superior moisturizing properties as they are odorless, provides smooth spreading and non-tacky feeling when applied onto skin[3].

COMMERCIAL ISO-OLEIC ACIDS

Isomerization reaction at industrial scale with proper reactor choice , reactor design and the choice of catalyst. All the parameters requires the kinetic study and theoretical calculations of process related terms. This all is studied in this research work .

EXISTING METHODOLOGY FOR ISO OLEIC ACID

The accepted process includes the porous clay as a catalyst . The process conditions been employed in this experimentation are optimum and isomer obtained is at maximum production.

EXPERIMENTAL PROCEDURE

MATERIALS

Oleic acid is the sole main reactant and porous clay catalyst plays a selective role, inert gas nitrogen is being employed to maintain the pressure .

2-(4-Ethoxy phenyl)-4-phenyl quinoline organic phosphor for solution processed blue organic light-emitting diodes

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Abstract

This paper reports the synthesis and characterization of 2-(4-ethoxyphenyl)-4-phenyl quinoline (OEt-DPQ) organic phosphor using an acid-catalyzed Friedlander reaction and the preparation of blended thin films by molecularly doping OEt-DPQ in poly(methyl methacrylate) (PMMA) at different wt%. The molecular structure of the synthesized phosphor was confirmed by Fourier transform infra-red (FTIR) spectroscopy and nuclear magnetic resonance spectra (NMR). Surface morphology and percent composition of the elements were assessed by scanning electron microscopy (SEM) and energy dispersive analysis of X-rays (EDAX). The thermal stability and melting point of OEt-DPQ and thin films were probed by thermo-gravimetric analysis (TGA)/differential thermal analysis (DTA) and were found to be 80°C and 113.6°C, respectively. UV-visible optical absorption spectra of OEt-DPQ in the solid state and blended films produced absorption bands in the range 260–340 nm, while photoluminescence (PL) spectra of OEt-DPQ in the solid state and blended thin films demonstrated blue emission that was registered at 432 nm when excited at 363–369 nm. However, solvated OEt-DPQ in chloroform, tetrahydrofuran or dichloromethane showed a blue shift of 31–43 nm. Optical absorption and emission parameters such as molar extinction coefficient (ϵ), energy gap (E_g), transmittance (T), reflectance (R), refractive index (n), oscillator energy (E_0) and oscillator strength (f), quantum yield (ϕ_f), oscillator energy (E_0), dispersion energy (E_d), Commission Internationale de l'Éclairage (CIE) co-ordinates and energy yield fluorescence (E_F) were calculated to assess the phosphor's suitability as a blue emissive material for optoelectronic applications such as organic light-emitting diodes (OLEDs), flexible displays and solid-state lighting technology.

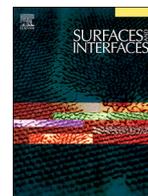
KEYWORDS

acid-catalyzed Friedlander reaction, displays, OEt-DPQ, OLEDs, PMMA, quantum yield, solid-state lighting, Stokes' shift, triplet energy

Abbreviations used: CHL, chloroform; CIE, Commission Internationale de l'Éclairage; DCM, dichloromethane; DPQ, 2-(4-ethoxyphenyl)-4-phenyl quinoline; DTA, differential thermal analysis; EBU, European Broadcast Union; EDAX, energy dispersive analysis of X-ray; EF, energy yield fluorescence; FTIR, Fourier transform infra-red; FWHM, full width at half maximum; ICT, intramolecular charge transfer; LED, light-emitting diode; NMR, nuclear magnetic resonance; OLED, organic light-emitting diodes; SEM, scanning electron microscopy; TGA, thermo-gravimetric analysis; THF, tetrahydrofuran.

1 | INTRODUCTION

In recent years, organic compounds containing significant amounts of carbon have brought a technological revolution to the light sources field. There has been great interest in these new materials as a means to construct flat panel displays.^[1,2] A wide variety of substrates can be used to deposit thin organic films on plastic so that flexible



Sonochemical synthesis of Pt-Co/C electrocatalyst for PEM fuel cell applications



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ABSTRACT

In this work, we demonstrated the sonochemical synthesis of carbon supported platinum-cobalt bimetallic (Pt-Co/C) electrocatalysts for a proton exchange membrane (PEM) fuel cell. The particle size of Pt-Co/C nanoparticles was less than 5 nm and they were spherical in shape, as revealed by the transmission electron microscope (TEM) image. The electrochemical-active surface area (EASA) of the Pt-Co/C was found to be 8.7 m²/g whereas, the open circuit potential (OCP) was measured to be 0.91 V. The incorporation of Co decreased the kinetic barrier and provided high catalytic activity. Pt-Co/C showed an ideally polarizable behavior similar to an electric double-layer capacitor. The membrane electrode assembly (MEA) was fabricated for PEM fuel cell using as-synthesized Pt-Co/C nanoparticles coated on the cathode and Pt/C nanoparticles on the anode. The polarization and power density curves of the PEM fuel cell revealed the adsorption of hydrogen and resistance to electron charge and ionic mass transport.

1. Introduction

Low-temperature proton exchange membrane (PEM) fuel cell is a sustainable solution due to a clean energy source. Enhanced energy conservation efficiency, low-temperature operation, and ability to utilize the regenerative fuels make PEM fuel cell a strong candidate for energy generation. However, there are some challenges, which need to be addressed. The slower oxygen reduction reaction (ORR) kinetics at the cathode is a major barrier for the commercial use of PEM fuel cell [1]. Typically, platinum (Pt) is used as a metal electrode in PEM fuel cell due to its higher chemical activity and stable electrical properties [2,3]. However, Pt nanoparticles are likely to dissolve from carbon support and agglomerate under intense cathodic conditions during the fuel cell operation. Due to the instability of Pt, the electrochemical active surface area (EASA) decreases and further affects the performance of the PEM fuel cell. Pt is an expensive catalyst, which limits its wider usage in fuel cells. To solve these issues, a number of attempts have been made to replace the Pt metal to reduce the overall cost of fuel cell assembly. Hence, it is necessary to enhance the stability, activity,

and durability of the electrocatalysts. Recently, the alloys of Pt and other metals such as Co, Ni, Fe, Cu etc., are being explored for partial replacement of Pt catalyst [4]. Usually, these bi- and tri-metallic alloys are coated onto carbon support with different atomic ratios [5] and in many cases, the electrocatalytic activity for ORR is higher for Pt-alloys than the pure Pt [6]. It has been reported that the alloys of Pt with transition metals improve the electrochemical activity [7,8]. In order to achieve higher ORR activity, the uniform distribution of particles on the support and higher surface area of catalyst is necessary. The shorter distance between the Pt–Pt molecules enhances the ORR activity of an electrocatalyst due to improved adsorption of the oxygen molecules. On the other hand, many researchers are exploring different types of supporting materials [9–11] to promote the electrocatalytic properties and efficiency. Carbon has attracted researchers' interest for catalyst support due to its high surface area, high electrical conductivity, and significant durability. Due to higher activity and stability in an acidic environment, the Pt-Co/C is considered as the most promising electrocatalyst alloy, among the various Pt alloy electrocatalysts [12,13]. Strasser et al. [14] demonstrated the effectiveness of Pt-Co/C

List of Abbreviations: Pt, platinum; Co, Cobalt; TEM, transmission Electron Microscope; EASA, electrochemical-active surface area; OCP, open circuit potential; MEA, membrane electrode assembly; PEM, proton exchange membrane; ORR, oxygen reduction reaction; PVP, polyvinylpyrrolidone; EIS, electrochemical impedance spectroscopy; CV, cyclic voltammetry; LSV, linear sweep voltammetry; IPA, isopropyl alcohol; GDL, gas diffusion layer; GDE, gas diffusion electrode; XRPD, X-ray powder diffraction; NHE, normal hydrogen electrode; fcc, face-centered cubic; hcp, hexagonal closed packed

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RESEARCH ARTICLE

Assessment of spectroscopic parameters of solvated Eu(dmh)₃phen organometallic complex in various basic and acidic solvents

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Email: thejokalyani@rediffmail.com**Abstract**

We report on the comprehension of novel europium activated hybrid organic Eu(dmh)₃phen (Eu: europium, dmh: 2,6-dimethyl-3,5-heptanedione, phen: 1,10 phenanthroline) organo-metallic complexes, synthesized at different pH values by the solution technique. Photo physical properties of these complexes in various basic and acidic solvents were probed by UV-vis optical absorption and photoluminescence (PL) spectra. Minute differences in optical absorption peaks with variable optical densities were encountered with the variation in solvent from basic (chloroform, toluene, tetrahydrofuran) to acidic (acetic acid) media, revealing bathochromic shift in the absorption peaks. The PL spectra of the complex in various acidic and basic organic solvents revealed the position of the emission peak at 613 nm irrespective of the changes in solvents whereas the excitation spectrum almost matched with that of the UV-vis absorption data. The optical density was found to be maximum for the complex with pH 7.0 whereas it gradually decreased when pH was lowered to 6.0 or raised to 8.0 at an interval of 0.5, demonstrating its pH sensitive nature. Several spectroscopic parameters related to probability of transition such as absorbance $A(\lambda)$, Napierian absorption coefficient $\alpha(\lambda)$, molecular absorption cross-section $\sigma(\lambda)$, radiative lifetime (τ_0) and oscillator strength (f) were calculated from UV-vis spectra. The relative intensity ratio (R -ratio), calculated from the emission spectra was found to be almost the same in all the organic solvents. The optical energy gap, calculated for the designed complexes were found to be well in accordance with the ideal acceptance value of energy gap of the emissive materials used for fabrication of red organic light-emitting diode (OLED). The relation between Stoke's shift and solvent polarity function was established by Lippert-Mataga plot. This remarkable independence of the electronic absorption spectra of Eu complexes on the nature of the solvent with unique emission wavelength furnishes its potential to serve as a red light emitter for solution processed OLEDs, display panels and solid-state lighting.

KEYWORDS

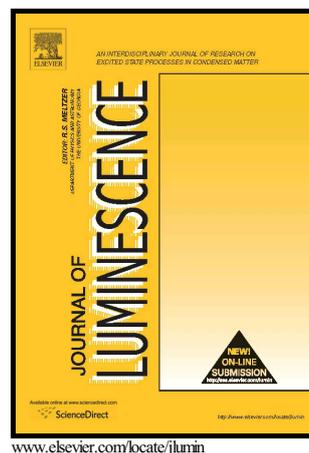
Lippert-Mataga plot, molecular absorption cross-section, oscillator strength, solution processed OLEDs, spectroscopic parameters

Abbreviations used: dmh, 2,6-dimethyl-3,5-heptanedione; Eu, europium; OLEDs, organic light-emitting diodes; phen, 1,10 phenanthroline; PL, photoluminescence; THF, tetrahydrofuran.

Author's Accepted Manuscript

Effects of octadecylamine molar concentration on the structure, morphology and optical properties of ZnO nanostructure prepared by homogeneous precipitation method

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Treatment of ternary dye wastewater by hydrodynamic cavitation combined with other advanced oxidation processes (AOP's)

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Advanced oxidation process
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ABSTRACT

In this work, the application of hydrodynamic cavitation (HC) and its combination with other advanced processes such as hydrogen peroxide (H₂O₂), Fenton, photo-Fenton, photolytic (UV irradiation), and photocatalytic process (UV irradiation + TiO₂) for the removal of mixed dye (Methylene blue, Methyl orange, Rhodamine-B) from aqueous media was studied. Commercial anatase phase nanosized TiO₂ was used as nano-photocatalyst in conjunction with HC process for the decolorization of ternary dye. Effect of different operating conditions such as inlet pressure to the cavitation device (Orifice), initial solution pH, different molar ratio of dye to dosage of H₂O₂, different molar ratio of FeSO₄:H₂O₂ was studied in combination with HC process. The degradation reaction of ternary dye using HC and HC combined with other AOP's followed a pseudo first order reaction kinetics. HC combined with H₂O₂ shown 100% decolorization in 40 min for the molar ratio of 1:40 (ternary dye:H₂O₂), whereas the combined approach of HC + Fenton and HC + photo-Fenton process shown 98% and 98.28% decolorization respectively at the dosage of 1:30 molar ratio of FeSO₄:H₂O₂. HC + Photolytic process shown 74.53% decolorization and HC + photocatalytic process shown 82.13% decolorization in 120 min of operation at optimum conditions of pH 3 and 6 bar inlet pressure. The combined approach of HC + H₂O₂ process has shown the higher synergetic effect 28.97 compared to other hybrid AOP's such as HC + Fenton (6.285), HC + Photo-Fenton (4.923), HC + Photolytic (1.801), and HC + Photocatalytic process (2.11).

1. Introduction

Industrial effluents from the textile industry contain a wide variety of coloring agents. Treatment of textile wastewater is considered as expensive and time consuming with biological treatment methods [1]. Advanced oxidation processes (AOP's) such as photocatalysis [2,3], Fenton and photo-Fenton [4,5], and hydrodynamic cavitation [6,7] are widely investigated for the degradation of many organic pollutants in wastewater. Out of these AOPs, hydrodynamic cavitation and chemical oxidation were reported as efficient techniques for treatment of dye wastewater. Recently, hydrodynamic cavitation is being used by many researchers for the wastewater treatment as a versatile hybrid AOP's [8–16]. In hydrodynamic cavitation when an aqueous solution passed through cavitating device such as orifice or venturi, substantial pressure change occurs which is attributed to the modification/restricting the flow path. When the pressure of liquid at the throat or vena contracta of the cavitating device falls below its vapor pressure, cavities are formed and the subsequent growth and the collapse of the cavities occur. This sudden collapse of the cavities generates high localized temperatures

(5000–10,000 °K) and pressures (500 atm). In this extreme environment, OH· radicals are formed, which are able to reduce the concentration of organic pollutants by oxidation. Sivakumar et al. [17] studied the degradation of rhodamine-B dye using different geometry of the multiple hole orifice plates. In this work, authors have also compared the degradation efficiency of rhodamine-B dye with the ultrasound cavitation. Senthil kumar et al. [18] investigated the efficacy of the hydrodynamic cavitation reactor for the decomposition of KI solution. Authors have studied the effect of different geometry of the multiple hole orifice plates for the decomposition of KI. Pandit et al. [19] reported that the chemical reactions can be effectively improved by the mean of hydrodynamic cavitation process. Many studies were reported that hydrodynamic cavitation alone is not able to give required removal of polluting components present in water. Therefore, it is being many times coupled with other processes such as addition of photocatalyst, Fenton reagent, H₂O₂ etc. as a hybrid advanced oxidation process, which gives significantly higher degradation in lesser time.

Degradation of mixture of dyes using photocatalytic techniques have been studied by many researchers over the past two decades.

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Green synthesis of nanocapsules for self-healing anticorrosion coating using ultrasound-assisted approach

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Abstract: The present work deals with the production of nanocapsules containing a natural corrosion inhibition component. *Azadirachta indica* was encapsulated in urea-formaldehyde polymeric shell using ultrasound-assisted and conventional approaches of *in situ* polymerization. Subsequently nanocapsules were incorporated into clear epoxy polyamide to develop the green self-healing corrosion inhibition coating. The actual performance of the coating was evaluated based on the studies involving the repair of the crack of high solid surface coating. Corrosion inhibition of the healed area has been evaluated using the electrochemical impedance spectroscopy and immersion test based on the use of standard epoxy coating. The obtained results confirmed better corrosion protection in terms of the electrochemical impedance spectroscopy data and Tafel plot. It was found that current density decreases from 0.0011 A/cm² (for standard epoxy coating) to 5.22 E⁻⁷ A/cm² as 4 wt% nanocapsules incorporated in coating.

Keywords: *Azadirachta indica*; electrochemical impedance spectroscopy (EIS); *in situ* polymerization; self-healing coating; ultrasound.

1 Introduction

Interest in developing smart polymer coating, which either gives adequate corrosion inhibition or quick healing based on the use of natural materials has significantly increased in recent years and is considered as a green processing approach. One of the important examples of smarter coatings is the self-healing coating [1] where the self-healing agent is dispersed in the polymer resin matrix and the responsive release to a crack in the coating can lead to effective healing of the coating. Using natural materials as healing agents can be considered as mimicking the nature and these coatings should have the ability to heal themselves when subjected to mechanical or thermal damage recovering the initial functionalities in the absence of any external influences or corrective actions [2, 3]. The self-healing coating provides advantages over conventional coating in terms of the self-responsive healing process, better barrier protection over the substrate, preserving the esthetic properties of coatings, and recovery of the mechanical properties of the coatings [4]. Such green coatings have significant applications as a protective coating has a positive impact on the substrate and also gives the required corrosion protection [5]. Till date, several approaches have been used for the fabrication of the self-healing coating with application to protect a metallic surface [4]. Different types of organic coatings have been reported to be effective in protecting metal surfaces based on corrosion inhibitors [6–8], cathodic protection [9], and barrier coatings [10–12]. The self-healing coating is important, especially in the case of microscale cracks as it is very difficult to repair the cracks which are at the microlevel with external interventions and hence, the development of smart functional coatings is of great importance. To the best of our knowledge, White et al. [13] was the first to report the development of self-healing coating based on the intrinsic system.

In this work, dicyclopentadiene (DCPD) was used as a healing agent encapsulated in urea-formaldehyde (UF) microcapsules and for the self-repairing function, DCPD was polymerized with the help of Grubbs catalyst as an

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Review

A review on microreactors: Reactor fabrication, design, and cutting-edge applications



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HIGHLIGHTS

- Materials for microreactor fabrication, fabrication methods, and design principles are presented.
- Challenges in microreactor commercialization and need for integrated process is highlighted.
- Applications of microreactors in the field of nanoparticles, polymers, organic chemicals, and medicines are presented.

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ABSTRACT

This review focuses on the latest trends and advancements in microstructured reactors. With the recent drive towards the production of miniaturized systems, microstructured reactors have gained significant prominence in the chemical and process industries. Herein, we describe the fabrication, commercial aspects, design principles, and cutting-edge applications of microreactors. An overview of the significant areas of application under broad categories such as biological and pharmaceutical applications, inorganic and noble metal nanoparticles, and organic chemicals and polymers is also included. Finally, the article discusses future research prospects and key issues on microstructured reactors.

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Facile chemical route for multiwalled carbon nanotube/mercury sulfide nanocomposite: High performance supercapacitive electrode

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RESEARCH ARTICLE

Synthesis and characterization of high quantum yield and oscillator strength 6-chloro-2-(4-cynophenyl)-4-phenyl quinoline (Cl-CN-DPQ) organic phosphor for solid-state lighting

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Abstract

A novel blue luminescent 6-chloro-2-(4-cynophenyl) substituted diphenyl quinoline (Cl-CN DPQ) organic phosphor has been synthesized by the acid-catalyzed Friedlander reaction and then characterized to confirm structural, optical and thermal properties. Structural properties of Cl-CN-DPQ were analyzed by Fourier transform infrared (FTIR), nuclear magnetic resonance (NMR) spectroscopy, X-ray diffraction technique (XRD) and scanning electron microscopy (SEM) and energy dispersive analysis of X-ray (EDAX) spectroscopy. FTIR spectra confirmed the presence of different functional groups and bond stretching. ¹H-NMR and ¹³C-NMR confirmed the formation of an organic Cl-CN-DPQ compound. X-ray diffraction study provided its crystalline nature. The surface morphology of Cl-CN-DPQ was analyzed by SEM, while EDAX spectroscopy revealed the elemental analysis. Differential thermal analysis (TGA/DTA) disclosed its thermal stability up to 250°C. The optical properties of Cl-CN-DPQ were investigated by UV-vis absorption and photoluminescence (PL) measurements. Cl-CN-DPQ exhibits intense blue emission at 434 nm in a solid-state crystalline powder with CIE co-ordinates (0.157, 0.027), when excited at 373 nm. Cl-CN-DPQ shows remarkable Stokes shift in the range 14800–5100 cm⁻¹, which is the characteristic feature of intense light emission. A narrow full width at half-maximum (FWHM) value of PL spectra in the range 42–48 nm was observed. Oscillator strength, energy band gap, quantum yield, and fluorescence energy yield were also examined using UV-vis absorption and photoluminescence spectra. These results prove its applications towards developing organic luminescence devices and displays, organic phosphor-based solar cells and displays, organic lasers, chemical sensors and many more.

KEYWORDS

fluorescence energy yield, Friedlander reaction, OLED, oscillator strength, quantum yield

1 | INTRODUCTION

As the late 1980s, light-emitting diodes (LEDs) based on either small organic molecules (OLEDs) or polymers (PLEDs) had been an object

Abbreviations used: CRI, colour rendering index; EBU, European Broadcast Union; EDAX, energy dispersive analysis of X-ray; EF, energy yields of fluorescence; FTIR, Fourier transform infra-red; FWHM, full width at half-maximum; HOMO, highest occupied molecular orbital; ICT, intermolecular charge transfer; LOMO, lowest occupied molecular orbital; NMR, nuclear magnetic resonance; NTSC, National Television System Committee; OLED, organic lighting emitting diodes; PL, photoluminescence; SEM, scanning electron microscopy; TGA, thermogravimetric analysis; THF, tetrahydrofuran; UV, ultraviolet; XRD, X-ray diffraction.

of great interest because of their numerous potential applications such as in solid-state lighting^[1–5], solar cell displays, organic lasers^[6,7] and chemosensors.^[8–11] Large numbers of organic luminescent materials have been synthesized to meet the demands in the above-mentioned areas. A flat panel display and solid-state lighting sources should possess: (i) the ability to produce nearly all the colours from the real world; and (ii) white-light generated from solid-state lighting sources should show high colour rendering index (CRI) (≥80).^[12,13] In order to fulfil these approaches, three primary red (r), green (g), and blue (b) emitting colours of luminescent materials are generally employed according to the primary-colour theory.^[14–18] However, greater success has been achieved in the development of a green and red emitter than that of



Sonochemical synthesis of Graphene-Ce-TiO₂ and Graphene-Fe-TiO₂ ternary hybrid photocatalyst nanocomposite and its application in degradation of crystal violet dye



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Ultrasound
Graphene
TiO₂
Nanocomposite
Photocatalyst doping

ABSTRACT

The present work deals with the preparation of graphene oxide (GO) using Hummers-Offeman method in the presence of ultrasonic irradiations. Further loading of TiO₂ photocatalyst on prepared GO was accomplished which is basically oxidation reduction reaction between graphene oxide and titanium isopropoxide that leads to the formation of graphene-TiO₂ nanocomposite. Graphene-Ce-TiO₂ and Graphene-Fe-TiO₂ nanocomposites were prepared using one step in-situ ultrasound assisted method using GO, titanium isopropoxide, cerium nitrate, ferric nitrate, and 2-propanol. The successfully prepared graphene-TiO₂, Graphene-Ce-TiO₂, Graphene-Fe-TiO₂ nanocomposites were then characterized using XRD, SEM and TEM analysis. The obtained XRD patterns clearly indicates the formation of anatase TiO₂ on graphene nanosheets and it also indicates the presence of Ce and Fe in the Graphene-Ce-TiO₂ and Graphene-Fe-TiO₂ nanocomposite respectively. Further the use of the prepared nanocomposites as a photocatalyst have been studied for the degradation of crystal violet dye. The effect of various parameters such as catalyst doping, catalyst loading and initial concentration of dye on its degradation were studied. The effectiveness of the prepared catalysts were compared for the degradation of crystal violet dye. It has been observed that Graphene-Fe-TiO₂ exhibits maximum photocatalytic activity compared to Graphene-Ce-TiO₂ and Graphene-TiO₂ nanocomposite photocatalyst.

1. Introduction

Titanium dioxide (TiO₂) is considered very close to an ideal semiconductor for photocatalysis because of its high stability, low cost and safety toward both humans and the environment [1]. TiO₂ is a promising photocatalyst due to its abundance, stability, non-toxicity and low cost [2]. Various studies have been conducted to explore the potential of TiO₂ as photocatalyst [3,4]. Therefore, increasing the photocatalytic activity of TiO₂ is of great interest. However TiO₂ has very limited optical absorption and the recombination of photo generated electron-hole pair is higher which results in low activity of TiO₂ as a photocatalyst [5]. The spectral response of TiO₂ photocatalyst can be extended to visible light with the help of doping [4,6]. Transitional metals are used as dopants which enhances its catalytic activity and reduces the recombination of photo-generated electrons and holes. The photocatalytic activity can be achieved with doping and can be extended the excitation wavelength from the UV to the visible light range.

Hunge et al. [7] have studied the degradation of oxalic acid with the use of WO₃ and WO₃/TiO₂ photocatalyst in the presence of sunlight. It has been reported that the degradation efficiency of oxalic acid is higher with the use of WO₃/TiO₂ compared to WO₃ and 83% removal efficiency of oxalic acid is reported after 180 min. Hunge et al. [8] and Hunge [9] have carried out degradation of phthalic acid and benzoic acid in the presence of sunlight with the use of WO₃/ZnO composite and reported 63.63% and 66% removal efficiency, respectively. The enhanced degradation efficiency is attributed to suppression of electron hole pairs. Hunge et al. [10] further studied the degradation of sugarcane factory wastewater using highly crystalline Cu₂ZnSnS₄ (CZTS) in presence of visible light and shows its 90% degradation. CZTS film shows optical band gap energy of 1.90 eV which in the range of visible region of the solar spectrum and useful for photocatalysis application. Hunge [11] have used α-Fe₂O₃ thin films for the degradation of 4-chlorophenol in the presence of sunlight and shows 50% degradation after 240 min.

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Original research article

Exploration of photophysical properties of green light emitting bis(8-hydroxyquinoline) zinc (Znq_2) metal chelate under various environments

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ABSTRACT

Investigations have been made on the photophysical behaviour of 8-hydroxy quinoline zinc metal chelate (Znq_2) under various environments such as temperature, humidity, UV radiation, acidic and basic solvents and polymer (PMMA: polymethylmetacrylate) matrix in order to explore the effect of these parameters on the photo luminescence (PL) spectra. Znq_2 is solvated in acetic acid and chloroform at different molar concentrations to calculate optical energy band gap as well as to study the shift of $\pi \rightarrow \pi^*$ and the $n \rightarrow \pi^*$ optical transitions in Zn^{2+} ions and 8-hydroxy quinoline moieties. When the complex was subjected to annealing, the position of the emission peak remained unaltered at 504 nm with hypochromic shift at higher temperatures. The same has been observed when the complex is subjected to humid environment and UV exposure with no alteration in the emission peak in the former case and 1 nm alteration in the later. The excitation and emission spectra of Znq_2 were recorded in basic and acidic solvents at different molar concentrations so as to establish a relation with the obtained absorption spectra. However, the emission peak blue shifted in basic media and red shifted in acidic media with variation in optical density. The PL spectra of molecular doped Znq_2 in PMMA blended films display an emission peak at 499 nm under excitation wavelength of 437 nm. CIE coordinates of Znq_2 were found to be close in all considered environments. These results prove that the emission from the synthesized metal complex can be tuned in the wavelength range of 433–524 nm by selecting the solvent or the polymer according to the requirement, inferring its potential as emissive material for the fabrication of organic light emitting diode (OLED), displays as well as in other optoelectronic applications where green light is essential.

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1. Introduction

In recent years, organic electroluminescence (EL) display devices have attracted more intensive attention as a promising technology for flat panel displays [1]. Many emitting materials, including low-weight molecules and polymers, have been designed and utilized in fabricating OLEDs [2–5]. Among them, metal 8-hydroxyquinoline (Mq_n) chelates, especially for tris(8-hydroxyquinoline) aluminum (Alq_3) and bis(8-hydroxyquinoline) zinc(II) (Znq_2), have been extensively investigated due to their high stability, intense emission and electron-transporting properties [6–8]. The result furnished from an efficient

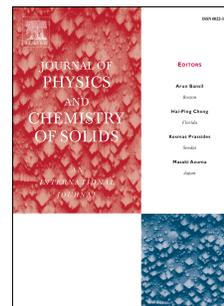
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Accepted Manuscript

Tunable emission in Ln^{3+} ($\text{Ce}^{3+}/\text{Dy}^{3+}$, $\text{Ce}^{3+}/\text{Tb}^{3+}$) doped $\text{KNa}_3\text{Al}_4\text{Si}_4\text{O}_{16}$ phosphor for w-LEDs synthesized by combustion method

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Synthesis of iron oxide nanoparticles in a continuous flow spiral microreactor and Corning® advanced flow™ reactor

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Abstract: In the present work, synthesis of iron oxide nanoparticles (NPs) using continuous flow microreactor (MR) and advanced flow™ reactor (AFR™) has been investigated with evaluation of the efficacy of the two types of MRs. Effect of the different operating parameters on the characteristics of the obtained NPs has also been investigated. The synthesis of iron oxide NPs was based on the co-precipitation and reduction reactions using iron (III) nitrate precursor and sodium hydroxide as reducing agents. The iron oxide NPs were characterized using transmission electron microscopy (TEM), Fourier transform infrared spectroscopy, and X-ray diffraction (XRD) analysis. The mean particle size of the obtained NPs was less than 10 nm at all flow rates (over the range of 20–60 ml/h) in the case of spiral MR, while, in the case of AFR™, the particle size of NPs was below 20 nm with no specific trend observed with the operating flow rates. The XRD and TEM analyses of iron oxide NPs confirmed the crystalline nature and nanometer size range, respectively. Further, magnetic properties of the synthesized iron oxide NPs were studied using electron spin resonance spectroscopy; the resonance absorption peak shows the *g*-factor values as 2.055 and 2.034 corresponding to the magnetic fields of 319.28 and 322.59 mT for MR and AFR™, respectively.

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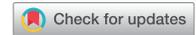
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Keywords: advanced flow reactor (AFR™); co-precipitation; iron oxide nanoparticles; microreactor (MR); particle size distribution (PSD).

1 Introduction

Over the past decade, research related to the synthesis and modification of nanoparticles (NPs) has made a great impact on material engineering and surface science applications attributed to the unique chemical and physical properties for the NPs as compared to the bulk materials [1]. The colloidal NPs have applications in a variety of fields including biosensors, catalysis, targeted drug delivery system, detection of genes, conducting inks, magnetic resonance imaging, energy storage devices such as fuel cells, batteries etc., medical diagnostics, and antimicrobial agents [2–13]. In recent years, interest in the efficient synthesis of magnetic iron oxide NPs has increased significantly due to the wide range of applications in the field of magnetic storage devices, chemical processing industries, biotechnology, water purification, and biomedical applications like thermal therapy, chemotherapy, diagnostic magnetic resonance imaging, magnetofection, and drug delivery [12–21]. The common forms of iron oxide generally found are maghemite (γ -Fe₂O₃), hematite (α -Fe₂O₃), magnetite (Fe₃O₄), and oxo-hydroxide (FeOOH) [22, 23]. Yuvakkumar et al. [24] prepared nano-scaled zero valent iron (50–100 nm) using the reduction method based on the use of ferric ions and sodium borohydride in ethanol under atmospheric conditions. Behera et al. [25] also prepared iron oxide NPs for antibacterial applications using co-precipitation method. Lee et al. [26] investigated the synthesis of iron oxide nanomaterials in microfluidics device under ambient conditions with the use of co-precipitation method. The reported particle size of iron oxide NPs was less than 10 nm with applications explored in the biomedical fields. Shahane et al. [27] used low temperature co-precipitation method for the synthesis of superparamagnetic Fe₃O₄ NPs for ferrofluids application. It was reported that the nanocrystalline sizes of 11.5 and



Fractional heat conduction in a thin hollow circular disk and associated thermal deflection

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ABSTRACT

The time nonlocal generalization of the classical Fourier law with the “Long-tail” power kernel can be interpreted in terms of fractional calculus and leads to the time fractional heat conduction equation. The solution to the fractional heat conduction equation under a Dirichlet boundary condition with zero temperature and the physical Neumann boundary condition with zero heat flux are obtained by integral transform. Thermal deflection has been investigated in the context of fractional-order heat conduction by quasi-static approach for a thin hollow circular disk. The numerical results for temperature distribution and thermal deflection using thermal moment are computed and represented graphically for copper material.

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KEYWORDS

Fractional; integral transform; quasi-static; thermal deflection; thermoelasticity

Introduction

In the recent past, a lot of applications were found for fractional calculus in various engineering disciplines such as proportional-integral-derivative (PID) controllers, signal processing, fluid mechanics, viscoelasticity, mathematical biology, and electrochemistry. This has led to research in the area of noninteger calculus. The idea of fractional-order calculus is appealing but poses a serious challenge when one embarks on a journey to know the physical interpretations. Podlubny [1] gave the geometric interpretation of fractional integration as “Shadows on the walls” and its physical interpretation is “Shadows of the past.” The most important advantage of using fractional-order differential equations is their nonlocal property. This is more realistic, and an important reason why fractional calculus has gained popularity.

Classical theory of thermoelasticity underlines the interplay between the elastic properties of a material and its temperature. The problems in thermoelasticity are broadly classified as uncoupled and coupled problems. In uncoupled theory of thermoelasticity the temperature is governed by a parabolic partial differential equation, which does not contain any elastic term whereas in coupled theory of thermoelasticity to eliminate the paradox inherent of this theory that elastic changes have no effect on the temperature. The heat equation for both the theories i.e. coupled and uncoupled, however, are of the diffusion type predicting infinite speed of propagation for heat wave. The classical theory of thermoelasticity in its formulation uses the Fourier law of heat conduction which is parabolic in nature, predicting instantaneous propagation of heat waves throughout the elastic body. Clearly, this is not physically plausible. Hence, several modifications were suggested, such as Lord–Shulman theory [2], Green–Lindsay theory [3], in which the Fourier law and the parabolic heat conduction equation are replaced by hyperbolic equations which predict finite propagation of heat and elastic waves in the medium. Green and Naghdi [4] developed the theory of thermoelasticity without energy dissipation.

Fractional order generalized thermoelastic response in a half space due to a periodically varying heat source

Fractional
order
generalized
thermoelastic

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Abstract

Purpose – The present work is concerned with the solution of a fractional-order thermoelastic problem of a two-dimensional infinite half space under axisymmetric distributions in which lower surface is traction free and subjected to a periodically varying heat source. The thermoelastic displacement, stresses and temperature are determined within the context of fractional-order thermoelastic theory. To observe the variations of displacement, temperature and stress inside the half space, the authors compute the numerical values of the field variables for copper material by utilizing Gaver-Stehfast algorithm for numerical inversion of Laplace transform. The effects of fractional-order parameter on the variations of field variables inside the medium are analyzed graphically. The paper aims to discuss these issues.

Design/methodology/approach – Integral transform technique and Gaver-Stehfast algorithm are applied to prepare the mathematical model by considering the periodically varying heat source in cylindrical co-ordinates.

Findings – This paper studies a problem on thermoelastic interactions in an isotropic and homogeneous elastic medium under fractional-order theory of thermoelasticity proposed by Sherief (Ezzat and El-Karamany, 2011b). The analytic solutions are found in Laplace transform domain. Gaver-Stehfast algorithm (Ezzat and El-Karamany, 2011d; Ezzat, 2012; Ezzat, El Karamany, Ezzat, 2012) is used for numerical inversion of the Laplace transform. All the integrals were evaluated using Romberg's integration technique (El-Karamany *et al.*, 2011) with variable step size. A mathematical model is prepared for copper material and the results are presented graphically with the discussion on the effects of fractional-order parameter.

Research limitations/implications – Constructed purely on theoretical mathematical model by considering different parameters and the functions.

Practical implications – The system of equations in this paper may prove to be useful in studying the thermal characteristics of various bodies in real-life engineering problems by considering the time fractional derivative in the field equations.

Originality/value – In this problem, the authors have used the time fractional-order theory of thermoelasticity to solve the problem for a half space with a periodically varying heat source to control the speed of wave propagation in terms of heat and elastic waves for different conductivity like weak conductivity, moderate conductivity and super conductivity which is a new and novel contribution.

Keywords Thermoelasticity, Fractional order, Gaver-Stehfast, Half space, Heat source

Paper type Research paper





A smart coating established with encapsulation of Zinc Molybdate centred nanocontainer for active corrosion protection of mild steel: release kinetics of corrosion inhibitor

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ABSTRACT

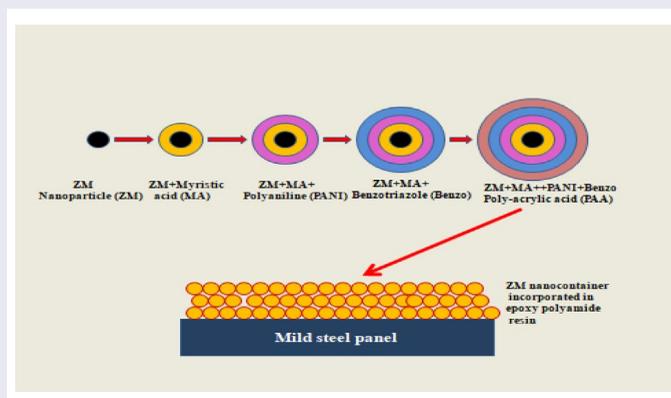
In the current work smart coating of corrosion inhibitive nanocontainer was developed based on the encapsulation of ultrasonically synthesized Zinc Molybdate (ZM) nanoparticles. The ZM nanoparticles were doped ultrasonically with the layers of Myristic acid (MA), Polyaniline layer (PANI), benzotriazole layer and polyacrylic acid layer respectively to prepare layer by layer assembled nanocontainer. Results of XRD, PSD, FTIR, zeta potential and TEM analysis proves the successful formation of the layered structure of ZM nanocontainer particles. The release rate of benzotriazole at various experimental pH values was estimated using UV–vis spectroscopy. Different semi-empirical models were examined to predict the release mechanism of the benzotriazole. The corrosion inhibitive performance of ZM nanocontainers has been evaluated by incorporating 1wt % ZM nanocontainer in the epoxy based coating formulations and assessing by DC polarization measurement and Bode plots. The results from corrosion potential and Bode plots suggest the successful use of ZM nanocontainer in the multifunctional anticorrosion coating formulations.

