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The 3rd International Conference on Nanoscience and Nanotechnology -2016
(ICNSNT-2016)

15th-16th, December, 2016
Colombo, Sri Lanka

Committee of the ICNSNT - 2016
The International Institute of Knowledge Management (TIIKM)
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Official website of the conference

www.nanoconference.co

Book of Abstracts of the 3rd International Conference on Nanoscience and Nanotechnology -2016 (ICNSNT-2016)

Edited by Prof. K.M. Nalin De Silva and Others


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MESSAGE OF PROF. C.N.R. RAO: KEYNOTE SPEAKER OF ICNSNT 2016

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BANGALORE - 560 054, INDIA

Professor C. N. R. Rao, F.R.S
National Research Professor
and
Honorary President

8 December, 2016

Message

I am delighted that the International Institute of Knowledge Management, Sri Lanka is organizing the 3rd International Conference on Nanoscience and Nanotechnology during December 14-16, 2016.

Nanotechnology has the potential to change the world. ICNSNT 2016 has invited Chemists, Physicists, Material Scientists, Biomedical Researchers, Engineers and other researchers and experts across the globe for their active participation. I trust that this event will act as a forum for academia, industry and start-ups to exchange notes on latest developments in the field. I also believe that, this conference will set a platform for researchers to initiate new collaborative research projects.

I appreciate the efforts of the conveners and organizers in the popularization of nanotechnology and wish the conference success.

(C.N.R. Rao)
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FORUM
Graphene has been a sensational discovery of recent years. In the last two to three years, there has been effort to prepare graphene-like layered inorganic materials such as MoS$_2$, WS$_2$, GaS and BN. Several methods of synthesis of such nanosheets have been developed.$^{1,2}$ Some of the recent results on few-layer metal chalcogenides and BN will be presented. Specially interesting are the physical properties of these nano materials such as magnetism and superconductivity.$^3$ Transistors and devices have been fabricated with many of the few-layered inorganic materials.$^{2,3}$ A new graphene-like material is B$_x$C$_y$N$_z$ with high surface area and novel gas adsorptive properties. These materials have other extraordinary properties, their use as electrocatalysts being specially noteworthy.$^4$

Artificial photosynthesis is a promising method for producing renewable energy by use of sun light. Artificial photosynthesis employing the modified Z-sheme of natural photosynthesis can be exploited both for the oxidation and reduction of water. Oxidation of water is successively achieved by the use of cobalt and manganese oxides with the cations in the 3+ state with one $e_g$ electron.$^{1,2}$ Hydrogen can be produced by the dye-sensitized photochemical process$^3$ or by the use of semiconductor heterostructures$^4$. In this presentation, ways of splitting water will be presented, followed by recent results obtained on the photochemical generation of hydrogen by different strategies specially those involving semiconductor heterostructures of the type ZnO/Pt/CdS$^4$ or nanosheets of chalcogenides$^{3,5}$ such as MoS$_2$ and MoSe$_2$. Other novel strategies for hydrogen generation such as the solar-thermal route based on oxides$^6$ will also be examined.

KEYNOTE SPEECH
THE APPLICATIONS OF CARBON NANOTUBES FOR THE SUSTAINABLE WORLD

Morinobu Endo
Institute for Carbon Science and Technology, Shinshu University, Japan

ABSTRACT

Carbon nanotubes have been attracting lots of attention from various fields of science and technology because of their extraordinary physical and chemical performances owing to their intrinsic nano-sized one-dimensional nature. The most common process to synthesize carbon nanotubes is CCVD method, because this technique is very powerful for large scale production and controlling the nanostructure. CCVD method uses most commonly the nano-sized iron particle that are either dispersed on the substrate or sprayed for floating reactant technique [1, 2]. We are facing many environmental problems such as global warming and pollution, constant shortage of water, and processing of agricultural wastes, etc. Therefore, finding measures for the resolution of such urgent issues is required. In this account, since we believe that carbon nanotubes and nanocarbons have the ideal properties to solve such problems, some applications aiming toward resloving the environmental issues will be introduced. Firstly, the current usage of carbon nanotubes in energy storage devices as one of the important component of lithium ion secondary batteries is shown. Mainly, the effectiveness of the addition of carbon nanotubes to both cathode and anode electrode on the performance of lithium ion secondary batteries will be discussed. Secondly, the industrial usage of carbon nanotubes as multi-functional filler in polymeric composites such as functional rubber, water desalination membranes and anticorrosion paint will be summarized. Thirdly, for successful developments of CNT’s, the safety of carbon nanotubes is the most important issue [3, 4, 5]. By openly sharing all the information on risks and benefits of the carbon nanomaterials with all the stakeholders, by the responsible productions and uses, through designing the safe nanostructure based on CNTs, we will be able further enhance the use of CNTs to contribute for the sustainable world.

Keywords: carbon nanotubes, applications, design safe nano


PLENARY SPEECH
STRATEGIES FOR ENHANCING THE PERFORMANCE OF HYBRID NANOCRYSTALLINE METAL OXIDES/POLYMER SOLAR CELLS

S. Paranthaman\textsuperscript{1}, P. Sumanthiran\textsuperscript{1}, T. Thivakarasarma\textsuperscript{1}, S. Loheswaran\textsuperscript{1,3}, K. Balashangar\textsuperscript{1,3}, K. Prashanthan\textsuperscript{1}, M. Thanihaichelvan\textsuperscript{1}, S. Rasalingam\textsuperscript{2}, N. Robertson\textsuperscript{4}, J. Nelson\textsuperscript{5}, V. Dhayalan\textsuperscript{6} and P. Ravirajan\textsuperscript{1}

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\textsuperscript{2}Department of Physical Science, Trincomalee Campus, Eastern University of Sri Lanka
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\textbf{ABSTRACT}

Hybrid metal oxide / polymer solar cells are one of the promising classes of Organic Photovoltaic (OPV) device and have been intensively studied for more than a decade because of the availability to control interface morphology for improving their performance. Several strategies have been reported to improve photovoltaic performance of metal oxide / polymer solar cells. This work discusses a range of new strategies which include, the use of metal oxide:carbon nanotube blend films and interface modifiers such as, Self-Assembled Monolayers (SAMs), dyes and insulating thin alumina layers. Further, the Time of Flight (TOF) photocurrent measurement technique has been employed as a tool to determine the hole-mobility in nanocomposite films of porous titanium dioxide and poly (3-hexylthiophene), with or without interfacial layer.

This study concludes that the hybrid metal oxide / polymer composite is a good model system to study the effects of interfacial properties and film morphology on the performance of bulk hetero junction photovoltaic devices. Moreover, expertise gained with this hybrid systems has proved to be valuable in improving the performance of other PV systems.

Keywords: Titanium dioxide, poly (3-hexylthiophene), solar cells, interface modifier, efficiency
ORAL PRESENTATIONS
SRI LANKAN VEIN GRAPHITE AS A VALUE ADDED ANODE MATERIAL FOR LI-ION RECHARGEABLE BATTERIES

H.P.T.S Hewathilake¹, ², R.I.C.N. Karunarathne¹, T. H. N.G. Amaraweera¹, ², H. W. M. A. C Wijayasinghe¹, N.W.B. Balasooriya³ and H.M.T.G.A. Pitawala⁴

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³Faculty of Applied Sciences, South Eastern University, Sammanthurai, Sri Lanka
⁴Department of Geology, University of Peradeniya, Peradeniya, Sri Lanka

ABSTRACT

Many investigation have focused on application of natural graphite as the anode material in Lithium-ion rechargeable batteries (LIB). Vein graphite is the highly crystalline and chemically purest form of natural graphite, other two are flake and amorphous. Already, flake graphite have been introduced to the anode application in LIB, however, through very costly and hazardous processes. Comparable to flake graphite, vein graphite possess a great potential with its excellent characteristics. Presently, Sri Lanka is the only commercial supplier of vein graphite in the world. However, in order to make them feasible for LIB application, our vein graphite have to be subjected to a thorough value addition. Therefore this study focused on the value addition to Sri Lankan vein graphite through purification and necessary surface modification, for the anode application of LIB. For that, raw graphite samples (<53 µm) were treated with a mixture of acids (HF, HNO₃ and H₂SO₄) until the mixture evaporated and the residue was and vacuum dried. The material characterization study based on C% (ASTM 561), FTIR and XRD analysis confirmed the achieving of a purity over 99.9% with simultaneously modified vein graphite surface. Electrochemical half-cell testing was performed with CR2030 coin cells assembled with upgraded vein graphite anode. The discharge-charge profiles of the vein graphite anode exhibited 378 mA h g⁻¹ discharge capacity over 50 cycles with minimum irreversible capacity loss of 53 mA h g⁻¹ for the first cycle. Altogether, this study reveals the suitability of our vein graphite for the anode application of LIB.

Financial assistance by the Innovative Research Grant -2013 of University Grant Commission (UGC), Ministry of Higher Education is acknowledged

Keywords: Vein graphite, Anode material, Li-ion rechargeable batteries
USE OF HYDROXYAPATITE COATED IRON OXIDE NANO PARTICLES (HAP/IONPS) FOR THE PURPOSE OF ANTI-CANCER DRUG DELIVERY TO BREAST CANCER CELLS

D. C Manatunga¹, W.R.M de Silva¹, G.N. Malavige², D.T. Wijeratne² and K.M.N de Silva¹,³

¹Department of Chemistry, University of Colombo
²Center for Dengue Research, Department of Microbiology, Faculty of Medical Sciences, University of Sri Jayawardanapura
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ABSTRACT

The novel approach in anti-cancer research is to screen anti-cancer agents with natural origin which has lower extent of side effects that the anti-cancer agents with synthetic origin. Curcumin is one such anti-cancer agent which is common spice in Indian cuisine. It is known to possess strong anti-oxidant and anti-inflammatory properties and could also induce apoptosis in number of cancer cell lines. However the practical application of curcumin has been limited due to its poor aqueous solubility and its instability to heat and light. Therefore this study reports a novel approach to create a drug carrier for curcumin where its delivery is targeted to achieve on breast cancer cell line (MCF-7). Iron oxide nanoparticles coated with hydroxyapatite (HAP/IONPs) was selected as the carrier molecule to encapsulate curcumin which in-turn has resulted with increased solubility and stability in aqueous medium. Synthesized curcumin loaded HAP/IONPs (Curcumin@HAP/IONPs) was analyzed for its ability to perform controlled release of curcumin in pH sensitive manner. Nanoparticles were then tested against MCF-7 cells to demonstrate their anti-proliferation effect on cancer cells. The results implicated that these Curcumin@HAP/IONPs has given rise to enhanced anti-proliferative effect over MCF-7 with respect to neat curcumin. Moreover the fluorescence imaging studies has further proven that Curcumin@HAP/IONPs has time controlled apoptotic effect which is much profound when compared with the neat curcumin. Therefore this study has highlighted the possibility of using curcumin incorporated HAP/IONPs as a novel drug carrier system for controlled killing of MCF-7 breast cancer cells.

Keywords: curcumin, hydroxyapatite, iron oxide, controlled, anti-proliferation
INVESTIGATION OF THE EFFECTS OF PLASTICIZERS IN A GEL ELECTROLYTE ON THE PHOTOVOLTAIC PERFORMANCE OF DYE-SENSITIZED SOLAR CELLS

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ABSTRACT

Although liquid electrolyte-based dye-sensitized solar cells (DSCs) have shown higher photovoltaic performance in their class, they still suffer from some practical limitations such as solvent evaporation, leakage and sealing imperfections. These problems can be circumvented to a certain extent by replacing the liquid electrolyte using a gel polymer electrolyte. Even though, the use of gel polymer electrolytes sacrifices the performance of DSCs to some extent due to low ion mobility, they show cohesive nature of solids and diffusive nature of liquids while showing good stability in outdoor applications. This study focuses on a comparative study on the use of different plasticizers in polyacrylonitrile-based (PAN) gel polymer electrolyte. The plasticizers were dimethyl formaldehyde (DMF), dichloromethane (DCM), dimethyl sulphoxide (DMSO), ethylene carbonate (EC) and propylene carbonate (PC). In addition, the use of tert-butylepridine (TBP) as a recombination suppressing agent was also investigated. The DSC device structure was FTO/TiO₂/N 719 dye/gel electrolyte/lightly-platinized FTO counter electrode with I⁻/I₃⁺ as the redox couple. The plasticizer combinations used in the gel electrolyte were EC/PC, EC/PC/TBP, DMF/DCM, DMF/DMSO, DMF/DMSO/TBP and their respective cell efficiencies were 5.00 %, 5.50 %, 3.84 %, 4.50 % and 4.70 %. It was observed that the JSC for the EC/PC/TBP system was the highest. This could be due to the formation of more cross-linking sites among C=O groups of the EC and PC and C≡N group of PAN leading to better diffusivity of I₃⁺. Comparison of the Voc values of 630 mV and 720 mV respectively of the EC/PC/TBP-based devices shows that the presences of TBP reduces the recombination due to TBP on spaces that are not covered by the dye molecules.