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Ultrasonication; release kinetics; core-shell morphology; bode plots



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Structural and optical characterization of RE (Eu²⁺, Ce³⁺) doped SrMg₂Al₆Si₉O₃₀ nanocrystalline phosphor

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Abstract This article present the reports on optical study of Eu²⁺ and Ce³⁺ doped SrMg₂Al₆Si₉O₃₀ phosphors, which has been synthesized by combustion method at 550 °C. Here SrMg₂Al₆Si₉O₃₀:Eu²⁺ emission band observed at 425 nm by keeping the excitation wavelength constant at 342 nm, whereas SrMg₂Al₆Si₉O₃₀:Ce³⁺ ions shows the broad emission band at 383 nm, under 321 nm excitation wavelength, both the emission bands are assigned due to 5d–4f transition respectively. Further, phase purity, morphology and crystallite size are confirmed by XRD, SEM and TEM analysis. However, the TGA analysis is carried out to know the amount of weight lost during the thermal processing. The CIE coordinates of SrMg₂Al₆Si₉O₃₀:Eu²⁺ phosphor is observed at x = 0.160, y = 0.102 respectively, which may be used as a blue component for NUV-WLEDs. The critical distance of energy transfer between Ce³⁺ ions and host lattice is found to be 10.65 Å.

1 Introduction

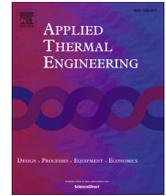
Today, the whole world facing an problem associated with energy conservation and consumption reduction. Advanced materials is an emerging fields to solve the problem deals with energy by using a novel materials having the energy saving potential and storage capabilities. Thus, in case

of applied as well as basic research fields, recently rare earth doped oxides based phosphor materials received an fast-growing interest due to their merits in high luminous efficiency, energy savings, potential, environmental friendliness, long persistence and reliability, high thermal and chemical stability [1, 2]. Among the different host used in luminescent materials aluminosilicates is an best candidates due to their physical, chemical properties and stability. There are very few work has been done on rare earth activated aluminosilicates host phosphors, because they have required high temperature for the phase formation due the combination of tetrahedral Al³⁺ and Si⁴⁺ bonding in their crystal structure. Also the mechanism of energy transfer between two different emission centres plays an important role in the development of luminescent display devices due to their theoretical and practical applications [3]. The luminescence efficiency of various rare earth ions can be enhanced by the energy transfer process from other co-doped rare earth ions; because most of the rare earth ions, have only narrow f–f transition lines from 300 to 500 nm locate at the range of near-UV, have low oscillator strength. Therefore rare earth ions have limitations in the application of UV–LED phosphors. Thus to avoid this drawback, RE ions with broad band emitting ions, such as Ce³⁺, Eu²⁺ can be co-doped as sensitizers and it help in improving the luminescence properties of the phosphors materials [4–7]. There are some well known reported aluminosilicates based phosphor such as, BaMg₂Al₆Si₉O₃₀:Eu²⁺ [8], NaAlSiO₄:Dy³⁺ [9], Sr₃Al₈SiO₁₇:Eu²⁺ [10]. Wei Lu et al. had reported SrMg₂Al₆Si₉O₃₀:Eu²⁺, Mn²⁺ phosphor synthesized by solid state reaction method [11]. In the present work we have reported optical properties of Eu²⁺ and Ce³⁺ doped SrMg₂Al₆Si₉O₃₀:phosphors, which has been synthesized here by combustion method successfully.

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Research Paper

Experimental investigation on intensified convective heat transfer coefficient of water based PANI nanofluid in vertical helical coiled heat exchanger



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HIGHLIGHTS

- Heat transfer coefficient increases with an increase in vol% of PANI nanofibers.
- The effect of Reynolds number of nanofluid on heat transfer coefficient was examined.
- Around 70% enhancement in Heat transfer coefficient for 0.5 vol% PANI nanofluids.
- Increase in heat transfer coefficient was found with an increase in the Reynolds number.

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Helical coil

PANI nanofluid

Ultrasound

Heat transfer coefficient

Reynolds number

ABSTRACT

In the present study, heat transfer enhancement with the use of water based PANI (polyaniline) nanofluid was investigated in vertical helically coiled tube heat exchanger. Initially, PANI nanofibers were prepared with the use of ultrasound assisted emulsion polymerization method. Then the prepared PANI nanofibers were dispersed in base fluid in varying concentration (0.1–0.5 vol%) in order to get uniformly dispersed PANI nanofluid in the presence of sonication. The effect of PANI nanofibers concentration in nanofluid and Reynolds number on heat transfer coefficient have been investigated in helical coiled heat exchanger. It was found that the average heat transfer coefficient increases with an increase in the volume% of PANI nanofibers in nanofluid and Reynolds number. The heat transfer coefficient of base fluid i.e. distilled water was found to be $304 \text{ W/m}^2 \text{ }^\circ\text{C}$ (at $x_i/D = 692.3$) whereas it was found to be increased to $515.8 \text{ W/m}^2 \text{ }^\circ\text{C}$ (at $x_i/D = 692.3$) for 0.5 vol% PANI concentration in nanofluid. The percentage enhancement in the heat transfer coefficient was found to be 10.52% at 0.1 vol% of PANI nanofibers in nanofluid and was found to be increased to 69.62% for 0.5 vol% of PANI nanofibers.

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1. Introduction

In recent years cooling of mechanical, electrical and electronic components has become a problem in today's fast-growing technologies and also similar problem was observed in the thermal management in the area of optical devices. Therefore the devices for the effective removal of heat are being required for these applications. Further it is essential to develop compact devices with use of efficient cooling fluids which will provide more effective cooling systems with superior cooling capacities and decreased sizes is a need of the hour. It have been observed that the use of different shaped heat exchange devices (helical, spiral) offers heat transfer

enhancement. Therefore use of helical coils for heat exchange (cooling devices) will enhance the heat transfer capability of the fluid itself i.e. with nanofluids without ant sedimentation in the tube [1–4].

The geometry of the heat exchanger also plays a critical role in determining heat transfer characteristics. Due to their compact structure and high heat transfer coefficient, curved tubes have been introduced as one of the significant heat transfer enhancement techniques. Helical tubes are well known types of curved tubes which have been used in a variety of applications, such as heat recovery processes and steam power plants, membrane separation, air conditioning, refrigeration and cryogenics processes, chemical reactors, food and dairy processes, electronics, environmental engineering, manufacturing industry and solar energy concentrators systems [5,6]. Secondary flow in coiled tubes as a result

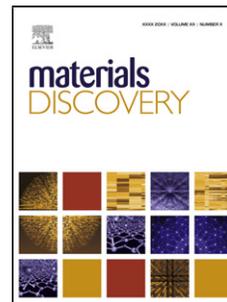
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Title: UV–vis downshifting in $\text{CdWO}_4:\text{Ce}^{3+}$ nanosized phosphor

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Fractional Order Thermoelastic Deflection in a Thin Circular Plate

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Abstract

In this work, a quasi-static uncoupled theory of thermoelasticity based on time fractional heat conduction equation is used to model a thin circular plate, whose lower surface is maintained at zero temperature whereas the upper surface is insulated. The edge of the circular plate is fixed and clamped. Integral transform technique is used to derive the analytical solutions in the physical domain. The numerical results for temperature distributions and thermal deflection are computed and represented graphically for Copper material.

Keywords: Quasi-static; thermoelasticity; fractional; integral transform; thermal deflection; parabolic; heat conduction

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Title: Deep blue light emitting Cyno-DPQ phosphor with large stokes shift and high thermal stability for OLEDs and display applications

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Ultrasound assisted synthesis of performic acid in a continuous flow microstructured reactor



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ABSTRACT

The present work establishes in depth study of ultrasound assisted preparation of performic acid (PFA) in a continuous flow microstructured reactor. The influence of various parameters viz. formic acid: hydrogen peroxide molar ratio, flow rate, temperature and catalyst loading on the PFA formation were studied in a continuous flow microstructured reactor. In a continuous microstructured reactor in the presence of ultrasonic irradiation, the formation of PFA was found to be dependent on the molar ratio of formic acid: hydrogen peroxide, flow rate of reactants, temperature and catalyst loading (Amberlite IR-120H). The optimized parameter values are 1:1 M ratio, 50 mL/h, 40 °C and 471 mg/cm³ respectively. Further, the performance of Amberlite IR-120H catalyst was evaluated for three successive cycles in continuous microstructured reactor. The performance of catalyst was found to be decreased with the usage of the catalyst and is attributed to neutralization of the sulfonic acid groups, catalyst shrinkage, or loss in pore sites. The experimental results revealed that, for an ultrasound assisted synthesis of PFA in continuous microstructured reactor the observed reaction time was even less than 10 min. The observed intensification in the PFA synthesis process can be attributed to the intense collapse of the cavities formed at low temperature during ultrasonic irradiations, which further improved the heat and mass transfer rates with the formation of H₂O₂ during the reaction. The combined use of ultrasound and a continuous flow microstructured reactor has proved beneficial process of performic acid synthesis.

1. Introduction

Performic acid is a powerful, environmentally friendly and very cheap oxidizing agent used in chemical processing, synthesis and bleaching. Being similar to that of peracetic acid (PAA), the preparation of PFA could be performed with formic acid (FA) and hydrogen peroxide (HP) in the presence of a catalyst. Performic acid belongs to the category of percarboxylic acids. Percarboxylic acids are acids which contain an acidic –OOH group [1]. They are generally strong oxidizers and commonly used as disinfectant and food preservatives in the medical field and food industry respectively. It is very effective against viruses, bacterial spores, algae, microscopic fungi and mycobacteria, as well as other microorganisms such as zooplankton. The popularity of performic acid as a sterilizer originates from the safe nature of its degradation products, mostly carbon dioxide, oxygen and water. The disinfecting action of performic acid is also faster than that of the related compounds peracetic acid and hydrogen peroxide [2,3]. It is

also used as epoxidizing agent for epoxidation of unsaturated oil to synthesize epoxy plasticizer with high yield [4–6]. Performic acid is unstable and explosive chemical, which increases the risk in continuous and batch production and transportation. The major drawbacks of performic acid are handling hazards due to its high reactivity, as well as instability, especially upon heating, which increases the risk in continuous and batch production and transportation [7]. Further it may ignite or explode at room temperature when combined with flammable substances like formaldehyde, benzaldehyde, and also get explode violently with the addition of metal powders [3,8]. Therefore, continuous safe production through microfluidics reactor is getting considerable attention [9,10].

The future chemicals and pharmaceutical industries needs to be more flexible to manufacture products very selectively and in sustainable manner, in different quantities, "JUST-IN-TIME" and close to the source of raw material. Catalytic reactions are becoming more important in synthesis of fine chemicals and pharmaceuticals [11]. While

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EXPERIMENTAL ANALYSIS AND COMPUTATIONAL FLUID DYNAMICS SIMULATIONS FOR HEAT TRANSFER IN SOUND ASSISTED FLUIDIZED BED OF FINE POWDERS

by

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Original scientific paper

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Fine powders in the size range of 20-200 μm are widely used in industries for fluid bed operations and are ideal for gas-solid reactions because of their large external surface areas and favorable heat transfer rates. The fine powders have very poor flow characteristics. Most of the earlier research work in heat transfer in bubbling fluidized beds is focused on coarse grained Geldart B and D particles. Acoustic energy of sufficient intensity and sound pressure level improved the quality of fluidization of fine powders. The objective of this investigation is experimental analysis and CFD simulations for heat transfer in a fluidized bed of fine powders at different acoustic conditions. The Eulerian approach has been identified as an efficient method for the numerical simulation of fluidized beds. The experimental and CFD results are in good agreement with each other.

Key words: *fluidization, heat transfer, acoustics, CFD*

Introduction

Due to high cost and more time consuming experimentation on fluidization, more researchers are extending their efforts towards developing the mathematical model and numerical simulation with the help CFD and validating the experimental results with CFD results. It is possible to study large number of parameters in stipulated time and develop the optimized solution to work. There are two approaches for CFD modelling of gas-solid flows: Eulerian – Eulerian model and Eulerian – Lagrangian models. In the current work, experimental analysis and numerical simulation for the heat transfer between a fluidized bed and immersed heat transfer surface in the absence and presence of acoustic waves is of particular interest.

The heat transfer coefficients were estimated numerically by Karamavruc *et al.* [1] from governing heat conduction equations using both 1-D and 2-D analysis. The analysis showed that temperature gradient existed around the tube which led to different heat transfer coefficients for 1-D and 2-D cases. At velocities close to minimum fluidization velocity, the instantaneous heat transfer coefficient showed considerable difference. At higher gas velocities, the increase in bubble frequency resulted in decrease in temperature gradients around the circumference of the tube. This led to difference in heat transfer coefficients. Kuipers *et al.* [2] developed a computer model for a hot gas fluidized bed. They used two fluid model (TFM) approach in which both the phases were considered to be continuous and fully interpenetrating. Local wall-to-bed heat transfer coefficients were estimated by the simultaneous solution of the TFM conservation of mass, momentum, and thermal energy equations.

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Original Research Paper

Experimental investigation of heat transfer enhancement in helical coil heat exchangers using water based CuO nanofluid

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ABSTRACT

The present work deals with the study of heat transfer enhancement using water based CuO nanofluids in the helical coil heat exchanger. Nanofluids were prepared using two-step method by using wet chemical method. Nanofluids with various volume percentage between 0 and 0.5 of CuO nanoparticles and their flow rate between 30 and 80 LPH (Reynolds number ranging from 812 to 1895, Laminar flow regime) were considered in the present study. The setup consists of a test section (helical coil), cooler, reservoir, pump, flow meter, thermocouples and flow controlling system. The temperature measurements were carried out with the help of thermocouples. The investigation was carried out to study the effect of particle loading and flow rate on heat transfer coefficient and Nusselt number. It has been found that the increase in the loading of CuO nanoparticles in base fluid shows a significant enhancement in the heat transfer coefficient of nanofluid. In the present study, at 0.1 vol% concentration of CuO nanoparticles in nanofluid, enhancement in heat transfer coefficient was 37.3% as compared to base fluid while at 0.5 vol%, it is as high as 77.7%. Also with the increase in the flow rate of the CuO nanofluid, significant increase in heat transfer coefficient was observed.

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1. Introduction

Heat transfer is a very important process in many fields such as power generation, air conditioning, transportation, and microelectronics due to the heating and cooling processes involved. It is necessary to increase the efficiency of heat transfer devices used in these fields, as it can reduce the size of the devices and decrease the operating costs of the processes. Several researchers have tried various modification in these devices in order to increase heat transfer rate. Few techniques reported in literature are structure vibration, vibration of heat surface, injection or suction of fluids, applying electrical and magnetic fields etc. [1]. One of such techniques is the addition of metal particles to the base fluids to enhance its thermal conductivity that in turn can increase heat transfer rate [2–9]. This idea triggered because of the fact that metals have higher thermal conductivity as compared to fluids. Many research groups tried and tested this method but they encountered failure. The reason found was the size of the particles. Several researchers have used micro and millimetre sized particles in base

fluid that created many technical problems such as clogging, erosion, high-pressure drop etc. Thus due to advancement in nanotechnology, a novel concept “Nanofluids” came into existence and Choi [2] introduced this concept first time.

Nanofluids are the uniform, agglomeration free and stable suspension of nanoparticles (metallic, metal oxides, nitrides, CNTs etc.) in base fluids such as water, ethylene glycol, base oil. Several beneficial characteristics of nanofluids such as enhanced thermal conductivity, long time stability, smaller pressure drop and tube wall abrasion have diverted attention of many researchers to study on thermal and flow behavior of nanofluids [2–9]. These studies mainly focused on effective thermal conductivity, phase change behavior, tribological properties, flow and convective heat transfer of nanofluids [10–17]. Besides enhancement in heat transfer and modulation of thermal properties nanofluids serve a wide range of applications which includes transportation, electronics application, solar devices, industrial cooling application, space and defence, friction reduction, biomedical applications, anti-bacterial activities, nano-drug delivery [18]. Another method, which is used, for heat transfer augmentation is a use of helical coil instead of straight tube [15,19–21]. Helical coils exhibit high heat transfer coefficient and due to their compact size, they have wide industrial

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Electrochemical approach of chemically synthesized HgS nanoparticles as supercapacitor electrode

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Optical and bandgap study of rare earth doped phosphate phosphor

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Abstract This article presents reports on optical and band gap study of rare earth doped (RE = Tb³⁺, Pr³⁺, Ce³⁺, Dy³⁺ and Ce³⁺/Pr³⁺ ions) K₂Sr(PO₄) nanoparticles. The K₂Sr(PO₄) phosphor is synthesized by wet chemical method at 120 °C in a hot oven. Pure phase of K₂Sr(PO₄) phosphor material is achieved by sintering it at 950 °C for 2 h in muffle furnace. Photoluminescence investigation shows that K₂Sr(PO₄) doped with Tb³⁺, Pr³⁺ ions shows an emission in visible to NIR range after exciting it under UV and visible wavelength. Whereas, K₂Sr(PO₄) doped with Ce³⁺/Pr³⁺ ions shows the emission in NIR range extend from 650 to 800 nm, under 295 nm excitation band. Further Dy³⁺ doped ions, shows the characteristic emission band that corresponds to blue and yellow region, under UV excitation. The observed emission bands of Ce³⁺, Tb³⁺, Pr³⁺ and Dy³⁺ ions are assigned due to *d-f* and *f-f* transition respectively. Also the band gap of the prepared phosphor is found to be approximately 4.9 eV. Study on micro and nanoscale nature of phosphor are carried out by SEM, HRTEM analysis, indicating the core shell structure of materials with spherical shaped nano particles.

1 Introduction

Today an photovoltaic (PV) solar cells are appealing and promising renewable power sources of twenty-first century, and it is the future substitute for fossil-fuel-based electricity generation systems. In the past decade, rare earth ion doped with NIR DC and DS phosphors have been focused worldwide and deeply investigated from the viewpoint of emission spectroscopy of materials. These kind of rare earth doped inorganic phosphor acts as an active layer for Si-solar cell due to their potential in improving the spectral response of Si solar cells and enhancing the light conversion efficiency of Si solar cells. Among the different lanthanides used in DC/UC, DS process such as Eu³⁺, Ce³⁺, Yb³⁺, Er³⁺, Nd³⁺, Tb³⁺, Sm³⁺, Pr³⁺, Ho³⁺ etc [1–3]. The emission originates from these ions are assigned due to *5d-4f*, *4f-4f* transitions respectively, also they play a crucial role in the field of modern application such as solid state lighting, displays, solar cells, optoelectronics devices and medical applications. However, the fluorescence arising from forbidden transition (*f-f*) appears in the narrow absorption band and it has a ability to absorb a wide range of solar spectrum. These characteristics features of rare earth makes them an interesting for the development of solar cell devices. Because it acts as active layer when doped with suitable host lattice to enhance the light conversion efficiency of c-Si solar cells. Among the different lanthanides ions Tb³⁺ is an most important activator for doping because it shows emission in visible to NIR range, also it has a relatively simple energy levels structure that corresponds to ⁷F_J, ⁵D₄, and ⁵D₃ states. To intensify the absorption of Tb³⁺ ion in the UV region, one of the prominent way is to introduce sensitizer (such as Ce³⁺, Eu²⁺) to transfer effective energy to Tb³⁺ ion. Therefore Ce³⁺ is an extensive doping ions due to their broad band *5d-4f* allowed transitions

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Improved synthesis of aluminium nanoparticles using ultrasound assisted approach and subsequent dispersion studies in di-octyl adipate



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ABSTRACT

The present work reports on an efficient and simple one pot synthetic approach for aluminium nanoflakes and nanoparticles based on the intensification using ultrasound and provides a comparison with the conventional approach to establish the cutting edge process benefits. *In situ* passivation of aluminium particles with oleic acid was used as the method of synthesis in both the conventional and ultrasound assisted approaches. The aluminium nanoflakes prepared using the ultrasound assisted approach were subsequently dispersed in di-octyl adipate (DOA) and it was demonstrated that a stable dispersion of aluminium nanoflakes into di-octyl adipate (DOA) is achieved. The morphology of the synthesized material was established using the transmission electron microscopy (TEM) analysis and energy dispersive X-ray analysis (EDX) and the obtained results confirmed the metal state and nano size range of the obtained aluminium nanoflakes and particles. The stability of the aluminium nanoflakes obtained using ultrasound assisted approach and nanoparticles using conventional approach were characterized using the zeta potential analysis and the obtained values were in the range of -50 to $+50$ mV and -100 to $+30$ mV respectively. The obtained samples from both the approaches were also characterized using X-ray diffraction (XRD) and particle size analysis (PSA) to establish the crystallite size and particle distribution. It was observed that the particle size of the aluminium nanoflakes obtained using ultrasound assisted approach was in the range of 7–11 nm whereas the size of aluminium nanoparticles obtained using conventional approach was much higher in the range of 1000–3000 nm. Overall it was demonstrated that the aluminium nanoflakes obtained using the ultrasound assisted approach showed excellent morphological characteristics and dispersion stability in DOA showing promise for the high energy applications.

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1. Introduction

Developing efficient methods for the production of uniform size aluminium nanoparticles is an interesting and very important endeavour for the researchers due to the versatile application options offered by aluminium nanoparticles, generally based on the characteristic properties dependent on the size and its distribution, including the high energy capacities in the pure or metallic form. Aluminium nanoparticles are used as solid fuels due to high enthalpy of combustion (31 kJ mol^{-1}) and also have significant applications in pyro techniques [1]. The aluminium nanoparticles

easily react with humid air/water generating hydrogen gas and also releasing heat energy [2]. Recently, aluminium nanoparticles have been used in many applications due to its better reactivity as compared with the micro sized particles, which can be easily obtained based on the conventional methods of synthesis. The important applications of aluminium nanoparticles include oxidizing agent in solid propellant fuel, active catalyst, nanofluids, nanocomposites etc. Though aluminium nanoparticles offer significant potential, it is also an important challenge to synthesize aluminium nanoparticles effectively with the desired particle characteristics. In general, there are two approaches for the synthesis of aluminium nanoparticles or any nanomaterials in general viz. the top-down (size reduction from bulk materials) approach and bottom-up (material synthesis from an atomic level) approach.

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Studies in Properties of Plant Waxes : Carnauba and Candelilla Waxes Using DSC, FT-IR and Conventional Methods of Testing

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ABSTRACT

The animal waxes are used in many different applications in the industries mostly in pharmaceuticals and fruit processing industries. The application of waxes for any particular applications will depends on its properties. In this study the two animal waxes namely Bee and Shellac waxes had been studied for their properties like melting point, needle penetration, drop melting point, flash point, viscosities and densities. The testing was carried out as per ASTM standards. These properties were correlated with the results obtained from the DSC and FT-IR data.

Keywords: Bee wax, Shellac wax, FT-IR, DSC, Conventional properties.

I. INTRODUCTION

At one time the word wax meant only bees- wax and as the most important insect wax it has attracted the most attention. Beeswax generally refers to wax of the European bee, *Apis mel/i/era*, but Asiatic species *A. dorsata*, *A. Jlona* and *A. indica* are sometimes also commercial sources of wax. The wax scales are secreted by eight wax glands on the underside of the abdomen of the worker bee.[1,5]

The good quality of beeswax depends greatly on the production methods. There are two wax extraction methods: melting and chemical extraction. Melting is the most frequently used procedure. Wax can be melted by boiling water, by steam, or by electrical or solar power. Chemical extraction by solvents is feasible only in a laboratory, where small scale wax production is needed. Good wax solvents are gasoline and xylene.[3]

Beeswax components fall into the following chemical groups: esters (67%), hydrocarbons (14%), fatty acids (12%), and alcohols (1%). Among the hydrocarbons, the most numerous group are linear saturated hydrocarbons (n alkanes), accounting for ca. 67% of all hydrocarbons occurring in beeswax; branched alkanes occur in much smaller amounts (0.2%). Apart from saturated

hydrocarbons, unsaturated hydrocarbons containing one double bond alkenes) can also be found in beeswax.[2,4] Some of the important uses of Beeswax are in Candles and ornaments, Lip balm. Medicinal cream in pharmaceutical firms. Water proofing shoes. Polishing the furniture and making soaps.

Shellac is the purified product of lac, a natural resinous oligomer (MW \approx 1000 D) secreted by the parasitic insect *Kerria lacca* on various host trees in India, Thailand, and Myanmar. Shellac consists of polyesters of mainly aleuritic acid, shellolic acid, and a small amount of free aliphatic acids. The composition varies depending on the insect species as well as the host tree from which the raw material is obtained. After harvesting, the so-called "stick lac" is chopped and separated from wood and resin. A washing step extracts the water-soluble dye, laccic acid, yielding the raw material "seed lac." There are three different processes used for refining, resulting in different shellac qualities: The melting filtration process, where melted seed lac is filtered through a cotton hose, leads to wax containing shellac. Bleached shellac is obtained by treating the dissolved polymer with sodium hypochlorite. [4,5,6]

Shellac wax consists of long- chain esters of monovalent alcohols and acids. Typical for this wax is the content of more than 30% of free wax alcohols with a chain length

Studies in Properties of Microcrystalline and Paraffin Waxes with the Help of Gas Chromatography (GC), DSC, FT-IR and by Conventional Methods

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ABSTRACT

In this paper different properties of two paraffin waxes and two microcrystalline waxes have been studied using GC, DSC, FT-IR and conventional method of testing. Petroleum waxes are mixtures of hundreds and thousands of different hydrocarbons. Paraffin wax contains C18 to C40 straight chain saturated normal hydrocarbons whereas microcrystalline waxes are predominantly highly branched C27 to C68 hydrocarbons. Petroleum waxes were characterized by gas chromatography, Differential Scanning Calorimetry and FT-IR. The resulting GC, DSC and FT-IR data were correlated with various physical properties of the waxes, such as kinematic viscosity, needle penetration, melting point, refractive index, and flash point.

Keywords: GC, DSC, FT-IR, Petroleum Waxes, Properties.

I. INTRODUCTION

Petroleum waxes are complex mixtures of high molecular weight saturated hydrocarbons, predominantly alkanes in the range C18–C65. Paraffin waxes are produced from the vacuum distillates in lubrication oil refineries. The following de-waxing process of the vacuum distillates leads to by-products called slack waxes. Their oil residues have to be further reduced by different deoiling processes to oil contents < 0.5%. These raw paraffin waxes are then refined by hydro-finishing processes. During hydrogenation hetero- and aromatic substances are modified to harmless hydrocarbons. The obtained white and odour free fully-refined paraffin waxes are mainly used in food grade applications in a lot of different industries automotive, candle, cosmetics, polishing, rubber etc.

Micro-crystalline waxes are not obtained from vacuum distillation cuts, as the macro- and intermediate-paraffin waxes, but from the vacuum residue. The raw material for the production of microcrystalline wax is petrolatum or brightstock. Brightstock is derived from the heavy vacuum residue with the aid of propane de-asphalting, followed by de-aromatization and solvent de-waxing.

The suitability of the wax for a particular industry depends upon the physical properties like melting point, melt viscosity, hardness, and crystallinity among others. For example, in applications such as the paper industry, crystallinity of wax is an important parameter, whereas for hot-melt adhesives the viscosity is more important. For the application of coatings the hardness of the wax is an important parameter. For the paraffin wax hardness is one of the most important properties for its application in various industries. For the dental application the melting point is an important. Each application requires specific performance properties, and waxes are tailor-made for a particular application by the use of processes such as fractionation and blending.

In this paper the carbon number distribution have been studied using GC, the thermal transitions have been studied using DSC, the distribution of -CH- have been studied using the FT-IR. The properties like Penetration Index, melting point, kinematic viscosities, refractive index and flash point have been studied using ASTM methods of testing. These properties have been correlated with the data obtained from the GC, DSC and FT-IR analysis.

Studies in Properties of Animal Waxes : Bees and Shellac Waxes Using DSC, FT-IR and Conventional Methods of Testing

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ABSTRACT

The plant waxes are used in many different applications in the industries. The application of waxes for any particular industries depends on their properties. In this study the two plant waxes namely Carnauba and Candelilla waxes had been studied for their properties like melting point, needle penetration, drop melting point, flash point, viscosities and densities. The testing were carried out as per ASTM standards. These properties were correlated with the results obtained from the DSC and FT-IR data.

Keywords: Carnauba wax, Candelilla wax, FT-IR, DSC, Conventional properties.

I. INTRODUCTION

Natural waxes are unique mix of long-chain, linear and even-numbered aliphatic mono-esters. Partially varying amounts of linear hydrocarbons (candelilla), free wax alcohols respectively polyicosanoles (carnauba wax) and other ingredients like phytosterols, natural resins are also present.[1]Carnauba wax is used in the manufacture of polishes for floors, automobiles, furniture , shoes, etc.. It is used in candles to raise the melting point; in carbon paper; and in a variety of moulded products. Articles published by scientific men in technical and trade journal reveal a curious lack of accurate information about this wax in any stage of its production or in any form other than that in which it appears on the market. The actual production of carnauba wax is exceedingly crude. The original native methods of production have been little improved. The harvesters go forth into the farms armed with a sharp sickle-like knife fastened to the end of a long pole. With this long-handled knife they cut the desired number of leaves from the trees. Harvesting takes place from July to January; the time varies in different localities, depending primarily upon rainfall.[2,4]

Candelilla wax is a yellowish-brown hard, brittle, lustrous solid with an aromatic odour when heated. It

consists primarily of odd-numbered saturated straight-chain hydrocarbons (C29 to C33), together with esters of acids and alcohols with even-numbered carbon chains (C28 to C34). The most abundant n-alkane, C31, comprises more than 80% of total n-alkanes. Free acids, free alcohols, sterols, neutral resins, and mineral matter (<1%) are also present.[3]

Candelilla wax may be obtained from several species of *Euphorbiaceae*; the primary source is *Euphorbia antisiphilitica*. The plant grows as a bush or shrub in dense stands, principally in the Chihuahuan desert in north eastern Mexico. The plant consists of numerous slender, leafless, cylindrical stalks covered with a powdery wax that gives the plant a blue-green colour.[4]

The Candelilla wax is used in Textile industry, Leather industry, Casting, Precision electroplating and Automobile for coating. It is also used for manufacturing Greases, adhesive agents, Lipstick and chewing gum.

II. EXPERIMENTATION AND OBSERVATIONS:

The DSC of Carnauba and Candelilla waxes were carried out using ASTM D 4419. The experiment has been done using aluminium container heated at a controlled rate of

ULTRASONIC STUDY OF MOLECULAR INTERACTIONS IN TERNARY LIQUID MIXTURE OF 1,4-BIS(DIPHENYLAMINO)BENZENE WITH 3-NITROBENZOIC ACID AND PICRIC ACID IN ETHANOL AT 298K

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ABSTRACT

Densities and ultrasonic speeds of the ternary liquid mixture of 1,4-Bis(diphenylaminobenzene) with 3-nitrobenzoic acid and Picric acid in ethanol at 298 K over the entire composition range were measured. From these data, acoustical parameters such as adiabatic compressibility (β), free length (L_f), acoustic impedance (Z) and molar volume (V_m). Excess values of above parameters have been also evaluated. The evaluated data have been analyzed in terms of Nomoto's Relation (NR), Ideal Mixing Relation (IMR), Free Length Theory (FLT), Impedance Dependence Relation (IDR) and Junjie's method (JUN). Theoretical data of ultrasonic velocities obtained from these theories compared with experimental values.

Keywords: Ultrasonic speeds, Acoustical properties, Molar excess volume, Ternary liquid mixtures, Molecular interaction

1. INTRODUCTION

Measurements of ultrasonic investigations find extensive applications in predicting the physico-chemical behaviour of liquid mixtures [1-4]. The viscosity of liquid mixtures is required in several calculations of engineering that involve fluid dynamic and heat and mass transference [5]. These studies can also be used to identify complexation and to calculate the stability constants of complexes [6-7]. Several researchers [8-11] carried out ultrasonic investigations on binary and ternary liquid mixtures and compared the experimental values with theoretical relations [12-16] of Nomoto's relation (NR), Ideal Mixing Relation (IMR), Free Length Theory (FLT), Impedance Dependence Relation (IDR) and Junjie's method (JUN) and the results are explained in terms of molecular interactions. The donor-acceptor complex formation is biologically important. Oxygen transfer in blood involves reversible complexation between haeme and oxygen. Electron-deficient carbons of carbonyl group can act as electrophiles. Basic groups like amino groups can interact with this group to form a complex and influence the properties of such compound [17]. In this paper, the results obtained in the study of molecular interaction between 1,4-Bis(diphenylaminobenzene) with 3-nitrobenzoic acid and Picric acid in ethanol solvent have been reported over the entire composition at 298 K. Molecular interactions among the components of the mixtures were inferred from the sign of the excess and deviation properties.

2. EXPERIMENTAL

1,4-Bis(diphenylaminobenzene), 3-nitrobenzoic acid and Picric acid were AR grade. The solvent ethanol was purified by distillation (b.p.69°C) before use. Densities, Viscosities and Ultrasonic Velocities were measured at 298 K over a wide range of concentrations. The densities of pure compounds and their solutions were measured accurately using Rudolph digital densitometer (accuracy ± 0.1). Viscosities of pure compounds and their mixtures were determined using Ostwald's Viscometer calibrated with double distilled water. The ultrasonic velocity was measured by using variable path single crystal interferometer (Model F-81S, Mittal Enterprise, India) at fixed frequency 2 MHz with accuracy of $\pm 0.1 \text{ ms}^{-1}$. The temperature of the solution under study is maintained constant using the electronic Juloba thermostat. This thermostat is equipped with a heater, a stirrer, a thermometer and a regulator. The temperature was maintained with an accuracy of $\pm 0.1\text{K}$. Acoustical parameters such as adiabatic compressibility (β), free length (L_f), acoustic impedance (Z) and molar volume (V_m) were calculated using standard equations [18].

$$\text{Adiabatic compressibility } (\beta) = 1/U^2 \rho \quad (1)$$

$$\text{Free length } (L_f) = K \beta^{1/2} \quad (2)$$

Where K is temperature dependant constant

The acoustic impedance is given by the product of ultrasonic velocity and density as shown below.

$$\text{Acoustic impedance } (Z) = U\rho \quad (3)$$

Where ρ is the density and U is the ultrasonic velocity in the liquid system.

$$\text{Molar Volume } (V_m) = M_p \quad (4)$$

ECOFRIENDLY STAIN REMOVER BASED ON SUGAR BASED POLYMERIC SURFACTANTS

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Abstract - Sugar based polymers containing citric acid, Maleic and phthalic anhydride have been synthesized with special intension of developing stain removing surfactants. The polymers were analyzed for Physico chemical characteristics like acid value, viscosity, surface tension and HLB value. Selected polymers have been used in formulation of stain removing compositions. Sugar based polymers successfully remove stain of Katha, soil, ink and turmeric. The result was compared with multinational brand stain remover. Our sample were excellent and on par with commercial products. Our stain remover does not harm the surface of white or colored cloths.

Key Words: Polymers, Stain Remover, Sugar Polymers, Surfactant etc...

1.1 Classification of Stains

Table no. 1 classification of stain types

Enzymatic	Blood	Egg	Grass
Oxidisable	Tea	Coffee	Red Wine
Greasy	Olive oil, Ground nut oil, ruff & collar stains (On shirts)	Motor oil	Butter, Ghee etc
Particulate	Clay	Mud	Dirt
Pigment and Dye stains	Paints	Inks	Dyes

1. INTRODUCTION

Stain removing is always a challenging problem of working housewife's. The careless family members always stain their cloths with variety of stains like haldi, ink, tea, coffee, soil and what not? As the advertisements of multinationals suggest it is never as easy as shown in advertising films. Let us try to understand the basics and remedies of various stains.

Stain removal is the process of removing mark or spot left by one substance on a specific surface like fabrics. A solvent or detergent is generally used to conduct stain removal and many of these are available in the market. Most stains are removed by dissolving them with a solvent. The solvent to use is dependent on two factors the agent that causing the stain and the material that has been stained. Different solvents will dissolve different stains and the application of some solvents is limited by the fact that they not only dissolve the stain but also dissolve the material that is stained as well. Another factor in stain removal is the fact that stains can sometimes have two separate staining agents which require different routes of removal.

- Enzymatic stains are removed with the help of enzymes.
- Oxidisable stains are removed with an oxidising agent, bleach and are called bleachable stains.
- Greasy stains are removed by the use of surfactants.
- Particulate stains are removed by builders like Sodium carbonate & Bicarbonate. Pigments, Paints & Inks are removed by stronger solvents.
- In the present work we are using polymeric surfactant as a base for stain remover. Polymeric surfactant is a based on carbohydrate skeleton & acid. This medium should be an excellent medium for removing most of the stains. A special sugar based polymer has been synthesised which has best possible stain removing ability. This sugar polymer along with coherent surfactant like acid slurry and organic solvent like Isopropyl alcohol has been used in combination with Polyethylene Glycol 400 Which is excellent solvent for many stains.

2. EXPERIMENTAL SET UP

2.1 SYNTHESIS OF SUGAR BASED POLYMER

The synthesis of novel polymer was carried out in a glass reactor of 2 litre capacity. Lower part of the reactor is a round bottom vessel with very wide mouth. The upper part of the reactor is its lid having four necks with standard joints. A motor driven stirrer is inserted in the reactor through the central neck, while another is used for temperature measurement. A condenser is fitted through the

FLOOR CLEANER BASED ON SUGAR BASED POLYMER

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Abstract - In the present work sugar based polymer containing higher proportion of organic acids (20%) have been synthesized by special technique. Polyethylene Glycol 400 has been incorporated to improve the stain removing and dirt removing capacity. The polymers have been systematically analyzed and incorporated in floor cleaning composition to the extent of 2 to 15%. Floor cleaner based on sugar polymer have been analyzed and compared with commercial products. Techno economically viable floor composition have been identified and recommended for pilot scale trials.

Key Words: Floor cleaner, Polyethylene Glycol 400, Sugar polymer, Stain remover etc...

1. INTRODUCTION

The house hold cleaners like floor cleaners are used to remove normal inorganic organic soil such as dust, sand, mud, street dirt oils, fats and greases present on the surface of the floor. Generally, they are alkaline in nature (pH=8.0). Many cleansers keep the pH acidic in order to remove water deposits, minerals and rust. The main ingredients of surface cleaners are surfactants, builders, solvents and antimicrobials. In the present floor cleaner compositions high amount of citric acid has been incorporated in sugar polymer and isopropyl alcohol has been used as a solvent. The attempt is to maintain antimicrobial activity by using citric acid and alcohol. We have already studied the antimicrobial activity of liquid glucose based polymers. We have already studied the use of carbohydrate based polymers in detergent powder¹, liquid detergent², Hand wash³ and Floor cleaner⁴. So here a specific attempt has been made to design a floor cleaner based mainly on sugar and citric acid based polymer. The formulation does not use any high amount of petroleum based surfactant it also does not utilize polluting substances like sodium Tripolyphosphate. The product is the alkaline so it will not harm ceramic tiles.

1.1 Synthesis of sugar polymer in laboratory:

The synthesis of polymer was carried out in a glass reactor of two litre capacity. Lower part of the reactor is a round bottom flask of two litre capacity with very wide mouth. The upper part of the reactor is its lid having four necks with standard joints. A motor driven stirrer was inserted in the reactor through the central neck while another neck was used for the thermometer. A condenser

was fitted with the reactor through third neck and the fourth neck was used for closing the chemicals in reactor. The reactor was heated by an electric heating mantle having special arrangement for smooth control of temperature ($\pm 2^{\circ}\text{C}$) of the reactor. A regulator controlled the speed of stirrer. The reaction vessel and its lid were tied together with the help of clamps.

STEP 1: - All the ingredients were converted into a homogeneous dispersion (or slurry) which has got excellent flow and reasonable mobility.

STEP 2: - The mass was slowly heated to 80°C in about 15 minutes. The reactant contents were then raised to desired temperature of 120°C in about 20 minutes. The reactor charge was monitored for flow, homogeneity and acid value.

STEP 3: - After attaining desired characteristics which take normally three hours at 120°C . The heating was stopped and the reactor content was cooled to 80°C .

STEP 4: - The batch was withdrawn and filtered through a strainer and stored in tightly closed transparent bottles.

The polymer samples were analyzed for their physicochemical properties by standard methods (5-10.)

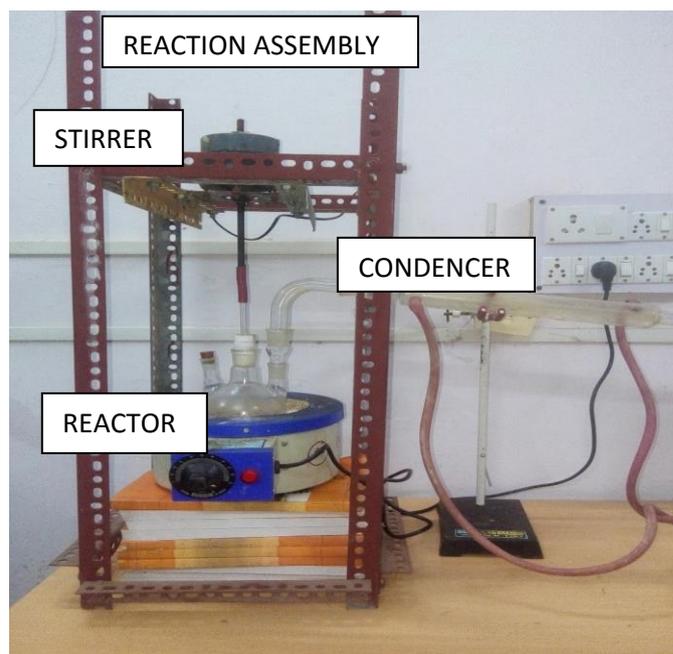


Fig: Photograph of Reactor

DEVELOPMENT OF POLYANILINE GRAFTED CHITOSAN SENSOR FOR DETECTION OF AMMONIA & ETHANOL VAPOUR

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Abstract - The use of conducting polymers as sensing elements in electrochemical or chemical sensors is a center of attraction due to their good sensitivity in changing electrical and optical properties when exposed to different types of gases and liquids. The demand for gas sensor is increasing day by day due to requirements in air quality monitoring, safety of processes & medical applications. Polyaniline is one of the most commonly used polymer and its characteristics as sensor can be enhanced by adding other material to form composite. Chitosan has promising characteristics to be used as biosensor, vapor sensor, electrochemical sensor etc. The present work explores the possibility of development of electrochemical gas sensor by using conducting polyaniline and chitosan base composite film using cloth and paper substrates. Six electrodes, three each of cloth and paper base using PANi powder and PANi-gf-Ch film as sensing elements have been developed. These electrodes are evaluated for their sensitivity for ammonia and ethanol vapor using electrochemical cell. Based on the result & discussion, it can be said that the sensitivity of PANi-gf-Ch composite film electrode showed higher current output than using only PANi powder coated electrode. The best response in ammonia sensing, is obtained by the filter paper based substrate electrode PPCh1 of the magnitude of 0.15 mA, followed by cloth based film electrode CPCh1 as 0.04. Similarly CPCh1 and PPCh1 are observed to be effective in sensing ethanol with good current output when compared with electrodes like CP1, C1, P1 and PP1 which do not contain chitosan.

Key Words: Polyaniline grafted Chitosan film Electrodes, Electrochemical sensor, filter paper, cloth strips.

1. INTRODUCTION

Today, the use of conducting polymers as sensing elements in electrochemical or chemical sensor is a centre of attention due to their good sensitivity in changing electrical and optical properties when exposed to different types of gases and liquids. The demand for gas sensors is increasing day by day due to requirements in air quality monitoring, safety of processes and medical applications. These conducting polymers can be synthesised easily by means of chemical or electrochemical methods. The sensitivity at room temperature adds to the sensor's advantage and is importance particularly as ammonia or alcoholic compounds are used in different applications in process industries.

Polyaniline is one of the most commonly used conducting polymers due to its unique electrical properties, atmospheric stability and intrinsic redox reaction. Polyaniline is also used in different applications such as light emitting diodes, rechargeable batteries and photovoltaic cells, anticorrosive coating material etc. However the disadvantages of these conducting polymers are their low processing ability, poor chemical stability and mechanical strength due to its thinness. There is an approach for improving the mechanical strength and characteristics of sensors by adding organic or inorganic material to form composites.

Chitosan can be synthesized by using seafood waste like crab & shrimp. Chitosan has promising characteristics to be used as biosensor, vapour sensor, volatile organic compound sensor, electrochemical sensors and many more. Chitosan has been used as a biosensor due to its excellent film forming properties and ability to retain its original properties. Apart from that, chitosan is low cost because it is synthesized from waste and is a natural reproducible polymer. Another important feature is that, chitosan can be effective in sensing vapour at room temperature.

1.1 Literature Survey

Sadanand Pandeya et al studied and reported in review paper some of the current breakthrough developments in the area of gas sensors based on polyaniline (PANI) nanocomposite. PANI-based sensor experiences some important disadvantage of poor reproducibility, selectivity & stability. In order to overcome this restriction PANI was functionalised or incorporated with nanoparticles (NPs), carbon compounds and shows outstanding properties for gas sensing. Herein, author summarize recent advantages in PANI nanocomposite preparation, sensor construction, and sensing properties of various PANI nanocomposites based gas/vapor sensors, such as NH₃, H₂, HCl, NO₂, H₂S, CO, CO₂, SO₂ & LPG.[1]

Li Huixia, et al investigated the gas sensing properties of hydroxyapatite based composites which were prepared by mixing different contents of conductive polymers: polypyrrole and polyaniline (PAni). The compositions, microstructures and phase constitutions of polymer/HAp composites were characterized, and the sensing properties

A Unique Polymeric Surfactant for Hand Washes

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Abstract - A Polymeric Surfactant, based on Sugar, Polyethylene Glycol 400 and organic acids has been synthesized. The Polymers have been analyzed systematically and selected polymer has been used to the extent of 25 to 35% in Hand wash compositions. The Hand wash give excellent foaming, viscosity and surface tension reductions characteristics. The characteristics are comparable to commercial Hand wash in the market.

Key Words - Hand wash, Polymer, Surfactant.

1. INTRODUCTION

Awareness about hygiene cleanliness in developing countries is increasing at very fast pace in last decade. With increasing standard of living, better per capita income, role of T.V. media the hand wash now has become an essential commodity in every family.

In developing countries childhood mortality rates related to respiratory diarrhoeal diseases can be reduced by 50%, by proper use of soap and hand washes. In the present work we have synthesized polymers based mainly on sugar. As we know sugar and liquid glucose are natural preservatives which have been used for centuries in our Mango and Lemon based preparations. In our laboratories we have already synthesized polymers based on sorbitol¹, starch², liquid glucose³ and Maleinized vegetable oils⁴. These polymers have been successfully utilized in various surfactant compositions. In our country large number of sugar factories are producing sugar. We export sugar and sometimes surplus is available. This work is to generate value added product from sugar for a non-food use like surfactant⁸. If we are able to generate value added product at reasonable rate, then this will also help the economics of sugar industry and sugar cane growers. The raw materials used are sugar, polyethylene glycol-400, organic acids and sodium bisulphate. These polymers have been analysed systematically and selected polymer has been used to prepare Hand wash compositions with following special features.

- 1) The product does not contain any large amount of acid slurry or petroleum based surfactant. Thus the product is likely to be eco-friendly.
- 2) Any phosphate has not been used in formulation so it will not create any pollution.

- 3) Use of sugar gives clean, transparent, free flowing homogeneous product which does not irritate the hand. A smooth feel is obtained.
- 4) The product does not use any alcohol. Let us try to understand what are the essential and desirable characteristics of a hand wash.

- It should completely & quickly remove dirt, oil, grease and other foreign material deposited on hand.
- It should have a moderate viscosity neither too high nor too low because higher viscosity sometimes make it difficult to remove from the bottle and very low viscosity is also not desirable.
- It should be clear, transparent with excellent stability at least for one year. It should not show any separation on standing.
- It should contain some glycerine or sorbitol so that after application it should not show any skin dryness or irritation.
- The special features of hand wash is its pH. It should be slightly acidic pH 5-6(1% solution) which should match with our skin.
- It should have excellent minimum negative effects like stripping skin of natural oils.
- It should give excellent foaming properties non-foaming compositions are not popular in India.
- It should not show any feeling of stickiness after application and removal.
- The hand should be clean of pathogeus including bacteria or viruses and chemicals which can cause personal harm or disease to the person using it. In our laboratory we have already prepare hand wash and commercial surfactant based on liquid glucose, starch, sorbitol and Maleinized oil. In the present research work special polymers based on sugar have be synthesised and used in formulation of hand wash. The use of sugar based polymer is expected to give stability and excellent technical properties.
- A mild perfume should be incorporated which will give decent and pleasant feeling after application.
- Some Herbal extracts like neem, aloe Vera or other plants should be incorporated this will make the product acceptable to Indian customers who have special taste for herbal products.

Synthesis of Biolubricants from Non Edible Oils

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Abstract - Crude mahua oil and karanja oil were analyzed for their chemical and physical properties such as density, acid value, saponification value, viscosity at 40°C and 100°C, viscosity index. Both the oils were then converted into oil methyl esters (biodiesel) separately by esterification and trans-esterification respectively. Each biodiesel was then processed through trimethylolpropane (TMP) route. Esterification of oil methyl ester with polyol alcohol like trimethylolpropane (TMP) yields di-esters and tri-esters. The mixture of di-esters and tri-esters is called biolubricant. Properties of resulted products which are Mahua Biolubricant and Karanja Biolubricant were found out and compared with 2T engine oil.

Key Words: Vegetable oil, Mahua, Karanja, Polyester, Biodiesel, Biolubricants

1. INTRODUCTION

Innovating biobased alternatives for mineral products like fuel and lubricants has become one of the most researched topics of the day. The depletion of the world's crude oil reserve couple with the consumption rate, increase in petroleum prices and scarcities, and issues related to conservation have brought about renewed interest in the use of bio-based materials [1]. Although mineral oil has provided us with efficient and cost-effective lubricants over the decade, they pose a great deal of environmental hazard. Today most of the lubricants for industrial need are made from non-biodegradable materials such as synthetic oils or petroleum derivatives. It is well known that millions of tons of lubricating oil (Hydraulic, machinery, industrial) is discharged every year into source of water such as river and sea which contaminate groundwater. This is a great threat to plant and aquatic life [2].

It is very important to find solution for this environmental problem by making good research in biolubricant synthesis. Bio-based lubricants have begun to replace non-biodegradable fossil based mineral lubricating oils. We can significantly reduce carbon footprints by using biolubes than mineral oils.

Lubricants were synthesized from plant oils and other environmentally friendly sources which are referred to as biolubricants and these are primarily triglyceride esters

derived from plants and animals. There is an increasing demand for environmentally compatible lubricants, particularly in areas where they can come into contact with water, food or people. Lubricants are generally composed of a majority of base oil plus a variety of additives to impart desirable characteristics. Lubricants are generally based on one type of base oil, but mixtures of the base oils are also used sometimes to meet performance requirements.

The quest for renewable energy sources has since dominated most manufacturing industries with much emphasis on bio products. Several researchers have agreed on the possibility of obtaining more efficient lubricants from such (bio products) sources. Hence, there is need to investigate the possibility of obtaining an environmentally friendly and economically viable lubricant from one of such sources (mahua and karanja oil). This study was carried out with the objective of investigating the feasibility of producing biolubricant from mahua and karanja oil by conducting chemical modifications on the Mahua and Karanja crude oil. The modification involved improving some of the lubricating properties of these crude oils. The physicochemical properties of Mahua and karanja biolubricant were also compared with a certain standard properties of lubricants [1]

2. MATERIALS AND METHODS

The materials and reagents used in carrying out the research are as follows: crude mahua oil, crude karanja oil, methanol, sulfuric acid, sodium hydroxide, trimethylolpropane (TMP), sodium methoxide.

The instruments and equipments used in carrying out this study are: water bath, mechanical stirrer, two neck round bottom flask, water condenser, magnetic stirrer with heating plate, Ostwald viscometer(C type), paraffin bath, pipettes, burette, test tubes.

On the basis of methodology, the research is subdivided into four categories.

2.1 Characterization of the crude oil

2.2 Biodiesel synthesis

2.3 Biolubricant synthesis

The following steps were followed as methodology.

Artificial Neural Network modelling for pressure drop estimation of oil-water flow for various pipe diameters

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Abstract – The flow of two immiscible liquids in pipeline occurs many times in chemical industries. Oil-water mixture is dispersion and estimation of pressure gradient for flow through pipeline using empirical equation is tedious and less accurate. The present work is aimed at development of artificial neural network models for estimation of pressure gradient as a function of pipe diameter, flow rate, composition of oil-water mixture and angle of elevation of the pipe. 175 experimental runs have been conducted by varying process parameter combinations. Three ANN models have been developed using elite-ANN[®] based on the experimental data generated. Comparison among actual values with predicted values using ANN models is carried out. Based on the results and discussion, it can be said that all the ANN models developed have excellent accuracy level of prediction for both the training as well as test data sets. The relative error of prediction is in the range of 5 to 20%, highlighting the success of the present work. The work is demonstrative and it is felt that many such models can be developed for various combinations of input and output parameters that is readily available in process industry.

Key Words: Artificial Neural Network modelling, two phase flow, oil-water dispersion, pressure gradient and angle of elevation of pipe.

1. INTRODUCTION

1.1 liquid-liquid two phase flow

The flow of two immiscible liquids occurs in a pipeline many times in chemical industries, mostly in the petrochemical industry where oil and water are pumped from the wells and transported together [1]. The interactions between the two liquids, with respect to interfacial tension and the wetting properties of the pipe material, means that phenomena are more complex compared to gas-liquid systems [2]. There are large differences in the test fluids used in liquid-liquid experimental studies so that it is difficult to draw any definitive rules for flow pattern boundaries and properties [3].

The flow patterns of liquid-liquid flow are divided into three main categories that are separated flow, dual continuous and dispersed flow. In separated flow both liquids retain their continuity at the top and bottom of the pipe. It consists of

stratified flow, where the oil flows above the water and the interface between the two liquids is smooth; and stratified wavy flow where the flow is still stratified but the interface has large waves. Dual continuous flow is flow pattern where both phases remain continuous, but there is a degree of dispersion of one phase into the other. There are limited experimental studies for pressure gradient of liquid-liquid two phase flow in pipelines.

There are mainly two types of pressure measuring devices manometers and mechanical gauges. Mechanical gauges are the most used pressure gauges for industrial purposes. Types of mechanical gauges are Bourdon tube gauge, Bellow gauge, Diaphragm gauge and dead weight gauge.

1.2 Artificial Neural Network

Artificial Neural network is derived from biological neural network. It can be compared with a black box having multiple inputs and multiple outputs which operates using large number of data which have non-linear relationship with each other. Artificial neurons behave like biological neurons. It accepts signals from adjoining neurons and process to give output signals [4]. There are various types of ANN & Error Back-propagation is one amongst them. It requires at least two layers of nodes. One is the hidden layer and second is output layer. The nodes of two layers are interconnected by the constants called weights. In error back-propagation learning the weights in output layer are corrected first and after having these weights corrected together, the errors have been evenly distributed to the last hidden layer. Then the weights of last hidden layer are corrected and so on [5]. Learning of error back-propagation is in cycles called epochs. The period in which all inputs are presented once to the network is one epoch. After each epoch, RMS (root mean square) error is reported. RMS value decides the accuracy of the model [6]. The aim of all the researchers is to reach as small RMS value as possible. Various applications of ANN in modeling, simulation and optimization of chemical processes have been reported in literature, these include, Estimation of Pressure Drop of Packed Column Using Artificial Neural Network [7], Modeling of Artificial Neural Network for Leak Detection in Pipe Line [8], Artificial Neural Network Modeling of Equilibrium Relationship for Partially Miscible Liquid-Liquid Ternary System [9], Modeling of Packed Bed Using Artificial Neural Network [10], Developing Optimum ANN Model for

Ecofriendly Sugar Polymer based Toilet Cleaners

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Abstract - Sugar based polymers based on sugar, citric acid, Oxalic acid have been synthesized. These polymers were analysed for Physico chemical characteristics and cleaning efficiency of toilet bowl. Sample S2 was selected for formulation of toilet cleaner. Samples of toilet cleaners based mainly on sugar polymer (58-60%) have been prepared and tested in comparison to commercial toilet cleaner. Our samples give excellent cleaning and shine compared to commercial product. Sample T3 is recommended for commercial large scale production.

1. It should quickly or completely remove all organic waste, dust, and stains in the bowl and basin.
2. It should not adversely affect the sanitary materials.
3. It should give a germ free bowl after cleaning.
4. The sample should not be corrosive or irritating to hands.
5. It should incorporate good perfumes so that the bathroom and toilet should provide a pleasant atmosphere.

Key Words - Polymer, Sugar Polymer, Toilet cleaner.

1. INTRODUCTION

Increasing awareness about cleanliness and special "Swatch Bharat Movement" The demand for household cleaners is increasing every year. Conventional toilet cleaners are based on Hydrochloric acid, Sodium bisulphate, Sodium hypo chloride etc. This is a small scale industry and local manufacturer make these products on large scale.

Gary A Devis [5] has studied and surveyed a list of acid Toilet Bowl liquid cleaners to arrive at proper standards and Evaluate the existing formulates from the stand point of environment. Basically Formic, Phosphoric, and Hydrochloric acid are used. All types of non-ionic surfactants and polyethylene Glycol ethers have been used. The powder type bowl cleaners contain mainly Sodium hydrogen sulphate along with salt and carbonates. One of the leading commercial brands uses hydrochloric acid and Non-ionic surfactants. Our laboratory is working on sugar based polymers some of them have a high acid value. Instead of using corrosive Hydrochloric acid we can use these polymers as a base for laundry cleaners. We can avoid the use of any petroleum based surfactant.

The idea is to manufacture basic Toilet cleaner on an organic polymer rather than strong Hydrochloric acid. Our institute is working on Eco-friendly raw materials. [1-4] A specially designed sugar based polymer for this purpose has been used. The idea is to develop eco-friendly vegetable base Household products which does not utilise strong acids like Hydrochloric acid yet it is highly effective in removing organic and other dirt from toilet bowl. The toilet bowl cleaners have been designed with following objectives;

2. EXPERIMENTAL SET UP

Synthesis of Sugar Based Polymer:

The novel polymer was synthesized in a Glass reactor of two-liter capacity. The reactor consists of two parts. Lower part of the reactor is round bottom vessel with very wide mouth. The upper part of the reactor is its lid with having four necks with standard joints. A motor driven stirrer was inserted in the reactor through the central neck. While another neck was used for thermometer. A condenser was fitted with the reactor through third neck and the fourth neck was used for dosing chemicals in the reactor. The reactor was heated by an electric heating mantle having special arrangements for smooth control of temperature of the reactor. A regulator controlled the speed of stirrer. The reaction vessel and its lid were tied together with the help of clamps.

Step 1: Sugar and other ingredients were mixed in a homogenizer to get free flowing slurry this was introduced into the reactor.

Step 2: The mass was slowly heated to 50°C in about 30 minutes. The temp. was then taken to 120°C in about twenty minutes. After attaining the temp., the reactor was continuously monitored for viscosity, cleaning, pH, acid value. In about three hours the desired characteristics are reached.

Now the temp was lowered down to 80° C and sample withdrawn and filtered. The clear material is stored in corked bottles.

Step 3: The sample was analyzed for Acid value, % Solids, pH, Surface tension, and H.L.B., ratio by standard methods (1-4).

Recovery of Liquid Hydrocarbons by Catalytic Depolymerization of Waste Plastic and Blending with Automotive Fuel

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Abstract - In the present condition, the use of the plastic material in the day to day life has dramatically increases. Economical growth impossible without saving of fossil fuel like crude oil, natural gas or coal they are non-renewable resources. Recovery of liquid hydrocarbon by depolymerization of waste plastic collected from local hospital i.e. saline bottles(LDPE). It was found that the LDPE yield above 65% fuel with a copper based catalyst to feed ratio 1:200 at 300-400°C in a copper batch reactor. The optimum catalytic cracking temperature up to 300 to 310°C that depend on the optimum quantity of catalyst to feed ratio. This fuel can be directly compared or blended with automotive gasoline or diesel fuel from their characterization and boiling ranges as per ASTM distillation ASTM D86 test method.

Key Words: waste plastic, depolymerization, gasoline, diesel, blending.

1. INTRODUCTION

During last few decades the tremendous population increase worldwide together with need of people to adopt improved condition of living lead to a dramatical increase of the consumption of plastic material. The plastic material had a remarkable impact on the environment and leaving standard. Due to their diverse and attractive application in household and industries, the demand is continuously increasing.

According to Plast India report India's per capita plastic consumption approximately at 9.7 kilograms in 2012-13 is far below than 109 kilogram level in United states and 45 kilograms in China, But the plastic industry poised to benefit from increasing per capita income, rising consumerism, and modernization, particularly in an urban area the plast India foundation estimated that the demand for polymers to jump to 16.5 million metric tons by 2016-17 from 11 million tons during 2012-13, Resulting in consumption rising by 10.8 percent compound annual growth rate. India is expected to among top 10 packaging consumers in the world by 2016 with demand set to reach \$24 billion according to report.

Both the landfilling and incineration processes of plastic waste management system are identified as sources of

pollutant gas emitters.[1] Reprocessing is also uneconomical in comparison to the virgin plastic products in terms of commercial values due to polymeric contamination.[2] Thermal or catalytic cracking of waste plastics is one of the possible methods of their utilization. As a result of the cracking at 400°C or higher process temperature, some quantities of hydrocarbon mixtures in the form of gas, liquid products (gasoline and diesel fuel boiling range) as well as higher boiling liquid residue or solid can be obtained. All these products can be used as fuels or fuel components. Especially liquid products of gasoline and diesel fuel boiling range can be applied to components of engine fuels.[3] The yield of liquid hydrocarbon by catalytic cracking is depending on the catalyst to feed ratio, type of plastic composition operating temperature of the reactor, the length of the condenser, flow rate and temperature of circulating water through the condenser as the cooling medium. It has been observed that on the basis of boiling ranges liquid hydrocarbon product separated into two cuts. First, cut in the boiling range of gasoline and other in the range of diesel for blending purpose.

2. EXPERIMENTAL ASSEMBLY

The reactor was made up of a copper vessel of volume 4.5 liter, diameter 17.5 cm, and height 19 cm. the upper end of reactor fabricated with stainless steel flanges with nuts and bolt for tightening purpose and centrally drilled with 2cm diameter hole for removal of vapour during cracking when reactor suggested to heating. The thermowell fabricated to lied of the reactor for measuring feed temperature during cracking. The heating mental of capacity 5-liter use as a source of heating to the reactor that controlled by the dimmer state. The reactor opening for vapour was followed by Teflon bush which specially shaped in required dimension to avoid direct contact between metal and glass joint of B24 size. This joint followed by distillation head containing thermowell for measuring product vapour temperature and series of condensers to condense oil vapour by cold water as a cooling medium.

Extraction of Pectin from Unripe Banana Peel

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Abstract - This work aims to develop value-added product such as pectin from solid waste by extraction process from unripe banana peels. Pectin is widely used as a gelling agent, thickener, emulsifier and stabilizer in different food processing operations. Chemically it represents a polysaccharide, which is generally present in different amount in cell walls of all plants. Pectin was extracted from unripe banana peel powder using Hydrochloric acid acids at $90\pm 5^\circ\text{C}$ and at five different time period (1, 2, 3, 4, 5) hour and at constant pH 2. Pectin yields varied from 7.5% to 13%. The best extraction condition using HCl acid were temperature 90°C , pH 2 and extraction time of 4 hours with a pectin yield of 13%. The structure of the product is confirmed by Fourier transform infrared spectroscopy (FTIR) analysis. Extracted pectin was characterized by the estimating parameters moisture, ash content, methoxyl content, anhydrouronic acid content, degree of esterification and equivalent weight.

Key Words: Anhydrouronic acid content, Extraction, FTIR, methoxyl content, Unripe banana peels.

1. INTRODUCTION

The production of banana in India was 26509096 Metric Tones (25.58%) in 2015 (Post harvest profile of banana 2015). Main banana producing states in India are Tamil Nadu, Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Bihar, Assam and Madhya Pradesh. Key varieties of banana include Dwarf Cavendish; Robusta; Rasthali; Poovan; Nendran; Red Banana; Karpurvalli; Pachanadan; Virupakshi etc. Most of the bananas grown in India are for the domestic market. Even through more than half of the bananas produced in India are Cavendish types. Bananas are considered as one of the most important tropical fruits in the world market. In India bananas is most widely processed into chips which account for 95% of the country's earnings on processed banana. Banana fruit peels compose a significant quantity of wastes produced from banana processing, which is equivalent to 40% of the total weight of fresh banana. However, the peel of banana is often thrown away. Fruit wastes, which are highly perishable is a problem to the processing industries and pollution monitoring agencies. Suitable methods have to be adopted to utilise them for the for the conversion into value-added product. To reduce the environment problems, banana peels can be utilised in production of pectin. Pectins are complex

polysaccharides consisting mainly galacturonic acid units being linked by α -(1 \rightarrow 4) linkages (Wosiacki, 1977) which consists of chains of 300–1000 galacturonic acid units (kalapathy U., 2001). It also contains non-sugar substituents, essentially methanol, acetic acid, phenolic acids and occasionally amide groups. The presence of acetyl groups prevents gel formation with calcium ions but provides the pectin with emulsion stabilizing properties (B.R.Sharma., 2006). Following FAO regulation, pectin must contain at least 65% galacturonic acid. It was commonly found in the cell walls and middle lamella of plants. The degree of esterification (DE) is one of the properties influencing pectin application as it determines the gelling nature of pectin. The DE percentage above 50% is classified as high methyl ester (HM) pectin while those less than 50% is known as low methyl ester (LM) pectin

Pectin with DM > 50% forms gels in the presence of high sugar concentration, usually sucrose or fructose and low pH; whereas pectin with DM < 50% forms gels in the presence of divalent ions.

Pectin extracted from banana skin could find application as a gelling agent. It's use in food industry as a gelling agent for example by producing jellies, jam, marmalades, confectionary jelly products, and other food applications. The larges used of pectin is in the manufacture of jellies. About 85% of the commercial pectin in the world is used to make jelly and similar products. Pectins are widely used in the food science, nutrition, cosmetics and pharmaceutical (BeMiller, 1986). The yield and DE of a pectin source need to be determined prior mass production of pectin. An extraction process is the most important operation to obtain pectin from banana peel. Pectin extraction is a multiple-stage physical-chemical process in which hydrolysis and extraction of pectin macromolecules from plant tissue and their solubilisation take place under the influence of different factors, mainly temperature, pH and time.

The yield and quality of pectin depends mostly upon the source as well as the method employed for extraction of pectin (Rehman *et al.*, 2004). In the present study, unripe banana peel waste was utilized as the source of pectin. It aimed to optimize the conventional extraction method in terms of extraction time, and to chemically characterize the extracted pectin.

Membrane Distillation Review and Flux prediction in Direct contact Membrane distillation Process

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Abstract - Membrane distillation (MD) is a process which utilizes differences in vapour pressure to pass water through a porous hydrophobic membrane and rejects other non-volatile constituents present in the feed aqueous solution. The Driving force employed for MD process is vapour pressure difference, induced by the difference in temperature across the hydrophobic membrane.

This paper presents a review of MD and Flux prediction in direct contact membrane distillation (DCMD) process based on the published literatures till date and on preliminary analysis. The review covers the concepts such as membranes and modules design, configurations, Transport Mechanism, the terminology and fundamental concepts associated with MD, Commercially used membrane materials, MD membrane characterization, performance of MD process as well as an historical review of MD development, the heat and mass transfer phenomena, appropriate membrane properties, and applications of MD in different areas, and fouling in Membrane distillation.

There are four basic models for diffusion in MD; Knudsen number gives guidelines for identification of type of the model which can be the basis for further modelling. The DCMD theoretical mathematical modeling for a flat sheet membrane module is developed from the fundamental equation of mass and heat transfer. The Prediction of permeate flux can be done by using this model with the help of developed MATLAB codes and its results can be further compared with experimental process results.

Keywords: Membrane distillation (MD), direct contact Membrane distillation (DCMD), Heat & mass Transfer, Module configurations, Permeate flux, MATLAB.

1. INTRODUCTION

Membrane distillation (MD) is a thermally driven, membrane separation process [1-2], in which only volatile vapour molecules are transported through porous

hydrophobic membranes. The liquid feed to be treated by MD is kept in direct contact with one side of the membrane and doesn't penetrate inside the pores of the membranes because hydrophobic nature of the membrane prevents liquid from entering its pores due to the surface tension forces. The driving force for the MD processes is quite different unlike other membrane processes, having the vapour pressure difference across the membrane rather than an applied absolute pressure difference, a concentration gradient or an electrical potential gradient, which drives mass transfer through a membrane [1, 3]. The benefits of MD compared to other popular conventional separation processes are:

- 1) 100% rejection of ions, macromolecules, colloids, cells, and other non-volatile components.
- 2) Lower operating temperature than conventional distillation processes.
- 3) Lower operating pressure than conventional pressure-driven membrane separation processes.
- 4) Reduced chemical interaction between membrane and process solutions.
- 5) Less demanding membrane mechanical property requirements as it operating on lower operating conditions
- 6) Low vapour spaces compared to conventional distillation processes.

MD has also several limitations which must be overcome in order to this process become commercially successful for being a viable separation technology that includes:

- 1) Relatively lower permeate flux compared to other established pressure driven separation techniques.
- 2) Permeate flux decay with time due to concentration and temperature polarization effects, membrane fouling and total or partial pore wetting.
- 3) Desired Membrane availability and synthesis and difficulty in module design for MD.
- 4) Uncertain energy and economic costs for each MD configuration and its application.

Radicals-Catalyzed Oxidation Reactions for Degradation of Benzoic Acid

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Abstract

The presence of organic acids in aqueous waste continues to be an important environmental concern because of the odor and toxicity they impart to water. The photochemical degradation of benzoic acids (BA) which is among environmental priority pollutants, is studied in the present investigation by means of the Advanced Oxidation Processes (AOPs) namely by combinations of different oxidants and UV irradiation (UV/H₂O₂, UV/TiO₂, UV/ZnO and Fe(III)-oxalate complex). The photo-oxidative degradation was followed by studying their concentration decay over time period of exposure to UV-Oxidant combination. These observations figured out that the formation of Fe (III)-ligand complexes allows the system to more efficiently exploit the solar radiation. Thus, this paper aims at the examination of the optimum parameters which affect the photocatalytic degradation of benzoic acid.

Keywords: *Advanced oxidation process; UV/H₂O₂; benzoic acids; Hydroxyl radicals*

**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH
TECHNOLOGY****COMPARATIVE STUDY OF EXTRACTION & CHARACTERIZATION OF
LIGNIN FROM WET AND DRY COCONUT HUSK****S.L. Pandharipande *¹, Mayank Gujrati², Nidhi Mulkutkar³, Shruti Pandey⁴***Associate Professor Chemical Engineering Department, Laxminarayan Institute Of Technology,
India

DOI: 10.5281/zenodo.1228694

ABSTRACT

Recently lignin has been the object of a renewed interest because of the need to use raw materials from renewable resources. One such resource is coconut husk, a material usually discarded during the copra extraction process. Due to its high lignin content, coconut husk can be pursued as having a variety of applications. Therefore, it is important to know the approximate structure of coconut husk lignin and those variations introduced by different isolation methods. This work reports extraction and a general characterization of dry coconut husk and wet coconut husk lignin through FTIR. Results of percent yield of lignin obtained from different isolation processes are also discussed.

KEYWORDS: Lignin, Dry coconut husk, Wet coconut husk, Isolation.**I. INTRODUCTION**

The world commands a renewable and sustainable material that can substitute the present synthetic products which are generally obtained from non renewable sources and lignin is one among such a materials. It is considered to be one of the most encouraging future organic compounds as it is not only renewable but also comprises nearly one third of the material found in any plant. Lignin being purely natural can be obtained from agricultural and agro based industrial products or by products at economical prices. Given the abundant supply, excellent physical and chemical properties & potential to substitute petrochemical sourced products, research work is being conducted for converting these into industrial applications.[1]

Lignin is the second most abundant natural polymer next to cellulose. Its complex structure helps it to function like adhesive that binds cellulose and hemicelluloses. It is formed by photosynthesis and makes up to 15-25% of substance of every wood/plant. Lignin is a complex phenolic polymer which is important for mechanical support, water transport, defence in vascular plants. Compressive strength and hydro-phobisity of xylem cell wall is due to lignin polymer. The complexity and insolubility of the lignin polymer makes it resistant to degradation by most microorganisms. Therefore lignin serves an important function in plant defense. Variation in structure, content and location is likely to affect these essential processes. It is a complex hydrophobic network of phenylpropanoid units, which contain p-hydroxy phenyl, guaicacylandsyringyllignin as shown in Fig. 1.[2]

Synthesis and Characterization of Chitosan from Fish Scales

Shekhar Pandharipande¹, Riya Jana², Akshata Ramteke³

Abstract— Chitin is the most important natural polysaccharide found in shells of crab, prawn & other crustaceans after cellulose. However, it is not widely utilized for industrial application till now because it is insoluble in many solvents, relatively difficult to isolate from natural sources in pristine form and to prepare in a reproducible way under good economic condition. It's additionally arduous to characterize this polysaccharide. Chitosan has a number of commercial and possible biomedical uses. It is made by treating the chitin shells of shrimp and other crustaceans with an alkaline substance, like sodium hydroxide. The present study was undertaken to extract chitin & synthesize chitosan by chemical method. Chitosan is synthesized from waste fish scales by a sequence of chemical processes involving demineralization, deproteinization and deacetylation. Treatments with acid and alkali are carried out for better output & the analysis is done by FTIR of the product.

Index Terms—Chitin, chitosan, fish scales, demineralization, deproteinization and deacetylation.

1) INTRODUCTION

The last decade has seen tremendous growth in the biomedical applications of naturally occurring biopolymers. This has resulted in evoking a lot of interest amongst scientists & researchers in pursuing these biopolymers in exploring the potential further. Chitin & chitosan come under such a category. Chitin can be said to be one of the most abundantly naturally available biopolymer which is comprised of N-acetyl D glucosamine & derivative of glucose. Chitosan is obtained by removing number of acetyl groups from chitin. The chemical structure is given in figure 1. The common source of chitin is from shells of crustaceans such as prawns, crabs, fish scales etc.

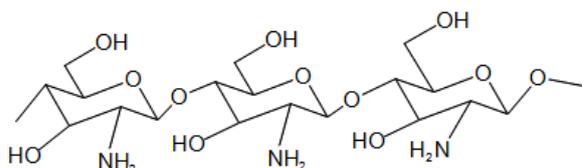


Figure 1. Chemical structure Chitosan

1) LITERATURE REVIEW

Tanvir Muslim et. al. extracted chitin from the fish scales of *Labeo rohita* and chitosan was successfully prepared from it by deacetylation reaction. The prepared chitosan was characterized by FT-IR spectral analysis and degree of deacetylation was determined by pH-metric titration. The molecular weight of chitosan was estimated by viscometric method. Chitosan was converted into its carboxymethyl derivative using alkali and monochloroacetic acid. [1]

Suneeta Kumari and Pradip Kumar Rath extracted and characterized Chitin and chitosan from fish scales of *Labeo rohita* using chemical method involving following steps:

1. Demineralization (calcium carbonate and calcium phosphate separation)
2. Deproteinization (Protein separation), decolorization (removal of pigments)
3. Deacetylation (remove of acetyl groups).