Keywords: conductivity, diffusivity, dye-sensitized solar cells, gel electrolytes, plasticizers
MULTIWALL CARBON NANOTUBE (MWNT) FOR ENHANCING THE PERFORMANCE OF HYBRID TITANIUM DIOXIDE /POLY(3-HEXYLTHIOPHENE) SOLAR CELLS

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ABSTRACT

Solar cells based on soluble conjugated polymers are of great interest because of the potentially low cost production by solution processing. However, the efficiency of these cells based on these structures is limited due to several factors including poor transport of the dissociated charges in the active layers. The primary objective of this study is to improve the efficiency of hybrid Titanium dioxide (TiO₂)/ polymer solar cells by reducing the losses by improving the charge transport in nanoporous TiO₂ layer.

This study focuses on improving the performance of the hybrid polymer/TiO₂ solar cells by introducing Multiwall carbon nanotube (MWNT) at the interface of polymer/TiO₂. The existence of uniformly distributed bundles of MWNTs in the nanoporous TiO₂ layer was confirmed by SEM image of MWCNT incorporated nanoporous TiO₂ film. The UV-Vis-NIR spectral measurements reveal that the insertion of MWNT has no effect on its absorption but improve polymer adsorption of nanoporous TiO₂ layer. This approach improves the overall power conversion efficiency by more than a factor of two, mainly due to the significant improvements in short circuit current density and the fill factor. This is attributed due to the enhanced number of effective carrier percolation routes in MWNT incorporated solar cells which reduces the back electron transfer and hence minimizes the losses.

Keywords: solar cell, carbon nanotube, TiO₂, P3HT, exciton
MONTMORILLONITE NANO COMPOSITES FOR WATER PURIFICATION

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ABSTRACT

Heavy metals are one of the main sources in polluting water which is a threat to living beings. Montmorillonite is one of the smectite-type clays which can be used to remove heavy metals from water, especially lead and cadmium ions. The objective of this research is to enhance the adsorption capacity of montmorillonite towards lead and cadmium ions by incorporating nanomaterials such as hydroxyapatite and zinc oxide. Mono-coated and bi-coated composites were synthesized by incorporating hydroxyapatite and zinc oxide nanoparticles. The prepared composites and neat materials were characterized using FTIR, SEM images and XRD patterns. Each of the composite and neat materials were then subjected to lead and cadmium adsorption studies. Optimizations of the contact time and pH levels were carried out for each of the adsorbent. Adsorption characteristics of newly synthesized composites along with the neat materials were analyzed using adsorption isotherm studies. Maximum adsorption capacities were shown by neat hydroxyapatite. However the leaching effect of Ca²⁺ of neat hydroxyapatite was very much higher when compared with the composites. Highest adsorption capacity towards Pb²⁺ ions (312.79 mg g⁻¹) with less leaching effect was shown by bi-coated montmorillonite composite where the top coating was done using hydroxyapatite. Highest adsorption capacities towards Cd²⁺ ions (1.36 mg g⁻¹ and 1.57 mg g⁻¹) were shown by both bi-coated montmorillonite composites with less leaching effects. According to the results, it can be stated that the adsorption capacity of montmorillonite is significantly enhanced by the incorporation of hydroxyapatite and zinc oxide nanoparticles.

Keywords: montmorillonite, hydroxyapatite, zinc oxide, lead, cadmium
FABRICATION OF NOVEL GUM KONDAGOGU-CHITOSAN FILM CONTAINING GREEN SYNTHESIZED SILVER NANOPARTICLE FOR TISSUE ENGINEERING APPLICATIONS

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ABSTRACT

A novel biosheet has been prepared by blending Gum kondagugu with Chitosan containing microwave assisted green synthesize silver nanoparticles. The optical property, morphology, and structure of silver nanoparticle was characterized by using UV-Visible spectroscopy, Transmission Electron Microscope (TEM), Dynamic Light Scattering (DLS) and X-ray Diffraction (XRD). The result showed the formation of silver nanoparticle in size range of 50-60 nm. The synthesize composite biosheet was physically characterized by scanning electron microscopy (SEM) images, and entrapment of silver nanoparticle was confirmed by Energy-dispersive X-ray spectroscopy (EDX). The FTIR study showed a characteristic peak of each component proves the compatibility of the blend. Thermal stability was confirmed by Thermogravimetric analysis (TGA) and antimicrobial activities was studied with S. Aureus and E-Coli. The NIH 3T3 cell lines studies showed it’s highly biocompatibility in nature. In conclusion, synthesized biosheet may be a potential candidate for tissue engineering applications.

Keywords: Gum kondagugu, Chitosan, Silver nanoparticle, Microwave synthesis
FACILE SYNTHESIS OF SILVER NANOPARTICLES EMBEDDED REDUCED GRAPHENE OXIDE COMPOSITE

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ABSTRACT

Metal nanoparticles (NPs) have received a great interest due to its size effect on the physical and chemical properties. Silver NPs have been preliminary focused towards the synthesis of metal nanocomposite embedded in reduced graphene oxide (rGO) to obtain superior composite materials for many useful biological, chemical as well as mechanical applications. For this study, the matrix rGO material was prepared using natural vein graphite through chemical reduction method. The silver NPs were synthesized using millimolar concentrations of sodium borohydride (NaBH₄). The synthesized composite material was characterized by X-ray Diffraction (XRD), scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), high-resolution transmittance electron microscopy (HRTEM) and X-ray photoelectron spectroscopy (XPS) techniques. The XRD phase analysis confirms the presence of silver NPs in the composite material with the strong peak present at 2θ=38.01° with a d-spacing of (002) 2.36Å. The SEM analysis of composite material confirms the puffed-like morphology after the synthesis process. Further, the EDS surface mapping reveals the homogeneous distribution of silver nanoparticles in the rGO surface. The HRTEM analysis reveals that the average diameter of silver NPs embedded in rGO sheets is 1.63 nm with a lattice parameter of 0.409 nm, which is consistency with the theoretical lattice parameter of 111 zone axis of silver NPs. Moreover, XPS results clearly suggest the presence of a pure silver particle in the composite material. Interestingly, this results confirms the successful synthesis of rGO/Ag nanocomposite by the Sri Lankan natural vein graphite as the starting material.

Keywords: reduced graphene oxide, natural vein graphite, silver nanoparticles, chemical reduction
SYNTHESIS OF EUROPIUM DOPED HYDROXYAPATITE NANOPARTICLES FOR CELL LABELING

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\textbf{ABSTRACT}

Hydroxyapatite (HAP) as the primary inorganic component of bone and teeth is demonstrated to be an excellent candidate for biomedical applications because of its biocompatibility, biodegradability, and bioactivity. HAP can be used as the host of luminescent rare earth (RE) ions and the obtained RE-HAP nanoparticles can be used for cell labeling and medical diagnostics. Herein, the Eu\textsuperscript{3+} ions doped HAP nanoparticles (HAPnps) were synthesized by ultrasound irradiation assisted co-precipitation method. The effects of Eu\textsuperscript{3+} doping content and reaction temperature on phase composition, crystal size, crystallinity and luminescent properties of Eu-HAP were investigated. The potential application of Eu-HAPnps as cell labels was evaluated for Bel-7402 human liver cancer cells. Due to the incorporation of Eu\textsuperscript{3+} in HAP lattice, crystal size in length becomes shorter than pure HAPnps. It is because interfering of crystallization process by Eu\textsuperscript{3+} ions. The luminescence effectiveness could be enhanced by increasing reaction temperature, but on the other hand higher reaction temperature leads to a little higher particle size. By rising reaction temperature and Eu\textsuperscript{3+} doping content the luminescence intensity of Eu-HAPnps can be enhanced. In addition, experimental results of XRD patterns and FT-IR spectra display the characteristics of crystalline HAP, suggesting that the Eu\textsuperscript{3+} labeling does not change the crystalline phase composition. But the crystallinity degree and crystallite size of Eu-HAPnps are increased along with the increase of reaction temperature. Therefore, the preferable Eu doping content was identified as 2\% and reaction temperature was identified as 80\textdegree C for obtaining high luminescent Eu-HAPnps. Furthermore, the cell proliferation experiment of Bel-7402 was not significantly inhibited by Eu(2\%-)-HAPnps (0.1 mM) during 3 days.

Keywords: Hydroxyapatite, nanoparticles, Europium, Preparation, cell labeling
ADVANCED ELECTRON MICROSCOPIC STUDY ON FEW LAYERED BLACK PHOSPHORUS

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ABSTRACT

Advanced electron microscopic study for two dimensional Black phosphorus (BP) is presented. Black phosphorus is a layered allotrope of bulk phosphorus, and can be exfoliated similarly to graphite to few layers while getting an intrinsic band gap compared to graphene. As this is an emerging field, full characterization of BP is necessary for research applications. Yet there is lack of full characterization for BP in recent work. Electron energy loss spectroscopy (EELS) is an advanced technique to analyse the chemical composition and bonding information of materials. In the present study, High Resolution Transmission Electron Microscope (HRTEM) combined with EELS and Energy Dispersive X-ray spectrometer (EDX) were used to characterize few layered BP. BP was exfoliated in different organic solvents in an inert environment. DMSO, DMF, DMAC, and ethanol were used as organic solvents. The morphological analysis, diffraction pattern analysis, and EELS study were carried out for layered BP. Further Raman spectroscopy was used to study the layered nature of BP. With the diffraction data it confirms DMSO is the best solvent for the exfoliation of BP to few layers.

Keywords: high resolution transmission electron microscopy, electron energy loss spectroscopy, black phosphorus
OPTICAL CHARACTERISATION OF NEAR ATMOSPHERIC RF GLOW DISCHARGE PLASMA AND ENVIRONMENTAL FRIENDLY TREATMENTS

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ABSTRACT

Non-thermal plasma at near atmospheric pressure is an evolving green technology for many surface treatment applications. In this study, a rapid method for approximate determination of the span of electron energy distribution of non-thermal plasma is demonstrated. The capabilities of the particular plasma system was estimated by considering the N\textsubscript{2} (C-B) and N\textsubscript{2} (B-A) band transitions appearing in the RF air plasma glow discharge. Using the estimated energies of energetic particles, some surface modifications were predicted, depending on the bond dissociation energies of particular chemical bonds. Fragmentizing long polymer chains, in this case, nylon 6, 6 by end amine groups has been predicted and examined with FTIR and dye adsorption. Organic contaminant removal, oxide layer and surface layer etching were also demonstrated for Aluminium metal, through water contact angle measurements. In both cases, a strong agreement was seen between experimental results (enhancement in dye adsorption by 65\% and drop of water contact angle from 80\textdegree{} to 9.5\textdegree{}±1.7\textdegree{}) and predictions.

Keywords: Plasma, Near atmospheric, Dye, Optical Emission, FTIR
COMPARISON OF LOADING PROPERTIES OF CURCUMIN WITH RESPECT TO THE METAL CENTER IN DIFFERENT METAL ORGANIC FRAMEWORKS

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ABSTRACT

Metal Organic Frameworks (MOFs) are hybrid materials synthesized by self-assembly of polydentate organic ligands and metal centers. Organic ligands provide biocompatibility and high capacity for drug uptake while the interactions between the metal center and drug enable the controlled release of the drug from MOFs. Controlled releasing increases the solubility of the drug while preventing the drug from bio degradation and over dosage.