These three steps are the standard procedure for Chitin production. The waste shells of fish were used as raw material in the experiment and analysis is done by FTIR, XRD and SEM. [2]

Sumathi, Vignesh and Madhusudhanan extracted Chitosan from fish scales by chemical process including demineralization, deproteinization and deacetylation. The extracted chitosan was characterized using FTIR analysis. The anti-oxidant assay was studied using DPPH scavenging assay. The chitosan extracted from fish showed higher anti-oxidant activity. The anti-microbial assay was carried out by agar well diffusion method against microorganisms such as *E.coli*, *K.pneumoniae*, *P.aeruginosa*, *A.niger* and *A.terreus*. The chitosan extracted had also been studied for its effect on seed coating. The seeds treated with fish chitosan were found to be effective on seed germination. [3]

Javed Iqbal et. al, extracted Chitosan flakes from prawns and *labeo rohita* scales, with high adsorption capacity and were used to remove acid yellow dye from water. The results showed that adsorption capacity is dependent on pH, initial concentration of dye, surface area and pore volume of the adsorbent. They found in acidic conditions, the polymer amino groups were protonated (positively charged polymer chain), which showed attraction with negative ions

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Novel Use of Wheat Grass Extract in Enzymatic Deinking of Printed Paper

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ABSTRACT:Wheat grass is an excellent source of enzymes such as amylase, esterases, lipase etc. Use of enzymes for deinking is emerging over the chemical deinking techniques considering the drawbacks of latter such as high environmental impact and costs. The present work examines chemical and enzymatic deinking procedures for Mixed Office Waste (MOW) and newspaper samples. The novel feature of the present study is use of wheat grass extract for acquiring the required enzyme while the chemical deinking process uses conventional method for deinking. The effectiveness of the process depends upon the retention time for enzymes during the enzymatic hydrolysis and the extent of use of bleaching chemicals for chemical deinking. The choice of the enzyme also depends upon the quality and the grade of the paper used. Extent of deinking is estimated by analysing the optical properties of hand sheet paper made. The results are encouraging and show a good potential in use of wheat grass extract in enzymatic deinking over the conventional chemical deinking method.

KEYWORDS:MOW (Mixed Office Waste), ONP (Old Newspaper), Deinking Optical Analysis, Deinking, Wheat grass extract.

I. INTRODUCTION

Paper is an important material and inseparable part of human life, used for various purposes worldwide. The global production of paper was 407 million metric tons through a survey conducted in 2014. More than half of the paper produces goes for packaging and one third is attributed to the graphic paper. The world's largest producer and consumer is United States of America. U.S Forest, paper and packaging generates a revenue of 96.1 billion dollars. The per capita consumption in India accounts to 11 kg. This ever increase in demand of paper has increased the stress of reusing the wastepaper by recycling it.

For the purpose of recycling the waste paper chemical deinking process is widely used on a large scale The chemical deinking method were very effective in the past, but this has started to change as the use of inkjet printing on industrial levels. The efficiency of separation of ink depends upon the ink properties. The dyes, letter press inks and oil-based inks are easily removed. This is due to the fact that the ink particles are larger (50-200 microns) and hence they agglomerate effectively on the bubble during the washing or the floatation step and can be removed easily [1]. Non-impact printed paper are the most difficult to remove because of the thermoplastic and the synthetic polymers present in the laser and photocopy toner. Also the size of the ink particles in the offset prints are very small (5-20 microns) which makes it difficult to collect over the air bubble and hence not removed completely [2]. Generally the deinking industry for paper recycle deals with two main goals :- (i) Detachment of the ink particle from the paper. (ii) Removal and separation of the dispersed ink from the pulp solution.

The traditional chemical deinking method involves use of large amount of chemicals which makes it expensive and also has more damaging impacts on the environment [1]. On the contrary enzymatic deinking procedure dislodges the ink from the fibre without any discharge of pollutants Use of enzymatic deinking produces minimum treatment effluent and has comparatively less COD as compared with chemical deinking process [4]. Apart from the ink removal, enzymatic deinking may improve the strength of paper by removing fines content and improving the interfibrillar

An integrated approach to process modeling, kinetics and its parameters on osmotic dehydration of fruits and vegetables

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Abstract

Fruits and vegetables are the highly perishable commodity thus their preservation is the most important challenge to the food industry. To preserve them various processes are carried out but this process produces lots of losses (colour, flavour, nutritional and many more). Osmotic dehydration is one of them which are used to preserve the fruits and vegetables. This process is most beneficial for the preservation of fruits and vegetables because it produces very minimum losses as compared to other processes. This process is also economical in point of view to energy consumption, less equipment's required and it carried out at very less temperature. In this review article osmotic dehydration of various fruits and vegetables is covered. It also includes detailed mechanism of osmotic dehydration, various osmoactive substances and their effect on the mass transfer, mass transfer kinetics of osmotic dehydration process and effect of various process parameters on the osmotic dehydration on various fruits and vegetables.

Keywords: Osmosis, Osmotic dehydration, preservation, fruits, vegetables, osmoactive substance.

1. Introduction

India's diverse climate is favorable for the production of the variety of fruits and vegetables. That's why India is considered as a basket of fruits and vegetables. It ranks second in the production of fruits and vegetable after China. Out of this huge production of fruits and vegetable, only 2% raw fruits and vegetables are converted into processed products. Thus India ranks fifth in the processing sector of fruits and vegetables in the world. This is due to lack of skilled manpower, poor storage facilities, poor storage facilities and poor post-harvested management.

Fruits are one of the most important constituents of the human diet. They provide lots of vitamin, minerals, antioxidants and other nutrients. But fruits and vegetables are highly perishable and unavailable throughout the year. Thus to provide them throughout the year and provide where they do not produce its preservation is most important. Lots of conventional methods are available for the preservation of fruits and vegetable; drying is one of them (sun drying, air drying, vacuum drying etc.). But these methods provide lots of drawbacks like longer time, poor quality products, textural losses, colour and flavour losses etc. In order to decrease these undesirable losses there is need of modification in the conventional drying process. Osmotic dehydration is one of the pretreatment for the drying of fruits and vegetables because, it reduces drying time, less damage to the colour, flavour, texture, shrinkage and nutritional quality of the finish products.

Osmotic dehydration is the process by which transfer of solvent molecule from lower concentration to higher concentration through the semipermeable membrane. The drying force of osmotic dehydration process is countercurrent flow between fruit and osmotic solution. In osmotic dehydration there are three ways of mass transfer, first water removal from the food commodity, second solvent molecule transfer from solution into food commodity and last one is leaching of organic solids, minerals, and vitamins etc. from the food commodity (Gordana Koprivica et al., 2010). Osmotic dehydration reduces moisture content up to 30-50% (Josephine Selvi. N. et al., 2014). This process mainly used to obtain several products such as murambas (commonly home-made product in India), berry, and apple, candies of fruits and vegetables and pickles.

Osmoactive substance is the most important



ARTICLE

Structural, Thermal and Photo physical investigation of novel pbi-Cl blue light emitting phosphor for OLEDs

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Abstract: We have designed and synthesized a new blue light emitting organic phosphor 2-(4-Chlorophenyl)-1-phenyl-1H-benzimidazole (pbi-Cl) by Suzuki Coupling reaction at 135°C. The structural properties of given organic phosphor has been studied by X-ray diffraction, Fourier transform infrared spectroscopy and scanning electron microscopy. XRD graph demonstrates sharp peaks with maximum relative intensity observed at $2\theta = 23.501^\circ$ having inter planar distance $d = 3.7824 \text{ \AA}$. FTIR spectrum confirms the structural formation of the synthesized organic phosphor. TGA curve reveals its thermal stability to about 262°C proving its potential even at elevated temperatures, while DTA curve depicts its melting temperature at about 135°C and glass transition temperature is at 319°C. The photo physical properties were studied by using UV-Vis optical absorption spectra and photoluminescence spectra. The solvated pbi-Cl organic phosphor shows absorption peaks at 265 nm, 316 and 361 nm in acetic acid, 263 nm, 319 and 366 nm in chloroform. These results were used in calculating the energy band gap and the same were found to be 2.30 and 2.35 eV in acetic acid and chloroform, respectively. Stokes shift of about 7315 cm^{-1} and 7017 cm^{-1} was observed when the complex is solvated in acetic acid and chloroform, respectively. Under excitation wavelength of 342 nm, pbi-Cl emits light in blue region, peaking at 390 nm in solid state with CIE co-ordinates ($C_x=0.172$, $C_y=0.008$). These results reflect the potential of pbi-Cl as blue emissive material for organic light emitting diodes (OLED) devices, displays and solid state lighting.

Keywords: Sm(TTA)₃dpphen, β-diketonate, Photoluminescence, OLEDs, Solid State lighting.

Keywords: 2-(4-Chlorophenyl)-1-phenyl-1H-benzimidazole, Suzuki Coupling reaction, OLEDs

Introduction

Due to the phenomenal excellence such as low power consumption, wide viewing angle and high luminescence efficiency, the OLEDs have received major interest in flat-panel displays and solid state lighting (SSL) sources [1-6]. More and more interest in the field of optoelectronics is attracted towards synthesis of materials based on heavy metals (Ir(III), Pt(II), Os(II), Re(I)), which are used as phosphorescent dopants in OLEDs [7-15]. Among them, Iridium (III) [Ir(III)] complexes have been extensively studied owing to their relatively short phosphorescent lifetime, elevated phosphorescent efficiency, easy-tuning emission, thermal stability, and environmental inertness [16]. Photo physical properties of Ir(III) complexes are strongly governed by the nature of cyclometallated ligand [17-19]. Benzimidazole-type cyclometallated ligand is also very

important component to prepare highly efficient Ir(III) complexes in OLEDs due to their good electron mobility, excellent thermal stability and flexible modification ability. The present work deals with the synthesis of novel blue light emitting 2-(4-Chlorophenyl)-1-phenyl-1H-benzimidazole (pbi-Cl) organic phosphor followed by the study of its structural, thermal and optical properties.

2. Experimental

2.1 Materials

The reagents used in the present study includes: N-Phenyl-o-phenylenediamine [$C_6H_5NHC_6H_4NH_2$], 4-Chlorobenzaldehyde [ClC_6H_4CHO], 2-methoxyethanol [$C_3H_8O_2$] and dichloromethane [CH_2Cl_2], purchased from Aldrich chemicals.



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Analysis on structural, thermal and optical properties of Sm(TTA)₃dpphen hybrid organic complex for OLEDs and solid state lighting applications

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Abstract: We propose the synthesis of orange-red light emitting Sm(TTA)₃dpphen (Sm-Samarium, TTA-ThenyolTrifluoroacetone, dpphen- 4,7-diphenyl1,10-phenanthroline) hybrid organic complex at pH 7 by precipitation method. Structural, thermal and optical properties of the synthesized hybrid complex were characterized by X-ray diffraction (XRD), Fourier Transform Infrared (FT-IR) spectra, Thermo gravimetric analysis/Differential thermal analysis (TGA/DTA), UV-Visible absorption spectra and Photoluminescence spectra (PL), respectively. XRD spectra displayed many strong, sharp diffraction peaks inferring the crystalline nature of complex. The molecular bonding, packing arrangement and structure formation of the complex was explored by the FTIR spectra. TGA curve infers that the complex maintains its properties unchanged till around 250°C and significant loss in weight was observed thereafter. DTA curve shows good thermal stability with combination of endothermic and exothermic peaks. Two endothermic peaks at 333°C and 373°C corresponding to the distortion of water from the complex and evaporation of residual moisture respectively were observed. Exothermic peak at 420.67°C indicates the decomposition of the residual organic complex. To explore the spectroscopic properties of the synthesized complex, UV-Visible absorption spectra were carried out in different basic and acidic media. When the complex was excited under a wavelength range of 250 to 700 nm, a broad band with a prominent peak with maximum intensity at 379 nm has been observed in the excitation spectra, while emission peak registered at 566 nm, which falls in the orange-red region of visible spectrum of electromagnetic radiation. The emission wavelength corresponds to the chromaticity coordinates (0.387, 0.368) on CIE diagram, proving it's prospective as red light emitting phosphor for fabricating red organic light emitting diodes (OLEDs)

Keywords: Sm(TTA)₃dpphen, β-diketonate, Photoluminescence, OLEDs, Solid State lighting.

1. Introduction

The most noteworthy advance in the field of electronics and technology is the development of OLEDs and flat panel display on flexible substrates [1]. Passionate research has been carried on the use of organic materials for such electroluminescent devices as well as the next generation solid state lighting devices solely due to their energy saving traits [2]. Pioneer work of C. W. Tang [3] in this field demonstrated that the organic materials have numerous advantages like easy synthesis, elevated quantum efficiency, quick response, elevated contrast and lighter weight. In this regard lanthanide complexes, especially europium and samarium have long been recognized as bright red light emitters under UV radiation because of effective energy

transfer from ligands to central ions called antenna effect [4, 5]. These lanthanide trivalent cations exhibit well defined emission properties such as long lifetime, large Stokes shift and sharp band emission. As a result, more and more complexes of this kind have been synthesized and deliberated intensively. In congruence, we synthesized hybrid organic complex Sm(TTA)₃dpphen by solution technique at constant pH and investigated its structural, thermal and optical properties.

2. Experimental

All the chemicals used in the synthesis procedure are of analytical reagents (AR) grade, procured from Sigma Aldrich.

A Kinetic study on Malenised Castor Oil (*Ricinus Communis*)

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Abstract

Malenised oils are polymer synthesized from monomer such as oil obtained from edible or non – edible seeds and maleic anhydride. Malenisation of castor oil with maleic anhydride was investigated. Heating schedule was maintained properly and constant stirring was also provided which gave a homogenized polymer. Batch of Malenisation was carried out in absence of catalyst. The reaction mechanism and reaction kinetics are estimated for castor oil – maleic anhydride. The reaction was carried out with weight percent ratio of 95:5 castor oil : maleic anhydride at 230⁰C for 300 minutes with conversion of 82.48% and yield of 95.88%.

Keywords : castor oil , Malenisation , reaction mechanism , kinetics ,yield , conversion

1.BROAD INITIATIVES

Our understanding of the harmful effects of petroleum –based products has progressed enormously. Yet our global market is largely saturated with products from non-renewable sources. To reduce our dependence on petroleum, there is an urgent need to invest research efforts in improving the product range and economic viability of products obtained from renewable resources to foster greater production and consumer use. New cost effective technologies are needed to produce higher quality value –added chemicals from fats and oil.

Research activity throughout world is concentrated to produce eco friendly product from biodegradable polymer. Sustainable and eco friendly product has to be synthesized so that it is biodegradable in the nature so as to reduce environmental issues. Its availability for future generation

A KINETIC STUDY ON MALENISATION OF SOYBEAN OIL

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ABSTRACT

Malenisation of soybean oil with maleic anhydride was investigated. The effect of variations in weight percent ratio of reactants on rate of reaction has been studied.

Sodium bisulphate and sodium bisulphite are used as catalyst for the malenisation of soybean oil. The reaction kinetics is estimated for soybean oil – maleic anhydride ranging from 75:25 to 90:10. The optimum conditions are found to be 85:15 soybean oil:maleic anhydride weight percent ratio and 2 % catalyst at 230°C for 330 minutes with conversion of 82.48% and yield of 95%.

KEYWORDS: malenisation, catalyst, kinetics, conversion, yield.

INTRODUCTION:

Modification of vegetable oil in the recent years has gained a lot of momentum because of its known modified¹ properties. Polymer based on vegetable oils dates to as early 20th century². Research activity throughout world is concentrated to produce eco friendly product from biodegradable polymer. Sustainable and eco friendly product has to be synthesized so that it is biodegradable in the nature. Its availability for future generation should be there. With synthesis of these polymers is believed to replace the raw material obtained from petroleum origin of crude oil. Literature reports various works on the synthesis of novel chain polymer based on sorbitol, phthalic anhydride, maleic anhydride and benzoic acid which was used into formulation of liquid and powder detergent³.

A number of methods have been proposed for improving the properties of vegetable oil. The methods most generally used are segregation, reaction with unsaturated compounds, mono and diglycerides of fatty acids⁴. The unsaturated compounds used are those which react with double bonds present in fatty acids chains of oils.

Among various stated processes of modification, malenisation reaction of oil is considered in this study. The reaction process to be scaled up needs process engineering. The chemical kinetics for malenisation process has been studied here. The details of kinetics aspect are discussed in this research work.

A reaction mechanism consisting of an initial mass transfer controlled region followed by a kinetically controlled region is proposed. The experimental data for the latter region (kinetically controlled region) proposed during mechanism appear to be a good fit into a second order kinetic model. The data presented was analyzed by ANNOVA to evaluate the level of statistical significance.

Soybean oil and maleic anhydride are the main reactants used for malenisation process to obtain malenised oil. The variables affecting the malenisation process have been investigated as widening industrial uses. Molar ratio of vegetable oil to maleic anhydride, type of catalyst, temperature and viscosity of the product and acid value has been studied.

EXPERIMENTAL SECTION

MATERIALS

Soybean oil and maleic anhydride was procured from the local industry. All chemicals used in experimentation such as bisulphate and bisulphite both (98%) pure were of laboratory grade and were procured from Merck Chemicals and used such.

Also benzene, isopropyl alcohol few such organic solvents were also used during experimentation and calculation of few terms.

Tunable Light Emission from P-Acetylbiphenyl-Cl-DPQ Organic Phosphor: For Blue and Near UV-OLED Applications

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Abstract. A novel 2-([1, 1'-biphenyl]-4-yl)-6-chloro-4-phenylquinoline (P-Acetylbiphenyl-Cl-DPQ) phosphor was synthesized by Friedlander condensation reaction at 140°C. To check its suitability for fabricating near UV – organic light emitting diodes (UV-OLEDs) by vacuum vapor deposition, the synthesized organic phosphor is assessed by various characterization techniques such as Fourier Transform Infrared (FTIR) spectroscopy, H-NMR, C-NMR, Thermo gravimetric/ Differential Thermal Analysis (TGA/DTA), optical absorption spectra and photoluminescence (PL) spectra in solid state. The synthesized phosphor is molecularly doped in Polystyrene matrix different wt% to explore its compatibility with polymers. FTIR and NMR confirm the structural formation of the desired complex. TGA and DTA reveal appreciable thermal stability and melting point. Absorption spectra were employed to study optical transitions in the synthesized phosphor at 10⁻³ M concentration in various organic solvents. The energy band gap of the synthesized organic phosphor was found to be 3.37, 3.40, 3.02, and 3.03 eV in chloroform, dichloromethane, acetic acid and formic acid, respectively. PL spectra of the phosphor in solid state, various organic solvents and in polystyrene reveal emission in the range of 383-495 nm, under excitation wavelength ranging between 360-419 nm. Stokes shift of about 63-66 nm was observed. CIE coordinates reflect that the synthesized organic phosphor can be used as a tunable emissive material in the range of blue to near UV emission in the fabrication of blue and near UV -OLEDs.

Keywords: Friedlander condensation reaction, Vacuum vapor deposition, solution techniques, near UV-LEDs, Solid state lighting.

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1 Introduction

In this era of world-wide expansion of opto-electronics, UV and near-UV emitters play a vital role. There are hardly few emitters with exceptional properties that demonstrate to be good UV-emitters.¹⁻⁴ Researchers are intriguing enormous efforts to expand organic materials that emit visible light.⁵⁻¹¹ Tremendous significance has been focused towards the organic systems that emit light in the broad range, from deep-blue to violet/ ultra violet region. As an ultimate output of research investigations, Ultraviolet (UV) to deep blue OLEDs were found have versatile applications in chemical and biological sensors displays.¹²⁻¹⁶ It is well known fact that shorter wavelength emission leads to lower device efficiencies but in recent times, there had been numerous reports¹⁷⁻²² of high efficiency blue-to-violet OLEDs which emit light in-between 400-480 nm with external quantum efficiency values up to 3% to 6%.²³⁻²⁶ UV OLEDs have relatively broad emission peaks, with emission tail extending to the longer wavelength ranging between 450-550 nm. There also exists some blue-violet-UV OLEDs in the prior state of art,



CHANGES IN SMOKING TEMPERATURE OF OIL SUBJECTED TO REPEATED HEATING

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ABSTRACT

Deep fat frying is one of the oldest methods of food preparation. The turnover rate of oil, frying time and temperature affect the deterioration of oil during deep fat frying. The present study evaluated the changes in smoking temperature of four commonly used oils viz: Groundnut oil (GNO), Sunflower oil (SFO), Soybean oil (SBO) and Rice Bran oil (RBO), heated freshly and repeatedly reheated to fry potato chips. The initial smoking temperature of SFO was highest (242° C) and GNO the lowest (210°C). A progressive fall in smoke point was observed in all oils with increase in frying trials up to 11th trial of frying. Replenishing with fresh oil at the 12th trial reflected a slight increase in smoke point of all oils. A highly significant difference (p=0.00) between the changes in smoking temperatures of oils subjected to repeated heating in frying potato chips was observed. Paired sample analysis showed insignificant changes in smoke point of oils until third frying (p=.061) indicating the suitability of all oils until temperatures attained at third frying (198°C, 238°,238°,212° of GNO, SFO, SBO, RBO respectively). The smoke point is therefore an important characteristic for restaurants and housewives in deciding when to change the frying oil.

Keywords: Smoke point, Reheating, Replenishing, Deterioration.

INTRODUCTION

Frying is an old and traditional means to prepare food quickly and enjoy the preparation for culinary delight. Deep-fat frying seals the food by immersing it in the hot oil so that all flavors and the juices are retained by the crisp crust .During the frying process,

the physical, chemical and sensory characteristics of foods are modified, despite, texture, color and oil content being the main quality parameters of fried foods (Amany et al .2009).

The use of good quality frying medium becomes obvious when one considers that some of



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Synthesis and Characterization of a Novel Conducting Biopolymer Chitosan Grafted Polyaniline-Polypyrrole Flexible Copolymer



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Keywords: iopolymer chitosan; Polyaniline-Polypyrrole copolymer; grafting; electrical conductivity.

ABSTRACT

Conducting polymers like Polyaniline and Polypyrrole have been of interest as they combine the benefits of lightweight and low cost along with good electrical conductivity. However, the need for a more flexible and compatible matrix has led to the popularity of a bio-polysaccharide, Chitosan. In the present work, the copolymerization of conducting polymers; polyaniline and polypyrrole have been done along with subsequent grafting onto chitosan biopolymer to study the effect of alterations in molecular structures of polymer chains. The synthesis of the copolymer was carried out by chemical oxidative copolymerization. A 1:1 mixture of Aniline and Pyrrole monomers were used to prepare a polyaniline-polypyrrole copolymer (PAni-co-PPy). This was followed by its grafting onto chitosan to obtain a black powder of polyaniline-polypyrrole copolymer grafted with chitosan [Chit-g-(PAni-co-PPy)]. The Fourier Transform Infrared Spectroscopy (FTIR) spectroscopy and X-ray Diffraction (XRD) analysis confirmed the formation of a novel polymer with an altered structure. This fact was supported by the thermal studies, which also supports the formation of a compound with improved thermal stability. The addition of chitosan to PAni-co-PPy has been observed to retain the conductivity of these polymers which was found to be approximately 0.4 S cm^{-1} at 330K.



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Determination of physical, chemical and sensory characteristics of instant curry mix for vegetarian recipes

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Abstract

Spices mix is a new type of convenience food. The objective of this study is to standardize recipe of spices mix without addition of class II preservatives, thus producing ready to eat or instant curry mix. Also analyzing chemical, physical attributes and sensory evaluation of prepared sample were part of it. Study of rheological properties and changes during storage with respect to some parameters was also carried out. Firstly the spice mix formulation was standardized including ginger garlic paste (1.6:1) and paste of selective spices. The spices were oil roasted before preparing paste and later ginger- garlic paste and spices paste (1:6) were partially cooked and mixed (70-80°C) and allowed to cool to room temperature before packing. The spice mixes were then enriched with additives like Makhana flour (5%), corn flour (5%) and edible gum (0.5%). All this four samples were tested and compared with respect to physical, chemical and rheological properties. Also storage observation of fifteen days and sensory evaluation were carried out and compared. The sample having Makhana flour as additive showed satisfactory results comparatively hence could be selected as better among all other.

Keywords: curry mix, rheological properties, physico chemical analysis, sensory evaluation

1. Introduction

Indian cuisines are a vast array of spicy delicacies. Every food product acquires its final profile principally from two components, namely, ingredients and processing methods. Traditional Indian delicacies require processing of varieties of spices including one or more of unit operations such as roasting, frying, powdering, etc. in order to obtain an appropriate flavour profile from spices. These flavour profiles are caused by thermal effects and interactive effects due to processing of spices [1]. A kitchen preparation is prone to variations due to regional and ethnic practices and to subjective factors such as the skill and style of the chef. The 'recipe product in a commercial sense, should possess certain attributes such as a well-defined product profile, a scheduled manufacturing procedure, uniform quality and specified shelf-life, all of which are essential for organized trade [2]. Thus, there is a need for a pre-processed ready-to-use and shelf-stable spice mix formulation for the preparation of varieties of plant-based and muscle-based food products in order to minimize the drudgery of processing in kitchen and food preparation time to cater to the needs of increasing population of working couples, single persons living, etc. The curry paste usually consists of green chilli, galangal rhizome, shallot, cumin, lemon grass, kaffir lime, garlic and black pepper. The spices/ingredients used in the curry paste may differ from home to home or region to region. Many ingredients used in the curry paste have been found to contain antimicrobial, antioxidant, and have medicinal value. Garlic, one of the ingredients, is reported to possess allicin, a highly reactive volatile compound, which is unstable in the presence of heat. It has antimicrobial and antioxidant compounds with health

benefits [17-19].

Spices mix is a new type of convenience food. Spices mix has been used in cooking for vegetarian and non-vegetarian recipes [3]. They are prepared domestically in Indian families also they are manufactured commercially. The commercial demand of these ready mix spices has increased significantly throughout the years as need of urban or faster life style. Use of such products avoids collection and preparation for individual items. *Pulihora* mix is a popular South Indian household item is cumbersome, lengthy and time consuming. The instant pulihora mix made by dehydrated raw green mango powder was a convenient ready mix [6]. Pickles and chutneys are another popular adjuncts with snack foods and breakfast foods such as poha, pakoda, upama, idali doas. Several standard blends of chutney powders are based on tamarind leaf, curry leaf, pudina and hibiscus species, raw tamarind leaf and raw mango were reported in literature [7, 8]. These products are versatile and can be used in households or institutional feeding.

Growing population, changing lifestyles and increased consumerism have increased the consumption of such products over the last few years. With growing demand for it, there is a good scope for a spices mix. Apart from individual households, other customers for the product include caterers, restaurants, etc. Attractive packaging and catering to the local taste are important factors to boost the sales of the product.

Keeping the above facts in view the main of the work was to standardization of recipe of spices mix, to determine the effect of processing on pH, and additives on physicochemical characteristics of instant curry mix to produce acceptable, shelf stable product that can retain the delicate spice odour of

Strategy for the Separation of Azeotropic Mixture by Pressure Swing Distillation

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Abstract

Pressure swing distillation (PSD) is a technique coming forward as a strong alternative to the conventional separation methods for separating azeotropes. The conventional pressure swing distillation involves two columns operated at two different pressures. This work puts forward a new three column pressure swing distillation strategy for the separation of azeotropic Isobutyl Alcohol (IBA) - Isobutyl Acetate (IBAc) mixture. Two of the columns are operated at atmospheric pressure while third at a lower pressure. CHEMCAD (version 6.5) software is used to perform the simulations to get the optimized configuration which gives minimum energy requirements. The proposed process comes out to be more energy efficient when compared to the conventional two column techniques.

Keywords: *Pressure swing distillation; Isobutyl alcohol; Isobutyl acetate; Simulation*

1. Introduction

Azeotropes are widely encountered mixtures in the chemical industry and their separation is process of great speculations. There are many techniques used for the separation of such mixtures. Pressure swing distillation (PSD) is one such process which is widely being considered as an alternative to other methods like extractive distillation (Berg and Yeh An, 1988, Doherty and Malone, 2001), reactive distillation (Maier et al, 2000) of late, membrane pervaporation (Fleming, 1992), adsorption (Garg and Ausikaitis, 1983). The Vapour-liquid equilibrium of a mixture is affected by changes in pressure (Seader and Henley, 1998). This fact makes the basis for pressure swing distillation where in the azeotropic point is jumped over by changes in pressure and the desired separation is achieved. The choice of suitable operating pressure can shift the azeotropic point considerably and a highly pure product can be obtained. In the conventional pressure swing distillation process two columns (Seader and Henley, 1998) are used which are operated at different pressures. A typical pressure swing distillation strategy with two columns for the separation of Isobutyl Alcohol (IBA) from Isobutyl acetate (IBAc) is shown in the Fig. 1.

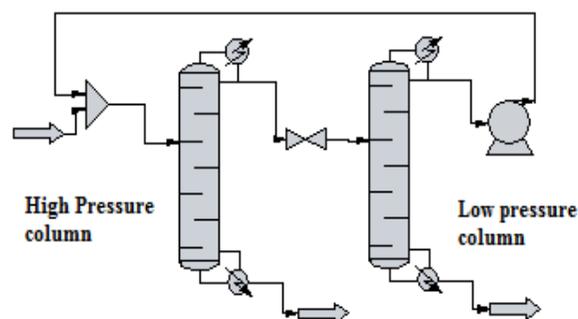


Figure 1. Conventional two column PSD process for separation for IBA-IBAc

IBAc is widely used as a solvent for coatings, inks, adhesives, industrial cleaners, degreasers etc. IBA-IBAc forms an azeotrope at 86 mol% of IBA. In the two columns technique first column is operated at atmospheric pressure while the second column is operated at lower pressure (Munoz et al, 2006). In this process IBAc comes out as the bottoms from the high pressure column (HPC) and IBA in the bottoms from the low pressure column (LPC). The distillation can continue in the LPC since the azeotropic point is jumped over and since the activity coefficients are crossed the higher volatile component (IBA) comes through the bottoms of the LPC. Many studies are reported in the literature for this scheme for different azeotropes (Frank 1997, Mulia-Soto and Flores-Tlacuahuac, 2011).

2. Choice of Operating Pressure

Choosing the operating pressures for the columns is an important step in the design of PSD scheme. A pressure is selected such that the azeotropic point is shifted sufficiently. The azeotropic composition of IBAc as a function of pressure is shown in Figure 2 for IBA-IBAc mixture.

BIOLUBRICANT BASE STOCK SYNTHESIS FROM NON-TRADITIONAL (MAHUA) OIL USING MODIFIED GLYCEROL

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ABSTRACT

With the increasing demand of mineral-oil based lubricants, they are burdened by environmental issues and depleting supplies. Constantly efforts are made by the technologists to reduce the use of fossil fuels for sustainable development. Due to this, the renewable sources of lubricants have gained significant importance in this environmental-concerned world. India is endowed with over 100 species of non-traditional oils that have not been focused for the commercial applications till the date. Though these oils are in abundance, their potential has not been utilized. Such oils with the high oleic acid content are considered to be the best alternative source to substitute the mineral oil based lubricating oils. In this paper mahua oil was selected as a raw material to produce biolubricant. It was initially transesterified to yield mahua methyl esters and further converted to biolubricant using trimethylolpropane (TMP). The biolubricant thus prepared was analyzed for its properties and was compared with a commercial 2T Engine oil. This chemically modified ester is relevant for performance as a lubricant in various industrial applications. In addition to this, an alternative to TMP in the form of modified glycerol was found and the properties of the biolubricants produced using TMP and modified glycerol were compared.

KEYWORDS: Non-traditional oil ; Transesterification ; Biodiesel ; Biolubricant ; TMP.

INTRODUCTION

The environmental threats posed by the fossil fuels are currently a major global concern. Major ecological problems the world is facing today is due to emission of green house gases mainly CO₂ and these emissions are closely related to the use of fossil fuels. It has been widely reported that not less than ten major oil fields from the 20 largest world oil producers are already experiencing decline in oil reserves. Depletion of the world's crude oil reserve coupled with the consumption rate, increase in petroleum prices and issues related to conservation has brought about renewed interest in the use of bio-based materials.

**ABSTRACT**

Polymers were used as insulators of electricity & considered as non conducting material. Polyaniline (PANI) is one of the most commonly studied organic conducting polymer having wide applications. Chitosan is one of the most abundantly used biomaterial, which is similar to cellulose having easy biodegradability. Chitosan has various applications in industries such as medicine, food, textiles etc. It has potential to be used as sensing element in chemical and biosensor. The objective of the present work is to synthesize polyaniline grafted chitosan film followed by its characterization using FTIR, SEM & Electrochemical potential difference studies. Five film samples CP1- CP5 of varying proportions of these two materials are prepared. From the interpretation of IR data it is clear that the grafted copolymer PANi-g-chit has characteristic peaks of PANi and chitosan, which could be a strong evidence of grafting. SEM images of samples CP1 to CP5 have clearly indicated grafting of polyaniline on the surface of chitosan, however the distribution may not be uniform and as homogenous at places. The Electrochemical potential difference of electrode made of polyaniline grafted chitosan is more than graphite powder coated electrode by magnitudes of 10 to 20 %. Hence it can be concluded that the present work has demonstrated successfully the development of composite film of polyaniline grafted chitosan with enhanced electrochemical properties. The work is demonstrative and more experimental runs are required to validate the claim further.

KEYWORDS: Polyaniline grafted Chitosan, NMP, Composite film, electrochemical potential difference

INTRODUCTION

For a long time, polymers were used as insulators of electricity and considered as non conducting material. Polyaniline (PANI) is one of the most commonly studied organic conducting polymer having wide applications, mainly in rechargeable batteries, corrosion protection of metals, biosensors, gas-separation membranes, electronic devices like printing circuit board etc. PANi also called as aniline black, exists in different forms based on its oxidation level, pernigraniline base is the fully oxidized, half-oxidized emeraldine base and fully reduced leucoemeraldine base of PANi. Emeraldine base form of PANi, is the most stable and conductive. It bears thermal, chemical and good environmental, electrical and optical properties. Chitosan is one of the most abundantly used biomaterial, which is similar to cellulose having easy biodegradability. Chitosan has various applications in industries such as medicine, food, textiles etc. It has potential to be used in chemical and biosensor. The present work aims at synthesis of polyaniline grafted chitosan followed by its characterization.

LITERATURE SURVEY

Tiwari and V. Singh have investigated mucopolysaccharide chitosan that was grafted with polyaniline through oxidative-radical copolymerization using ammonium persulfate in acidic medium. The grafting conditions were extensively studied by varying grafting parameters. All the findings have been discussed and proposed a plausible mechanism for the graft copolymerization. The representative chitosan-graft-polyaniline (Ch-g-PANI) was characterized using UV-vis, FTIR, TGA, X-ray diffraction and Scanning electron microscopy taking chitosan as reference. Ch-g-PANI exhibited electrical conductivity, which increases with the extent of grafting onto chitosan backbone. Its electrical conductivity is further influenced by pH and showed pH switching electrical conduction behavior when exposed to NN₃/HCl vapors. The application of conducting biomaterial such as PANi-g-Ch in the electronic devices especially for the fabrication of sensor devices would be attractive not only in terms of product cost and environmental safety but also from a material science point of view.

Synthesis and Characterization of Bio-composite Films using Chitosan, CMC, Starch & Essential oils

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ABSTRACT: The increase in number & variety of food products has drawn attention of manufacturers, government regulatory bodies & consumers towards food storage, packaging & safety of these products. Researchers are also channelizing their energy & efforts in development and testing of newer packaging materials such as bio-composite films having antimicrobial properties. Bio-materials like chitosan, carboxymethyl cellulose, starch, etc. are some of the potential materials having necessary properties that include biodegradability, biocompatibility, antimicrobial activity & non-toxicity. The present work aims at synthesis & characterization of thin films of bio-composites made from chitosan and starch or carboxymethyl cellulose as base materials blended with essential oils such as eucalyptus, lemongrass, etc. Besides food product preservation and packaging, there could be other possible applications of these bio-composite films in pharmaceutical industry.

KEYWORDS: Bio-composite films, chitosan, carboxymethyl cellulose, essential oils.

I.INTRODUCTION

Bio-composite is the material synthesized from two or more constituent bio materials having biological origin. These materials are combined to form a new material which often show the similar properties of the materials which are involved in the making process. The bio-materials used in the present work are chitosan, carboxymethyl cellulose, starch, essential oils like eucalyptus oil, lemongrass oil, oleoresin, etc.

Chitosan is a polymeric compound composed of acetylated unit and de-acetylated unit made by treating chitin shells obtained from shrimps and other crustaceans with alkaline substance like sodium hydroxide. Starch is a composition of a large number of glucose units. It is present in large amounts in the food grains like wheat & rice. The other important sources are corn & potatoes. Carboxymethyl cellulose (CMC) is the cellulose derivative containing carboxymethyl groups (-CH₂-COOH) and some hydroxyl groups. It is formed by alkali-catalyzed reaction of cellulose with chloroacetic acid. Eucalyptus oil is the concentrated hydrophobic liquid obtained from eucalyptus plant. Similarly lemongrass oil and oleoresins are obtained from lemongrass plant and chilies. Essential oils are added to further enhance antimicrobial properties.

IMPROVEMENT OF DIETARY FIBER CONTENT AND ANTIOXIDANT PROPERTIES IN CHAPATTI WITH THE INCORPORATION OF DPPP

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ABSTRACT:

Pomegranate (*Punica granatum*) peel is rich source of dietary fiber and bioactive compounds, hence, attempt was made to see the effect of dried pomegranate peel powder (DPPP) on the bioactive constituents and micro structural quality of chapatti. Chapatti dough prepared from 5, 7.5 and 10% DPPP was examined for dough stickiness, dough strength and dough hardness. With increased level of DPPP, dough stickiness increased due to increased water absorption capacity whereas dough strength and dough hardness decreased due to presence of large amounts of dietary fibre in DPPP. Chapatti incorporated with 10% DPPP showed DPPH radical scavenging activity up to 64.4% showing presence of active antioxidants. The microstructure of chapatti prepared from dough added with 10 % starch granules, fibrous structures and protein bodies were adhered to starch granules and protein matrix while in the control protein is seen either in association with starch granules or as clusters of storage protein. Chapatti's prepared from DPPP had softer chapatti.

KEYWORDS: Dried pomegranate peel powder (DPPP), Chapatti, Microstructure, antioxidant activity, Dough texture, SEM.

I. INTRODUCTION

Pomegranate (*Punica granatum* L.) is a small tree that is native to the Mediterranean region and has been used extensively in the folk medicine of many countries (Negi and Jayaprakasha 2003). There is a growing interest in this fruit because it is considered to be a functional product of great potential benefit in the human diet as it contains several groups of substances that are useful in disease risk reduction and is of significant economic importance because the fruits are either consumed fresh or used commercially in the juice industries. Once the pomegranate juice has been extracted, the wastes that remain are composed mainly of two fractions: (1) pulp and bagasses; and (2) peel.

Uses for these coproducts are scarce and their disposal represents a problem. However, because of their composition they have the potential to be used for other ends, for example, to obtain bioactive compounds and dietary fiber that could be used as ingredient in food processing (Viuda-Martos et al. 2011). Thus, new aspects concerning the use of these coproducts for further exploitation as food additives or supplements with high nutritional value have gained increasing interest because these are high-value products and their recovery may be economically attractive (Murthy and Naidu 2010).

Pomegranate peel comprise about 50% of the total fruit weight and is an important source of minerals especially potassium, calcium, phosphorus, magnesium and sodium; complex polysaccharides (Mirdehghan and Rahemi 2007) and high levels of a diverse range of bioactive compounds such as phenolic acids, flavonoids, proanthocyanidin compounds (Li et al. 2006) and ellagitannins, such as punicalagin and its isomers, as well as lesser amounts of punicalin, gallic acid, ellagic acid and ellagic acid-glycosides (hexoside, pentoside, rhamnoside, etc.) (Devatkal et al. 2010).

Wheat is one of the daily staple foods in India and 90 % of the wheat produced is consumed mainly in the form of chapatti. Softness and flexibility are the most important quality parameters for chapatti. Chapatti is very susceptible to moisture loss and staling after baking. Chapatti is abundant source of dietary fibre that helps in diverticular diseases and reduces constipation and rate of chronic bowl diseases and diet related cancers. Since, chapatti is consumed every meal of the day, with the addition of dried pomegranate peel powder (DPPP), it could be a good vehicle with improved nutritive value. With this background, an attempt was made to study the effect of incorporation of dried pomegranate peel powder (DPPP) on the bioactive constituents and micro structural quality of chapatti. With this background, the aim of the present work is to provide chapattis with enhanced nutritive value, prolonged shelf life and better micro structural quality.



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Synthesis of Bipolyol using Intermediate Byproducts from Biotech Industries

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Abstract : Due to higher demand of biodegradable industrial products concept of bioprocess arises. Polyol has been widely used as a raw material for synthesis of polyurethane which has many applications in our daily life such as foam synthesis, thermoset, thermoplastic and mainly coating materials. In general, looking into the environmental aspect associated with the Polyol derived from petroleum base and with the increasing demand of Polyol, effort is needed to find out alternative raw materials in particular potential to feedstock coming from Bio fuel Industrial Waste. Crude glycerin, a useful byproduct of Biodiesel industry is used as a starting material for substitute of petroleum based polyols. The crude glycerol is acting as media for digestion process. The product formed after digestion in acidic condition can be used as raw material for synthesis of polyurethane. Polyurethane is used for making rigid as well as flexible foam which is having wide application in thermal insulation, bedding and mattresses respectively. The effect of key independent variables such as liquefaction temperature, reaction time, concentration of biomass and catalyst on the hydroxyl value of product was quantified. The liquefaction process was performed in a batch reactor equipped with thermometer and reflux condenser using glycerol as a solvent and reactant. A central composite design with four independent variables and one response function was applied to determine the influence of independent variables. The concentration of biomass and acid catalyst has significant effect on the hydroxyl value of bio Polyol product. The hydroxyl value is a linear function of biomass and catalyst concentration. The optimal operating condition was achieved at a temperature of 160°C, reaction time of 300 minutes, using debranned Rice husk as Biomass along with Crude Glycerol along with Acid Catalyst. The viscosity of bio Polyol obtained are in the range of 217.5-727.5 cP.

Keywords : Polyol, crude glycerin, polyurethane, bio Polyol, foam, hydroxyl value.

Introduction

A polyol is an organic compound containing multiple hydroxyl groups also called Polyhydric alcohols. Polyols can be used as a major raw material for manufacturing polyurethane foam. Polyols are also used as a key additive in Lubricant formulation. In food industry polyols are acting as sweeteners, solubilizers, stabilizers in food ingredients.

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Prediction of Liquid Detergent Properties using Artificial Neural Network

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Abstract : Neural networks have the potential to derived meaning from complicated or imprecise data. They can be used to extract patterns and detect trends, which are too complex to be notice by either humans or other computer techniques. A trained neural network can be thought of as an “expert” in the category of information it has been given to analyse. This expert can then be used to provide projections of given new situations of interest and answer “what if” question. Artificial network can be effectively used in various fields for different purposes. In this study, liquid detergents based on polymeric surfactant alkyd resin were formulated, analysed for various properties like foam volume, percent detergency and surface tension. The generated experimental data was used for training of feed forward artificial neural network with back propagation technique. The trained artificial neural network model was used for prediction of detergent properties. The result shows that artificial neural network is an excellent option modeling of such experimental data.

Keywords : Artificial neural network, ANN, liquid detergent, properties.

Mcculloh & Pitts¹ are pioneer of Artificial Neural Network (ANN) which has its fundamentals in reach interdisciplinary history from the early 1940s. Hebb² put forward a learning scheme to relocate the synaptic strength between neurons. His ‘postulate of learning’ which is also known as ‘Hebbian learning’, which presented that the information can be stocked in synaptic connections and strength of synapse would raise by the repeated activation of neurons by the other ones across that synapse. Rosenblatt³ & Block et al⁴ gave rise to neuron like element called ‘perceptron’ & its learning procedure. There perceptron conversion procedure which is renewed form and more feasible over ‘Hebb rule’ for changing synaptic connection. Minsky & Peppert⁵ have given the limitations of the single level perceptron. Nileson⁶ recommended that the Multilayer Perceptrons (MLP) can be used to separate pattern nonlinearly in a hyperspace and in single layer perceptron, the perceptron convergence theorem should be used. Rumelhart et al⁷ has demonstrated the conceptual basis of the back propagation which can be surely reminded as a revolutionary step put forward, which no one has previously

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Fractional Heat Conduction in a Thin Circular Plate With Constant Temperature Distribution and Associated Thermal Stresses

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In this work, a fractional-order theory of thermoelasticity by quasi-static approach is applied to the two-dimensional problem of a thin circular plate whose lower surface is maintained at zero temperature, whereas the upper surface is insulated and subjected to a constant temperature distribution. Integral transform technique is used to derive the solution in the physical domain. The corresponding thermal stresses are found using the displacement potential function. [DOI: 10.1115/1.4035442]

Keywords: quasi-static, thermoelasticity, fractional, integral transform, thermal stresses

Introduction

Recent advances in fractional calculus are dominated by modern examples of applications in differential and integral equations, physics, signal processing, fluid mechanics, viscoelasticity, mathematical biology, and electrochemistry. It is generally known that integer-order derivatives and integrals have clear physical and geometric interpretations. However, in the case of fractional-order integration and differentiation, it is not so. Since the appearance of the idea of differentiation and integration of arbitrary (not necessarily integer) order, there was not any acceptable geometric and physical interpretation of these operations for more than 300 yr. In Ref. [1], it is shown that geometric interpretation of fractional integration is “‘Shadows on the walls’ and its Physical interpretation is ‘Shadows of the past.’”

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The classical theory of thermoelasticity has aroused much interest in recent times. The heat conduction of classical coupled theory of thermoelasticity is parabolic in nature and hence predicts infinite speed of propagation of heat waves. Clearly, this contradicts the physical observations. Hence, several nonclassical theories, such as Lord–Shulman theory [2] and Green Lindsay theory [3], have been proposed, in which the Fourier law and the parabolic heat conduction equation are replaced by more complicated equations, which are hyperbolic in nature predicting finite wave propagation. Green and Naghdi [4] developed the theory of thermoelasticity without energy dissipation. Chandrasekharaiah [5] gave review of thermoelasticity with second sound. Tripathi et al. [6–8] studied problems in generalized thermoelastic theories. Recently, Tripathi et al. [9] studied a dynamic problem in fractional-order thermoelasticity with finite wave speeds. In the last decade, study on quasi-static thermoelasticity incorporating the time fractional derivative has gained momentum. The work on quasi-static fractional-order thermoelasticity can be found in the literature [10–15]. Raslan [16] studied the application of fractional-order theory of thermoelasticity in a thick plate under axisymmetric temperature distribution. The fractional-order theory of thermoelasticity was developed by Sherief et al. [17]. Raslan [18] solved a problem for cylindrical cavity. Aouadi [19] studied a generalized thermoelastic problem for coupled theory of thermoelasticity in context with Lord–Shulman with mass diffusion, while Povstenko [20] studied fractional heat conduction in space with a source varying harmonically in time and associated thermal stresses without numerical illustration. Kulkarni et al. [21] discussed a quasi-static uncoupled thermoelastic problem in a thin hollow circular disk and discussed thermal stresses due to heat generation. Deshmukh et al. [22] studied a quasi-static thermal deflection problem of a thin-clamped circular plate due to heat generation. A brief note on heat flow with arbitrary heating rates in a hollow cylinder was studied by Deshmukh et al. [23].

In this study, a mathematical model of a fractional-order thermoelastic problem for a finite thin circular plate under constant temperature distribution is developed. Copper material is chosen for numerical purposes, and the results for temperature, stresses, and displacement are discussed and illustrated graphically for weak, moderate, and strong conductivity for a copper material.

Formulation of the Problem

Consider a thin circular plate of thickness h occupying space D defined by $0 \leq r \leq b$ and $0 \leq z \leq h$, whose lower surface is maintained at zero temperature, whereas the upper surface is insulated. The constant heat flux Q_0 is applied on the fixed circular boundary ($r = b$), and a mathematical model is prepared considering nonlocal Caputo type time fractional heat conduction equation of order α for a thin circular plate.

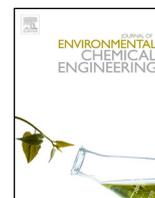
The definition of Caputo type fractional derivative is given by [10]

$$\frac{\partial^\alpha f(t)}{\partial t^\alpha} = \frac{1}{\Gamma(n-\alpha)} \int_0^t (t-\tau)^{n-\alpha-1} \frac{d^n f(\tau)}{d\tau^n} d\tau, \quad n-1 < \alpha < n \quad (1)$$

For finding the Laplace transform, the Caputo derivative requires knowledge of the initial values of the function $f(t)$ and its integer derivatives of the order $k = 1, 2, \dots, n-1$

$$L\left\{\frac{\partial^\alpha f(t)}{\partial t^\alpha}\right\} = s^\alpha f^*(s) - \sum_{k=0}^{n-1} f^{(k)}(0^+) s^{\alpha-1-k}, \quad n-1 < \alpha < n \quad (2)$$

where the asterisk denotes the Laplace transform with respect to time, and s is the Laplace transform parameter.



Novel hybrid system based on hydrodynamic cavitation for treatment of dye waste water: A first report on bench scale study



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ABSTRACT

In this article, a first report on novel hybrid technique (hydrodynamic cavitation + hydro gels packed bed adsorption) has been reported for dye degradation and subsequent adsorption of dye molecules. Initially, hydrodynamic cavitation (HC) was employed for the degradation of crystal violet dye molecules and subsequent adsorption of dye molecules have been carried out by adopting synthesized polymer hydro gels. Poly-acrylic acid (PAA)/nano composite hydro gels have been synthesized via ultrasound assisted emulsion polymerization technique. Modified bentonite clay was used as a cross-linker during the synthesis of PAA in the presence of ultrasound for the uniform dispersion of bentonite clay in the hydro gel matrix and to improve the adsorption capacity of the hydro gels. The morphology of synthesized hydro gels has been studied by XRD and TEM analysis. Operational parameters such as effect of inlet pressure on CV dye removal, effect of bentonite clay content in PAA hydro gel, effect of quantity of hydro gel loading in packed bed, effect of pH, and effect of inlet flow rate to the packed bed on integral removal of crystal violet dye in the hybrid system have been investigated. The combined process of hydrodynamic cavitation and packed bed hydro gel demonstrated the higher percentage removal of the crystal violet dye as compared to packed bed hydro gel alone. Synergistic effect of combined technique was evaluated based on the total organic carbon removal from the dye solution.

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1. Introduction

Textile manufacturing industries utilizes enormous quantity of water for dyeing the cloths and finishing [1]. Few manufacturing industries such as leather, paint, pulp mills, and textile industries mainly release highly colored wastewater in to the environment which is harmful [1–4]. Scientists have been proposed many treatment methods over the inception of research on wastewater treatment such as adsorption, chemical coagulation, electro coagulation, conventional advanced oxidation processes (photo catalysis, ozonation, chlorination) etc [5–8].

Over a two decades back, scientist have been identified and applied the cavitations based advanced oxidation processes

(AOP's) for the degradation of organic pollutants. Cavitation based AOP's are similar to catalysis based AOP's (photo catalysis) which are able to generate $\cdot\text{OH}$ radicals and react with water contaminants [9,10]. Ultrasound and hydrodynamic cavitation based AOP's have been studied widely for oxidizing a wide range of organic compounds in wastewater. During the progress of cavitation process, the generation, growth, and collapse of bubbles in a liquid medium releases high temperatures (5000 K) and pressures (1000 atm) [11]. The existence of these extreme conditions during cavity collapse makes the surrounding water molecules dissociate thermally into $\text{H}\cdot$ and $\cdot\text{OH}$ radicals. Integration of two or more techniques able to produce the synergistic effect and it may resultants into complete mineralization of organic compounds [12–15]. Scientist have been proposed many process integration techniques based on cavitation technique such as sono-photocatalysis, sono-Fenton, sono-photo-Fenton, Ultrasound + H_2O_2 and sono-sorption, HC-Fenton [12,16,17]. Very few studies have been reported on the removal of organic pollutants

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Process intensification for continuous synthesis of performic acid using Corning advanced-flow reactors

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Abstract: The present paper reports the experimental details for the synthesis of performic acid (PFA) using Corning advanced-flow reactors (AFRs) using formic acid and H_2O_2 as reactants, and sulfuric acid as homogeneous catalyst. The effect of different operating parameters on PFA concentration such as reactant flow rates (residence time), temperature, reactant and catalyst concentration were studied. The experimental results indicate that the heart-shaped pellet structure in AFR provides better mixing, and hence more conversion with less residence time achieved. Moreover, AFR technology offers the possibility to conduct chemical reactions in a more sustainable way due to miniaturization and increased safety. Reactions show optimum results at 30°C with a feed flow rate of 80 ml/h in the presence of 1 w/w % H_2SO_4 as catalyst. The optimized results demonstrated the capability of AFR technology for enhancement in the formation of PFA (time equal to 1 min) with high conversion (95.85%). Further, it

has been found that the concentration of PFA was reached at maximum value within 1 min of time. Therefore, the production of PFA is very fast in a microreactor, which saves our time and energy and in turn it saves the environment on fuel requirement and therefore this process is green.

Keywords: continuous synthesis; Corning advanced-flow reactor; homogeneous catalyst; performic acid.

1 Introduction

Performic acid (PFA), an unstable colorless liquid, can be produced by reacting formic acid with hydrogen peroxide (H_2O_2). It belongs to the category of percarboxylic acids which are acids which contains an acidic -OOH group [1]. Percarboxylic acids are commonly strong oxidizers and are used as disinfecting and bleaching agents in various industries like paper, textile and fine chemicals. PFA is a nontoxic but potent chemical which can cause skin irritation, and is a very unstable chemical, since even 50% solution is highly reactive which makes its use within 12 h mandatory. Being unstable and explosive, there is a risk in the batch production and transportation of PFA and hence researchers are paying attention towards its process development using microfluidics reactors, which are comparatively considered as safe [1, 2].

Various types of organic solvents like alcohol, ether, benzene, and chloroform generally are used for the dissolution of PFA. Due to its strong oxidizing properties, PFA is used for breaking the disulfide bonds in protein, epoxidation, hydroxylation and oxidation reactions in organic synthesis [3]. It is also used to sterilize the equipment in medical and food industries. PFA is a popular safe sterilizer due to formation of safe degradation products such as oxygen, water, and carbon dioxide. Further, PFA is being used for disinfection purposes and it is more active compared to hydrogen peroxide and peracetic acid [4, 5]. The spontaneous decomposition

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A novel approach for continuous synthesis of calcium carbonate using sequential operation of two sonochemical reactors



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ABSTRACT

A novel continuous process for the synthesis of calcium carbonate based on precipitation reaction has been developed involving the sequential operation of two sonochemical reactors for the first time. The reactors were also operated as control (conventional approach without ultrasound) to clearly establish the process intensification benefits due to the use of ultrasound. The effect of different operating parameters such as $\text{Ca}(\text{OH})_2$ concentration, CO_2 flow rate and $\text{Ca}(\text{OH})_2$ slurry flow rate on the particle size has been investigated. The obtained calcite particles were characterized using Fourier transform infrared (FTIR), wide angle X-ray diffraction (XRD) and particle size distribution (PSD) analysis. The morphology of the obtained particles was also analyzed using scanning electron microscopy (SEM) and transmission electron microscopy (TEM). It was established that the average particle size obtained in the presence of ultrasound was smaller with much narrow size distribution as compared to the conventional approach. Further, the average particle size was established to decrease with an increase in the $\text{Ca}(\text{OH})_2$ slurry concentration and CO_2 flow rate with the optimum conditions giving a particle size of 164 nm. The particle size was also influenced by the $\text{Ca}(\text{OH})_2$ slurry flow rate and under optimum condition of $\text{Ca}(\text{OH})_2$ slurry flow rate as 24 mL/min, particle size of 135 nm was obtained. Only calcite phase of CaCO_3 was observed to be formed as established based on the XRD analysis during both the synthesis approaches confirming the stability of the obtained particles. It was also observed that the shape of the crystals varied with the method of synthesis. Rhombohedral calcite particles were formed in the presence of ultrasound whereas the conventional stirring method resulted in spindle shaped particles. Overall, the utility of the ultrasound assisted approach has been clearly established with novel results based on the use of sonochemical reactors in series.

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1. Introduction

Synthesis of calcium carbonate based on the precipitation reaction is an important industrial process attributed to the significant applications of calcium carbonate as a raw material in paints, plastic, adhesive, paper and rubber industries [1,2]. For better effectiveness in the end application, obtaining narrow particle size distribution, uniform shape and crystallinity for the precipitated calcium carbonate (PCC) powders is very important [3], which is usually dependent on the synthesis conditions. Pure calcium carbonate has three distinct crystalline forms as calcite, aragonite and vaterite and the generally observed morphologies are rhombo-

hedral, needle-like and spheroidal [4]. Vaterite and aragonite are thermodynamically less stable than the calcite form and these two metastable phases eventually transform into calcite via a recrystallization mechanism [2]. The development of novel processing routes to obtain uniform size distribution as well as the desired morphology is an important investigation area due to the strong dependency of the properties on the morphological characteristics [5]. The conventional approach for the production of precipitated calcium carbonate (PCC) depends on the operating parameters such as the reactant concentration and flow rate as well as use of additives for the desired control over the phase and morphological characteristics such as particle size, aspect ratio and specific surface area [6]. However, the batch process which is frequently used for the production of calcium carbonate has number of limitations due to the problems of non-uniform particle size distribution attributed to the non-homogeneous mixing of the

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VARIOUS TECHNOLOGICAL
PROCESSES

Halloysite Nanocontainers for Controlled Delivery of Gibberellic Acid¹

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Abstract—Inorganic halloysite nanocontainers were employed for controlled delivery of plant growth regulator (PGR) – Gibberellic Acid. The cylindrical geometry of nanocontainer was found to be found to indicate 600 ± 200 nm length and 50 ± 10 nm outer diameter with inner lumen to be in the range of 12–15 nm. Attempts were made to encapsulate GA and obtain controlled release in aqueous buffer through nanocontainers capped with a copper stopper. Halloysite nanocontainers were characterized using TEM, EDX and TGA. In vitro release studies of GA in water were studied wherein the pH of the solution was maintained using phosphate buffer. Increase in amount of copper was found to be successful in retarding the amount of GA release. Complex between GA and copper ions was found to be responsible for the stopper formation. For tube stopper opening, addition of excessive amounts of ammonia solution was added. Parameters such as effect of temperature, pH and UV light were studied in detail. Encapsulation and stopper formation onto the nanocontainer was found to effective in achieving overall release control. Kinetic release model proposed by Peppas was analyzed for best fit.

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Plant growth regulators (PGR) are synthetic or organic compounds that are applied directly to the plant body, which act as a bio-stimulant and modify plant physiological processes [1]. These are different from plant nutrients and are found to be more active in plants are very small concentration ranges. Modifications in physiological process may involves, regulation of plant metabolism and stimulation of specific enzymes or enzyme systems. Some other effects of plant growth regulators are improvement of fruit size, structural quality, yield etc. PGR consist natural occurring hormones and synthetic compounds. These compounds are auxins, gibberellins, cytokinins, ethylene, growth retardants and growth inhibitors [2, 3]. Increased use of such compounds has been observed in order to get increased harvested yields and crop quality. Among all PGR, low concentration dosage

of gibberellins or Gibberellic Acid (GA₃) find wide applications so as to inhibit root growth, germination and fruit setting, flowering etc [2, 4, 5]. Most of the time the solutions of GA can be applied to the target areas using a foliage spray for drip down coverage and very few times it is directly added to the soil [6–8].

Many researchers report the use of clay minerals in variety of controlled release applications [13–16]. Attention has been towards development of delivery systems with prolonged release at specific time intervals [17, 18]. Providing cargo at the desired location (site-specific and receptor targeting) have also been studied by various researchers [19, 20]. Aguzzi et al. has presented an extensive review on the possibility of clay minerals for the delivery purpose of active molecules [21]. Halloysite is found to be one of the most distinctive types of clay mineral having number of potential delivery applications. This may be due to the properties like specific surface

¹ The text was submitted by the authors in English.

Esterification of free fatty acids present in Jatropha oil: A kinetic study

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Methanesulfonic acid has been used as a catalyst for the esterification of free fatty acids (FFA) present in jatropha oil with methanol. The reaction kinetics are estimated for 1 to 2.5 wt% catalyst concentrations, temperature from 45-60°C and methanol-FFA mole ratios ranging from 10:1 to 25:1. The optimum conditions are found to be 20:1 methanol-FFA mole ratio and 1 wt% catalyst at 60°C and 400 rpm for 270 min which give a maximum conversion of 97.9%. A second-order kinetic model for both the forward and backward reactions is proposed to study the reaction. The effect of temperature on the reaction rate constants and equilibrium constant has been determined using Arrhenius and van't Hoff equations respectively. The heat of reaction is found to be 25.936 kcal/mol.

Keywords: Biodiesel, Esterification, Free fatty acids, Jatropha, Kinetics, Methanesulfonic acid

In recent years, biodiesel has gained a lot of momentum because of its properties such as low carbon monoxide emissions, particulate matter, high flash point and unburned hydrocarbons¹. Biodiesel consists of long-chain fatty acid methyl esters (FAME) and are derived from renewable sources such as vegetable oils or animal fats. Oils like rapeseed, sunflower, soybean, palm and peanut oil, as well as animal fat are being used for the preparation of biodiesel²⁻⁴. However usage of these oils for biodiesel is limited because of their high cost and non availability, this forced some researchers to take up work using non-edible oils, animal fats and waste cooking oils⁵. Non-edible oils like *Jatropha curcas* L oil are attractive as potential raw material for the preparation of biodiesel. *Jatropha curcas* L belongs to the family of Euphorbiaceae and can grow in arid, semi-arid and waste lands⁶.

Methanesulfonic acid was used to reduce the acidity of crude palm oil prior to the alkaline transesterification reaction by Hayyan *et al.*⁷. The authors also used ultrasonic energy for the reduction of FFA in crude palm oil Hayyan *et al.*⁸. Aranda *et al.*⁹ studied esterification of palm fatty acids using methanesulfonic acid. The authors showed that the presence of water in the reaction medium gave a negative effect in the reaction velocity. Protonation of the carboxylic moiety of the fatty acid

were defined as rate determinant step for the reaction. Tran *et al.*¹⁰ also used methanesulfonic acid for the production of biodiesel. Fassbender *et al.*¹¹ reports a process for preparing fatty acid esters and/or fatty acid ester mixtures of monohydric alcohols having 1 to 5 carbon using methanesulfonic acid for preparing fatty acid esters. Biodiesel was produced from the oil of *Raphia taedigera* Mart commonly known as jupati, by Leyvison Rafael V. da Conceicao *et al.*¹² using methanesulfonic acid.

Gernon *et al.*¹³ reviewed chemical and physical characteristics of methane sulphonic acid and the short-chain alkane sulfonic acids in general. The article emphasizes that the conductivity, low solubility and aqueous solubility of metal methane sulfonates make methane sulfonic acid (aq) an ideal electrolyte for many electrochemical processes, especially those involving tin and lead. Different aspects of aqueous process effluent treatment, acid recovery and metal alkane sulfonate salt preparation are discussed. Economic aspects of methanesulfonic acid are also considered.

Though literature reports little work using methane sulphonic acid as catalyst for esterification of free fatty acids in oil there is no detailed kinetic study available, hence this work was taken up with an aim to study the effect of process variables esterification of FFA in *Jatropha curcas* L oil using methane sulphonic acid as catalyst and also interpret the kinetic parameters.

Accepted Manuscript

Title: Portrayal of structural, thermal and optical properties of pH Eu(TTA)₃bipy hybrid organic complex for OLEDs

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Anisotropic Bianchi Type I Cosmological Models with Generalized Chaplygin Gas and Dynamical Gravitational and Cosmological Constants

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Abstract This paper deals with study of generalized Chaplygin gas model with dynamical gravitational and cosmological constants. In this paper a new set of exact solutions of Einstein field equations for spatially homogeneous and anisotropic Bianchi type I space-time have been obtained. The solutions of the Einstein's field equations are obtained by considering (i) the power law relation between Hubble parameter H and scale factor R and (ii) scale factor of the form $R = -1/t + t^2$, $t > 1$. The assumptions lead to constant and variable deceleration parameter respectively. The physical and dynamical behaviors of the models have been discussed with the help of graphical representations. Also we have discussed the stability and physical acceptability of solutions for solution type-I and solution type-II.

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Key words: Bianchi type I space time, cosmological constant, gravitational constant, generalized Chaplygin gas

1 Introduction

On the basis of recent cosmological observations obtained by distant type Ia Supernovae,^[1] WMAP,^[2] SDSS,^[3] and X-Ray^[4] it has been established that currently the Universe is undergoing the accelerated phase of expansion. Physical mechanism and driving force of the accelerated expansion of the Universe is yet to achieve. To understand the accelerated behavior of the Universe the cosmological constant has played a very important role. Many researchers have proposed cosmological models with time varying cosmological constant in order to solve the discrepancy between the cosmological constant inferred from observations and the vacuum energy density resulting from quantum field theories. Number of researchers^[5–9] have investigated cosmological constant problem and consequences on cosmology with a time varying cosmological constant.

A variation of G has many interesting consequences in geology and astrophysics. Ever Since Dirac^[10] first considered the possibility of variable G , then has been numerous modifications of general relativity to allow a variable G . Canuto and Narlikar^[11] have shown that G varying cosmology is consistent with cosmological observations. Singh and Kotambkar^[12] have discussed cosmological models with G and Λ in higher dimensional space-time. Vishwakarma^[13] has investigated a Bianchi type I model with variable G and Λ . Singh *et al.*^[14] have studied a new class of cosmological models with variable G and Λ .

Bali and Yadav^[15] have investigated Bianchi type IX viscous fluid cosmological model in general relativity. Bali and Tinkar^[16] have suggested Bianchi type V bulk viscous barotropic fluid cosmological model with variable G and Λ . Singh and Baghel^[17] have investigated Bianchi type V Universe with bulk viscous matter and time varying gravitational and cosmological constants.

It is believed that during early stages of the Universe, it was not having isotropic behavior. Astronomical and astrophysical observations suggest that observed Universe is homogeneous and isotropic, hence space-time is usually described by Friedman–Lemaître–Robertson–Walker (FLRW) cosmology. It is widely believed that FLRW model does not give correct matter description in the early stage of the Universe. Anisotropic model plays a significant role in description of evolution of the early phase of Universe. Bianchi models I to IX present a middle way between FRW model and inhomogeneous and anisotropic Universe and thus important in modern cosmology.^[18–26]

According to recent observational evidence the expansion of the Universe is accelerated, which is dominated by smooth component with negative pressure so called dark energy. Among the different theories put forward to understand the nature of dark energy, single component fluid known as Chaplygin gas (CG) with equation of state (EoS) $p = -B/\rho$,^[27] where ρ and p are energy density and pressure respectively and B is a constant has attracted large interest in cosmology. Chaplygin gas is also an interest-

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Effect of nonionic surfactant additives on the performance of nanofluid in the heat exchanger

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Abstract

A nanofluid is mixture of nano sized particles and a base fluid. This paper investigates by using laboratory based double pipe heat exchanger model, the performance of nanofluid containing about 48.46nm particle size nanoparticles (ZnO) without or with addition of nonionic surfactant Rokanol K7 (500ppm) into the base fluid double distilled water to prepared three different concentrations 1.0%, 2% and 3% (v/v) of ZnO-water or ZnO-RK7. Effects of temperature and concentration of nanoparticles on viscosity and heat transfer coefficient in heat exchanger are investigated. The experimental results shows that the viscosity of nanofluids increased with increasing concentration of fluid whereas decreased with increasing temperature from 20 to 60°C. However, it has been also observed that heat transfer coefficient increases with the operating temperature and concentration of nanoparticles. The conclusion derived for the study is that overall heat transfer coefficient enhanced with increasing concentration upto 3% of ZnO-RK7 as compared to without surfactant nanofluids.

Keywords: Heat exchanger; Heat transfer coefficient; Nanofluid; Nonionic surfactant; Viscosity.

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INTRODUCTION

In the recent years, there has been a necessity of requirement for energy conservation and thermal management due to increasing demand for power and the rising energy cost. Heating and cooling processes play important role in most of the energy systems; therefore, there is a need to increase the heat transfer and energy efficiency of these thermal management systems. New strategies for industrial world have to be developed to improve the thermal behavior of fluids in the heat exchangers. It is well established that the thermal performances of conventional working fluids in heat exchangers, such as water, ethylene glycol, propylene glycol, engine oil, mineral oil, kerosene oil and silicon oil are commonly used in heat transfer equipment [1]. The thermal effectiveness of such type of equipment can be greatly enhanced by improving the thermal conductivity of working fluids and this

can be achieved by dispersing a small quantity of solid particles such as Cu, Al₂O₃, Ag, TiO₂ in water and ethylene glycol as base fluids [2].

The augmentation of thermal conductivity of conventional fluids through the suspension of solid particles in mm or μm sized has not been interest for practical applications, due to the problems associated with sedimentation, erosion, fouling, and increased pressure drop through the flow passages. However, the effective thermal conductivity and viscosity of nanofluids introduced nanoparticles (NPs) in low volume fraction within base fluids, leading to the concept of “nanofluids” [3, 4].

In the previous report, Cu as NPs had larger velocity and temperature values than Ag as NPs [5]. The study showed that the effect of NPs on nanofluids viscosity under wide ranges of temperatures experimentally indicated that viscosity drops sharply with temperature especially

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Exploration of spectroscopic properties of solvated tris (thenoyltrifluoroacetate)(2,2'-bipyridine)europium(III)red hybrid organic complex for solution processed OLEDs and displays



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ABSTRACT

In order to explore the spectroscopic properties of a novel europium activated hybrid organic tris(thenoyltrifluoroacetate)(2,2'-bipyridine)europium(III), Eu(TTA)₃bipy phosphor in various solvents at different pH and molar concentrations, UV–vis optical absorption and photoluminescence spectra were carried out. With a variation in the solvent from basic (chloroform, toluene, tetrahydrofuran) to acidic (acetic acid, formic acid) media, staggering differences in optical absorptions and optical densities were noticed with hypsochromic shift in the absorption peaks. The optical density was found to be maximum for the complex with pH = 7.0 and the intensity as well as optical density gradually decreased when pH is lowered to 6.0 or raised to 8.0 (at an interval of 0.5), proving that the complex is pH sensitive. Its optical energy gap and Stokes shift values in various organic solvents were also calculated on the basis of Lippert–Mataga plot. The exploration of spectroscopic properties of solvated Eu(TTA)₃bipy complex demonstrates its prospective for solution processed OLEDs and display devices.

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1. Introduction

Since times immemorial, rare earth β – diketone complexes are recognized because of their large Stokes' shifts, narrow emission bandwidths and long emission lifetimes [1–14]. However, they exhibit low absorption coefficients as the f–f electronic transitions are forbidden. Owing to the poor absorption abilities of lanthanide ions, lanthanide complexes are being designed with organic ligands having strong absorption of light energy. As described by Weissman, this absorbed energy acts as the excitation energy which is transferred to the central metal ion by the surrounding organic ligand, commonly known as antenna effect [15]. The emission wavelength depends upon the lanthanide ion but shows only limited dependence on the local environment of the lanthanide ion. The emission from Eu(III) complexes are nearly monochromatic and results from the transitions between f–levels. These complexes are utilized as red emitters in a variety of display devices [16–21], organic light emitting diodes (OLEDs) [22–29] and also in wide variety of low energy requirement applications [30]. They are gaining tremendous attention as lamp and display phosphors. Earlier state of art reports the low solubility of the

lanthanide β - diketone complexes in acidified aqueous solution as well as the problem of formation of an aggregate with the solvent can further quench the luminescence thereby affecting the performance of the complex. However, with the introduction of second ligand into the complex, a noticeable improvement in the photophysical ability as well as solubility of the Eu tris(β - diketone) complexes can be observed [31,32]. Fabrication of OLED is now made simpler and cheaper by solution processing techniques such as spin coating technique and ink jet techniques [33] which involves the spraying solvated organic complexes on the substrate, thereby achieving a desired thickness of organic material after the evaporation of the solvent. The choice of solvent is significant as the emission intensity in that particular solvent depends upon the absorption spectra of the solvated complex. The advantage of these hybrid organic complexes is that they are soluble in most of the organic solvents as well as in some acidic medium, paving an approach to study the absorption as well as emission spectra in different solvents with different molar ratios. Considering these facts, we propose to synthesize and study the spectroscopic properties of solvated red-emitting Eu(TTA)₃bipy complex (at different pH) in various basic solvents (chloroform, toluene, tetrahydrofuran) and acidic solvent (acetic acid, formic acid) of different polarity at different molar ratios and also to calculate optical energy band gap in different solvents.

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Genetic Programming based Drag Model with Improved Prediction Accuracy for Fluidization Systems

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Abstract: The drag coefficient plays a vital role in the modeling of gas-solid flows. Its knowledge is essential for understanding the momentum exchange between the gas and solid phases of a fluidization system, and correctly predicting the related hydrodynamics. There exists a number of models for predicting the magnitude of the drag coefficient. However, their major limitation is that they predict widely differing drag coefficient values over same parameter ranges. The parameter ranges over which models possess a good drag prediction accuracy are also not specified explicitly. Accordingly, the present investigation employs Geldart's group B particles fluidization data from various studies covering wide ranges of Re and ε_s to propose a new unified drag coefficient model. A novel artificial intelligence based formalism namely *genetic programming* (GP) has been used to obtain this model. It is developed using the pressure drop approach, and its performance has been assessed rigorously for predicting the bed height, pressure drop, and solid volume fraction at different magnitudes of Reynolds number, by simulating a 3D bubbling fluidized bed. The new drag model has been found to possess better prediction accuracy and applicability over a much wider range of Re and ε_s than a number of existing models. Owing to the superior performance of the new drag model, it has a potential to gainfully replace the existing drag models in predicting the hydrodynamic behavior of fluidized beds.

Keywords: Fluidization, drag force, modeling, genetic programming, computational fluid dynamics

1 Introduction

The fluidized beds are versatile contactors employed in a wide range of chemical industries producing, for example, petroleum, food, and pharmaceuticals products. They are preferred in processes such as catalytic cracking of petroleum, and combustion and gasification of coals and biomasses. The preference for fluidized beds (FB) stems from their excellent heat and mass transfer, and solids mixing characteristics. These features are in turn related to the existence of bubbles and their behavior in the bed. In a fluidized bed, bubbles are responsible for mixing between various phases, circulation of fluid, and stabilization of temperature. Hence, understanding their transient behavior, and characteristics becomes essential. Especially, the knowledge of time averages of gas and solids velocities, void fraction, pressure, reaction kinetics, and catalytic influence is crucial for the design, operation, and optimization of a fluidized bed reactor. For many decades, the design of FB reactors was primarily dependent on the data from laboratory, bench-scale, and pilot plant scale experiments. Since these experiments are time and cost intensive to perform, design and operation of an FB reactor is also conducted by developing mathematical models based on the fundamental laws of mass, momentum, energy, and reaction conversion kinetics. An exhaustive literature on the modeling of fluidized beds and related concepts such as minimum fluidization velocity, bubble diameter, bubble velocity, bubble coalescence, splitting and slugging in the bed, particle velocity, flow pattern, and pressure distribution in and around the bubbles, is available in various books (Davidson and Harrison 1963, 1971; Kunni and Levenspiel 1991; Gibilaro 2001; Jackson 2000).

The Navier-Stokes equations have been widely used in modeling and designing of fluidized beds. With an exponential increase in the processing speeds of computers in the last few decades, the computational fluid dynamics (CFD) approach has gained a widespread

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Green Route for Silver Nanoparticles Synthesis by *Raphanus Sativus* Extract in a Continuous Flow Tubular Microreactor

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The present work deals with the investigation of the greener route for the production of silver nanoparticles using *Raphanus sativus* (*R. sativus*) bioextract in a continuous flow tubular microreactor. The parameters affecting the particle size and distribution were investigated. From the results obtained it can be inferred that the ascorbic acid (reducing agent) present in the *R. sativus* bioextract is responsible for the reduction of silver ions. At optimum condition, the particle size distribution of nanoparticles is found between 18 nm and 39 nm. The absorbance value was found to be decreased with an increase in the diameter of the microreactor. It indicates that a number of nuclei are formed in the micrometer sized (diameter) reactor because of the better solute transfer rate leading to the formation of large number of silver nanoparticles. The study of antibacterial activity of green synthesized silver nanoparticles shows effective inhibitory activity against waterborne pathogens, *Shigella* and *Listeria* bacteria.

Keywords: Microreactor; *Raphanus Sativus* bioextract; silver nanoparticles; green synthesis; particle size distribution.