Curcumin has many pharmacological activities but is not widely used in medicine due to its poor aqueous solubility and rapid metabolism. These drawbacks could be overcome by using stable highly interactive MOFs as drug carriers. In order to recognize the optimum Metal Organic Framework as a drug carrier for Curcumin, we have quantitatively investigated drug loading properties of Curcumin to five different MOFs with different metal centers and organic ligands. It has been observed that highly porous Copper containing MOFs show high loading capacities (>75%) and encapsulation efficiencies even at low concentrations of Curcumin (5 ppm) with respect to other transition metals as Zinc and Iron. This is the first time that properties of Curcumin loading has been compared with respect to the metal center, the first time Curcumin has been loaded in to MOFs using the diffusion method where the drug is diffused in to the synthesized MOF, and the first time that Curcumin has been loaded to a Copper containing drug carrier that show significantly high interaction with Curcumin.

Keywords: Metal Organic Framework, Drug Carrier, Curcumin, Controlled release
PHOTOCATALYTIC REDUCTION OF Cr(VI) IONS TO Cr(III) IONS USING META-TITANIC ACID

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ABSTRACT

It is known that portable water sources get contaminated by various improper discharge of wastewaters and contain Cr(VI) species which are hazardous in carcinogenicity. International Agency for Research on Cancer (IARC) classified hexavalent chromium is human carcinogen and trivalent chromium is not its carcinogenicity to humans. In literature, TiO₂ nanoparticles have been used to reduce Cr(VI) photocatalytically. Our research studies were carried out using a photocatalyst which was meta-titanic acid isolated from naturally occurring Pulmuddai Ilmanite. Meta-titanic acid was extracted as an intermediate product at the aging step of our new method. The main objective of the research study is to isolate meta-titanic acid in nano size. However, Scanning Electron Microscope (SEM) photographs indicated that the particles are in macro size. Further meta-titanic acid particles were characterized using Thermogravimetric Analysis (TGA), and Fourier Transform Infrared (FT-IR) Spectroscopy. In our studies meta-titanic acid was mixed with Cr(VI) oxide solution and exposed to UV light to convert hexavalent chromium state into Cr(III) species. The experiment was accomplished by varying the pH, concentration of meta-titanic acid and Cr(VI) ion concentration. The completion of the reaction was monitored using diphenyl amine, since it gives a dark purple color in the presence of Cr(VI). The time was recorded for the disappearance of the color change. Through the analysis of the experimental data the optimum pH value for the photocatalytic reduction was pH 2 and the order with respect to meta-titanic acid was zero.

Keywords: Meta-titanic acid, hexavalent chromium, trivalent chromium, Pulmuddai ilmanite
CONTROLLED RELEASE OF ANTIMICROBIAL CEPALEXIN DRUG FROM
GRAPHENE OXIDE – Fe₃O₄ NANOCOMPOSITE

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ABSTRACT

Release of antimicrobial drugs in a controlled fashion for extended duration of time has been investigated in many studies due to its usefulness in medicinal applications. Large surface area with oxygenated functional groups, Graphene Oxide (GO) exhibits better drug loading capacity, selectively releasing ability and in vivo stability. Along with biocompatibility, Fe₃O₄ nanoparticles have high potential of enhancing the antibacterial action and their super paramagnetic properties could allow targeted drug delivery. Cephalexin as a model drug is a first-generation cephalosporin. In this study a new hybrid nanomaterial was synthesized, which integrates the properties of Fe₃O₄ nanoparticles and GO for loading Cephalexin, targeting for controlled releasing in the biological fluids. The formation, stability and structure of the nanomaterials were characterized by spectroscopy (FTIR, UV-Visible, Raman), TGA, SEM, EDX and zeta potential measurements. The releasing studies were carried out via a membrane dialysis method and the released amount of Cephalexin was primarily quantified using UV–Visible spectrometry. Releasing ability was further analyzed by well diffusion method on four bacterial species. The nano-characterization results indicated that successful synthesis of all the nanomaterials. According to SEM results Fe₃O₄ nanoparticles were well deposited on to GO sheets, with an average size of 74.68 ± 9.73 nm. Release of Cephalexin during the whole analysis time proved the controlled release of drug. Well diffusion results directly supported this hypothesis with zero antibacterial activity for first 24 hours. This work demonstrated that GO-Fe₃O₄ nanocomposite was able to release Cephalexin efficiently in controlled concentrations for considerable period of time.

Keywords: Cephalexin, drug, GO, Fe₃O₄, nanomaterials, nanoparticles
INVESTIGATION OF ALKALI ROASTING METHOD FOR PURIFICATION OF SRI LANKAN VEIN GRAPHITE

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ABSTRACT

Sri Lanka is the only commercial producer in the world for highly crystalline and high purity natural vein graphite with around 95-98% carbon content. The increasing demand for cheaper but high purity graphite (99.9 % carbon), specially for upcoming large-scale applications in nanotechnology and rechargeable batteries, has directed for novel approaches to purify natural graphite. Under that, the present study is based on an investigation of the low-cost and efficient alkali roasting method to purify Sri Lankan natural vein graphite. This investigation was carried out using two different alkaline solutions of NaOH and KOH, separately. Under that, vein graphite was mixed with the alkaline solution and roasted at 250 °C, followed by leaching with a mixture of HCl and HNO₃. The carbon content determined according to ASTM - 561 showed around 99.9 % carbon in the graphite samples purified by both NaOH and KOH alkaline solutions. X-ray diffraction, Fourier transform infrared spectroscopy, scanning electron microscopy and the electrical conductivity by d. c. four probe technique were used for material characterization. The characterization study reveals the existence of the appropriate graphite phase also with very high purity. It further indicated a semiconducting nature for the purified graphite within the order of 1 S/cm of conductivity at 25 °C. Accordingly, this study reveals the successfulness of the alkali roasting method to purify Sri Lankan natural vein graphite with purity required for advanced nanotechnological and rechargeable battery applications.

Keywords: Vein Graphite, Alkali Roasting, purification, Li-ion battery
DEVELOPMENT OF SUPERHYDROPHOBIC SURFACES USING NANOMATERIALS

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ABSTRACT

Self-cleaning surface is a one designed to clean itself, often automatically. The lotus leaf is a good example of a naturally existing self-cleaning surface. This property of a surface could be improved by using suitable coating materials with high surface roughness and low surface energy. Such materials with superhydrophobic properties have a wide range of applications in many industries. For this purpose graphene oxide (GO) nanoparticles were synthesized using graphite oxide made from graphite by modified Hummer’s method. Similarly, silica (SiO₂) nanoparticles were prepared using tetraethyl orthosilicate precursor and its surface was chemically modified using a silane coupling agent 3-aminopropyltriethoxysilane. By using SiO₂ and GO the hybrid GO/SiO₂-NH₂ was synthesized. Characterization of synthesized nano particles was done using SEM, XRD and FT-IR spectroscopy. To prepare coatings with different compositions different proportions of graphene oxide/ silanized silicon dioxide (GO/SiO₂-NH₂) hybrid was added to polyvinylidenefluoride in order to form 0.00%, 5.00%, 15.00%, 25.00%, 35.00% and 45.00% compositions. Glass slides were coated with this material using spin coating method. Water contact angles were measured using computer software. The water contact angle for polyvinylidenefluoride (PVDF) coating (the control) was 78.21°. The highest contact angle of 165.62° was observed with double coated 25.00% GO/SiO₂-NH₂ hybrid composition. It was concluded that hybrid of nano GO and silanized nano SiO₂ with organic polymers like PVDF show promising superhydrophobic properties which could be further improved by better coating methods.

Keywords: self-cleaning, superhydrophobic, graphene oxide, silica, polyvinylidenefluoride
MAGNETITE-CARBON FIBER NANOComposite AS HEAVY METAL SCAVENGERS FOR WATER PURIFICATION APPLICATIONS

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ABSTRACT

To enhance arsenic removal in water bodies, nano-magnetite embedded carbon fibers were fabricated using polyacrylonitrile (PAN) as the precursor material for carbon fiber synthesis. The magnetite-PAN fiber nanocomposite was synthesized by an electrospinning process. The temperature controlled pyrolysis of the fiber nanocomposite yielded magnetite doped carbon fiber nanocomposite. The pyrolysis temperature conditions of magnetite-PAN nanocomposite were predetermined by thermogravimetric analysis (TGA). The surface morphology of the nanocomposites were characterized by the scanning electron microscopy (SEM). Further chemical and structural details were extracted using X-ray diffraction (XRD), Fourier transformed infrared (FT-IR) spectroscopy and atomic force microscopy (AFM) techniques. The arsenic (V) adsorption capacity of magnetite-carbon fiber composite was studied in batch experiments using inductively coupled plasma mass spectrometry (ICP-MS). The magnetite doped carbon fibers were able to reduce the As(V) concentration below its maximum contaminant levels required by local drinking water standards. The same phenomenon could be applied to scavenge a variety of heavy metals in water bodies, just by selecting the nanoparticle of correct selectivity towards target contaminant, in synthesizing the composite fibers.

Keywords: nano composite, carbon fibers, magnetite, arsenic, adsorption
POLYANILINE/PALLADIUM NANOPARTICLE HYBRIDS FOR MOISTURE AND HYDROGEN DETECTION

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ABSTRACT

Palladium nanoparticles display fascinating electronic, optical and catalytic properties as a consequence of their dimensions, thus can be used for various applications such as sensor fabrication. Conducting polymers such as polyaniline has been widely used in sensor technology due to its cost effectiveness, versatility and easy synthesis. Importantly, polyaniline has been used for the detection of both hydrogen and humidity. In this project attention has been given to construct Palladium nanoparticle incorporated polyaniline film hybrids to detect hydrogen and moisture. Firstly, gold sputtered epoxy resin boards were prepared to use as electrodes in electrochemical polymerization of aniline. Scratch was made to divide the gold sputtered epoxy resin board into two electrodes. Then, polyaniline films were developed on the surface of gold sputtered epoxy resin boards until the separated electrodes were connected by polyaniline film using electrochemical polymerization. Palladium nanoparticles were prepared using sonochemical reduction method. Resulted nanoparticles were then incorporated in to polyaniline film using drop dried method. Polyaniline film only and palladium nanoparticles only sensors were also fabricated to do a comparative study. These sensors were then used to determine hydrogen and humidity sensing properties. The sensors were then calibrated for hydrogen by exposing it to controlled hydrogen flows and for humidity by exposing it to controlled humidity environments by measuring impedance. According to the result obtained, polyaniline films exhibited a decrement of impedance in the presence of humidity and the response was significantly improved once Palladium nanoparticles were incorporated. Interestingly, polyaniline films did not respond to hydrogen which is controversial to reported literature. Nevertheless, Palladium nanoparticle incorporated Polyaniline films exhibited remarkable response towards hydrogen.

Keywords: polyaniline/palladium nanoparticle hybrids, humidity, hydrogen, sensor, impedance
THEORETICAL INVESTIGATIONS OF INTERACTION OF COMPOUNDS PRESENT IN SWEAT WITH POLYESTER FABRICS

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ABSTRACT

Currently, polyester is the first choice for apparels due to the extensive characteristics of polyester textiles over other textiles. PET (polyethylene terephthalate) is the most popular synthetic polymer which is used in polyester. The major drawback of polyester is the malodor generation after a short usage and even after a detergent wash. This phenomena occurs due to the interactions between PET and odorant compounds in sweat. For this analysis acetic acid, propionic acid, butyric acid, isovaleric acid and (E)-3-methyl-2-hexenoic acid are selected as sweat materials which are experimentally proven odorants in sweat. Basically this research was carried out to investigate whether these acids interact with PET over SDS (Sodium Dodecyl Sulfate) surfactant to determine which acid among the selected carboxylic acids cause the malodor generation in polyester even after the detergent wash. The interaction between two molecules cannot be calculated experimentally. Therefore theoretical analysis was conducted using GROMACS software. The umbrella sampling method, which is a classical mechanical technique is used to compare the free interaction energy of each system. According to the experiments, it has been proven that all selected carboxylic acids cause the malodor generation in polyester clothes even after short usage whereas all of them except propionic acid are removed during the washing process since all carboxylic acids highly interact with SDS over PET. Hence, propionic acid cause the malodor generation in washed polyester since it is strongly adhered to the polyester fabric.

Keywords: polyethylene terephthalate (PET), Sodium Dodecyl Sulfate (SDS), umbrella sampling method
Pd(II) COORDINATED THIOL FUNCTIONALIZED MAGNETITE NANOPARTICLES FOR HIS-TAGGED PROTEIN ISOLATION

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ABSTRACT

Transition metal cations coordinated on the surfaces of nanoparticles using different support structures has proven to enhance the isolation of 6×Histidine tagged recombinant proteins than the conventional Immobilized Metal Affinity Chromatography (IMAC) columns. Therefore, this study was focused on developing a magnetically retrievable nanoparticle which could isolate 6×His tagged recombinant proteins with high yield and purity using a less complex and a rapid protocol. A coprecipitation method was used to synthesize the magnetite core of the nanoparticles and they were protected with a silica layer synthesized using a modified Stöber method. This multi-beneficial silica layer facilitated the establishment of thiopropyl groups on surfaces of the nanoparticles through base hydrolysis of (3-Mercaptopropyl)trimethoxysilane (MPTMS). Ultimately, the Pd(II) cations were coordinated on to the nanoparticles using the thiol functionalized surfaces. The synthesized system was characterized using XRD, FT-IR, PSA and SEM. These particles were used to isolate r-SDUP (recombinant Setaria digitata uncharacterized protein), comprising the 6×His fusion tag, using a modified protocol. The efficiency of isolation was evaluated using SDS-PAGE. The synthesized isolation system exhibited considerable affinity towards 6×His fusion tag of r-SDUP within the given conditions. Since the canonical eluting agent imidazole, was not efficient at displacing r-SDUP even at high concentrations further studies have focused on the elution process. However, the rapid capturing and high specificity towards the 6×His tagged r-SDUP demonstrates the potential of this system for recombinant protein isolation.

Keywords: 6×His-tag, isolation, magnetite-nanoparticles, thiol, Pd(II)
CLAD-MODIFIED FIBER OPTIC GAS SENSOR WITH SILVER NANOPARTICLES SYNTHESIZED BY LASER ABLATION USING CITRUS LIMETTA JUICE EXTRACT

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ABSTRACT

Silver nanoparticles were synthesised by laser ablation using citrus limetta juice extract in solutions at ambient temperature and the particle sizes were in the range of about 9 - 13 nm for different ablation durations (20, 40, 60 and 80 min.). Silver nitrate (0.1 M) was dissolved in water (20 ml) and mixed with orange juice (2 ml) and then laser irradiated. Nd: YAG laser with pulsed energy of 725 mJ, pulse width 10 ns, wavelength 1.06 µm, beam diameter 10 mm and unfocused beam, was used. The formation of Ag nanoparticles which were in the colloidal form and stable, were confirmed by UV-visible absorption spectra which exhibited absorption band around from 400 to 430 nm. TEM results showed that poly dispersed Ag nanoparticles were formed when the ablation time was 20, 40 and become mono dispersed when it was 60 and 80 min. The silver nanoparticles were coated on small portion of the optical fiber, where the cladding of the fibre was removed and used this portion for gas sensing. The fiber optic sensor exhibited very good response for ammonia gas (100 - 500 ppm). The response is linear and gas sensitivity is about 42 counts/ 100 ppm.

Keywords: laser ablation, Ag nanoparticles, fiber optic sensor, ammonia gas
ENHANCED FERROELECTRIC PROPERTIES OF P(VDF-HFP)/ZnFe$_2$O$_4$ NANOCOMPOSITE FILMS

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ABSTRACT

Flexible, self-standing films of poly(vinylidenefluoride-hexafluoropropylene) P(VDF-HFP) and ZnFe$_2$O$_4$ nanocomposite of different weight percentages (0, 5, 10, 15, 20 %) were fabricated through spin coating technique. The structural, compositional, ferroelectric and dielectric behaviors were investigated. XRD and FTIR studies confirmed the presence of both electro-active β phase and non-electro active α phase in P(VDF-HFP). The enhancement of ferroelectric and dielectric properties with the addition of ZnFe$_2$O$_4$ was confirmed with the help of the ferroelectric hysteresis loops and also the dynamic contact electrostatic force microscopy (DC-EFM) studies. P(VDF-HFP) – ZnFe$_2$O$_4$ film of 20 wt% was observed to have better enhancement than other films. The films exhibited enhanced ferroelectricity, high dielectric constant, low dielectric loss and low leakage current which make them the potential candidates in the storage device applications.

Keywords: P(VDF-HFP), ferroelectric, DC-EFM, Dielectric
MODELING OF A NANOGRIpper FOR TENSION TEST

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ABSTRACT

The design and disassembling of structures consisted of carbon nanotube (CNT) is not possible without having any information regarding their mechanical properties such as force endurance capacity and range of reversible behavior. In this paper, the maximum admissible lateral force for different ranges of nanotube length which do not cause irreversible structural deformation is determined with the molecular dynamics (MD) simulation method. It is shown that for a certain gripping force, friction between the CNT and the gripper is nonlinearly proportional to the contact area up to a certain value, and remains unchanged afterwards. The obtained results show that CNT in its middle length has remarkable capacity of force endurance rather than its two ends. The implications of this finding could affect the way nanogrippers are designed for the construction/manipulation of nanoparticles. The reported results in this research have fundamental role in the design of nano-grippers that are needed in manufacturing and dislocating nanostructures.

Keywords: carbon nanotube, nanogripper, reversible deformation, molecular dynamics
ABSTRACT

The discharge of dye-containing waste effluent from the textile industry into water bodies has become a major problem in terms of environmental pollution. Therefore, the removal of dyes from waste effluent is of significant importance to the preservation of aquatic life. In this study, the adsorption of Direct Blue 86 onto synthesized Mg-doped hydroxyapatite was investigated. The hydroxyapatite was synthesized via wet chemical precipitation and characterized by FT-IR and SEM. Experiments were conducted to determine the influence of several factors on the dye uptake by the adsorbent such as the contact time under agitation, initial dye concentration, adsorbent dosage, temperature, and ionic strength. The results indicated that the amount of dye adsorbed per gram of adsorbent increased with an increase in the initial dye concentration. The dye adsorption capacity decreased with an increase in adsorbent dosage i.e. the amount of adsorbent per litre of solution. The uptake of dye onto hydroxyapatite decreased with an increase in the temperature of the dye solution. Therefore, the adsorption process was temperature-dependent and exothermic in nature with an enthalpy of adsorption of -1.57 kJ mol⁻¹. The presence of ions in solution contributed to a decrease in the dye uptake. Adsorption kinetics were analyzed using Langmuir and Freundlich isotherms. The equilibrium experimental data were best represented by the Langmuir isotherm model, and the maximum monolayer adsorption capacity was 25.29 mg g⁻¹.

Keywords: adsorption, hydroxyapatite, magnesium-doped, Direct Blue 86 Dye, isotherms, kinetics
**ABSTRACT**

Glycine-Nitrate Combustion (GNC) synthesis method is a low-cost wet-chemical technique, which can be improved to prepare ultra-fine powder particles with very high chemical homogeneity. In this study, the GNC method was successfully used to synthesize nanostructured Cu and Mg co-substituted Li(Ni<sub>1/3</sub>Mn<sub>1/3</sub>Co<sub>1/3</sub>-(x+y)Cu<sub>x</sub>Mg<sub>y</sub>)O<sub>2</sub>; (x + y = 0.11) cathode materials by optimizing the Glycine:Nitrate ratio in the precursor solution and calcining at 900 °C. The X-ray diffraction (XRD) phase analysis performed on synthesized materials revealed the formation of the required Li(Ni<sub>1/3</sub>Mn<sub>1/3</sub>Co<sub>1/3</sub>-(x+y)Cu<sub>x</sub>Mg<sub>y</sub>)O<sub>2</sub>; (x, y) (0.027, 0.083) and (0.055, 0.055) phases. It further elaborated the reduction of the degree of cation mixing due to Cu-Mg co-doping into Li(Ni<sub>1/3</sub>Mn<sub>1/3</sub>Co<sub>1/3</sub>)O<sub>2</sub>. Furthermore, scanning electron microscopy reveals the existence of somewhat spherical shaped micron size secondary powder particles formed by softly agglomerating nano-scale primary particles. This is regarded as a favorable morphology for the cathode of rechargeable Lithium Ion Batteries (LIB) very likely due to enhanced surface area. In the electrochemical performance study, Cu and Mg co-substituted Li(Ni<sub>1/3</sub>Mn<sub>1/3</sub>Co<sub>1/3</sub>-(x+y)Cu<sub>x</sub>Mg<sub>y</sub>)O<sub>2</sub>;(x + y = 0.11) materials show a significant drop in the first cycle discharge capacity, but with an improved cycle performance compared to Li(Ni<sub>1/3</sub>Mn<sub>1/3</sub>Co<sub>1/3</sub>)O<sub>2</sub>. More importantly, the differential capacity plots of Cu-Mg co-doped Li(Ni<sub>1/3</sub>Mn<sub>1/3</sub>Co<sub>1/3</sub>)O<sub>2</sub> implies the elimination of irreversible oxidation process, corresponding to loss of oxygen at higher potential (> 4.5 V). This is a very interesting feature of this study, since it addresses the most significant drawback associated with the layered transition metal oxides cathodes. Therefore these GNC synthesized cathode materials have the potential to be operated at higher voltage without undergoing any structural transformations.

Keywords: Cu and Mg co-substitution, Glycine Nitrate Combustion, Li(Ni<sub>1/3</sub>Mn<sub>1/3</sub>Co<sub>1/3</sub>)O<sub>2</sub>
SYNTHESIS OF LIGNIN NANOPARTICLES FROM LOCAL WOOD WASTE

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ABSTRACT

Lignin is the most abundant aromatic natural polymer and comprises about 25% of woody biomass. It has a highly cross-linked, three-dimensional structure composed of three types of substituted phenols; coniferyl, sinapyl and p-coumaryl alcohol. Lignin can easily be extracted from wood waste by treating with acid or base. In this study, lignin was extracted from saw dust by heating with a mixture of formic and acetic acids or refluxing in sulfuric acid. The yield and the composition varied depending on the extraction method. Lignin particles were synthesized either by sonication of an aqueous suspension of lignin or by dialyses of lignin dissolved in tetrahydrofuran (THF) against distilled water. Sonication yielded particles around 10 µm whereas dialysis yielded particles with sizes ranging from 400 nm to 1 µm depending on the amount of lignin dissolved in THF. Thus obtained particles were characterized using SEM, FTIR and XRD. Upon further optimization of synthesis and controlling the particle size, lignin nanoparticles can be used in many applications as a low cost alternative for other carbon-based nanomaterials.

Keywords: Lignin, Saw dust, SEM, FTIR, XRD
MAGNETOFECION-BASED NOVEL GENE DELIVERY SYSTEM

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ABSTRACT

Salivary glands can be a good model for gene delivery to treat systemic and oral disease. Non-viral vectors show little concern about the safety and biocompatibility issues but transfection efficiency is extremely lower than that of viral vectors. In this study, we report a magnetic gene transfer system combining extra-dermal magnetic field and Iron oxide-Mesoporous sillica-PEI nanoparticle to overcome those major hurdles of gene transfer to salivary glands. Uniformly constructed iron oxide nanoparticles were encapsulated by mesoporous silica, then chemically conjugated with linear 10kDa PEI(Poly-ethyl-imine) and TAT peptide (MSNNP). MSNNPs were complexed with therapeutic Aquaporin 5-GFP gene in 20:1(w/w) ratio then transferred to HSG cell-line. Under non-flowing condition transfection efficiency of MSNNP combined with magnetic field was 3 times higher than that of Lipofectamine 2000 but under the 60ml/hr flowing condition MSNNP/magnetic field showed 2.7 folds higher transfection efficiency than Lipofectamine 2000. Confocal image of HSG transfected with MSNNP showed distinctive AQP5-GFP protein expressed and located at membrane region. Magnetofection using MSNNP seems to be a practicable and promising system for non-viral gene delivery to salivary glands.

Keywords: salivary glands, gene delivery, magnetic, mesoporous silica, iron oxide nanoparticle
MULTI-WALLED CARBON NANOTUBES FROM COCONUT SHELLS

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\textbf{ABSTRACT}

Carbon nanotubes (CNT), a versatile material, used for applications in energy storage, automotive parts, boat hulls, sporting goods, water filters, thin-film electronics, coatings, actuators and electromagnetic shields. CNTs are cylinders of one or more layers of graphene. The synthetic methods of carbon nanotubes include arc-discharge, laser ablation and chemical vapour deposition (CVD). We have used CVD method to synthesize CNT due to its simplicity and the cost. Coconut shells have been utilized as the carbon source for CNT synthesis. The pyrolysis of coconut shells produces various hydrocarbons both in liquid and gaseous forms. Liquid was separated from the gas by condensing the gas-liquid mixture before entering the tube furnace for final reaction with the catalyst. The separated gas was passed through various metal catalysts at high temperature under argon atmosphere. The produced multi-walled carbon nanotubes were collected and purified by treatment with mild acid. Carbon nanotubes were characterized using thermal methods, scanning electron microscopy (SEM) and transmission electron microscopy (TEM).