1. Introduction

Metal nanoparticles have found remarkable applications in diverse fields like catalysis, electronics, surface coating, drug delivery, biomedical science, biotechnology, nanofluids, environmental remediation, energy storage devices, etc.¹⁻⁷ Nanoparticles

show drastic improvements in the properties than their bulk counterparts and further, the applications are mainly dependent on their shape, size and functionalization.⁸⁻¹⁰ Therefore, it is important to achieve the required shape and size of nanomaterials without any other considerable variation^{11,12} and it



A review on graphene–TiO₂ and doped graphene–TiO₂ nanocomposite photocatalyst for water and wastewater treatment

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ABSTRACT

TiO₂ is a more effective photocatalyst for the photocatalytic degradation of organic pollutants. However it shows more reactivity under UV light and around 5% of solar spectrum contains UV radiations. A new approach for the degradation of pollutants present in wastewater is suggested by making use of nanocomposite photocatalysts. The technique has potential for the treatment of wastewater because of the use of doped graphene-based nanocomposite photocatalysts. Graphene is a one-atom-thick planar sheet of *sp*²-bonded carbon atoms that are densely packed in a honeycomb crystal lattice. Furthermore, graphene has high electron mobility and therefore it will suppress the recombination of the electron-hole pair formed which in turn improves the effectiveness of the graphene–TiO₂ photocatalyst. In addition, development of doped graphene–TiO₂ photocatalyst will be useful as it can be effective for the degradation of pollutants in the visible sunlight. Recently, there has been an increase in interest in the preparation of high performance graphene-based TiO₂ photocatalyst with doping of it using metal and non-metal ions. In this review, the preparation method and application of TiO₂, graphene–TiO₂ and doped graphene–TiO₂ photocatalyst are presented.

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photocatalyst; doping

Introduction

Organic pollutants play a very important role in the water pollution, it mostly takes up more than 50% of water pollutants. Water contamination majorly comes from human activities, which produces a large number of industrial, agricultural and domestic wastes that are directly discharged into the water. The major path of this kind of organic pollutants are concerned with the industry of plastics, synthetic fibres, synthetic rubber, detergents, pigment, solvents synthesis, paints, pesticides, food additives, pharmaceuticals and other organic compounds. These hazardous pollutants in water and wastewater are very dangerous for human and aquatic life. Also they are well thought-out as toxics or a contributor diseases to human that includes the human hepatic dysfunction, carcinogenics, hindering the development of human body and endangering body endocrine system [1–3].

In the late 1960s, photocatalysis technology was utilized for the application of water and wastewater treatment. Studies have paid more attention to photochemical-assisted techniques for water and

wastewater treatment. Photocatalysis is an important technique which is useful for the decomposition of various organic toxins into carbon dioxide and water using very less energy and it is totally environmentally friendly. Numerous studies have been reported on the use of TiO₂ as a photocatalyst for various applications such as degradation of organic pollutants, hydrogen generation from water splitting and air purification [4–6]. However, photocatalysts have drawbacks such as high cost, low efficiency, high electron–hole pair combination speed and UV-radiation response. TiO₂ is a broadly used photocatalyst for the treatment of wastewater; the possible reasons are (1) high stability, (2) low cost and toxicity and (3) enhanced photocatalytic activity compared to other semiconductor materials. However, TiO₂ has photocatalytic activity in the UV region and the earth's solar spectrum contains around 5% UV radiations. Therefore, it has limited photocatalytic activity in the visible range of the solar spectrum. Also the recombination rate of electron and hole is higher in TiO₂. These problems

Research paper

Modeling the adsorption of benzenecetic acid on CaO₂ nanoparticles using artificial neural network

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Abstract

The present work reported a method for removal of benzenecetic acid from water solution using CaO₂ nanoparticle as adsorbent and modeling the adsorption process using artificial neural network (ANN). CaO₂ nanoparticles were synthesized by a chemical precipitation technique. The characterization and confirmation of nanoparticles have been done by using different techniques such as X-ray powder diffraction (XRD), high resolution field emission scanning electron microscope (HR-FESEM), transmittance electron microscopy (TEM) and high-resolution TEM (HRTEM) analysis. ANN model was developed by using elite-ANN software. The network was trained using experimental data at optimum temperature and time with different CaO₂ nanoparticle dosage (0.002–0.05 g) and initial benzenecetic acid concentration (0.03–0.099 mol/L). Root mean square error (RMS) of 3.432, average percentage error (APE) of 5.813 and coefficient of determination (R^2) of 0.989 were found for prediction and modeling of benzenecetic acid removal. The trained artificial neural network is employed to predict the output of the given set of input parameters. The single-stage batch adsorber design of the adsorption of benzenecetic acid onto CaO₂ nanoparticles has been studied with well fitted Langmuir isotherm equation which is homogeneous and has monolayer sorption capacity.

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Keywords: Feed forward neural network; Single-stage batch; Benzenecetic acid; CaO₂ nanoparticles; Adsorption

1. Introduction

Carboxylic acids have a wide range of application especially in pharmaceuticals, food, and polymers industries. Hence, recovery of carboxylic acids from aqueous solution is an important process in chemical engineering [1]. A number of separation processes have been developed to recover carboxylic acids from aqueous acid [2–5]. Adsorption is low cost and allows an easy operation for the recovery of carboxylic acids [6].

Benzenecetic acid has a white scale-like crystal look and a honey-like odor at low concentration [7]. It is largely employed in the pharmaceutical industry for making of antibiotics. It is used as a precursor (reactants) in the production of penicillin G

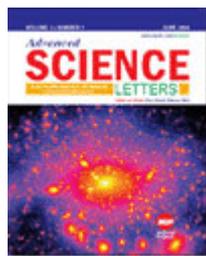
[8]. It is an important chemical for the chemical industry. It is found in neroli, rose oil and in many fruits [9]. It has a wide range of biological activity, antibacterial, analgesic, and virucidal properties [10]. It is produced by both fermentation of soya beans using *Bacillus licheniformis* [11,12] and strains of *Bacteroides asaccharolyticus* and *Bacteroides melaninogenicus* subspecies isolated from human and animal sources [13]. It powerfully inhibits the activity of penicillin acylase. Removal of a benzenecetic from fermentation broth, reaction mixture and waste water is the vital step of complete production process because it directly affects the overall economy of the process [14]. The removal of benzenecetic acid is required to get higher productivity. Because of these multiple applications in various chemical industries and also medicinal, so it is necessary to remove benzenecetic acid from aqueous solution is necessary.

CaO₂ nanoparticles are used as an adsorbent for the recovery of benzenecetic acids because they provide large surface area and are low cost [8]. The basis of separation of benzenecetic acids (adsorbate) from the feed mixture onto the CaO₂ nanoparticles (solid adsorbent) is governed by the variation

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The doped KNbO₃ single crystals were prepared using flux method by taking K₂CO₃ and Nb₂O₅ as a starting material in the molar ratio of 1.2:1 with an impurity of TiO₂ (10 mg). The effect of TiO₂ doping on phase transition temperatures of KNbO₃ single crystals was investigated. The dielectric studies and thermal characterization techniques were used to probe phase transition temperatures and dielectric behavior of TiO₂ doped KNbO₃ single crystals. The X-ray diffraction showed the presence of single phase and lattice parameters were found to be $a = 5.6821 \text{ \AA}$, $b = 3.9609 \text{ \AA}$ and $c = 5.7064 \text{ \AA}$ with volume of the unit cell $V = 128.43 \text{ \AA}^3$. The present material is orthorhombic at room temperature with space group PCCA. Our results reveal that phase transition temperatures are 235 °C, 450 °C which are confirmed by dielectric and thermal characterizations with some thermal hysteresis which may be due to TiO₂ doping. Electrical properties were studied over a wide range of frequency, which show that dielectric constant and dielectric loss factor decreases with frequency.

Keywords: Dielectric Properties; Thermal Properties; TiO₂ Doped KNbO₃; XRD

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Original research article

Blue light emitting P-Hydroxy DPQ phosphor for OLEDs

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ABSTRACT

A blue light emitting novel P-Hydroxy DPQ organic phosphor based on pyrazoloquinoline derivative was synthesized by Friedlander condensation reaction of P-Hydroxyacetophenone and 2-aminobenzophenone in the presence of diphenylphosphate and m-cresol at 140 °C. Structural, thermal and optical properties of the synthesized organic phosphor were characterised by recording X-ray diffraction (XRD), Fourier Transform Infrared (FT-IR) spectra, Thermo gravimetric analysis/Differential Thermal analysis (TGA/DTA), UV-absorption spectra, Photoluminescence (PL) spectra, respectively. XRD reveals its crystalline nature, while FTIR spectra reveal the formation of the quinoline complex. TGA/DTA analysis reveals significant loss in the weight of sample above room temperature, while the DTA curve of the complex shows two endothermic peaks at 99 °C and 355 °C and two exothermic peaks at 200 °C and 380 °C. The UV-vis absorption spectra of P-Hydroxy DPQ in acetic acid solution (10^{-3} concentration) shows a strong absorption peak λ_{\max} at 376 nm with a weak shoulder at 281 nm, which may be attributed due to $n \rightarrow \pi^*$ and $\pi \rightarrow \pi^*$ transitions of quinoline moieties, respectively. Optical energy band gap E_g of P-Hydroxy DPQ was measured by optical process absorption method and was found to be 2.78 eV. When P-Hydroxy DPQ powder is excited at 385 nm, it displays emission peak at 468 nm, which falls in the blue visible region of electromagnetic radiation with (0.1391, 0.1887) as CIE coordinates. Thus this polymeric compound exhibits bright emission in blue region, indicating its potential as blue emissive material for organic light-emitting diodes (OLEDs).

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1. Introduction

Organic polymers are promising materials, used as an active layer in optoelectronic devices [1–8] such as the field-effect transistors (FET) [9], light-emitting diodes (LEDs) [10] and photovoltaic cells [11]. Most organic semiconductors are based on π -conjugated molecules, ranging in size from small molecules to polymers. Organometallic compounds with π -conjugated bridges are showing great potential as building blocks for carbon-rich networks that are relevant to the development of new optical materials and optoelectronic devices [12]. Their organic nature allows for the fabrication of flexible, lightweight materials that can be processed very conveniently, particularly for low power and low cost applications [13]. Important advantages of using organic materials rather than inorganic semiconductors are the relatively low production and processing costs, flexibility and light weight. Organic semiconductors can often be processed from solution, using techniques such

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Novel ceramic-polyamide nanocomposites approach to make flexible film of PZT ceramics: Structural and dielectric study

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ABSTRACT

In the present attempt, Lead zirconate titanate/polyamide Nylon-6 (PZT/N-6) nanocomposite films were successfully prepared using solution casting approach. The nanoscale PZT particles synthesized by sol-gel route were homogeneously dispersed in Nylon-6 matrix by ultrasonication. Formation of nanocomposite was confirmed by X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FT-IR). The structural study verifies the semi-crystalline nature of Nylon-6 and rhombohedral phase of PZT with formation of compositions as physical mixture having no interface interaction. Structural stability of the nanocomposite was investigated by Thermal gravimetry analysis (TGA) and Differential thermal analysis (DTA) up to about 340°C. The surface microstructure of nanocomposites film having 50:50 compositions of PZT and Nylon-6 shows uniform dispersion of PZT nanoparticles in Nylon-6 matrix with negligible pores. However higher % of PZT in composition exhibits agglomeration with significant number of pores; it causes reduction in dielectric constant and hence rise in dielectric loss. Room temperature (298 K) dielectric constant of PZT/N-6 nanocomposite films are smaller than pure PZT and found highly influenced by dispersion of PZT in N-6 matrix. For higher content of PZT in N-6 leads to lower dielectric constant and higher dielectric loss, while 50:50 PZT/N-6 nanocomposition gives highest dielectric constant and comparative lower loss. 50:50 PZT/N-6 nanocomposites film can be used in devices where flexibility of PZT is expected.

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Lead zirconate titanate (PZT); nylon 6; composites; dielectric properties

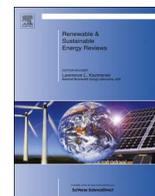
1. Introduction

Piezoceramic-polymer composite systems with various connectivity patterns are emerging as technologically very useful system in current decade even though it was introduced in early 1970s [1]. Polymers have relatively low dielectric constant in the range of 2 to 10 and it is difficult to use for dielectric devices [2]. However, Polymers flexibility, high mechanical strength and environmental inertness are highly needed in dielectric devices for miniaturization view point [3–6]. On other hand piezoceramics have high dielectric constant but high sintering temperature, low mechanical strength limit its functionality. Development of

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Escalating opportunities in the field of lighting

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ABSTRACT

This paper aspires to replicate the current global scenario concerning the prevalent lighting system and elucidates the importance of solid-state lighting (SSL) which has the prospective to stimulate energy saving, energy efficient green technology in the field of lighting. Margins and comprehensive haphazards of currently used lighting systems such as incandescent and fluorescent lamps can be conquered by reinstating the current lighting scheme by green technology called solid state lighting. In addition, the enduring confronts and future perspectives of this cutting edge research with assured measures that can be employed to trim down the driving voltage, curtail the degradation issues and intensify their life time are illustrated. Once we accomplish these challenges, OLEDs can be judged as subsequent substitutes of the existing sources that would volunteer a world of escalating opportunities in the field of lighting.

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Formulation of approximate generalised experimental data based model in a liquid–liquid extraction using zinc oxide nanomaterial[☆]

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Summary The present phenomenon, i.e. enhancement of mass transfer coefficient in liquid–liquid extraction operation is a complex one and it cannot be reasoned out by any logic based model, so it is find out by experimental data based model. The present investigation is focused on the behaviour of nanofluid in the liquid–liquid extraction process. The chemical system of toluene–acetic acid–water was used, and nanofluids containing 0.1%, 0.2% and 0.3% (V/V) of zinc oxide nanoparticles of size 48.79 nm synthesised by chemical precipitation method. Maximum enhancements in the rate of mass transfer of were achieved using about 0.3 wt% zinc oxide based nanofluids; however, a decreasing variation was observed at higher concentrations. The effect of nonionic surfactants Rokanol K7 (500 ppm) on mass transfer of the liquid–liquid extraction process was also investigated and it was observed that the mass transfer coefficient increases rapidly with surfactants under a varying speed of agitation but deteriorates at high concentration. The formulation of approximate generalised experimental data based model has been developed followed by interpretation and the quantitative analysis of the model. For the aim of modelling, the experimental results obtained from liquid–liquid extraction were validated with mathematical modelling for calculation of reliability of model. © 2016 Published by Elsevier GmbH. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

[☆] This article belongs to the special issue on Engineering and Material Sciences.

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Introduction

The quest of further excavation in the present research propelled towards formulation of a mathematical model.

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Surfactant-based dispersive liquid–liquid microextraction for the determination of zinc in environmental water samples using flame atomic absorption spectrometry

Kamlesh Shrivastava,^a Khemchand Dewangan^b and Asar Ahmed^c

Zinc metal is an essential micronutrient which is required for different biological and physiological processes in humans, animals and plants. Here, a simple, rapid and sensitive method for the determination of zinc in environmental water samples using surfactant-assisted dispersive liquid–liquid micro-extraction (SA-DLLME) prior to flame atomic absorption spectrometry (FAAS) analysis has been reported. This method involved the formation of a zinc complex with 4-(2-pyridylazo) resorcinol (PAR) and subsequently SA-DLLME was applied to extract the Zn(II)–(PAR)₂·CPC complex into chloroform in the presence of a cationic surfactant. Optimum extraction of the complex was observed when the concentration of cetylpyridinium chloride (CPC) and PAR was 0.1% for both at pH 9.0 and with an extraction time of 10 min. The calibration curve was found to be linear over the range of 1.5–60 μg L⁻¹ with a correlation of estimation (*r*²) of 0.997. This optimized method has been successfully applied for the determination of zinc in environmental water (tap, river and well) samples.

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Introduction

Among all the micronutrients, zinc is an essential trace mineral that people need to stay healthy.¹ The recommended dietary allowance (RDA) of zinc per day is 14 mg for men and 12 mg for women. The average concentrations of zinc found in surface water and drinking water are in the range of 0.02–0.05 mg L⁻¹ and 0.01–0.1 mg L⁻¹, respectively. Carboxypeptidase A is a zinc metalloenzyme that breaks down peptide linkages present in proteins during their digestion. It plays a number of roles in many other biological functions such as cellular integrity, protein synthesis and metabolism of nucleic acids as well as in the development of the brain.^{2–4} Deficiency of zinc in human beings may lead to several disorders such as delayed wound healing, retardation of growth, decrease in the immunological defense, skin lesions and infertility.⁵ Therefore, the determination of zinc in water samples is quite necessary to know the amount of the element taken by an individual through water samples.

Several sophisticated analytical techniques have been reported for the determination of zinc in a variety of samples such as flame atomic absorption spectrometry (FAAS),^{6,7} graphite

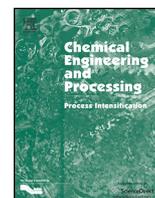
furnace atomic absorption spectrometry (GF-AAS),^{8,9} inductively coupled plasma-atomic emission spectrometry (ICP-AES),^{10,11} inductively coupled plasma-mass spectrometry (ICP-MS),^{12,13} X-ray fluorescence spectrometry (XRF)¹⁴ and voltammetry.^{15,16} However, GF-AAS, ICP-AES, ICP-MS and XRF are quite expensive techniques and skilled manpower for the operation of these instruments is needed. FAAS is a simple and readily available analytical instrument in many laboratories. The cost of the instrument is quite low as compared to the above mentioned instruments. It has been widely used for the determination of heavy metals due to its low cost, ease of operation, high sample throughput and good selectivity.

The main drawback of using the FAAS technique is its low sensitivity as compared to other sophisticated instruments such as GF-AAS, ICP-AES and XRF. The sensitivity of the FAAS technique can be improved by using separating and preconcentrating sample probes prior to instrumental analysis. Liquid–liquid extraction (LLE) is known to be a simple sample preparation method that can be used for the separation and preconcentration of trace metals from the aqueous phase to the organic phase. However, it is considered to be a time consuming, tedious and multistage operation method. At the same time, LLE also requires large amounts of toxic organic solvents^{17,18} and exposure of hazardous organic solvents to the environment. The disadvantages of the LLE method can be removed by the use of single drop microextraction (SDME) and hollow fibre-liquid phase microextraction (HF-LPME) methods. SDME is a simple, inexpensive and fast sample preparation

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Intensification of heat transfer using PANI nanoparticles and PANI-CuO nanocomposite based nanofluids



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ABSTRACT

The present work deals with the preparation of CuO, polyaniline (PANI) and PANI-CuO nanocomposite by in-situ emulsion polymerization which is subsequently dispersed in water to get PANI and PANI-CuO nanocomposite based nanofluid to study its convective heat transfer performance. The enhancement in the convective heat transfer of PANI and PANI-CuO nanocomposite based nanofluids was investigated by adding 0.1–0.5 volume% PANI and PANI-CuO nanocomposite particles individually (having particle size less than 100 nm) in deionized water (basefluid), respectively. Further, the effect of percentage of PANI and PANI-CuO nanocomposite particles and inlet temperature, on convective heat transfer performance was investigated. The experimental results show an enhancement by more than 12% and around 38% in heat transfer coefficient, when 0.5 vol% of PANI and PANI-CuO nanocomposite particles were added to the base fluid, respectively. This is attributed to use of PANI encapsulated CuO nanocomposite particles in nanofluids, which enhances the heat transfer coefficient significantly compared to PANI nanoparticles alone in nanofluid.

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1. Introduction

The nanofluids have found applications in numerous industries [1–5]. Several industrial technological systems also necessitate ultrahigh cooling performance so as to maintain the instruments cool for an efficient operation [6,7]. Inefficient heat transfer performance of conventional heat transfer fluids is the major limitation for the development of energy efficient heat transfer fluids which are meant for cooling purposes. Further, because of the inherent poor thermal conductivities of the conventional fluids, various efforts to create turbulence, increase in the area, etc. have been attempted in order to increase the heat transfer performance. With the addition of nanoparticles in base fluids resulting into a nanofluid is expected to have a significant effect on heat transfer performance. This is generally attributed to several hundred times higher thermal conductivity of the metallic solids or some polymers than that of conventional heat transfer fluids such as water, oil, ethylene glycol etc. [8–13]. A stable suspension of these particles in the base fluid to enhance the heat transfer

performance is an innovative approach. This enhancement in heat transfer performance by the suspension of these particles is attributed to a significant increase in the overall thermal conductivity of the resulting fluid [14–23]. However, millimeter or micrometer sized particles have many limitation and cannot be used in many industrial applications such as microsystems because of several problems like increase in the pressure drop, clogging of microchannels, rapid settling, damage or wear out of pipes, pumps or bearings, etc.

Recently, nanotechnology has given a smart solution to these problems. Nano-sized particles have greater surface to volume ratio for conduction and these particles show better suspension properties due to low dimensional structure in base fluids and give an increase in heat transfer performance. Nanoparticles, uniformly suspended in a base fluid will not have higher pressure drop, do not clog the microchannels and prevent sedimentation. The term nanofluid refers a mixture of a continuous liquid phase and a dispersed phase made of extremely fine metallic/metal oxide particles (of size below 100 nm). The addition of these nanoparticles to base fluids does increase the heat transfer performance by the virtue of increase in thermal property values of the resulting nanofluid [24–32]. Sommers and Yerkes [33] studied the convective heat transfer performance dilute suspensions of 10 nm

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Sonoprocessing of LiFePO₄ Nanoparticles and Nanocomposites for Cathode Material in Lithium Ion Batteries

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Lithium iron phosphate (LiFePO₄) nanoparticles and lithium iron phosphate/halloysite (inorganic nanotubes) (LiFePO₄/INT) nanocomposites were prepared by ultrasound-assisted synthesis in an aqueous solution of lithium hydroxide containing ammonium dihydrogen phosphate and ferrous chloride and used as cathode materials in lithium ion batteries. The performance of the cathode material was measured using cyclic voltammetry. The oxidation potential for LiFePO₄ polyaniline/nanotubes/anode cell was found to be in the range of -1.12 to 1.063 V while the reduction potential for lithium iron phosphate cell was in the range of -1.03 to 1.15 V. POLYM. COMPOS., 00:000-000, 2015.

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INTRODUCTION

Lithium-ion batteries show excellent performance such as good capacity retention, wide range of operating temperatures, and they are safe to operate [1]. Current research is focussed on improving the charge capacity, cycle life, energy density, environmental stability, safety, etc. [1, 2]. The Olivine LiFePO₄ materials have a great prospectus as a positive electrode in lithium ion battery

due to their high theoretical charge capacity (170 mAh/g), good cycle life, low equivalent weight, and environmental benignity. They can also be considered for future electronics applications to satisfy the need of storage devices [1-4]. LiFePO₄ has a stable three-dimensional framework structure due to the strong P—O bonds in (PO₄)³⁻, which proscribe the liberation of oxygen [1]. In addition, the inductive effect of the covalent P—O—Fe bonding in lithium iron phosphate compound gives rise to a high discharge voltage (~3.4 V versus Li⁺/Li) [4]. Compared to Co, Ni, and Mn, iron-based compounds have an advantage of low cost and abundant availability [3]. The major disadvantage of lithium iron phosphate is slow charge and resistance to mass transport because of the release of oxygen from transition metal oxides. The use of lithium ion batteries in large-scale commercial applications is avoided since the oxygen release at higher temperatures can cause explosion [5]. A number of attempts were made to overcome these limitations [6-8]. Electron transport of these materials was enhanced by applying conducting layer around LiFePO₄, which includes silver [8], carbon-based materials [6, 7], conducting polymers [9-11], and doping of LiFePO₄ using foreign conducting materials [9, 10]. Secondly, the improvement in capability of LiFePO₄ materials was carried out by increasing the surface area by reducing the particle size and use of a uniform narrow particle size distribution [12-17]. A number of attempts were made in synthesizing LiFePO₄ nanomaterials such as

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Original Article

Ultrasound assisted preparation of ZnO nanostructures: understanding the effect of operating parameters

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Novel optical properties of $\text{Ca}_{12}\text{Al}_{10.6}\text{Si}_{3.4}\text{O}_{32}\text{Cl}_{5.4}:\text{Ce}^{3+},\text{Li}^+$ phosphor for solid-state lighting

M. Kolte,^a V. B. Pawade^{b*} and S. J. Dhoble^a

ABSTRACT: This article reports a novel blue emission in a series of $\text{Ca}_{12}\text{Al}_{10.6}\text{Si}_{3.4}\text{O}_{32}\text{Cl}_{5.4}:\text{Ce}^{3+}$ phosphor under excitation in the near-UV wavelength range. This phosphor was prepared using the combustion method. Here, the Ce^{3+} emission band is observed over a broad range of 380–550 nm, under 365 nm excitation, and is due to 5d–4f transition. The effect of a Li^+ charge compensator on the emission properties of the phosphor was also investigated for the first time. X-Ray diffraction confirmed the phase purity of the synthesized phosphor. The surface morphology and elemental composition of the phosphor were studied using scanning electron microscopy and energy-dispersive X-ray spectroscopy. Copyright © 2016 John Wiley & Sons, Ltd.

Keywords: phosphor; XRD; EDS; SEM; PL

Introduction

The search for new phosphor materials for use in the conversion of near-UV from a light-emitting diode (LED) chip into visible light has opened up an interesting new field in the development of inorganic luminescent materials. Rare earth (RE)-activated (divalent or trivalent) inorganic compounds with an allowed d–f transition are well known and are used worldwide. RE ions showing an f–f transition are not suitable for such uses, because their absorption strength in the near-UV and visible parts of the electromagnetic spectrum is too low and hence they cannot be excited by a near-UV LED chip. RE ions with allowed absorption into the 5d state are highly sensitive due to their chemical surroundings and are not well shielded like the 4f state. Thus, broad band absorption and an emission band in the 5d–4f transition are very useful for solid-state lighting.

Recently, much effort has been put into the development of white (W)-LEDs, due to their wide application in consumable electronic devices (1–3). In general, white light can be obtained in two ways. First, by mixing primary colors, i.e. blue, green and red, to form white light and second, by combining a blue LED and a yellow phosphor (YAG: Ce^{3+}) (4). Issamu Akasaki, Hiroshi Amano and Shuji Nakamura were awarded the 2014 Nobel Prize for inventing blue-LEDs. In addition to the red and green components, the blue component is special. 'The blue thing, though was very difficult to accomplish', said Olte Inganas, a physics expert on the Nobel Committee.

RE-doped oxide-based phosphors are chemically and physically stable and are easier to synthesize than nitride-based phosphors (5–7). Among the different oxide-based phosphors, very little work has been done on aluminosilicate-based phosphors doped with a RE ion (8). In general, Ce^{3+} ions show an emission band within the UV to visible spectral range that depends on the cations (9,10). The emission intensity of Ce^{3+} can be improved by using different charge compensators such as Li^+ , Na^+ and K^+ ions. Kelsey and Brown reported that a charge-compensator phosphor is brighter than an uncompensated phosphor (11). Li^+ co-doping may

incorporate Ce^{3+} into Ca^{2+} sites by compensating for different changes between the Ca^{2+} host (12).

In this article, we mainly focus on the photoluminescence (PL) properties and effect of Li^+ on the emission band of $\text{Ca}_{12}\text{Al}_{10.6}\text{Si}_{3.4}\text{O}_{32}\text{Cl}_{5.4}$ phosphor when activated with Ce^{3+} ions, and prepared using combustion synthesis. The prepared phosphor materials may be applicable in W-LEDs using either InGaN-based blue LEDs or GaN-based near-UV LEDs.

Experimental

A series of Ce^{3+} -doped $\text{Ca}_{12}\text{Al}_{10.6}\text{Si}_{3.4}\text{O}_{32}\text{Cl}_{5.4}$ phosphors was synthesized using the combustion method at 550°C. This method involves an exothermic reaction between individual metal nitrates with urea as a fuel. Combustion synthesis is a well known and easy technique for the preparation of complex oxide ceramics such as aluminates, silicates, ferrites and chromites within few minutes.

To synthesize chloro-aluminosilicate-based phosphor the starting materials are $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ (Merck 99.9%), $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ (Merck 99.9%), SiO_2 (A.R.), $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ (Merck 99.9%), urea NH_2CONH_2 (Merck 99.9%) and $(\text{NH}_4)_2\text{Ce}(\text{NO}_3)_6$ (Merck (99.99% purity)). The weight of materials was calculated in a stoichiometric ratio using the concept of propellant chemistry. Individual metal nitrates and fuels were mixed in an agate mortar and a small amount of dilute nitric acid was added to the mixture during crushing, which helped to homogenize the materials. After gel formation, the mixture was transferred to a crucible, which was kept in a vertical muffle furnace, preheated to 550°C. Within 3–5 min, the pasty solution in the crucible dehydrated, swelled, ruptured

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Investigation of TiO₂ photocatalyst performance for decolorization in the presence of hydrodynamic cavitation as hybrid AOP



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ABSTRACT

In this article, an acoustic cavitation engineered novel approach for the synthesis of TiO₂, cerium and Fe doped TiO₂ nanophotocatalysts is reported. The prepared TiO₂, cerium and Fe doped TiO₂ nanophotocatalysts were characterized by XRD and TEM analysis to evaluate its structure and morphology. Photocatalytic performance of undoped TiO₂ catalyst was investigated for the decolorization of crystal violet dye in aqueous solution at pH of 6.5 in the presence of hydrodynamic cavitation. Effect of catalyst doping with Fe and Ce was also studied for the decolorization of crystal violet dye. The results show that, 0.8% of Fe-doped TiO₂ exhibits maximum photocatalytic activity in the decolorization study of crystal violet dye due to the presence of Fe in the TiO₂ and it may act as a Fenton reagent. Kinetic studies have also been reported for the hybrid AOP (HAOP) that followed the pseudo first-order reaction kinetics.

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1. Introduction

Dyes are having many applications in different industrial processes such as textile, printing, leather, paint, plastic, food, cosmetics, and pharmaceutical industries [1]. Waste water discharge from these industries containing high concentrations of dyes, high toxicity and intense color causes serious problems on surrounding ecosystem [2]. Many treatment methods are available for the treatment of above mentioned industrial wastewater, such as conventional biological treatment (aerobic and anaerobic), adsorption, coagulation and flocculation. The main drawbacks of these methods are not being able to completely degrade the dye molecules present in the waste water due to the complex and bio-recalcitrant nature of the dye molecules. Azo dyes are known to be more non-biodegradable under aerobic biological conditions and these dyes are converted to more hazardous intermediates under anaerobic conditions [3]. Some methods such as coagulation/flocculation and adsorption are physical treatment methods and these methods did not involve chemical transformation and therefore generally transport the waste components from one phase to another phase, that leads to secondary waste pollutant on the environment [4,5]. Therefore, it is necessary to find an effective treatment technology for the degradation of the complex and non-biodegradable

molecules to smaller molecules. For this application, advanced oxidation processes (AOPs) have been employed and evaluated since the 20th century to degrade azo dyes from the wastewater. Among AOPs, electrolysis and photocatalysis are extensively studied [6]. AOPs involve the generation of hydroxyl radicals and complete oxidation of such pollutants including dyes converted into end products, such as CO₂, H₂O, etc. [7]. Recent literature has indicated that hybridization of different AOPs has been found to be more efficient for the wastewater treatment than individual oxidation process [8,9].

Recently, hydrodynamic and acoustic cavitation has been widely applied as an advanced oxidation technology along with other AOPs for wastewater treatment as a hybrid treatment technique [10–12]. When an aqueous solution is passed through a mechanical constriction, large pressure differentials are generated due to the change in flow geometry. If the pressure of the aqueous solution at the constriction falls below the vapor pressure of the aqueous solution, cavities are formed, and grow and/or subsequently collapse on the recovery of pressure [13]. Sudden collapse of these cavities (occurring in microseconds) yields localized high temperatures and pressures. Water molecules under such extreme conditions undergo thermal dissociation to form hydroxyl radicals, which are powerful oxidants for the complete mineralization of many organic pollutants [14].

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Quenching and dipole–dipole interactions in $\text{Sr}_2\text{Al}_2\text{SiO}_7:\text{Ce}^{3+}$ host lattice

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Abstract This article reports novel results on the optical properties of Ce^{3+} -doped $\text{Sr}_2\text{Al}_2\text{SiO}_7$ host lattice which has been synthesized by the combustion method at 550 °C for the first time. $\text{Sr}_2\text{Al}_2\text{SiO}_7:\text{Ce}^{3+}$ phosphor shows the blue emission bands at 430 nm due to $5d-4f$ allowed transition of Ce^{3+} ion, keeping the excitation wavelength constant at 357 nm. Some theoretical study is carried out on the critical distance of energy transfer, concentration quenching and type of interaction in host and rare earth ion, and it is done by using the equation reported by Van Uitert et al. Further phosphor is well characterized by XRD, SEM and EDS analysis to study phase purity, surface morphology and elemental analysis.

1 Introduction

From the fundamental physics point of view, excited state dynamics of rare earth or impurity ions is of great importance, because this rare earth ion consists of free electrons. And the interaction of this atom or ion with radiation leads to different processes in materials medium. These processes involve the absorption, excitation and emission mechanism. Thus, the rare earth ions play an important role as activators in phosphor materials that are used in optical devices. Therefore, the phosphor is an excellent material

used in luminescent lighting from the past to recent, and new development on rare earth-activated inorganic phosphor materials is also going towards low cost-effective smart materials for lamp industries [1–3]. The emission in rare earth-activated phosphor materials originates from their abundant energy levels. Generally, Ce^{3+} ion contains only two states existing from where emission originates that is $5d$ and $4f$ states, respectively. The position of $5d$ excited state in the phosphor host lattice provides the important information about the interaction between $5d$ electron and the free ligand ions in the host [4]. When the electron level in the $5d$ state is above the host conduction band, then it will have the possibility to delocalize. This is called photo-ionization because the delocalization occurs through the photo-excitation of $5d$ electrons. In case of thermally assisted photo-ionization, a promotion of one or more electrons from the $5d$ component of crystal field (excited state) to the conduction band that assisted by phonon has also been investigated [5]. Therefore, the Ce^{3+} ion is one of the most attractive rare earth ions than other RE ions in the lanthanide series, due to their $5d$ state dynamics research in applied as well as basic field of physics. From the energy level splitting in Ce^{3+} ion, it is observed that they contain two ground-state terminating levels $^2F_{5/2}$, $^2F_{7/2}$ in $4f$ state (ground state) and two to five component splitting observed in $5d$ state (crystal field splitting/excited state) [6]. If the Ce^{3+} $5d$ excited state bands are higher than the conduction band, then it is unable to emit the light. The luminescence from Ce^{3+} $5d$ is observed only when at least one of the $5d$ states observed lies below the bottom of the conduction band. This type of dynamics of Ce^{3+} emission is observed in many host lattices. Therefore, the lanthanides with 3+ stable state are usually used as an activator in luminescent materials because of its $d-f$ transition which confer unique

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Intensification of ultrasound-assisted process for the preparation of spindle-shape sodium zinc molybdate nanoparticles



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ABSTRACT

In the present work, sodium zinc molybdate (SZM) nanoparticles were prepared using conventional and an innovative ultrasound assisted co-precipitation of sodium molybdate, zinc oxide and HNO₃ at different temperatures. Prepared product was characterized by XRD, TEM, FT-IR, particle size distribution (PSD), TGA and DTA techniques. TEM analysis shows the spindle-shaped morphology of the formed SZM nanoparticles. The average particle size of SZM nanoparticles is found to be lower in case of sonochemical method (78.3 nm) compared to conventional method (340.2 nm) which is attributed to faster solute transfer rate due to ultrasonic irradiation leading to rapid nucleation and restricted growth of SZM nanoparticles. Further, the kinetics of synthesis of SZM nanoparticles are studied using the sonochemical method at different operating temperature and conventional method at 80 °C. It is shown that the rate of reaction is significantly faster at 40 °C compared to other temperatures and also conventional method. This can be attributed to intense cavity collapse at lower temperature (low vapour pressure) compared to higher temperature (high vapour pressure) of the reaction mixture.

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1. Introduction

Sodium zinc molybdate (SZM) has been identified as a novel corrosion inhibiting pigment and is recommended as non-toxic anticorrosive pigment for marine coatings as these pigments possess low toxicity as compared to chromate/lead based anticorrosion pigments [1]. SZM is essentially white and non-toxic pigment, which has anticorrosive properties better than those of zinc yellow and other commercially available pigments. Zinc yellow pigment has disadvantages such as its yellowish colour and toxicity. Corrosion protection of metals and the replacement of toxic compounds in paint formulations are the most important considerations claimed in the field of paint technology. Consequently, many attempts have been made to replace toxic pigments with those which do not have these disadvantages [2–4]. Many compounds have been proposed as possible replacements for chromates and lead compounds, but zinc phosphate and related substances have become the leading substitutes for toxic inhibitors [5–9]. Sodium zinc molybdate pigment can be applied as an anticorrosive pigment due to the following reasons (i) zinc element

gives the anticorrosion performance by sacrificial mechanism, (ii) molybdate group partially dissolves in water and forms adsorbed inhibitive layer of metal complex on the metal surface, and (iii) it is white and nontoxic pigment. Sodium zinc molybdate acts as a corrosion inhibitor and hence used in many industrial corrosion protective coatings.

Recently, the study of physical and chemical effect of ultrasound irradiation on the synthesis of inorganic materials is rapidly developing into a major research area [10–14]. The chemical and physical effects arise from extreme adiabatic conditions (high temperature and pressure pulse) generated locally due to cavity collapse [15–18] and it is gradually becoming an important tool for the synthesis and modification of nanosized functional inorganic materials [19]. Further, the extreme conditions of high temperature, pressure and intense micromixing achieved during acoustic cavitation lead to the formation of nanometer sized particles with improved solute transfer and nucleation rate in aqueous suspension [19]. Hence the use of ultrasonic irradiation to prepare anticorrosive nanopigments is likely to improve the product distribution (lesser size) leading to well-dispersed nanoparticles to be used in the coatings with lesser dosage of nanopigments, which would reduce the overall cost [20–24].