Keywords: carbon nanotubes, coconut shells, chemical vapour deposition, SEM, TEM
ENHANCING THE PROPERTIES OF METAL OXIDE NANOPARTICLES BY USING GREEN SYNTHESIS METHODS

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ABSTRACT

Nanotechnology has gain much attention due to the unique properties possessed by nanomaterials compared to the bulk materials. By combining nanochemistry with natural products, properties of nanoparticles can be enhanced. Here, we report the synthesis of copper oxide nanoparticles using a green synthesis method and applications of these nanoparticles to gauge their enhanced properties comparative to the chemically synthesized counterparts. Copper oxide nanoparticles were synthesized by co-precipitation method using Spondias dulcis and Coriandrum sativum extracts and characterized by using FTIR and UV-vis spectroscopy and Scanning electron microscopy. Photocatalytic degradation of dye molecules by CuO nanoparticles was investigated using Rhodamine B as the dye. Usually, when CuO nanoparticles are used in photocatalytic degradation of Rhodamines, hydrogen peroxide is added to generate hydroxyl radicals and it takes few hours to bleach the colour. Further, in the absence of hydrogen peroxide, copper oxide nanoparticles are not as effective as a photocatalyst for dyes. Interestingly, we found the CuO nanoparticles synthesized with Coriandrum sativum extracts are capable of bleaching the colour of Rhodamine B solutions within 15 min when irradiated under UV light or sunlight without adding hydrogen peroxide. Copper oxide nanoparticles synthesized using Coriandrum sativum seed and fresh leaf mixtures showed best results. Our study demonstrate that careful combination of nanoparticles and plant extracts can enhance the usefulness of nanoparticles and with enhanced properties we expect that our green synthesized nanoparticles can become useful candidates in various applications where the nanoparticles synthesized with chemical methods show limitations.

Keywords: Green synthesis, Coriandrum sativum, Spondias dulcis, Copper oxide nanoparticles, Rhodamine B
APPLICATIONS OF A RECYCLABLE HETEROGENEOUS Au/Pd BIMETALLIC CATALYST IN ORGANIC OXIDATION AND REDUCTION REACTIONS

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ABSTRACT

Amine functionalized magnetite nanoparticles (AMNPs) were synthesized via a polyol synthesis with concurrent surface functionalization. The next step involved the surface decoration through the in situ reduction of the Au and Pd precursors onto the AMNPs. The synthesized catalyst was characterized by XRD and FT-IR. The catalyst proved to be effective at catalyzing the oxidation of phenylboronic acid to phenol and aromatic amines to aromatic nitro compounds, while also catalyzing the hydrogenation of aromatic nitro compounds and carbonyl compounds. The Au/Pd ratio on the catalyst carrier surface, the amount of catalyst used, effects of the solvent system and effects of the substituent groups on the respective aromatic compounds were varied and studied. The catalyst displayed excellent recyclability without substantial loss of activity. No significant changes were seen in the surface chemistry of the post-reaction catalyst.

Keywords: heterogeneous catalysis, oxidation, reduction, palladium, gold, bimetallic
EXPERIMENTAL INVESTIGATION ON EFFECT OF MECHANICAL AND STRUCTURAL PROPERTIES OF REINFORCED NANOCOMPOSITES

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ABSTRACT

More than ever nano composites are being utilized in the wide applications such as aircraft marine, chemical, nuclear, bio-medical etc. Based on the unique character of Montmorillonite namely its powder particles to separate in to nanometer –size particles, clay composites were obtained by mixing of Hydrazine Hydrate (Hardener), Cytyl Pridinium Bromide, Benzoyl Peroxide, Polymethyl Methacrylate with montmorillonite clay –water dispersion and coagulating the mixture. Thus the characterization of these materials for various loading and geometric configuration has become a primary concern to designers as well as manufacturers. Indeed brittle and ductile behavior makes the composites sensitive to stress concentration and intensification factors, like holes, cracks, scratches, thickness variations and other defects. In the work efforts has been made to fabricate some nano clay epoxy composites by reinforcing of various thermo plastic fillers. In this research, the experimental work was carried out for evaluation of the behavior of reinforced nano clay based epoxy composites which places fewer constraints on designers and less time consumed to fabrication of composites for various applications under mechanical and chemical constraints. Experimental test were performed on several specimens at different configurations based on different volume fractions and materials. Specimens were fabricated as per ASTM standards. The structural test was performed on the fabricated specimens and various structural analyses were carried out to determine the controlling factors, design parameters and optimum results. The results indicates that, the reinforcement of nano clay has induced appreciable modifications in the thermal stability and structural strength and hence the nano composites are better properties both in Mechanical and Structural aspects than other composites.

Keywords: Epoxy, Montmorillonite clay, Polymethyl Methacrylate, Benzoyl Peroxide, Hardner
OPTICAL, RAMAN SCATTERING AND NONLINEAR OPTICAL LIMITING PROPERTIES OF AG/AU:ZNO NANOSTRUCTURES

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ABSTRACT

We report, synthesis of metal oxide: metal hetero structures and their optical, Raman scattering along with optical power limiting capabilities. ZnO:Ag, ZnO:Au nanostructures with different morphology were obtained by the self-assembly of ZnO nano entities using metal nanoparticles as seeds. ZnO nanostructures, hetero structures show enhanced optical absorption and emission. Raman spectral studies show that increases in the intensities of phonon bands and multiphonon Raman bands of nano ZnO while Ag and Au became a composite with ZnO. Further Raman results indicate that lattice vibrations of semiconductors are sensitive to the presence of metal nanoparticles. Open aperture Z-scan measurements carried out at 532 nm using 5 ns laser pulses reveal metal nanoparticle induced changes in the optical limiting properties of the nanocomposites.

Keywords: Nanoparticle, Fluorescence, NLO, Optical limiting
A NOVEL, FACILE, AND GREEN CHEMICAL ROUTE TO GOLD NANOPARTICLES

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ABSTRACT

Gold nanoparticles (GNPs) encompass many desirable traits which allows them to be successfully utilized in consumer products such as cosmetics, medicine and catalysts. There is a plausible tendency for these nanoparticles to be in direct contact with biological systems. Hence, there is an innate necessity for synthesizing GNPs with minimal or no consumption of harsh chemicals, which may lead to bioaccumulation of those chemical species. We have developed a novel and economical synthetic procedure for the facile preparation of GNPs mediated by green tea, a mild, biologically benign substance known to have positive impacts upon biological systems. The chemical constituents in green tea synergistically acts as the reducing agent and as the stabilizer for the synthesized GNPs. The as prepared nanoparticles are deep red color with a characteristic absorption centering around 530 nm, thus being similar in nature to GNPs synthesized via alternative, conventional routes. This synthesis can take place even at room or slightly elevated temperatures hence alleviating the typical harsh conditions used during conventional synthetic approaches. These GNPs show considerable stability for periods up to weeks or months, even in the absence of any auxiliary stabilizing agents. A complete kinetic evaluation and a morphological assessment of the resulting GNPs is currently in progress. Optimization in this regard will potentially lead to the preparation of green GNPs pertinent for various novel nanotechnological applications.

Keywords: GNPs, green chemistry, green tea
PREPARATION AND OPTIMIZATION OF SILVER NANOPARTICLES TO TREAT HOUSEHOLD WASTEWATER

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ABSTRACT

Nanotechnology is the art and science of manipulating matter at the nano scale. Silver nanoparticles are a frequently used nanomaterials with wide range of applications. The present study deals with biosynthesis and investigating the antimicrobial activity of silver nanoparticles. Silver nanoparticles were synthesized by reacting 2.5% neem leaf extract with 0.001 M silver nitrate at 1:8 ratio. Synthesized silver nanoparticles were initially characterized by colour change and then by UV-visible spectroscopy. Different silver nanoparticle solutions of 20, 25, 30, 40 and 50 µg/ml were tested on collected Household wastewater samples from Ratmalana area to determine the antimicrobial effects of silver nanoparticles on growth of bacteria. Household wastewater samples and each silver nanoparticle solution were mixed at 1:40, 1:80 and 1:120 ratios and they were shaken for 3 h at 120 rpm. Each mixture was cultured in nutrient agar medium and they were kept for an overnight in order to check the effectiveness of silver nanoparticles in reducing microbial load in household wastewater. The colour change from pale yellow to ruby red colour and an expected absorption peak in the visible range of UV-visible spectroscopy (model U-1800) confirmed the formation of silver nanoparticles. The presence of these particles at an approximate concentration range of (25-50) µg/ml at 1:40 ratio inhibitedthe bacterial growth by more than 99%. In conclusion, silver nanoparticles have proven to be used as effective growth inhibitors of microorganisms, making them applicable to treat household wastewater.

Keywords: microbial load, silver nanoparticles, household wastewater
PREPARATION AND CHARACTERIZATION OF ALGINATE BASED CURCUMIN NANOPARTICLES AS A POTENTIAL ANTIBACTERIAL AGENT

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ABSTRACT

Curcumin, a yellow color, phytochemical constituent obtained from Turmeric (Curcuma longa) shows profound anti-inflammatory, anti-oxidant, chemo preventive and anti-microbial activities. However, pharmacological effects of curcumin is limited due to its low aqueous solubility, rapid hydrolytic degradation and poor bioavailability. Efficiency of increasing hydrophillicity of curcumin is therefore crucial in order to use it as a potential drug. To address these issues, we developed Alginate-Curcumin (Alg-Ccm) nanoparticles (NPs) which was characterized using various tools including florescence spectra, FTIR, DLS and SEM. The conjugate which was dispersed in aqueous medium showed an average hydrodynamic diameter of 459 ± 0.32 nm. The spherical Alg-Ccm nanoparticles with 50nm diameter were visualized by SEM. In vitro release studies of both free curcumin and Alg-Ccm conjugate were carried out using Snakeskin pleated dialysis tubing (3500 MWCO) in phosphate buffered saline (PBS) at pH 7.4. Released curcumin concentration was determined by using UV- vis spectrophotometry data at twenty minute time intervals. The quenching process between alginate and curcumin was determined by florescence emission spectra. Testing of the anti-microbial activity of functionalized Alg-Ccm NPs was carried out using agar well- diffusion assay method against Escherichia coli and Staphylococcus aureus and the zone of inhibition was determined.

Keywords: Alginate, Curcumin, Alg-Ccm nanoparticles, Hydrophillicity, Anti-microbial efficacy
NOVEL, MICROWAVE-ASSISTED SYNTHESIS OF NANOCRYSTALLINE SrZnO$_2$

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ABSTRACT

Nanoparticles of luminescent ternary metal oxides can be very advantageous due to their high brightness, and enhanced chemical and thermal stability. Therefore, these materials are important for the production of light emitting diodes (LEDs) and emissive displays for computers or mobile telephones. Recently, oxides containing alkaline earths have been developed for applications in optoelectronics, biology and medicine, arising from the practice of nanotechnology. The example is SrZnO$_2$, a significantly luminescent oxide. Many synthetic routes are well-documented for the synthesis of SrZnO$_2$, for example, conventional solid state reaction routes, the sol-gel method and the gel-combustion method. However, these methods require very high temperature, namely about 1200$^\circ$C, to achieve ample crystallization. A simpler method that employs lower temperatures is therefore desirable. We have developed a microwave-assisted solution-reaction method for synthesizing SrZnO$_2$ that is not only rapid, but can be carried out at a temperature of less than 200$^\circ$C.

This has been made possible by the development in our laboratory of a novel β-diketonate complex of strontium. In this paper, we report the synthesis and characterization of the new strontium complex, and the synthesis of SrZnO$_2$ employing the new complex and titanium isopropoxide. The as-prepared SrZnO$_2$ has characterized by x-ray diffraction and found to be crystalline, and nearly monodisperse with average grain size of 30 nm. The material has also been examined by FE-SEM and TEM. The luminescence characteristics of the as-prepared and annealed SrZnO$_2$ will be reported. The microwave-assisted method has been extended to obtain thin films of SrZnO$_2$ on various substrates. The microstructure and luminescence characteristics of the films will also be reported.