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Investigation of the Thermal Performance of Green Roof on a Mild Warm Climate

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Abstract- Global warming has become a threat of our time. It poses challenges to the existence of all biota on this earth and has made a clear impact on the level of energy and water consumption. No doubt, increase in the ambient temperature increases indoor and outdoor temperature level of the buildings which catalyzes the use of energy and cost intensive mechanical air-conditioning systems. Green roof tops belong to such an idea for cutting down the energy consumption and enhancing the comfort level of commercial and residential buildings. This paper investigated the impact of green roof on thermal performance and cooling potential in mild warm climate of India. It was observed experimentally that compared to the exposed roof, the room air and interior surface temperature of the green roof were reduced by a maximum of 17% and 22% respectively. Heat flux studies show that not only the peaks are lower but also the diurnal heat fluctuation through the green roof assembly is lower than that of the conventional roof in the case of heat in-leak. Further, a thermal lag of around 2 to 3 hours has been observed. The simulated model developed in this study has been closely replicated by the experimental data, thereby efficacy of the model is demonstrated unequivocally.

Keywords Green roof; heat flux; canopy; evapotranspiration; Thermal comfort.

1. Introduction

Onmura et al. [1], in 2001, in his studies in a three story building in Japan, investigated the evaporative cooling effect from roof lawn gardens and it was confirmed that the surface temperature of the roof decreased from 6°C to 30°C during day time which was estimated to be a reduction of 50% heat flux. A detailed analysis of the thermal properties and energy performance study through mathematical approach was done by Niachou et al. [2], in 2001. This study was conducted in a hotel situated in Athens, Greece. In his findings the greatest energy savings during a whole year period was 37% for non-insulated buildings, 4% for moderate insulated buildings and 2% in well-insulated buildings. Theodore et al. [3], studied a technique for the inclusion of a model in building energy simulation in 2003. The results were validated by the use of real data taken from an existing construction in the city of Thessaloniki, Greece and a parametric study was performed in order to evaluate the main planted roof characteristics that affect the performance of a planted roof as a passive cooling technique. It was shown that relative humidity is the most important climatic factor which affects the cooling potential of the green roof.

Wong et al, (2003) conducted a field study in a low rise commercial building in Singapore [4]. In his studies a maximum reduction of surface temperature of 30°C was obtained and the temperature reduction varied on the type of plants and density LAI (Leaf Area Index) of the plants. Thermal performance of green roof installed by the Vicenza Hospital, Italy was studied and analyzed by Lazzarin et al. [5], in 2005. The role of the latent flux of the evapotranspiration was studied and with the soil in almost dry conditions the green roof allows an attenuation of the thermal gain entering the underneath room of about 60% with respect to a traditional roofing with an insulating layer

Evaluation of the cooling potential of green roof with solar thermal shading in India was developed by Kumar, et. al. in 2005 [6]. The model was validated against the experimental data from a similar green roof-top garden in Haryana, India, and in his findings green roof combined with solar thermal shading reduced average indoor air temperature by 5.1°C, from the average indoor air temperature for the bare roof. The studies [7] have reported that green roofs can reduce summer daily peak surface temperature by 15°C–45 °C and peak air temperature by up to 5°C. Energy demand

Giant dielectric response and magnetoelectric behavior of 95BiFeO₃–5BaTiO₃ (95BFO–5BT) ceramics

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Abstract A detailed study of electrical behavior of 95BiFeO₃–5BaTiO₃ (95BFO–5BT) ceramics through comprehensive analysis of temperature and frequency dependent dielectric behavior, ac impedance and magnetodielectric (MD) properties is reported here. Addition of insulating BaTiO₃ into BiFeO₃ have exhibited enhanced dielectric and ferromagnetic responses. The remnant polarization (P_r) was found to be 6 $\mu\text{C}/\text{cm}^2$, while the dielectric constant was found to be very high ($\epsilon'_r \geq 10^2$, for $T \geq 140$ °C). Along with strong conductivity contribution to ϵ'_r , spectroscopic plots of ϵ'_r revealed the Maxwell–Wagner type relaxation in the sample, which ultimately could have led to an apparent high ϵ'_r in 95BFO–5BT ceramics. Origin of such a high ϵ'_r in BFO–BT was further investigated using impedance spectroscopy. MD studies revealed the magneto-electric coupling in the ceramics. The MD studies along with anomaly in dielectric data near antiferromagnetic ordering temperature ($T_N = 170$ °C) of BFO suggests the magnetic bearing on the electrical properties of 95BFO–5BT ceramics.

1 Introduction

Materials exhibiting two or more coupled functional properties have gained much attention during the last two decades due to their potential applications in advanced technologies. Multiferroic materials simultaneously exhibit multiple ferroic properties, such as ferroelectricity, ferroelasticity, and ferromagnetism (or antiferromagnetism). These multiferroic materials have been used in the magnetic data storage devices, sensors, transducers, etc. [1–6]. Amongst the materials exhibiting multiferroic properties, BiFeO₃ (BFO) has emerged as one of the most extensively investigated multiferroic material, which have shown multiferroic behaviour at room temperature. BFO is ferroelectric with a Curie temperature (T_C) of about 830 °C and antiferromagnetic with a Neel temperature (T_N) at around 370 °C [7, 8].

BiFeO₃, a semiconducting material, forms a solid solution with BaTiO₃ (BT), which is insulating in nature, the small addition of BT into BFO have resulted in enhancing the overall electrical properties. This have also resulted in stabilizing the perovskite structure, as both the materials have perovskite (ABO₃) structure [9–16]. In this paper, BT has been chosen to form solid solution with BFO, owing to its excellent ferroelectric properties (for single crystal, $T_C = 120$ °C, $P_S = 26$ $\mu\text{C}/\text{cm}^2$ and $\epsilon'_r = 2000$, and for polycrystalline, $T_C = 130$ °C, $P_S = 14.6$ $\mu\text{C}/\text{cm}^2$, and $\epsilon'_r = 1400$ –2100) [17, 18]. Considering these useful electrical properties exhibited separately by BFO and BT, BFO–BT in solid solution/composite form has been widely studied for improvement in the dielectric, multiferroic, piezoelectric properties of pure BFO [9–16].

Along with the interesting electrical properties, the structural properties of BFO–BT solid solution are also fascinating. With earlier investigations on BFO–BT

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Experimental Study of CO₂ Gasification of Biomethanation Waste

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ABSTRACT

Gasification is one of prominent thermochemical processes generally used to convert organic feedstock to combustible syngas (CO and H₂). An experimental study of biomass gasification using carbon dioxide as an gasifying medium was carried out in a fixed bed gasifier. The main aim of this study was to determine the effect of temperature on the output syngas. The present study reported the results for producing syngas with CO₂ as gasification agent and biomass (rice husk and bio-methanation waste) as raw material. The gasification was performed at 700-900°C respectively and CO₂ flow rate was maintained at 0.5 lpm. Maximum syngas production found at high temperature (900°C). The syngas analysis showed higher hydrogen yield at higher temperatures.

Keywords: Rice husk, Bio-methanation waste, Gasification, Hydrogen.

I. INTRODUCTION

Biomass has a great potential as renewable energy resource due to huge availability and some prominent fuel properties like minimum sulfur content and low percentage of ash (Ahmad et al. (2016); Chan and Tanksale 2014). The Green energy policy has given tremendous importance to generation of energy from agro-waste (Alipour Moghadam et al. 2014). Generally organic feed stocks are converted to syngas (CO + H₂) via gasification route (Arafat and Jijakli 2013). Solid waste management via thermochemical processes (e.g. incineration, pyrolysis, or gasification) can resolve the waste management issues of impact on human beings and environment. Gasification is a efficient technology to produce syngas from solid wastes (Begum et al. 2014) and involves high temperature reactions to convert solid materials containing carbon, such as coal, solid waste or biomass, into a gas called syngas which contains hydrogen and carbon monoxide (Rajasekhar et al. 2015).

Many gasification studies have been reported in literature. Air gasification of rice husk at 750-850°C in a fluidized bed showed that carbon conversion rate decreased with respect to change in temperature and feed rate and equivalence ratio (Makwana et al. 2015). Gasification of various solid wastes (wood, textile, kitchen garbage, paper separately) in a fixed bed reactor with oxygen gave maximum syngas and lower CO₂ at higher temperatures (800-850°C) (Niu et al. 2014) Another research study reported that steam gasification of dried sewage sludge (in presence of activated carbon, dolomite, and CaO) yielded tar

free syngas, with low amount of ammonia in a fixed bed reactor at 900°C (Li et al. 2015). CO₂ gasification of thin wood biomass at 850°C has reported that the rate limiting step was the global pyro-gasification reaction as this reaction required nearly 95% of the entire biomass conversion time (Guizani et al. 2015). Gasification of coal at 1400°C in presence of CO₂, O₂ and H₂O separately showed that, soot formation slightly decreased during O₂ and H₂O gasification, while the soot formation was low with increase in carbon conversion rate in CO₂ gasification (Umemoto et al. 2016). Zhai et al. have investigated the steam gasification of bio char (prepared from rice husk) at 700-950°C and reported that the gasification temperature is the key factor in whole process i.e. char conversion rate increased from 27.7% to 90.73% and 46.9% hydrogen was obtained at 950°C (Zhai et al. 2015)). The effect of plastic addition in steam gasification showed an increase in syngas yield with higher amount of hydrogen in absence of catalyst (Alvarez et al. 2014).

The gasification process is mainly affected by temperature, catalyst, residence time and oxygen to fuel ratio (Bronson et al. 2016); Parthasarathy and Narayanan 2014)). In another research study, it was reported that gasification of cotton stalk at 850°C, with oxygen fuel ratio (0.12-0.4) in presence of Ca(OH)₂ yielded 45 % H₂, and 33% CO (Hamad et al. 2016). Gasification of woody biomass in fluidized bed using air as gasifying agent & fluidizing gas (with control flow rate) gave low calorific value syngas (Kim et al. (2013). Also autothermal steam gasification of biomass in fluidized bed gave low nitrogen content syngas

ABSTRACT

In recent years, there has been a marked increase of interest in biodegradable materials for use in packaging, agriculture, medicine, and other areas. As a result, many researchers are investing time into modifying traditional materials to make them more environmental friendly, and into designing novel polymer composites out of naturally occurring materials. In order to overcome the environmental problems associated with natural and synthetic waste, biodegradation of materials holds good promise and a detailed and systematic study of the process are needed. Under ambient conditions, polymers are known to undergo deterioration in their properties characterized by change in their molecular weight and other physical properties. In this study biodegradable polymer based on natural products glucose and sorbitol were synthesized and were used in preparation of liquid and powder detergents, hand wash and dish washers. This investigation reveals that the polymers synthesized from raw materials of natural origin namely liquid glucose, glycerol, sorbitol etc. are susceptible to biodegradation.

KEYWORDS: Biodegradable polymer, Chemical and Biological Oxygen Demand.

INTRODUCTION

Biodegradable polymers¹ are a newly emerging field. A vast number of biodegradable polymers have been synthesized recently and some microorganisms and enzymes capable of degrading them have been identified. In developing countries, environmental pollution caused mainly by synthetic polymers has assumed dangerous proportions. As a result, attempts have been made to solve these problems by introducing biodegradability into polymers through slight modifications of their structures. Biodegradation is a natural process, by which organic chemicals in the environment are converted into simpler compounds.

Since most of the polymers are resistant to degradation, research over the past couple of decades has focused on developing biodegradable polymers, which are degraded and catabolized ultimately to carbon dioxide and water by microorganism under natural environment. Another approach towards achieving biodegradability² has been through the addition of biodegradable groups into main chain during the preparation of industrial polymers by free radical copolymerization. Studies on the biodegradation of plastics have increased the information on degrading microbes, enzymes and their genes since the future lies in developing polymers that will degrade in the environment.

In the present investigation polymers based on natural products glucose and sorbitol were synthesized and were used in preparation of liquid and powder detergents, hand wash and dish washers³⁻⁴. These products were then evaluated for biodegradability. The details of the experimental work are explained below.

MATERIAL AND METHODS

Reaction programming and steps involved in synthesis of polymers

Polymers of various compositions were prepared in batch process. The mole ratios, reaction temperature and addition of ingredients are detailed below in four steps:-

ABSTRACT

One of the most widespread biopolymer in nature, after cellulose, is chitin. It can be extracted from sources like crustaceans, microorganisms and insects. However, the main commercial sources of chitin are shells of crustaceans such as prawns, crabs, lobsters and krill that are supplied in large quantities by the shellfish processing industries. Extraction of chitin can be done by two processes, chemical and biological. Chemical method requires acids and bases like sodium hydroxide, hydrochloric acid and acetic acid for deproteination, demineralisation and decolourisation processes respectively and microbial method includes the use of various micro-organisms for the similar steps as chemical process. The chitin obtained is further processed by deacetylation method using sodium hydroxide to convert into chitosan, another product having high industrial significance which possesses valuable properties like biocompatibility, biodegradability, antibacterial nature, film forming and fibre forming ability promoting its use in a variety of interesting applications. Applications of chitosan are found in industries such as textiles, medicine, food, agriculture, paper, cosmetics and wastewater treatment. The paper reviews the methods of synthesis, characterisation of chitosan with analytical methods like FTIR, SEM, NMR etc. and bioactivity determination of Chitosan as anti-microbial, anti-blood coagulant etc. properties.

KEYWORDS: Chitin, Chitosan, Characterisation

INTRODUCTION

Chitin is widely found in insects, fungi, and yeast and marine invertebrates. However, in higher plants and animals, chitin is not present. Generally, the shell of selected crustacean consists of 30-50% calcium carbonate and calcium phosphate, 30-40% protein and 20-30% chitin. The principal source of chitin is shellfish waste such as shrimps, crabs, and crawfish. Although chitin itself is insoluble in water, on deacetylation it yields chitosan, a product having a wide range of viable uses. Chitosan, which is very much similar to cellulose, is a non-toxic, biodegradable polymer of high molecular weight. It is a co-polymer of glucosamine and N-acetylglucosamine and has generated interest due to its biocompatibility, high charge density, non-toxicity and mucoadhesion. The biological properties like biodegradability, adaptability, hemostatic activity and wound healing properties of chitin and chitosan attracted much attention to their biomedical applications. They are also used in water engineering, in the food and nutrients industry, film forming and coagulating ability and many more applications [1].

Until now, chemical, microbiological and enzymatic methods have been used for preparing chitosan from prawn shell powders. The chemical method involves demineralization, deproteinisation, and deacetylation steps using strong acids and/or alkali. However, the use of such chemicals seriously pollute the ecological environment and harm human health, produce abundant waste and can hydrolyse the polymer. With increased demands on environment-friendly culture, more eco-friendly processes have been worked upon by researchers using microbiological and enzymatic methods for producing chitin and chitosan. The enzymatic method consists the use of trypsin, papain, and pepsin. However, the high cost of enzymes and the low extraction are some of the pitfalls of these methods [2].

This paper reviews the methods of synthesis, characterisation and bioactivity determination of Chitosan from prawn shells.

ABSTRACT

Chitin is one of the most widespread biopolymer found in nature. Shells of crustaceans such as prawns, crabs and lobsters are the main commercial sources of chitin. Chitin can be processed into chitosan, another, having varied industrial and biomedical significance. Lignin is another biomaterial, usually generated from agricultural waste and paper industry. The present work aims at synthesising chitosan from prawn shell and extracting lignin from wheat straw. It is further extended to form biocomposite films using these biomaterials by solution-casting technique. Appropriate analytical tests have been conducted like FTIR, SEM and tensile strength to study functional groups present, surface morphology and mechanical strength of the biomaterials synthesised and biocomposite films formed. The present work has successfully synthesised chitosan from crustacean shells and lignin from wheat straw. The results of analysis are encouraging & indicative of potential of lignin-chitosan biocomposite films specially in packaging of food material and in wound dressings. Use of lignin will reduce chitosan quantity and there by cost. It also utilises waste materials like crustaceans shell & wheat straw successfully in developing value added products chitosan and lignin.

KEYWORDS: Chitosan, Lignin, Prawn shells, Wheat straw, Chitosan-Lignin Biocomposite.

INTRODUCTION

The shell and head portions of prawns, shrimps and lobsters are generated as wastes, during the processing [1]. Although these wastes are biodegradable, it is comparatively slow. Extraction of commercially viable substances and conversion into value added seems to be the immediate solution to this problem [2].

Chitin and Chitosan

Chitin is the second most abundant natural, stable and biodegradable biopolymer after cellulose [3]. It is a long-chain polymer of N-acetyl D-glucosamine and derivative of glucose. Chitin is poly- β -(1-4)-N-acetyl-D-glucosamine as shown in Fig.1.

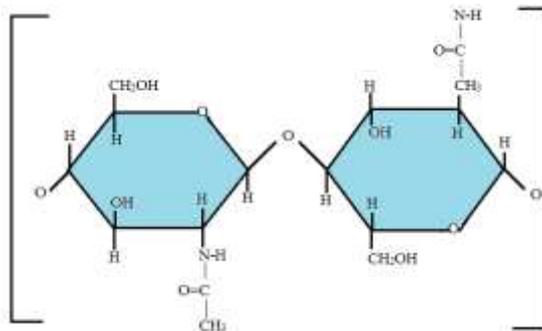


Fig.1: Molecular structure of Chitin

Although Chitin itself being insoluble in water, a valuable chemical substance, on deacetylation yields chitosan, having a wide range of viable uses, which is soluble under acidic conditions [4].

Chitosan is obtained by removing enough acetyl groups ($\text{CH}_3\text{-CO}$) from chitin. The acetyl content of the polymer is the actual difference between chitin and chitosan. Chitosan is a co-polymer of glucosamine and N-



Parameter Optimization of Thermal Barrier Coatings used in Two Stoke Externally Scavenged S.I. Engine using Non-Traditional Optimization Algorithms ☒

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Abstract

Various researchers have studied and introduced, although limited, varieties of thermal barrier coatings (TBC) materials. Each of these TBC materials has their own respective properties. Considering all these properties which one will be the effective choice among the available lot is very difficult to estimate. The optimisation is carried out using non-traditional optimisation techniques namely simple additive weighting method (SAW), weighted product method (WPM), technique for order preference by similarity to ideal solution (TOPSIS) & preference ranking organization method for enrichment evaluations (PROMETHEE) are used to find out the best optimal choice for the specified engine. The results of the above mentioned algorithms are compared and presented in this paper to decide which tbc material will perform comparatively better & give accordingly the good results.

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Evaluation of Damaged Corn Grains for Fuel Ethanol Production

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ABSTRACT: Physiochemical and biochemical characteristics of damaged blackened corn grain meals to ethanol production was evaluated and compared with sound grains. There was 40% and 17% decrease in starch and protein in damaged kernels. Endosperm structure of blackened and control. Corn was examined using Scanning Electron Microscope (SEM). Laboratory dry grind ethanol production process was used to study ethanol production from damaged corn grains. Damaged and fine corn contained 35 g/L and 48 g/L of reducing sugar at the end of liquefaction with α amylase. Liquefaction of fine corn was completed in 2 h. However, liquefaction progress of blackened corn is slightly slower as compared to control corn. Ethanol yield from damaged and fine corn grains are 0.17 and 0.22 g ethanol/g flour respectively. The blackened corn had 23 % reduced ethanol yields compared with control and this negative result may be due to dry matter loss occurred during storage. The research demonstrates that use of damaged corn kernels is feasible and a good alternative for biorefineries and could reduce the production cost of ethanol.

KEYWORDS: Physiochemical, Damaged, Endosperm, Ethanol.

I. INTRODUCTION

Corn (*Zea mays*) is grown throughout the year in India. It is predominantly a kharif crop with 85 per cent of the area under cultivation in the season. Maize is the third most important cereal crop in India after rice and wheat. It accounts for ~9 per cent of total food grain production in the country. Various starchy materials such as corn, wheat, sorghum, rice and potatoes produced in surplus quantities has been used for Industrial ethanol production [P. Nigam, D. Singh] to emerge as a renewable energy source for the future. Some qualitative and quantitative losses occur in the postharvest system of cereals. Mainly during drying in the field and storage and biotic factors such as insects, rodents and sprouting causes overall postharvest losses in corn can be around 29%. According to FAO (1993), the range of worldwide postharvest losses is between 10 and 37%. The use of insect, fungi and sprout-damaged grain for human consumption is not always possible and its utilization in other industrial processes could reduce, at least to some extent, the producer losses. A large quantity of different grains is spoiled every year in India because of unfavourable climatic conditions and inadequate transport and storage facilities. Regarding the use of damaged kernels in ethanol production, Yan et al. (2010) tested field-sprouted-sorghum and concluded that the use of these kernels significantly reduced fermentation time and yielded higher ethanol. The detrimental effect of aflatoxins associated with maize mashes was studied by Murthy et al. (2005). These authors concluded that maize containing 775 ppb or less aflatoxins did not affect ethanol yields. C. Chuck-Hernandez et al. (2012) investigated the bioconversion into ethanol of insect (*Sitophilus zeamais*), mold (*Aspergillus flavus*) and sprout damaged maize and sorghum. Their research demonstrates that the use of already damaged insect, mold or sprouted kernels is feasible and a good alternative for biorefineries.

The main objectives of this study were to investigate physiochemical characteristics and fermentation performance of damaged blackened corn. Furthermore, changes in physical properties of control, damaged blackened corn meal

EFFECT OF SIZE REDUCTION ON OSMOTIC DEHYDRATION OF GUAVA

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ABSTRACT:

The effect of parameters such as varying time duration of osmosis and sugar syrup concentration at the time of osmotic dehydration of raw guava slices (5 mm thick) and cubes on mass transfer data such as water loss, solid gain and mass reduction were studied. Sucrose solution of 70°B and 80°B was employed as per osmotic dehydration process. After completion of osmotic dehydration process, the water loss from guava cubes and guava slices of 70°B is found as 28.45 to 44.41 and 23.49 to 36.14 per cent resp. and of 80°B is found as 30.90 to 49.6 and 30.5 to 47.61 per cent resp. Similarly, sugar gain and mass reduction was calculated for guava slices and guava cubes. It was observed that the mass reduction, water loss and sugar gain increases with increase in sugar syrup concentration and duration of osmosis.

KEYWORDS: Osmotic dehydration, size reduction, water loss, mass reduction, sugar gain, duration of osmosis

I. INTRODUCTION:

The Guava, botanically known as *Psidium guajava* belonged to the family of Myrtaceae. Guava (*Psidium guajava*), is also called as the "poor man's fruit" or "apple of the tropics" [1]. It was a popular tree fruit of the tropical and subtropical climates and was native to the tropical America stretching from Mexico to Peru. It had been adopted in India so well that it appeared to be an almost Indian fruit. Guava was considered to be one of the most exquisite and nutritionally valuable remunerative crops. The guava fruit and its juice are mostly consumed for its taste, nutritional values and flavor. In India after mango, banana and citrus, guava is the fourth most important commercial fruit for production. Guava was a fruit which was grown all over the country and also in kitchen gardening and near the wells and tube wells premises and also grown on a commercial scale. For the production of guava fruit, nearly 0.15 million ha of land occupies with production of 1.80 million tons and productivity 12t/ha fruit per year in India. In India, guava is grown in Bihar, Andhra

Pradesh, Uttar Pradesh, Gujarat, Maharashtra and Karnataka on large scale [2].

According to various shapes, sizes and other characteristics, the guava fruit of the different Varieties are extremely variable. The various varieties of guava found as rounded, globular, ovoid or pear in shaped. The size of guava fruit is from 3 to 15 cm in length and has 4 or 5 sepal at the apex. The color of the guava fruit may be found as shades of green, yellow, or pink. The flesh may be of color white, pink, yellow, or red are observed. The small or hard seeds are present inside the flesh and outer layer of flesh is a finely granular pulp. Guava varieties have a taste from sweet to tart, all with musky flavor and odor. Guava fruits vary in the thickness of the fleshy mesocarp, but in some varieties is extremely thin. Varieties differ widely in flavor and seediness, some are seedless. After ripening of guava, it becomes soft and juicy [3].

At ambient temperature, the shelf life of guava fruits is short. Generally, at the time of peak arrival the wastage of guava fruits is high due to its perishable nature; that's why the spoilage occur primarily before it reaches the consumer due to microbial activity and an improper transportation, and also storage facilities. In tropical countries particularly in India observed that the postharvest losses of guava fruit are high. For reducing the huge loss of guava fruit one effective method is apply which converts guava into various commercial guava products as it can be utilized in many ways for making jelly, jam, paste, juice, puree, beverage base, syrup and wine. The guava fruit is a source of pectin also which is rich in minerals like phosphorus, calcium, iron and other sources like vitamins such as niacin, pathogenic acid, thiamine, riboflavin, vitamin A, vitamin C, and dietary fiber which is in high amount. Hence, there is a worldwide growing demand for guava as a healthy and nutritive fruit [4]. Guava is available in all seasons except summer season. The guava crop didn't require huge care but it gives high quality product. The guava production is not a costly production because the requirements for fertilizer, irrigation and plant protection are not more as compare to other fruit production. Also it contains higher nutritional value.



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International Journal of Chemical Studies

Studies on preparation and storage stability of whey based mango herbal beverage

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Abstract

A whey-based mango herbal beverage was prepared with addition of ginger extract ranging from 0.5 – 5ml (v/v). Quantity of mango pulp and sugar were 10 gm and 8 gm, respectively per 100 ml of the beverages. Whey quantity varied from 82 to 86 ml for each 100 ml of beverage depending on the quantity of ginger extract. Attempts were made to avoid separation of beverages with addition of 0.05% guar gum powder. Prepared beverages filled in sterile PET bottles and evaluated for storage stability at 7±1 °C. The organoleptic scores and overall acceptability of beverage found highest to refrigerated stored sample as compared to the sample which stored at room temperature. TSS, viscosity, pH and reducing sugar increased while acidity, total sugar and reducing sugar decreased during storage. Fresh beverage had highest overall acceptability, which was stored refrigerated. It contains mango 10 gm, sugar 8gm, whey 82ml, 0.5% ginger extract and 0.05% guar gum. An increasing trend was observed in Yeast & moulds, total plate count, *E. coli* during storage period of 30 days.

Keywords: Storage stability, based mango herbal beverage, *E. coli*

1. Introduction

Whey is the liquid left after Milk has been coagulated and strained. It is by-product of cheese and Paneer manufacturing industries having many commercial uses. It contains many valuable nutrients like lactose, proteins, minerals and vitamins etc., which have crucial value as human food. Whey contains 45-50% of total milk solids, 70% of milk sugar (lactose), 20% of milk proteins and 70-90% of milk minerals and most importantly, almost all the water soluble vitamins originally present in milk. Whey solids are not utilized beneficially and an enormous quantity of whey is being drained out globally, which poses a serious damage to environment because of its high biological oxygen demand (BOD) of 35,000 to 50,000 ppm (Yadav *et al.* 2010) [8]. In spite of the recent technologies have been evolved, full utilization of whey has not yet achieved in India. The disposal technologies and effective use of whey as a dairy waste is subject of growing importance in view of the increasing prominence on environmental and economic aspects (Sirohi, 2005) [10].

Of late, there is an enormous increase in research on whey. Numbers of reviews are available on the preparation of whey based beverages. Y. K. Naik *et al.*, (2009) [6] conducted studies on physico-chemical and sensory characteristics of whey based water melon beverages. Ritika B. Yadav (2010) [8] formulated whey based banana herbal (*Mentha arvensis*) beverages with 10 ml banana juice, 8 gm sugar, 0 to 4% *Mentha arvensis* and 72 to 84 ml of whey. Sirohi D. (2005) [10] studied the preparation and storage of whey based herbal pudina (*Mentha arvensis*) beverage by formulating with 0 to 4% pudina extract, 15 gm mango pulp and 8 gm sugar and 73 to 77 ml of whey. Sakhale B.K. (2012) [9] attempted to develop whey based RTS beverages from mango cv. kesar.

Herbal extract of ginger has preventive and curative medicinal value. It is used to treat nausea caused by sickness, health problem associated with inflammation, such as arthritis, bronchitis and ulcerative colitis. Also ginger oil is used in the treatment of fractures, rheumatism, arthritis, bruising, carbuncles, nausea, hangovers, travel and sea sickness, colds and flu, sores on the skin, cough, sore throat, diarrhea, fever etc. It also acts as a good appetizer, acceptable to consumer and the same time makes the product more palatable. Mango is one of the most popular, nutritional tropical fruit. It has excellent flavour and fragrances, delicious taste and high nutritional value

There is no systematic study reported in the available literature on standard manufacturing methods, storage studies and sensory characteristics of whey mango based herbal beverages.

Fermentation Kinetics and Ethanol Production from Different Corn Grains Varieties

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Abstract— Study of fermentation kinetics in ethanol production from damaged corn grains is crucial aspect for economical yield enhancement. Two samples of corn flour, namely control and damaged, with different carbohydrate and fibrous content, were used as substrates. Samples were liquefied and saccharified using commercial α -amylase and glucoamylase, for production of fermentable sugars; Amount of fermentable sugar obtained after hydrolysis of damaged and control corn grains were 97 gL^{-1} and 127 gL^{-1} respectively. Enzyme hydrolysates were then fermented to produce ethanol in batch mode. Glucose was consumed promptly in both cases, control and damaged; ethanol production was considerably higher in control (56 g/L), compared to damaged (45 g/L). Submerged fermentation of damaged corn grains flour represented about 80 % of total ethanol production, when fine corn grains flour was used as substrate. In damaged corn flour ethanol productivity and yield was 1.12 g/L/h and 0.18 g/g flour respectively. In control corn flour ethanol productivity and yield was 1.16 g/L/h and 0.22 g/g flour. Maximum sugar consumption rate (S_m) for damaged and control corn were $3.22 \text{ g. (L .h)}^{-1}$ and $3.2 \text{ g. (L .h)}^{-1}$ respectively. Maximum product formation rate for damaged and control corn (P_m) were $1.38 \text{ g. (L .h)}^{-1}$ and $1.35 \text{ g. (L .h)}^{-1}$ respectively. Fermentation efficiency of damaged and control corn grains were 91.3% and 91.7%.

Keywords— Fermentation kinetics, Ethanol production, Damaged corn grains

I. INTRODUCTION

Bio-fuels are being actively encouraged in the transportation sector. Research work is focused on the development of renewable resources, sustainable development, green energy, eco-friendly process, etc., in the transportation sector. Increasing the use of bio-fuels for energy generation purposes is of particular interest nowadays because they allow mitigation of greenhouse gases, provide means of energy independence and may even offer new employment possibilities. Bio-ethanol is by far the most widely used bio-fuel for transportation worldwide. Ethanol can be produced from various sugary substrates such as molasses, starchy materials like corn, wheat and potato (Maiorella *et al.*, 1981) and cellulolytic materials (Deshpande *et al.*, 1983), due to increasing demand for ethanol which is an alternative energy source (Lynd *et al.*, 1991). Sweet sorghum has the potential of becoming a useful energy crop (Fikret-Kargi *et al.*, 1983). However, fresh starchy materials are required for human consumption. A large quantity of different grains is spoiled every year in India because of unfavourable climatic conditions and inadequate transport and storage facilities. Damaged grains are those which are unfit for human consumption. The damage includes blackened, broken, cracked, attacked by fungi, insect damaged, partially softened by being damp, dirty and bad smell, etc. Ethanol production from damaged sorghum grains is feasible (Gawande and Patil 2014). Damaged sorghum grains are non edible could be utilized optimally for ethanol production (Gawande and Patil 2016). Non edible damaged corn grains were utilized for ethanol production in co-culture at 25% substrate concentration using co-culture of *Aspergillus niger* NCIM 1248 and *Saccharomyces Cerevisiae* MTCC 170 (Gawande and Patil 2017). In this research, two varieties of corn healthy/fine (control) and, damaged/blackened corn were used as fermentation substrates. Both of them were evaluated to study kinetics of the sugar consumption and ethanol production during fermentation, using a 5 L fermenter.

II. MATERIALS AND METHODS

A. SUBSTRATE

Control grains used were commercial yellow dent maize obtained from a local market, Nagpur and used as a control for experiment. These grains were purposely blackened by sprinkling water on them and keeping them in damp conditions spread on a clean jute bag, covered with damp cotton. Damaged grains samples were cleaned by removing debris and other contaminants by washing and drying

Green Synthesis of Biopolymer-Silver Nanocomposites for Gas Sensing

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Keywords: nanoparticles, Gaur Gum, silver nitrate, X-Ray diffraction, nanocomposites films, resistivity

Abstract In this research work, a very simple, low cost eco-friendly method is presented for the synthesis of silver nanoparticles to be used in colorimetric optical sensors based on localized SPR (LSPR) measurement for gas ammonia. Silver nitrate salts are reduced using gaur gum which acts as a capping and reducing agent. Commonly used reducing agents such as trisodium citrate or sodium borohydride are replaced by a more environmental friendly natural polysaccharide. Nanocomposite films of $\sim 1.5 \mu\text{m}$ thicknesses were fabricated using Gaur Gum and silver nanoparticles. The uniformity of nanoparticles size was measured by SEM and TEM, while face centred cubic structure of crystalline silver nanoparticles was characterized using the X-ray diffraction technique. The optical properties of the composite film were tested by UV-VIS Spectroscopy. The formation of Gaur Gum/silver nanocomposite films was confirmed using SEM images. Also the resistivity of nanocomposite thin film was measured which could be then used for gas sensing application.

Introduction

Metal nanoparticles of gold and silver have shown very good catalytic activity and sensing properties in the recent years. Silver nanoparticles, one of the noble metal nanoparticles, have attracted extensive attention in the past decades due to its wide application in catalysis, chemical sensing and nanotechnology. Recently, synthesis of silver nanoparticles based on nature biopolymer has attracted intense attention because of their rich source and biocompatibility.

Guar gum (GG) is an edible carbohydrate polymer extracted from the seeds of *Cyamopsis tetragonoloba* and is considered as a polysaccharide with one of the highest molecular weights of all naturally occurring water soluble polymers. It is a non-ionic, branched-chain polymer, consisting of straight-chain mannose units joined by β -d-(1-4) linkages having α -d-galactopyranose units attached to this linear chain by (1-6) linkages. Galactose and mannose are the repeating units in GG. GG has also a strong tendency to form gel in the presence of borax, an efficient crosslinker for polymers bearing hydroxyl groups [1]. These characteristics enable GG to entrap, protect and stabilize the synthesized metal NPs by acting as an excellent surface capping agent [2].

It was found that Guar Gum (GG) was a suitable medium for making composite with silver nanoparticles and cast into thin films by spin coating. Such biopolymer films could be used then for gas sensing applications and compared with some ongoing work in the laboratory. Therefore it was envisaged to fabricate silver nanoparticles, nanocomposite thin films by using biopolymer and characterize them for size, structure, optical properties and also measure the resistivity of the nanocomposite films.

Over the past few decades, the interest in metallic nanoparticles and their synthesis has greatly increased. This has resulted in the development of numerous ways of producing metallic nanoparticles using chemical and physical methods. Metallic nanoparticles are becoming increasingly important due to their potential applications in many fields. The development of an environmental friendly and inexpensive way of synthesis of such tailor made nanoparticles is therefore crucial.

Among the metal nanoparticles, silver nanoparticles (AgNPs) have become the focus of extensive research due to their wide ranges of applications [3]. AgNPs have several characteristics that make them useful in many different areas of science, medicine, agriculture and catalysis [4]. These

PARAMETRIC STUDY ON WASTE PLASTIC UTILIZATION IN BITUMEN

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Abstract - The use of plastic and related materials is increasing exponentially due to tremendous growth in population, urbanization and changed life style leads to widespread littering of plastic on the landscape. Disposal of waste plastic is a serious problem globally due to their non-biodegradability and hazardous to human health, since these are not disposed scientifically and thus, create ground and water pollution. In the present paper techniques has been developed to use plastic waste for construction of bituminous roads and flexible pavements. In general bitumen is used as binder in road construction. Binding properties of this bitumen can be modified by blending it with waste plastic pieces. It can be used for construction purpose. Waste plastic coated road aggregates can improve road strength. This modified bitumen mix and aggregates show better binding property, stability, density and more resistant to water thus increasing durability of roads with increased resistance to wear and tear of the road.

Key Words: Plastic waste, Mechanical characteristics, Bituminous mix, Plastic roads.

1. INTRODUCTION

A material that contains one or more organic polymers of large molecular weight, solid in its finished state and at some state while manufacturing or processing into finished articles, can be shaped by its flow, is called as 'Plastic'. Plastics are durable and degrade very slowly; the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. Plastics can be divided into two major categories: thermosets and thermoplastics. A thermo set used primarily in automobiles and construction applications. These plastics are polyethylene, polypropylene, polyamide, polyoxymethylene, polytetrafluorethylene, and polyethyleneterephthalate. A thermoplastic softens when exposed to heat and returns to original condition at room temperature. Use of plastic along with the bitumen in construction of roads not only increases its life and smoothness but also makes it economically

sound and environment friendly. Plastic waste is used as modifier of bitumen to improve some of bitumen properties Roads that are constructed using plastic waste are known as Plastic Roads and are found to perform better compared to those constructed with conventional bitumen. Further it has been found that such roads were not subjected to stripping when come in contact with water. Use of higher percentage of plastic waste reduces the need of bitumen by 10%. It also increases the strength and performance of the road. Plastic increases the melting point of bitumen and hence missing can be done in more better and easier way.

Today, every vital sector of the economy starting from agriculture to packaging, automobile, electronics, electrical, building construction, communication sectors has been virtually revolutionized by the applications of plastics. Plastic is a non-biodegradable material and researchers found that the material can remain on earth for 4500 years without degradation. Several studies have proven the health hazard caused by improper disposal of plastic waste [1]. Plastics, a versatile material and a friend to common man become a problem to the environment after its use. Disposal of a variety of plastic & rubber wastes in an eco-friendly way is the thrust area of today's research [2]. Looking forward the scenario of present life style a complete ban on the use of waste plastic cannot be put, although the waste plastic taking the face of a devil for the present and the future generation. But the use of waste plastics in road construction is gaining importance these days because plastic roads perform better than ordinary ones and the plastic waste considered to be a pollution menace, can find its use. The main objectives of the study are: To determine the relevant index and engineering properties of plastic waste, and compare them with conventional bitumen. To select the optimum percentage of plastic waste to be blended with commonly used bitumen to produce maximum compressive strength. To study the important properties of the bitumen concrete mixes with polyethylene carry bags, PET bottles to determine how they affect the properties of mixes.