Keywords: Microwave, SrZnO$_2$, light emitting diodes
FABRICATION OF TRANSPARENT HEATERS USING SILVER NANOWIRES

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ABSTRACT

Highly crystalline silver nanowires (AgNW) of average width 80 nm and length about 30 µm were synthesized by glycerol mediated polyol process and purified by centrifugation and vacuum filtration processes. The purified AgNW were further dispersed in isopropyl alcohol at a concentration of 1 mg/ml. The AgNW dispersed solution was coated on glass using spin coating technique. Different density of AgNW films were obtained over the glass by adapting the repeated coating process and their sheet resistance were measured using four point probe. Optical transmittance was decreased as the density of coated films increased. Scanning electron microscopy images of AgNW films reveal the random network of AgNW. Three times coated film on glass shows an average sheet resistance of 20 Ω/□ with 81% transmittance having figure of merit 100 Ω⁻¹. Electrothermal properties of the fabricated AgNW transparent conducting films were studied in the voltage range from 2 to 6 V. The fabricated heaters showed fast thermal response and uniform thermal distribution. The time dependent temperature change and heat distribution were performed. The heater performance and measurement set-up are given in Fig.1.

Keywords: AgNW, transparent heaters, electrothermal properties, polyol process, spin-coating technique
ENHANCED PERFORMANCE IN HYBRID TITANIUM DIOXIDE / POLY (3-HEXYLTHIOPHENE) POLYMER SOLAR CELLS: A COMPARATIVE STUDY WITH NOVEL RU BASED DYE AS INTERFACE MODIFIER

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ABSTRACT

Nanoporous Titanium dioxide (TiO₂) combined with poly (3-hexylthiophene) polymer is a promising nanocomposite for cost efficient photovoltaic devices. However, the poor power conversion efficiency found in such devices is mainly attributed to the lower chemical compatibility between the metal oxide and polymer. As such, it causes poor polymer penetration into highly-structured nanoporous TiO₂. More recently, we have shown that polymer penetration can be improved by coating the nanoporous TiO₂. We further showed that hole-mobility of the polymer can also be improved by modifying the nanoporous TiO₂ with dye over layer.

In this work, monolayer of commercially available and widely used ruthenium (Ru) based dye, N719, and a newly synthesized [Ru(bpy)₂(dcbpy)]²⁺PF₆ (bpy = 2,2'-bipyridine; dcbpy = 4,4’-dicarboxy-2,2’-bipyridine)dye (RuC2) were introduced at the TiO₂ / P3HT interface, and their effect in photovoltaic parameters were examined.

RuC2 dye adsorption on nanoporous TiO₂ electrode is higher than other Ru based dyes studied. This is probably due to its chemical structures; the N719 dye consist NCSisothiocyanatefunctional group along with carboxylic acid (COOH)substituted two biphenyl rings, whereas the newly synthesized dye contains three biphenyl rings with two COOH groups, which can bind easily to TiO₂ due to less steric hindrance. Nanoporous TiO₂ films treated with these dyes showed a very weak optical absorption in the visible region in comparison with the absorption of the polymer used in this study. Quantum efficiency spectra of both control and dye coated devices show that dyes has no contribution in creating of carriers for device current, but the dye serves as interface modifier. RuC2 dye treated devices showed a 75 % of enhancement in the power conversion efficiency compared to the devices treated with the commercial (N719) dye, mainly due to increase in short circuit current density. This is attributed due to better interaction between RuC2 and TiO₂ as well as lower laying LUMO of synthesized RuC2 dye which enables an easy electron transfer cascade from P3HT to the RuC2 interface layer to TiO₂ and, thereby, potentially enhancing charge separation at the TiO₂ interface. Additionally, on account of the deep HOMO level of RuC2 relative to P3HT, the RuC2 layer is expected to obstruct hole-transfer between P3HT and TiO₂, and thus to localize hole-polarons in the P3HT away from the TiO₂ surface.

Keywords: hybrid solar cell, P3HT, Titanium dioxide, interface modifier, Ru dye
DEVELOPMENT OF GEOPOLYMER NANOCOMPOSITES FOR APPLICATIONS IN WATER PURIFICATION TECHNOLOGY

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\textbf{ABSTRACT}

Contamination of water caused by elevated levels of Pb\textsuperscript{2+} ions has increased focus on water purification and wastewater reclamation. The purpose of this study was to synthesize highly effective, economical and novel adsorbent materials using metakaolin based geopolymer prepared from the naturally occurring clay mineral kaolin to remove Pb\textsuperscript{2+} in contaminated water. Surface of the porous geopolymer was modified using hydroxyapatite (HAp) and iron oxide nanoparticles in a fixed mass ratio of 5:2. Prepared nanocomposites were characterized by SEM, XRD and FT-IR spectroscopy. Their adsorption ability was determined by conducting isotherm studies and measuring the equilibrium Pb\textsuperscript{2+} concentration in the test solutions using Atomic Absorption Spectrometry. Experimentally obtained isotherm curves fitted the Langmuir model over the Freundlich model, suggesting that the adsorption dynamics of these nanocomposites obey the mechanism of monolayer formation. Adsorption capacities recorded by the composites were higher than that of neat geopolymer (298.75 mg/g) and lower than that of neat nano HAp (774.60 mg/g). Sorption affinity of HAp coated geopolymer towards Pb\textsuperscript{2+} (654.88 mg/g) was higher than that of iron oxide coated geopolymer (508.38 mg/g). Leaching studies revealed that the prepared composites exhibit minimum levels of ion leaching. The tendency of leaching increased with the increasing amount of adsorbed Pb\textsuperscript{2+} ions, demonstrating that the adsorption of Pb\textsuperscript{2+} on the adsorbents takes place by an ion exchange process. Therefore, the findings of the study indicate that the newly synthesized adsorbents are very effective and hence they can be recommended to be used in water purification technology.

Keywords: geopolymer, hydroxyapatite, iron oxide, adsorption, isotherm, leaching
ANTIBACTERIAL AND ANTI FUNGAL COTTON FABRIC

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ABSTRACT

Cellulose-Nano TiO$_2$ dispersion was coated on the surface of cotton fabric by roller padding for antibacterial and antifungal properties. Morphology of coated cotton fabric was observed under scanning electron microscope. The characteristic peak at 25.4° in X-ray diffraction patterns confirms that TiO$_2$ was coated successfully. Maximum 98.2% reduction of Staphylococcus aureus bacteria and 81.6% reduction of Methicillin-resistant Staphylococcus aureus (MRSA) bacteria was observed on TiO$_2$-cellulose coated cotton fabric. Mixture of Penicillium digitatum (PHI26), Rhizopus stolonifer (CCM F-445), Cladosporium sphaerospermum (CCM F-351) and Chaetomium globosum (CCM 8156) fungi was used for antifungal testing and cultivation was carried out at room temperature for two weeks under daylight. The surface of agar in the Petri dishes was completely covered with fungi (filamentous hyphae forming the mycelium) in the first 4 days. However, the filamentous hyphae (mycelium) started to lose from the surface over the second week. Finally, the samples containing the titanium dioxide of 5 and 10% was most cleared.

Keywords: antibacterial activity, antifungal, cotton fabric, cellulose, TiO$_2$, padding etc
THEORETICAL INVESTIGATION OF ORGANIC PHOTOVOLTAIC SYSTEMS

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ABSTRACT

Material design through band gap and energy level tuning plays a key role in developing efficient photovoltaic materials. In an effort to seek low-cost, high-performance acceptor materials, computational methods were used to examine a variety of non-fullerene acceptor molecules. The main objective of this research was to identify the effects of different structural changes on photovoltaic characteristics of 4,7-bis(4-(N-hexyl-phthalimide)vinyl)benzo[c]1,2,5-thiadiazole (PI-BT) acceptor molecule. Energy Levels of acceptor molecules were modulated by synergistically combining fluorine, cyanide and selenium substitutions. Novel acceptors derived from PI-BT were combined with a polythiophene donor polymer and investigated at the density functional theory level using Gaussian 09 and SIESTA simulations. Results showed that the band gap, HOMO/LUMO energy levels and donor-to-acceptor charge transfer of the systems could be modulated in a controlled manner by altering the structure of terminal and core acceptor units in PI-BT. Fluorine substitution was found to stabilize the acceptor molecule while selenium showed a destabilizing effect. Substitution of fluorine and cyanide groups simultaneously lowered HOMO and LUMO levels of PI-BT while facilitating donor-to-acceptor charge transfer. However, selenium substitution had the opposite effect. The structure-property relationships established in this study offer great potential to further improve photovoltaic characteristics of PI-BT acceptor through band gap and energy level tuning.

Keywords: energy, organic, photovoltaics, band-gap, computational, modelling
MOLECULAR ADSORPTION OF H₂ ON SMALL SILVER-COPPER BIMETALLIC NANOPARTICLES: A SEARCH FOR NOVEL HYDROGEN STORAGE MATERIALS

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ABSTRACT

Transportation currently relies heavily on either gasoline or diesel fuels and the increased demand for oil supplies may cause energy crises. Hydrogen is the most promising clean energy source to replace the limited fossil fuels because its use creates neither air pollution nor greenhouse-gas emissions. The use of hydrogen requires an effective, safe, and stable storage medium. However, how to store hydrogen easily and cheaply is still a big and challenging problem. Although storage of hydrogen in porous solid-state materials and metal hybrid offers an alternative, there are no current solid-state storage materials that meet the industry requirements.

We investigated the use of bimetallic nanoclusters of silver and copper [AgmCun m + n ≤ 8] as the clean storage materials for hydrogen storage. Density functional approach was utilized for modeling and calculations. With the increase of cluster size, increased physisorption well above the accepted range (-6 to -18 kJmol⁻¹) was observed for m + n ≤ 4. For the cluster sizes larger than four, bimetallic motifs were shown to fall into the accepted range while neat motifs of same sizes are out in either side of the accepted range.

Keywords: hydrogen-storage, nanoclusters, bimetallic nanoalloys, simulation
PREPARATION OF PEROVSKITE TYPE COBALTTITANATE (CoTiO$_3$) USING MODIFIED PECHINI METHOD: APPLICATION TOWARDS VISIBLE LIGHT INDUCED PHOTOCATALYTIC DEGRADATION OF METHYLENE BLUE

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ABSTRACT

Aquatic pollution is one of the major concerns that directly impact the health of the ecosystem mainly due to waste mismanagement. Toxic organic pollutants that include, drugs, pesticides, and persistent organics are found to be major health concern even at their low concentration due to their endocrine disrupting potency. These reasons validate the need of the removal of such pollutants and minimize their long-term existence and accumulation. Considerable efforts have been devoted to achieve an effective removal of these organic pollutants from the polluted aquatic environment. Researchers have developed materials with attractive physico-chemical properties for the environmental remediation application. Among the various materials, TiO$_2$ was found to be the most promising one due to its durability and ease of preparation. However, the absorption of TiO$_2$ falls under UV region of the solar spectrum limits its applicability in visible region. The perovskite, ABO$_3$ type binary metal oxide materials, gained much attention and used for several applications due to its unique structural, magnetic, photochemical, and electrical properties. In this study, a set of CoTiO$_3$ materials were synthesized using a modified Pechini method with different ratios of precursors, such as citric acid and total metal ions ([CA]:[Co$^{2+}$ + Ti$^{4+}$]) and utilized for the degradation of a model dye, methylene blue, under visible light irradiation. Our results indicate that the change in the citric acid and total metal ions ratio impacts the formation of different phases in the resultant materials, and the phase composition and the physico-chemical properties influence the dye degradation efficiency. The materials with pure CoTiO$_3$ phase exhibited a better degradation efficiency than the other materials examined in this study.

Keywords: Pechini method, Cobalt titanate, Perovskite, Degradation, Methylene blue
SYNTHESIS AND PHOTOCATALYTIC ACTIVITY OF Ce-MODIFIED BiFeO$_3$ NANO-STRUCTURES

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ABSTRACT

In recent years, photocatalysis technology has received universal attention due to its applications in the abatement of pollutants in water and air. Among various oxide semiconductor photocatalysts, titanium dioxide (titania) has attracted intensive attention with the benefits of low cost, non-toxicity, excellent photocatalytic activity, and high chemical stability. Unfortunately, titania can only absorb ultraviolet (UV) light which is only 3–5% of solar light due to its large band gap of 3.0 eV and above, which limits its practical applications. Hence, development of non-titania semiconductors with strong absorbance in the visible region is current trend in photocatalysis. BiFeO$_3$ (BFO) with a typical ABO$_3$ type perovskite structure has coexistence of ferroelectric and magnetic orders, attracted considerable part among the researchers due to its wide applications in various catalytic activities, and also suitable for magnetoelectric devices like actuators, sensors, etc.

We here report the effect of rare-earth ion (Ce$^{3+}$) in the stabilization of the BFO and its effect on its photocatalytic activity towards the degradation phenol red. A hydrothermal method has been adapted to synthesis single phase [Bi$_{1-x}$Ce$_x$FeO$_3$ (BCFO: $x=0.0$, 0.05, 0.10 and 0.15)] nanoparticles. Synthesized nanoparticles were characterized for its phase, structural, chemical bonds, magnetic, optical properties, photocatalytic activity using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Vibrating sample magnetometry (VSM), UV-Vis diffused reflectance (UV-DRS), and UV-Vis spectroscopy respectively. The photocatalytic activities were evaluated by the degradation of phenol red in aqueous solution under visible-light irradiation using 150W of mercury vapor lamp. The results will be discussed in detail.

Keywords: BFO, Multiferroic, Photocatalytic, Hydrothermal
HEMOCOMPATIBILITY OF POLYETHYLENEIMINE (PEI) AND POLYETHYLENEIMINE-IRON OXIDE NANOPARTICLES (PEI-IONPs) ON PLATELET MEMBRANE INTEGRITY AND ERYTHROCYTE MEMBRANE DAMAGE USING LACTATE DEHYDROGENASE (LDH) ASSAY AND HEMOLYSIS ASSAY

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ABSTRACT

Among various non-viral gene transfection vectors, polyethyleneimine (PEI) attracts more scientific attention due to its high transfection efficiency. Moreover, PEI functionalized iron oxide nanoparticles (PEI-IONPs) may be a promising candidate for safe and efficient gene transfection. However, evaluation of immunological effects of PEI and PEI-IONPs is essential for its safe applications in the biomedical field. We studied the impact of PEI, PEI-IONPs and IONPs on platelet and erythrocyte membrane integrity. Platelet membrane integrity was measured by lactate dehydrogenase (LDH) assay. Rat platelets were incubated with 25, 75 and 150 µg/ml of PEI, PEI-IONPs and IONPs and tested for LDH activity by a commercially available kit (Human, Germany). Erythrocyte membrane damage was evaluated using the hemolysis assay. Rat erythrocytes were added to 50, 100, 150, 200, 250 and 300 µg/ml of PEI, PEI-IONPs and IONPs and incubated for two hours. The samples were centrifuged and absorbance at 541 nm was recorded. Pooled data were statistically analyzed with ANOVA, followed by Tukey’s HSD. The LDH assay showed a significant difference (p = 0.001) between concentration groups, with a significant difference between PEI and PEI-IONPs (p = 0.032) and PEI and IONPs (p = 0.048) at 75 µg/ml. Hemolysis assay revealed a significant difference between groups (p = 0.0001) and a significant difference between PEI and PEI-IONPs at 50 µg/ml (p = 0.0001). The present study established that PEI significantly affects both platelet and erythrocyte membranes than PEI-IONPs. Furthermore, the results suggest that the PEI-IONPs maybe more suitable for safe gene delivery.

Keywords: Nanoparticles, nanotechnology, polyethyleneimine (PEI), PEI functionalized iron oxide nanoparticles (PEI-IONPs), LDH assay, hemolysis-assay,
LOW VOLTAGE AND HIGH FIELD-EFFECT MOBILITY THIN FILM TRANSISTOR USING CRYSTALLINE POLYMER NANOCOMPOSITE AS GATE DIELECTRIC

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ABSTRACT

Operation of organic thin film transistors (OFETs) with low voltage is currently a prevailing issue. Anthracene thin-film transistor (TFT) with an ultrathin layer (~450nm) of Poly-vinylidene fluoride (PVDF)/CuO nanocomposites as a gate insulator have been fabricated. A device with excellent electrical characteristics at low operating voltages (<1V) has been designed. Different layers of the film were also prepared to achieve the best optimization of ideal gate insulator with various static dielectric constant ($\varepsilon_r$). Capacitance density, leakage current at 1V gate voltage and electrical characteristics of OFETs with a single and multi layer films were investigated. This device was found to have highest field effect mobility of 2.27 cm$^2$/Vs, a threshold voltage of 0.34V, an exceptionally low sub threshold slope of 380 mV/decade and an on/off ratio of $10^6$. Such favorable combination of properties means that these OFETs can be utilized successfully as voltages below 1V. A very simple fabrication process has been used along with step wise poling process for enhancing the pyroelectric effects on the device performance. The output characteristic of OFET after poling were changed and exhibited linear current-voltage relationship showing the evidence of large polarization. The temperature dependent response of the device was also investigated. The stable performance of the OFET after poling operation makes it reliable in temperature sensor applications. Such High-$\varepsilon$ CuO/PVDF gate dielectric appears to be highly promising candidates for organic non-volatile memory and sensor field-effect transistors (FETs).

Keywords: organic field effect transistors, gate dielectric, thin film transistor, organic semiconductor
SELECTIVE SURFACE FUNCTIONALIZATION AT THE NANOSCALE MEDIATED BY LOCALIZED SURFACE PLASMON EXCITATION

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ABSTRACT

In this talk, we demonstrate a new concept of plasmon-mediated surface functionalization at the nanoscale. Plasmonic nanoparticles have been shown recently to offer a unique platform to boost selectively the chemical reaction yields. However, their use for chemical surface functionalization has never been explored so far. In this work, we have performed a selective chemical surface functionalization at the nanoscale mediated by localized surface plasmon (LSP) excitation. The surface functionalization is demonstrated through aryl film grafting (derived from a diazonium salt), covalently bounded at the surface of gold lithographic nanoparticles. The aryl film is specifically grafted in areas of maximum near field enhancement, as confirmed by numerical calculation based on the discrete dipole approximation method - DDA. This selective grafting is attributed to hot electrons generation, which escape from the plasmonic structures and reduce the diazonium salts forming aryl radicals which attach the surface through covalent bonds. Moreover, we show that the aryl film thickness can be monitored by the energy of the incident light as well as the LSP wavelength. This work offers therefore a novel approach for the use of plasmonic structures in chemistry, opening an emerging field at the interface between plasmonics and surface functionalization.

Keywords: nanoscience, plasmonics, diazonium salts, surface functionalization
FLEXIBLE, LIGHT WEIGHT, AND REUSABLE NANOCOMPOSITE PACKAGING FOR HEATING APPLICATIONS

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ABSTRACT

There is an increasing interest on active packaging technologies introducing novel disciplines to the self-heated packaging industry. Current challenge is to develop flexible, light weight, and reusable packaging in which the extent of heating can be controlled. Herein, we report a facile, economical, and an efficient method to develop heated packaging which can overcome aforementioned challenges with applications in food industry, medical industry, and military industry etc. The present system includes an insulative first layer and the interior is composed of a conductive nanoparticle embedded fabric which is laminated between two layers of carbon fiber reinforced polyethylene composite. The carbon fiber reinforced polyethylene layers act as an electrical conductor as well as a good heat conductor on the lateral direction of the packaging system. The resistive heating layer has a pair of terminal end portions that could be coupled to a pair of external power leads to energize the resistance heating layer. The temperature inside packaging may be controlled by varying the applied voltage. We produce self-heated packaging which reach a maximum interior temperature of 75°C at a voltage of 20 V. These flexible, light weight, reusable self-heated packaging systems can provide new avenues in packaging manufacturing for heat management applications.

Keywords: self-heated packaging, reusable, conductive, joule-heating, carbon fiber, composite
**ABSTRACT**

Electro spinning has emerged as a facile and scalable strategy for preparation of micro and nanofibers over the years. Electro spinning can be used to deposit amat of fibers on a desired surface that can be processed subsequently for suitable applications. Qualities of the fiber deposit such as fiber diameter, coverage, thickness can be changed appropriately by tuning various spinning parameters. In this work we report facile preparation of electrospunpoly vinylpyrrolidone fibers that can be subsequently processed through thermal annealing to make conductive silver networks on a glass surface. Annealing conditions were analyzed using Raman spectroscopy which shows emergence of silver phase. X-ray diffraction studies of the prepared networks confirms the above observation. SEM studies indicate the average fiber diameters is around 2 um with strong atomic presence of silver detected through EDX analysis. Prepared silver networks are polycrystalline and interconnected across the length. TGA analysis shows that the significant weight loss due to thermal degradation of poly vinylpyrrolidone polymer phase in the temperature region of 250-300 ºC.Surface conductivity of the prepared silver networks depended on the density of the deposited material. This method may open up a new way of preparing transparent electrode materials that are useful in many applications.

Keywords: electrospinning, vinylpyrrolidone, conductive, transparent electrodes
PREPARATION OF KERATIN PROTEIN NANO FIBERS FROM MERINO WOOL YARN

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ABSTRACT

Wool keratin is a fibrous crosslinked protein with high molecular weight, high cysteine content and helical configuration. An individual wool fiber consists of, bundle of α-helical keratin nano fiber filament core, covered by an amorphous β-keratin protein matrix and overlapping cuticle cells, which lead to their unique chemical and physical properties. In this research study Keratin protein nano fibril and fiber filament was disintegrate from merino wool yarns using mechanical and chemical method. Controlled alkaline hydrolysis of parent wool fiber structure followed by ultrasonication has allowed to form nano fibers and fibrils of keratin protein with an average diameter of 5 nm and length less than 1.5 µm. FT-IR analysis of the sample confirmed the total hydrolysis of protein matrix and extracted nano structures constitute of keratin protein. The structural destruction of cuticle and cortical cells of the wool yarn is further confirmed by the thermal analysis performed using TGA. The morphology of the extracted nano fibers have a uniform circular cross section according to the images obtained using AFM and TEM.

Keywords: wool yarn, keratin, protein, nano fiber, hydrolysis
OPTICAL SIMULATION OF SUB-WAVELENGTH SILICON NANOSTRUCTURES FOR SOLAR CELLS

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ABSTRACT

Silicon nanostructures, with feature size and periodicity in the order of wavelength of light, exhibit excellent anti-reflection behavior for broad wavelengths and incident angles. These nanostructures significantly reduces the Fresnel reflection by gradually increases the refractive index from air to substrate. The reflectivity of these structures mainly depends on periodicity, height, duty cycle and shape of the nanostructures. The optical simulation for reflectivity was carried out using finite difference time domain (FDTD) method. The maximum achievable current density due to these nano texturing also estimated. The anti-reflection performance of nanostructures was further achieved with standard MgF₂/ZnS anti-reflection coating for crystalline silicon solar cell.

Keywords: Sub-wavelength texturing, FDTD method, Anti-reflection, Silicon solar cell
PHOTOCATALYTIC ACTIVITY OF PRISTINE AND BORON DOPED ZrO₂ NANOPARTICLES

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ABSTRACT

ZrO₂ is a transition metal oxide which is nontoxic, chemically inert and thermally stable. The pristine ZrO₂ nanoparticles were synthesized by sonochemical method and Boron doped ZrO₂ nanoparticles were synthesized by sol-gel method. The prepared nanoparticles were characterized by FTIR, XRD, UV visible, SEM, EDX and HRTEM. Both the nanoparticles were approximately 50 nm in size and they were in the monoclinic phase. These nanoparticles were dispersed in 10 ml of 20 ppm methylene blue solution and irradiated under the UV C light. The kinetics of photocatalytic degradation of methylene blue was studied by colorimetric analysis using UV visible spectrophotometer. The photocatalyst decomposition rate constant (k) was increased with the increasing nanoparticle concentration at the presence of both catalysts. At 500 ppm and 20000 ppm concentrations of photocatalysts the k value of pristine ZrO₂ is higher than Boron doped ZrO₂. Whereas at 10000 ppm and 15000 ppm concentrations k value of Boron doped ZrO₂ is the dominant. After 3 hours of exposure of methylene blue to the UV light at 5000 ppm, 10000 ppm, 15000 ppm and 20000 ppm concentrations of the nanoparticle, methylene blue had photodegraded 48.9%, 57.6%, 69.8% and 77.0% at the presence of pristine ZrO₂. The comparable degradation percentages of Boron doped ZrO₂ treated methylene blue was 40%, 63.5%, 71.1% and 74.1%. It is feasible to find the application of this photocatalysts in environmental protection such as treatment of dye contaminated water.