Shortcut Design Method for Multistage Binary Distillation via MS-Excel

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ABSTRACT

Multistage distillation is most widely used industrial method for separating chemical mixtures with high energy consumptions especially when relative volatility of key components is lower than 1.5. The McCabe Thiele is considered to be the simplest and perhaps most instructive method for the conceptual design of binary distillation column which is still widely used, mainly for quick preliminary calculations.

In this present work, we provide a numerical solution to a McCabe-Thiele method to find out theoretical number of stages for ideal and non-ideal binary system, reflux ratio, condenser duty, reboiler duty, each plate composition inside the column.

Each and every point related to McCabe-Thiele in MS-Excel to give quick column dimensions are discussed in details.

Keywords: Multistage distillation; McCabe-Thiele Method; Non-ideal System; Relative volatility

I. INTRODUCTION

More than 90 years ago, McCabe-Thiele developed a creative graphical solution technique based on Lewis assumptions of constant molar overflow for the rational design of distillation column.^[1]

There are two ways to do distillation calculations by McCabe-Thiele method. One is graphical method (by hand and time consuming), and other way is by using any other commercial simulation software. It is costly and require license. A third alternative is presented here: Merging the graphical and manual computational methods so that the inaccuracies of the former are compensated for by the speed of the computations. The calculations can be run by any spreadsheet program, such as Microsoft Excel, eliminating the need for employing expensive simulation software and for laboring over hand calculations. Further, the time involved from a programmer's point of view is no more (or considerably less) than that required to learn how to use a commercial simulation package.

The method presented here is easy to learn, and offers a quick way to make preliminary estimates of the tower diameter and height, number of stages, energy consumption, and reflux ratio. Although the calculation procedure is intended for binary systems, ternary systems can also be modeled if the third component is less than 10% by volume and its volatility is not drastically different from the those of the remaining two components.

II. SPREADSHEET CALCULATION PROCEDURE

While performing the distillation design calculation, it is necessary to do mass balance around the distillation column (i.e. by knowing feed, distillate and residue conditions), is determining the vapor/liquid equilibrium (VLE) data. Raoult's law is used to calculate the saturation pressure for the pure components^[2]. Since most systems are non-ideal, the Wilson equation is then applied to determine the liquid and vapor compositions^[3]. This equation includes the activity coefficients for a mixture, making it suitable for non-ideal systems. A water/Acetic Acid system is used to illustrate the overall method.

III. APPLY RAOULT'S LAW AND THE WILSON EQUATION

Use Raoult's law to find the saturated vapor pressure for each component. Published data are available for various compounds. The saturated vapor pressure of each component is expressed as:

$$\ln P_i^s = A_i - \frac{B_i}{C_i + T} \quad (1)$$

where, P_{1sat} is the saturated vapor pressure of component 1 (Pa), T is the temperature (K), and A , B , and C are the Raoult's law constants for each compound^[4]. The corresponding parameter values for Acetic Acid and water are given in Table 1. To calculate the saturation pressure of a

Synthesis of Hydroxyapatite from egg shell and preparation of bone like Bio-composites using it

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Abstract – Hydroxyapatite (HAp) is an inorganic constituent of human bone. Human bone contains 67% mineral matter, 22% collagen, 9% water and remaining proteins, carbohydrates, lipoids, etc. Bio-composites that would resemble natural bone containing HAp as inorganic matter blended with organic biomaterials are being researched. The present work is aimed at synthesis of HAp from egg shell, silica from rice husk and bio-composites C1 to C6 using varying compositions of HAp, silica, chitosan, carboxymethyl cellulose (CMC) & gelatin. Based on the Fourier Transform Infrared Spectroscopy (FTIR) analysis it can be said that HAp and silica are successfully synthesized. The bio-composite of HAp with CMC & HAp with CMC, chitosan, gelatin & silica are tested for their mechanical strength such as hardness & compressive strength. The composite of HAp with CMC & chitosan are tested for their antimicrobial property. The test results show that the composites have comparable mechanical properties to that of cancellous bone of human and also good antimicrobial property.

Index terms – Hydroxyapatite, Bone like bio-composites, Egg shell, Compressive strength, Hardness, antimicrobial property.

I. INTRODUCTION

Hydroxyapatite (HAp), $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ is an important inorganic biomaterial consisting of calcium and phosphorous which are important minerals found in human bone. Human bone constitutes 67% mineral matter comprising HAp, 22 % organic matter which is mainly collagen, 9% water and remaining is proteins, carbohydrates, polysaccharides etc. Thus, natural bone is a composite of inorganic and organic matrix. It consists of calcium and phosphorous in the ratio 1.67 which is same as the stoichiometric ratio present in the molecular formula of HAp [1],[2].

HAp provides sufficient toughness & hardness whereas the organic matrix provides the mechanical strength such as compressive & tensile strength to bone. Hence, composites of HAp with certain organic polymers that resembles collagen chemically can be used for bone grafting. The organic part may be substituted by polymers such

as Chitosan, Gelatin, Carboxymethyl Cellulose (CMC), etc.

HAp can be synthesized effectively from egg shell. The idea is to minimize the egg waste accumulation caused by the day to day increase in consumption of eggs, due to the large demand of the poultry products such as cakes, fast food, etc. The disposal of egg shell waste in land may cause land degradation that can be minimized by effective utilization of egg shell in HAp synthesis. Also silica can be synthesized from rice husk. Rice husk is a waste product of rice mill and can lead to waste accumulation if not disposed of properly. It contains 98% silica. Thus can be utilized in the synthesis of silica.

The present work aims to synthesize biomaterials; HAp using egg shell, Silica using rice husk and bio-composites of HAp using different organic biomaterials mentioned.

II. LITERATURE REVIEW

i) Synthesis of Hydroxyapatite

Eric M. Rivera et al [3] have worked on synthesis of hydroxyapatite from eggshell. In this paper HAp was synthesized from egg shell by thermally treating the egg shells. The Calcium Oxide thus obtained was transformed into HAp in a phosphate solution. The Ca/P ratio of 1.67 was used. The final product is characterized by X-ray diffraction and scanning electron microscopy SEM.

Gre'ta Gergely [4] have worked on preparation and characterization of hydroxyapatite from eggshell and phosphoric acid as raw materials. The present work aimed to synthesize HAp via mechano chemical activation using ball milling and attrition milling and the phase stability and powder characteristics were studied. The structures of the HAp were characterized by X-ray diffraction, scanning electron microscopy and infrared spectroscopy.

P. Hui [5] have worked on synthesis of hydroxyapatite bio-ceramic powder by hydrothermal method. Egg shells were treated thermally for and the calcium oxide obtained was treated with Tricalcium Phosphate solution. The final product was characterized by X-ray

Review on Synthesis of Hydroxyapatite and its Bio-composites

SHEKHAR L. PANDHARIPANDE¹, SMITA S. SONDAWALE²

Abstract: The focus of manufacturing, research and development is reorienting their approaches so as to make the entire process ecofriendly, economical and minimal waste generation. A lot of work is being carried out in utilization of naturally occurring substances into value added products. Hydroxyapatite (HAp) is one such product that can be manufactured from naturally occurring waste such as egg shell, fish scale and animal bones. HAp is an inorganic biomaterial having structural and chemical similarity with bone and teeth. HAp is a bioactive substance since it forms a strong chemical bond with the bone tissues and hence it is recognized as a good bone graft material. This paper is an effort to take a review of some of the recently published researched articles. The objective of this initiative is to be able to comment on suitable methods in synthesis of HAp and composites using it. Here are the 4 methods discussed which includes Microencapsulation technique, Wet chemical precipitation method, Sol gel method and Hydrothermal method. All these methods are compared based on the product yield, reaction kinetics, processing temperature, etc.

Keywords: Hydroxyapatite, Methods of Synthesis, Biocomposites.

I. INTRODUCTION

Hydroxyapatite is an inorganic biomaterial having structural and chemical similarity with the mineral phase of bone and teeth. HAp is a bioactive substance since it forms a strong chemical bond with the bone tissue and hence it is recognized as a good bone graft material. HAp is bioactive, osteo conductive, non toxic and non immunogenic. Bone is a inorganic-organic composite consisting mainly of collagen (20%), calcium phosphate (69%), and water (9%). Other organic substances, such as proteins, polysaccharides, and lipids, are present in small amounts. Bones contain a high % of mineralized calcium phosphate. The mineral phase is composed mainly of microscopic crystals of calcium phosphates, in which the HAp, is the most important. HAp can be a good source of Calcium and Phosphate [3]. HAp is manufactured in many forms and can be prepared as a dense ceramic, powder, ceramic coating or porous ceramic and also as biocomposites i.e; blending with organic binders such as Chitosan, Gelatin, Starch, Carboxymethyl cellulose and many other polymers as required for the particular applications. Actual bones are not only HAp but the composites of HAp with these organic binders. HAp is widely used for hard tissues repair. Dense sintered HAp has many bone replacement applications and is used for repairing bone defects in dental and orthopedic sites, immediate tooth replacement, augmentation of alveolar ridges and pulp capping material and maxillo facial reconstruction, etc.

Coatings of hydroxyapatite are often applied to metallic implants, especially stainless steels and titanium alloys to improve the surface properties. HAp can be used as a filler material to repair bone defects or voids [22]. However, the migration of the nano- hydroxyapatite particles from the

implanted site into the surrounding tissues might cause damage to healthy tissue. To find a solution, composites of nano-hydroxyapatite and polymers were prepared that retained the good properties of nano-hydroxyapatite and prevented the nano- hydroxyapatite particles from migrating. The review paper is divided into 2 parts:

- **Part1:** Review on the methods of synthesis of Hydroxyapatite.
- **Part 2:** Review on various possible biocomposites.

II. METHODOLOGIES OF SYNTHESIS

Hydroxyapatite can be synthesized from different biosources like Egg shell, Fish scale and Bovine Bone. All these biosources act as Calcium source in synthesis of HAp . The Phosphate source is provided using chemicals such as Diammonium Hydrogen Phosphate (DAP), P_2O_5 . The calcium source may also be provided using chemicals such as $Ca(OH)_2$, Calcium nitrate tetrahydrate . There are various methods of HAp synthesis such as: precipitation technique, sol-gel approach, hydrothermal technique, multiple emulsion technique, biomimetic deposition technique, electrodeposition technique, etc followed by various researchers. Here are the reviews of the preparation methodologies of HAp. The synthesis methods are divided into two parts. Firstly they are classified according to the type of biowaste used as a calcium source and secondly they are classified according to the method of synthesis used.

A. Synthesis Using Different Biowaste Materials

Egg Shell: Gre'ta Gergely et al ^[1] have worked on Preparation and characterization of hydroxyapatite from eggshell. The present work aimed to synthesize HAp via mechano chemical activation with the following three objectives: to form HAp from eggshell to compare two

Review on the characterization methods of Hydroxyapatite and its Bio-composites

Shekhar L. Pandharipande, Smita S. Sondawale

Abstract- Natural bone constitutes 67% of its weight as Hydroxyapatite (HAp) and is a bioactive substance having ability to form chemical bond with body tissues. It can be synthesized in laboratory using calcium and phosphate reagents and can be one of the potential bone graft material. The only factor that prohibits its use as natural bone is in its poor mechanical strength. Research is being conducted to enhance its compressive strength by formation of biocomposites using Carboxymethyl Cellulose, Gelatin, Chitosan and other polymeric materials. The characterization of HAp and its biocomposites synthesized is an important topic. The various characteristics analyzed include various functional group using Fourier Transform Infrared Spectroscopy (FTIR), morphology and surface properties using Scanning Electron Microscopy (SEM) / Transmission Electron Spectroscopy (TEM), crystallinity and chemical composition of compound using X-ray diffraction Spectroscopy (XRD), thermal stability using Thermogravimetric/ Differential Thermal Analysis (TG-DTA), surface area, pore size & pore volume using Brunauer–Emmett–Teller (BET), compressive strength using mechanical testing. This paper gives an elaborative review on these analytical methods reported in literature along with the detailed observations and interpretation. The suitability of analytical technique to be adopted and the interpretation of the findings would be eased by this review paper for prospective researchers working in this area.

Index Terms – Hydroxyapatite, Characterization methods, FTIR-SEM-TG-DTA, Biocomposite testing methods.

I. INTRODUCTION

HAp is an inorganic biomaterial constituting about 67% mineral matter of bone. Hence it can be used in bone repair such as to fill small defects or voids or as coatings on metallic implants. Due to some limitations in its mechanical properties such as it has poor tensile strength and brittleness HAp cannot be used in most load bearing application. Composites of HAp are prepared using various natural polymers such as Chitosan, Starch, Gelatin, etc which act as HAp binders. The composites thus obtained can be used to repair larger bone defects with enhanced load bearing properties. HAp and its biocomposites are being used as a better source of bone grafting in near future.

There are various methods of HAp synthesis such as precipitation technique, sol-gel approach, hydrothermal technique, multiple emulsion technique, biomimetic deposition technique, electrodeposition technique, etc each employing various process parameters^[1]. The general process of the synthesis of HAp includes the reaction between the calcium source and phosphate source in specific stoichiometric ratio of 1.67. The calcium source and the phosphate source may vary. The reactants mixing is employed with various temperature conditions followed by ageing and precipitation of solution. The precipitate is oven dried and sintered in furnace. The schematic is as shown in fig 1.1.

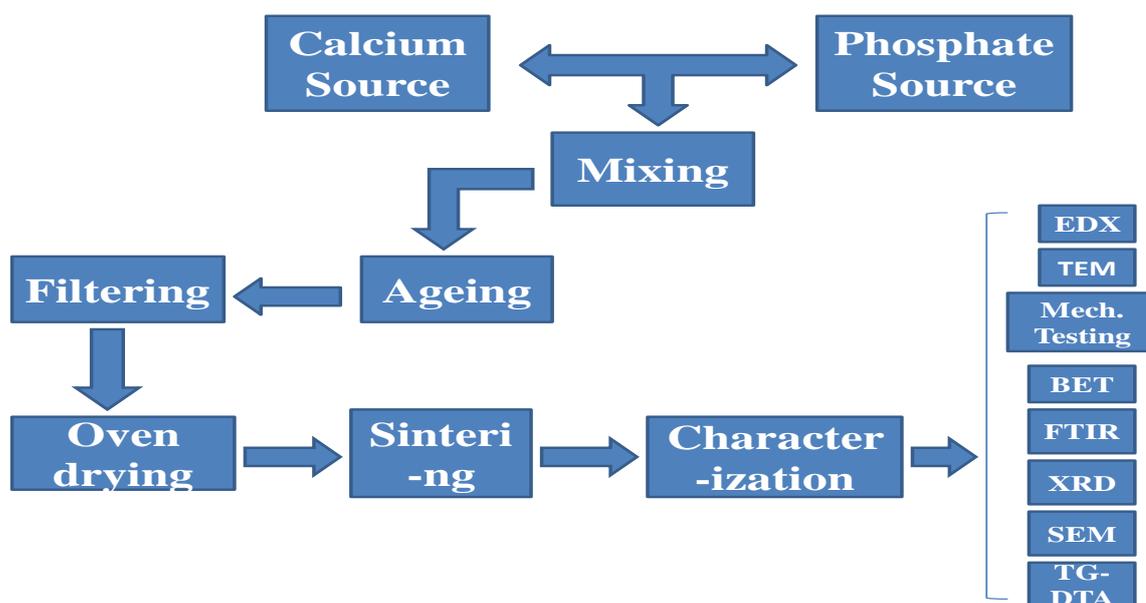


Fig 1.1 General block diagram of the process

EXPERIMENTAL STUDY OF EFFECT OF PRESSURE ON PYROLYSIS OF BIOMASS

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Abstract

Pyrolysis is thermal treatment of solid waste in the absence of an oxidizing agent (in inert atmosphere) which generally yields three products namely pyrolysis-oil (liquid), char (solid residue) and gas. The products obtained in pyrolysis can be further used as energy source. Rice husk and saw dust are considered as solid wastes in this study. The effect of temperature and pressure on pyrolysis was studied in a fixed bed reactor. The experimental runs were performed in nitrogen atmosphere. The temperature was varied from 300°C to 500°C, while the operational pressure was fixed at 4 bar, 7 bar and 10 bar. The products such as solid char, liquid pyrolysis oil and syngas were obtained. The solid char was characterized by CHNS analysis, while the pyrolysis oil was characterized by FTIR analysis,

Keywords- Rice Husk; Saw Dust, Pyrolysis; Pyrolysis-Oil; Char;

1. INTRODUCTION

Rigorous research on renewable energy sources is gaining attention for upcoming energy systems. Biomass has a great potential to replace the usual energy sources [1]. Only small amount of agro-waste biomass is used as feed in animal husbandry and huge amount of biomass is dumped into fields and landfills or used as paving material that causes environmental problems [2]. Pyrolysis is a type of thermal treatment that converts biomass in liquid (pyrolysis-oil), char, and syngas in absence of oxygen [3]. Biomass can be pyrolyzed to yield solid char, liquid pyrolysis oil, and syngas which may be used as fuels and chemicals for various purposes [4]. Pyrolysis is nowadays, a new type of solid waste utilization technique for transformation of biomass and waste material of low-energy density into pyrolysis oil of high-energy density with recovery of higher value chemicals [5]. Bio-char may also be used for soil amendments [6]. Biomass such as rice husk and sugarcane bagasse are preferred due to ease of availability, collection and transportation and are used in boilers for combustion

product distribution and yields of products. For example in case of waste paper, it has been reported that the pyrolysis oil yield was 49.13 % at 420°C with heating rate of 30°C min⁻¹ than at lower temperatures [11]. Particle size also plays an important role in product yield. Islam et. al. have reported that the pyrolysis of nutshells yielded maximum oil at 500°C for feed size of 300-600µm [12]. Punsuwan et al. have identified effect of temperature (250–1050°C) and particle size (0.18–1.55 mm) on yield of pyrolysis products in palm shell, palm kernel and cassava pulp concluded that higher temperature and smaller particle size caused an increase in the gas yield with decrease in the char yield [13]. It has also been reported that the presence of moisture affects the char yield [14].

Some researchers have reported a 52% pyrolysis oil yield at 400°C from pyrolysis of waste cup and their FTIR results showed that oil contained C6-C20 carbon chain compounds [5]. While another result showed that a linear chain of hydrocarbons (C13-C25) was obtained [15]. Similarly pyrolysis of bicycle tire at 600°C yielded 49 % pyrolysis oil [7]. Pyrolysis of para rubber yielded 56.22% pyrolysis oil at 450°C, having calorific values 22.11 MJ/kg [17]. Some researchers have reported that the pyrolysis of jack fruit peels yielded 52.6 % pyrolysis oil within the temperature range of 400°C to 600°C [18]. Guo et. al have reported that the thermal stability of pyrolysis oil was better in the light fraction, but worse in the middle and heavy fractions [19]. Another research showed that, fast pyrolysis at constant high temperature favored maximum oil yield and decreased char yield [20]. Some researchers have reported that catalytic (ZSM-5 catalyst) pyrolysis of rice husk, yielded less liquid of reduced oxygenated content [21]. High pressure pyrolysis

The pyrolysis oils are composed of a range of chemicals including cyclopentanone, methoxy phenol, acetic acid, methanol, acetone, furfural, phenol (aromatic ring), formic acid, levoglucosan, guaiacol and their alkylated phenol derivatives. The structural components of the biomass samples mainly affect the products of pyrolytic degradation [8, 9]. The major components of gas evolved during pyrolysis were CO, CO₂ and H₂O at lower temperatures, while lower concentrations of CO, CO₂, H₂O, H₂, and CH₄, C₂H₆ and oil were evolved at higher temperatures [10]. The pyrolysis temperature has a significant effect on product distribution, while heating rate plays a less effective role on

Phytoremediation Studies for Removal of Copper & Chromium Using Azolla Pinnata and Water Hyacinth

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ABSTRACT: Phytoremediation includes all the natural processes taking place within certain aquatic plants to accumulate or degrade polluting compounds. Water hyacinth and Azolla are amongst aquatic plants that are being investigated for removal of heavy metals Chromium and Copper in the present work from synthetic solutions having 50 and 10 ppm separately. Based on observations, results & discussion, it can be said that water hyacinth can survive in copper and Chromium concentration less than 50 ppm for around 15 days. The effective uptake for 50 ppm initial concentration is observed to 29% and 14% for copper and chromium respectively for 15 days. Similarly Azolla is effective to the extent of 6 and 62.5% copper and chromium removal respectively over 28 days period. The same figures for 10 ppm initial concentration for Water hyacinth are 13% and 71% for copper and chromium removal respectively..The present study has successfully addressed to the novel and upcoming method of removal of metallic ions by plants.

KEYWORDS: Phytoremediation, Copper, Chromium, Azolla pinnata, Water hyacinth

I. INTRODUCTION

The rapid growth in industries and increased agricultural activities over the last few decades have resulted in generation & accumulation of large quantities pollutants in the environment. These pollutants are distributed over wide areas by means of air and water. This has caused detrimental effects to the ecosystem and to human health.

Continuous efforts are being made to develop technologies that are easy to handle, sustainable and economically feasible in order to maintain good quality of soils and waters and keep them free from contamination. Physicochemical approaches have been widely used for remedying polluted soil and water, especially at a small scale. However when it comes to large scale water processing, like river cleaning, these conventional methods are not feasible economically. Phytoremediation may provide the effective alternative. It includes all the natural processes taking place within certain plants to accumulate or degrade polluting compounds in soil, water, or air. Aquatic ferns in particular exhibit exorbitant potential to remove various contaminants including heavy metals, organic compounds, and radio nuclides from the environment. The Water hyacinth and Azolla, these aquatic plants are used for removal of high concentration of heavy metals namely Chromium and Copper.

A number of research papers have been published in various journals over decades related to removal of metallic ions from water. Some of the papers referred in present work are cited here. Marieta Baysa et al [1] reported determination of concentration of lead & cadmium in the top, middle & bottom edible portions of Ipomoea aquatica. Ranjana Julias Thilakar et al [2] & Santosh Kumar et al [3] in separate work reported phytoremediation studies of chromium & copper and chromium & cobalt respectively using Pistia stratiotes. Malai rajan Singanan et al [4] & N. Gandhi et al [5] studied the removal chromium from industrial waste water using biomaterials & Ipomoea aquatica respectively. Review papers by Annie Melinda et al [6] & Nelson et al [7] give detailed information about the potential of the aquatic plants in

Synthesis of Chitin from Crab Shells and its Utilization in Preparation of Nanostructured Film

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ABSTRACT- Chitin is the second most abundant polysaccharide and produced annually as much as cellulose. It is the main structural component of the exoskeletons of animals like insects and crustaceans. Crab, shrimp, squilla and fish scale waste is ideal raw material for chitin production. The extracted chitin can be used to produce chitin-derived products, such as chitosan also for bioplastic and nanostructured film production. The present work is aimed at extraction of chitin from crab shells. The methodology include acid hydrolysis, demineralization followed by deproteinization step. The chitin is synthesized and analysed by FTIR based on the interpretation of the spectrogram of the two sample of chitin synthesized in the present work, it can be said that all the functional groups expected are seen and the yield is obtained between 10.6-12.73%. The biocomposite of chitin along with chitosan has resulted in the formation ultrathin, labile, nanostructured film with good apparent texture. The advantages of such product could be its biodegradability, biocompatibility and effective use as biomedical interface.

Keywords: Biomaterial, Chitin, Crab shells, and Nanostructured film.

I. INTRODUCTION

Minimization of waste material and its reuse into valuable and biologically sustainable material is a challenge to researchers and scientist. Chitin is the second most abundant polysaccharide after cellulose. Chitin is a widespread polysaccharide in nature and produced annually as much as cellulose. It is the main structural component of the exoskeletons of animals like insects and crustaceans with an outer skeleton that include shrimp, crab, and lobster. More than 10¹¹ tons per year of chitin is produced annually in aquatic

biosphere. The use of this waste for renewable products such as chitin biopolymer and its derivatives is a dual purpose opportunity. Therefore, crab, shrimp, squilla and fish scale waste is idea raw material for synthesis of chitin. Extracted chitin from crab shells can be used to produce chitin-derived products, such as chitosan also for bioplastic and nanostructured film. The crab shells contains 25-30% chitin. 25% protein, 40-50% calcium carbonate. The disposal of this waste creates sever problem for human life so that the present work is aimed at investigating utilization of waste crab shells in synthesis of chitin.

II. LITERATURE REVIEW

The last decade has witnessed a lot of publications related to synthesis of chitin from crab shells. The present work is based on the literature review of research papers related to this topic and a brief summary of the papers referred is given below.

The paper titled "Conversion of crab shells to useful resources using sub-critical water treatment" highlights the use of temperature condition 533K-593K and reaction time 1-20 minute and synthesized high quality chitin ^[1]. The use of exoskeletons of shrimp and crab for extraction of chitosan and production of nanomembrane is also reported in the literature ^[2]. The paper titled "Extraction and characterization of chitin; a functional biopolymer obtained from scales of common carp fish" reports about proposed chitin synthesis process using fish scales as raw material ^[3]. A new approach for synthesis of chitin based on preparation, modification and application of chitin nanowhiskers has been reported in literature ^[4]. The paper titled "Isolation and FTIR spectroscopy characterization of chitin from local sources" and "Structural characteristics of chitin and chitosan isolated from the biomass of cultivated rotifer" give the FTIR analysis and its interpretation for chitin ^[5, 6]. Another paper; "Nanostructured

Synthesis, Characterization and Adsorption Study of Composite Adsorbent using Corncob and Cornstarch

Shekhar L. Pandharipande, Grishma A. Borkar

Abstract—Agricultural waste contains carbon in significant proportions. The commercial grade activated carbon being a very effective adsorbent, the prime focus of the present work was on its synthesis using agro-based waste corncob. It also addressed the pelletization of the adsorbent powder synthesized from corncob and further making its composite using corn starch as binder. The BET surface area of the composite adsorbent pellet (CA) was found to be 17% more than that of the corncob activated carbon (CCA). The SEM images have indicated that the CCA synthesized has irregular porous structure and the CA had homogeneous bands with active sites. The adsorption studies showed that CA showed a maximum 77% adsorption for initial concentration of the 10 ppm solution of methyl violet in aqueous solution whereas the CCA showed a maximum of 63%. The novel feature of the present work was on pelletization of adsorbent powder which could ease the handling, separation and storage difficulties.

Keywords: agro-based waste, composite adsorbent, corncob activated carbon, pelletization.

I. INTRODUCTION

Use of dyes in order to color variety of products is increasing year after year. This is resulting in generation of considerable amount of colored wastewater. Usually it can be noted that public's understanding of water quality is highly influenced by its physical appearance i.e. its color. The dyes which are responsible for the color are many times toxic and even carcinogenic, which pose a danger to the aquatic living organisms as well as human beings. Various methods are being employed for decolorization, but among them adsorption is the method of choice and gives the best results. There are various commercial adsorbents such as activated carbon, silica gel, zeolite, etc. Out of these activated carbon are highly effective in the removal of dye from wastewater. The only disadvantage of the commercial adsorbent is its

huge cost and its regeneration problem. However this problem can be solved by using adsorbents made from agricultural by-products and waste materials. The different types of agro-based waste materials that are being developed as adsorbents are coconut shell, almond shell, peanut shells, coir pith, chestnut, mango leaves, banana leaves, papaya leaves, spent tea leaves, etc.

Adsorbents which are made from two or more materials are termed as **composite adsorbents**. The process in which these composite adsorbents are being used is known as composite adsorption. Composite adsorbents are made to increase the efficiency of the process which cannot be achieved by using single adsorbent material. Hence, composite adsorbents have a potential in applications in many fields when compared with the use of single adsorbent.

The objective of the present work is to utilize the agro-based waste material corncob with cornstarch to synthesize composite adsorbent.

II. LITERATURE REVIEW

A number of research papers have been published on the topic of synthesis of activated carbon from agro-based waste materials. Few are cited here;

a. Paper titled "Porous structure and surface chemistry of phosphoric acid activated carbon from corncob", reports a series of activated carbons prepared from agricultural waste corncob by chemical activation with phosphoric acid at 400°C using varied ratios of impregnation. It shows that carbons are highly porous (BET surface area 2081 m²/g, total pore volume 1.13 cm³/g) and contain large amount of acid surface groups (3.73 mmol/g).

b. The paper titled "Preparation of activated carbons from corncob with large specific surface area by a variety of chemical activators and their application in gas storage", reports that activated carbons were produced from corncob using different activation strategies and activators as reported in the paper titled. All carbons show microporous character, except for the sample that is activated by one-step phosphorous acid activation which shows hysteresis typical of mesoporous character.

c. The paper titled "Adsorption of cadmium(II) from aqueous solution on natural and oxidized corncob" showed that Ca-treated corn cobs powder is effective as an adsorbent compared to Al-treated corn cobs powder. The natural and corncob oxidized with CA and NA since they possess a greater amount of acid sites than basic ones. The PZC of

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Synthesis, Characterization and Comparative Adsorbent Study of Carbon Nanotubes, Graphene and Graphite

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Abstract— Carbon Nanotubes are allotropes of carbon. They are tubular in shape, made of graphite. The objective of this work was to produce carbon nanotubes at room temperature without any hazardous and high energy requiring operating conditions using Staudenmeyer's process. There was successful synthesis of graphene as well from the same process. Characterisation of CNTs and graphene was done using Scanning Electron Microscope (SEM) analysis. Batch adsorption studies were used to study adsorption of methyl violet from a solution using carbon nanotubes. Langmuir and Freundlich adsorption isotherms were developed to analyse the equilibrium adsorption data. The study resulted that Langmuir isotherm was a better fit to the adsorption. The adsorption studies of carbon nanotubes were compared to graphene and graphite. CNTs have shown highest adsorption capacity (K_F) of 39.27 mg/g and the value of constant n is 2.07 which indicates good adsorption characteristics for Freundlich adsorption model. The adsorption capacity of carbon nanotubes for Langmuir adsorption isotherm was 169.9 mg/g and % adsorption was 78.6% which were highest among the three i.e CNTs, graphene and graphite.

Index Terms— Adsorption isotherms, Carbon Nanotubes, Graphene, Graphite.

I. INTRODUCTION

Carbon is the element in the periodic table that provides the basis for life on Earth. Elemental carbon exists in two natural allotropes, diamond and graphite. It was also discovered that carbon atoms can form long cylindrical tubes known as carbon nanotubes or CNT for short. These molecules are shaped like a tube; imagine a sheet of graphene rolled into a tube. Carbon nanotubes have a very wide range of electronic, thermal, and structural properties. These properties vary with the diameter, length, chirality or twist and wall nature of these nanotubes.

Most part of the academic literature attributes the discovery of carbon nanotubes to Sumio Iijima of Nippon Electric Company in 1991.

Carbon nanotubes are classified in two types

1. SWNTs- Single walled carbon nanotubes.
2. MWNTs- Multiple walled carbon nanotubes.

Carbon nanotubes are sheets of graphene rolled to form seamless cylinders. Carbon nanotubes are again classified

based on the way the graphene sheets are wrapped into three types – armchair, chiral and zigzag.

General methods of production for Carbon nanotubes include Arc Discharge Method, Laser Ablation and Chemical Vapor Deposition.

Adsorptions of various gases, liquids or metals onto carbon nanotubes, and interactions between them, have attracted much attention recently.

II. LITERATURE REVIEW

A brief summary of literature review related to the theme of present work is given below.

A. Preparation of Carbon Nanotubes From Graphite Powder At Room Temperature^[8]

A new chemical route to prepare carbon nanotubes at room temperature is developed. Graphite powder is immersed in a mixed solution of nitric and sulfuric acid with potassium chlorate. After heating the solution up to 70°C and leaving them in the air for 3 days obtained carbon nanotube bundles are obtained. This process could provide an easy and inexpensive method for the preparation of carbon nanotubes.

B. Carbon nanotubes: properties and application^[9]

Carbon nanotubes are unique tubular structures of nanometer diameter and large length/diameter ratio. The nanotubes can be metallic or semiconducting depending on their structural parameters. This opens the ways for application of the nanotubes as central elements in electronic devices including field-effect transistors (FET), single-electron transistors and rectifying diodes. Possibilities for using of the nanotubes as high-capacity hydrogen storage media were also considered. This report is intended to summarize some of the major achievements in the field of the carbon nanotube research both experimental and theoretical in connection with the possible industrial applications of the nanotubes.

A Review on Economic Feasibility of Ethanol Production from Damaged Sorghum and Corn Grains

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Abstract:

The possibility of obtaining a renewable, available, safe and effective source of energy is one of challenges that world is facing today. The bio-fuels, particularly the bio-ethanol, are an environmentally clean source of energy. Production costs of fuel ethanol are higher than production costs of gasoline in some cases, although there is a strong influencing cost factor as feed-stocks for ethanol production. Nevertheless, many research scholars in different countries are continuously carrying out investigations aimed at reducing ethanol production costs. Diverse research trends and process improvements got success in the task of lowering ethanol costs by different steps of processing, nature of utilized feedstocks, and tools of process engineering, mainly process synthesis, integration and optimization. Grains are wasted every year all over the world that needs to be better utilised quickly and easily. Exhaustive review of literature is done for economical use of damaged sorghum and corn grains in ethanol production. These damaged or inedible sorghum and corn grains are harmful if consumed. It is observed that vast potential exists for economical conversion of damaged or inedible sorghum and corn grains into ethanol.

Keywords: Damaged Grains, Ethanol, Fermentation, Sorghum, Corn

1. INTRODUCTION

Definition of damaged food grains as per Federal Grain Inspection Service (FGIS) is simply grain that lacks the characteristics of quality grain. Grain damages are mechanical damages during harvesting and handling grain size reduces due to breakage. Moisture content and due to insecticides deterioration of grain occurs heavily. After identification of sorghum and corn grain in damaged condition, that is these grains are not usable as food or feed. The next one of option for its utilization is as fuel energy production. Food

loss and damaged grain have many negative economic and environmental impacts. The most important issues in industrial ethanol production are yield, efficiency, and energy consumption. Laboratory results in terms of ethanol yield and ethanol fermentation efficiency from artificially germinated high-tannin sorghum suggest that huge potential energy savings exist in production of ethanol from germinated sorghum grain. Using germination-damaged sorghum for industrial ethanol production might benefit the producer and end user by expanding market uses of what has been historically considered a low-value commodity. Germination not only causes compositional changes in the sorghum grain but also initiates a series of biochemical and physiological changes. Intrinsic enzymes such as amylases, proteases, lipases, fibre-degrading enzymes, and phytases are activated. Current fuel ethanol research and development deals with process engineering trends for improving biotechnological production of ethanol [1].

2. REVIEW OF LITERATURE ON ETHANOL PRODUCTION:

In this paper exhaustive review of literature is carried out for determination of main causes and type of sorghum and corn grains damages. Major causes of sorghum and corn grains damages are briefly discussed in this paper. It is revealed that grain gets damaged during harvesting, handling, and storage due to breakage. This cause reduction in grain size and protective shield of grains becomes weak. On these weak grains an insect infestation is able to reduce its chemical or nutritional value which is very important for its further utilization. The intensity of grain damage is difficult to quantify accurately but it can be measured with the help of physical and chemical tests [1].

All damaged grains lose some of the starch and increased soluble sugars, ash and crude fiber. It is observed that sprout-damaged grains contained the highest amounts of reducing sugars. Ethanol yields based on the already damaged grains indicated that



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Comparative cytological study of *Trigonella foenum graecum* and *Brassica compestris*'

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ABSTRACT

Thiosemicarbazides have found to contain antimicrobial, antiviral activities against various virus, bacteria and fungi strains. The objective of the study was to study the seed germination and physiological maturity stage of *Trigonella foenum graecum* and *Brassica (L.)*. The effect of various concentrations of 1- γ picolinoyl-4-phenyl Thiosemicarbazides on mitotic Indices in root tip cell in *Trigonella graecum* and *Brassica compestris* was studied. *Brassica* plants have been the subject of much scientific interest for their agricultural importance. Seeds used in exacerbations, cancer and tumours. Roots emollient and diuretic, juice used in chronic cough and bronchial catarrh. *Trigonella foenum graecum* balances blood sugar levels, and contains choline which aids the thinking process. Fenugreek has been the focus of several studies concerning the treatment of diabetes and the prevention of breast cancer. Its ability to balance hormone levels aids in treating PMS and menopause. Its antioxidants slow ageing and help prevent disease.

Keywords: chromosomal anomalies, mitotic index, Plant morphology, *Trigonella graecum* and *Brassica compestris*

INTRODUCTION

Plant physiology is a sub-discipline of botany concerned with the functioning, or physiology of plants [1] closely related fields include plant morphology (structure of plant), plant ecology (interaction with the environment), phytochemistry (biochemistry of plant), cell biology, genetics, biophysics and molecular biology. Fundamental process such as photosynthesis, respiration, seed germination, dormancy and stomata function and transpiration, both parts of plant water relations are studied by plant physiologists. The field of plant physiology includes the study of all the internal activities of plants those chemical and physical processes associated with life as they occur in plants. This includes study at many levels of scale of size and time. At the smallest scale are molecular interactions of photosynthesis and internal diffusion of water, minerals and nutrients. At the largest plant physiology includes phytochemistry (the study of the biochemistry of plants) and phytopathology (the study of disease in plants). Germination is the process by which a plant grows from a seed. The most common example of germination is the sprouting of a seedling from a seed of an angiosperm or gymnosperm. However, the growth of a sporeling from a spore, for example the growth of hyphae from fungal spores, is also germination. In a more general sense, germination can be simply anything expanding into greater being from a small existence or germ, a method that is commonly used by many seed germination. Germination is the growth of an embryonic plant contained within a seed; it results in the formation of the seedling. The seed of a vascular plant is a small package produced in a fruit or cone after the union of male and female sex cells. All fully developed seeds contain an embryo and, in most plant species some store of food reserves, wrapped in a seed coat. Some plants produce varying numbers of seeds that lack embryos these are called empty seeds [3] and never germinate. Most seeds go