Keywords: Pristine ZrO₂, Boron doped, sonochemical method, sol gel method, monoclinic
GRAPHENE OXIDE-HYDROXYAPATITE NANOCOMPOSITE FOR THE REMOVAL OF LEAD AND FLUORIDE IONS IN WATER

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ABSTRACT

Problems with drinking water are believed to emerge worse with the ongoing scarcity occurring globally. The objective of the study was to come up with a water filter matrix, which can remove Pb²⁺ and F⁻ ions in drinking water at lower cost and with less energy, while at the same time minimizing the use of chemicals and impact on the environment. The selected approach was to synthesize a nanocomposite combining Mg doped hydroxyapatite (Mg-HAP) and graphene oxide (GO) nanosheets. Characterization of synthesized nanocomposite with FT-IR spectroscopy, powder X-ray diffraction (XRD) and SEM images confirmed that Mg-HAP nanoparticles are successfully coated with GO nanosheets. Detailed adsorption studies for Mg doped GO coated HAP (Mg-GO-HAP) was conducted for Pb²⁺ and F⁻ ions. It resulted in a high Langmuir maximum adsorption capacity for Pb²⁺ adsorption, 1643.12 mg g⁻¹ at pH 6 at 37°C. This value was higher than for the value with the same conditions of Mg-HAP. The leaching of Ca²⁺ ions and Mg²⁺ ions by Mg-HAP and Mg-GO-HAP during adsorption of Pb²⁺ ions were also investigated and revealed a lower percentage of leaching of Ca²⁺ ions and significantly higher percentage of leaching of Mg²⁺ ions from Mg-GO-HAP when compared to Mg-HAP. Adsorption studies for the removal of fluoride ions for Mg-GO-HAP resulted in a maximum adsorption capacity of 1.68 mg g⁻¹ at pH 6 at 37 °C that it best fitted with the Freundlich isotherm. The methods involved no advanced instrumentation and exclude cumbersome lengthy procedures.

Keywords: graphene oxide, hydroxyapatite, lead, fluoride
POST DEPOSITION SURFACE TREATMENTS TO ENHANCE THE QUALITY OF NANOCRystALLINE CdTe THIN FILMS FOR PHOTOVOLTAIC APPLICATIONS

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ABSTRACT

At present, cadmium telluride (CdTe) is one of the topmost thin film nanocrystalline materials in the arena of photovoltaics (PV) with a considerable market share. However, it is essential to have a profound understanding of effects and mechanisms of post deposition treatments on the quality of CdTe material in order to improve its PV activities further. Hence, different post deposition processes, including treatment of CdCl2 were performed on CdTe thin films and the effects of individual process step on the materials properties have been analyzed in this study. The CdTe thin films were potentiostatically electrodeposited using the typical three electrode electrolytic cell consisted with a saturated calomel reference electrode and a high purity graphite counter electrode. CdSO4 and TeO2 were used as cadmium and tellurium precursors respectively and CdTe layers were deposited on fluorine doped tin oxide glass substrates at pre-identified growth conditions namely cathodic deposition potential of 660 mV, pH of 2.5 and temperature of 65 °C. Subsequently, deposited samples were annealed in air with CdCl2 and thereafter four comparable samples with two replicates were subjected to surface etching with diluted HCl, Br2-CH3OH (BM), HNO3-H3PO4 (NP) and K2Cr2O7-H2SO4. Surface treated samples were then characterized for their electrical, optical, structural, elemental and morphological properties using the techniques of photo-electrochemical cell, optical absorption spectroscopy, X-ray diffraction, energy dispersive X-ray and scanning electron microscopy respectively. The study reveals that, post deposition surface treatments of BM and NP etchings enhance the material qualities of nanocrystalline CdTe thin films prior to fabrication of PV devices.

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Keywords: cadmium telluride, nanocrystalline, electrodeposition, photovoltaics, surface treatments
CELLULOSE FIBERS GRAFTED WITH GRAPHENE OXIDE AND REDUCED GRAPHENE OXIDE AS EFFICIENT ADSORBENTS FOR REMOVAL OF HEAVY METAL IONS

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ABSTRACT

Nano structure based composite materials have brought many opportunities for environmental protection and water filtration due to their unique structural based physical and chemical properties. Even though there are a variety of materials developed, still the researchers are focusing on developing materials to refine the contaminants from water more efficiently. This research study was carried out to enhance the heavy metal ion adsorption from aqueous medium by using the cellulose fiber-graphene oxide composite (CE-GO) and cellulose fiber-reduced graphene oxide composite (CE-RGO). The CE-GO composites was prepared by incorporating graphene oxide to the cellulose fiber (prepared from waste cotton fabrics) and CE-RGO composite was prepared by incorporating graphene oxide to cellulose fibers followed by a chemical reduction. The heavy metal ion adsorption capacity of both the composites were assessed and compared with the control cellulose fibers taking Pb²⁺ as the reference heavy metal ion. The analysis showed that the heavy metal ion adsorption ability of CE-RGO is higher than CE-GO and both are superior to control cotton fibers. Further analysis were done for the CE-RGO and CE-GO composite using FTIR spectrometer, SEM, XRD, and TGA to study the mechanism and level of nano sheet grafting on the cellulose fibers.

Keywords: Adsorption, Heavy metal ion, Composite, Graphene oxide, Reduced Graphene oxide, SEM
AN ATTEMPT TO REDUCE CYTOTOXICITY OF CISPLATIN TO HEALTHY CELLS

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ABSTRACT

Cisplatin, also known as Cisplatinum, Platamin with the chemical formula of cis-diamminedichloridoplatinum(II) (CDDP), is a first-generation of platinum coordination compound-based anticancer chemotherapeutic drug that is used to treat different types of cancers including sarcomas, some carcinomas (e.g., small cell lung cancer, and ovarian cancer), lymphomas, bladder cancer and germ cell tumours. However, cisplatin is associated with numerous side effects which include nephrotoxicity, neurotoxicity, nausea and vomiting. Most of these side effects can be either reduced or overcome if cisplatin could be encapsulated in a suitable host material and directed towards cancer cells in a targeted manner and allowed to release only in minimum sufficient dose in uniform manner. This will not only reduce the cytotoxicity of cisplatin to normal cells but also reduce the dosage and increase the bioavailability of the drug. To do so we have developed a novel method to synthesize hollow nanoparticles of vaterite and to encapsulate cisplatin in them. Materials prepared were extensively characterized by XRD, FT-IR, XRF, SEM and encapsulation confirmed. Slow release kinetics in aqueous solutions of different pH values were studied by ICP-AES. We found that cisplatin is slowly released in solutions of pH comparable to those prevailing in cancer cell environments but there is no release at neutral or slightly basic pH values typical of those of blood plasma and healthy cell fluids. This would open up a novel and safe chemotherapeutic treatment methodology for various cancers. We are extending this study to other anticancer drugs also.

Keywords: cisplatin; vaterite nanoparticles; encapsulation; targeted delivery; slow-release
SUZUKI-MIYaura CROSS COUPLING REACTION CATALYSED BY A MAGNETICALLY RETRIEVABLE BIMETALLIC Au/Pd NANOCATALYST

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ABSTRACT

The heterogeneous catalytic system was prepared using a simple two-step process involving the solvothermal synthesis of amine functionalised magnetite nanoparticles followed by the coordination and in situ reduction of the Pd and Au precursors. The synthesised catalyst was characterised by XRD, FT-IR, SEM and XRF. The performance of the catalyst was evaluated using the Suzuki coupling reaction between 4-iodotoluene and phenylboronic acid. The effects of the Au/Pd ratio, amount of catalyst, effects of substituent groups of the organohalide were also investigated using this reaction as a model. The catalyst was found to function well even at Au/Pd loadings as low as 1.8% (mol%). This system also displayed excellent recyclability (up to five reaction cycles), while maintaining good selectivity. Post-reaction analysis indicates no significant alterations in surface chemistry. However, the effect on the Au/Pd ratio is yet to be evaluated. The catalyst can be stored under atmospheric conditions for up to 24 weeks without significant loss of functionality.

Keywords: heterogeneous catalysis, Suzuki coupling, Palladium, gold, Bimetallic
FABRICATION AND CHARACTERIZATION OF p-Si/ MgₓZn₁₋ₓO THIN FILM HETEROJUNCTION DIODES GROWN BY RF MAGNETRON SPUTTERING TECHNIQUE

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ABSTRACT

This work reports fabrication and characterization of p-Si/ MgₓZn₁₋ₓO thin film heterojunction diodes grown by low-cost RF magnetron sputtering technique. In this work, ZnO powder was mixed with MgO powder at per their weight percentage from 0 to 10% to prepare MgₓZn₁₋ₓO target. The microstructural, surface morphological and optical properties of as-deposited p-Si/ MgₓZn₁₋ₓO heterostructure thin films have been studied using X-ray Diffraction, atomic force microscopy and variable angle ellipsometer. AFM images demonstrate that the as-grown MgₓZn₁₋ₓO/Si heterostructure thin films are having homogeneous top surface with minimum roughness. XRD spectra exhibits that undoped ZnO thin films has preferred crystal orientation in (002) plane, whereas, due to phase segregation with increase in Mg-doping, ZnO (101) crystal plane is enhanced progressively, even though preferred growth orientation of ZnO crystals is still towards (002) plane. Increment in bandgap due to increase in Mg-doping is studied using ellipsometer. To prepare p-Si/MgₓZn₁₋ₓO heterojunction diodes, large area Al/Ti ohmic contacts were prepared on top of ZnO surface and Al layer was deposited on bottom of Si surface. Diode parameters, including reverse saturation current, barrier height, ideality factor are evaluated from current-voltage characteristics measured by semiconductor parameter analyzer. While the reverse saturation current and ideality factor is increased with increase in Mg doping concentration, however barrier height is decreased for the same condition. With rectification ratio of 27894, reverse saturation current of 20.5 nA and barrier height of 0.724, Si/Mg₀.₅Zn₀.₉₅O heterojunction diode has potential to be used in wider bandgap nanoelectronic device applications.

Keywords: RF magnetron sputtering, MgₓZn₁₋ₓO thin film, phase segregation, heterojunction diode, rectification ratio, band gap tuning
OPTIMIZATION, PREPARATION AND CHARACTERIZATION OF RUTIN-QUERCETIN DUAL DRUG LOADED KERATIN NANOPARTICLES FOR BIOLOGICAL APPLICATIONS

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ABSTRACT

Response surface methodology (RSM) by central composite design (CCD) was applied to statistically optimize the preparation of Rutin-Quercetin (Ru-Qr) dual drug loaded human hair keratin nanoparticles as well as evaluate the characteristics. The effects of three independent parameters, namely, temperature ($X_1$: 10-40°C), surfactant ($X_2$: SDS (1), SLS (2), Tween-20 (3)), and organic solvents ($X_3$: acetone (1), methanol (2), chloroform (3)) were investigated to optimize the preparation of dual drug loaded keratin nanoparticles, and to understand the effects of dependent parameters namely, drug releasing capacity, average particle size, total antioxidant power, zeta potential, and polydispersity index of Ru-Qr nanoparticles. Optimization was executed by CCD and RSM using statistical software (Design Expert, version 8.0.7.1, Stat-Ease, Inc., Minneapolis, MN, USA). The optimal Ru-Qr dual drug loaded keratin nanoparticles were obtained at temperature ($X_1$): 40°C, SDS ($X_2$), and acetone ($X_3$). Under this conditions to achieve highest drug releasing capacity of 98.3%, average size of nanoparticles are 125 nm, total antioxidant power 98.68%, zeta potential 28.09 mV, and polydispersity index of 0.54. Although majority of the experimental values were relatively well matched with the predicted values. Thus, this optimization study could be useful in pharmaceutical industry, especially for the preparation of new nano-therapeutic formulations encapsulated with drug molecules. This nanotechnology based drug delivery system is to overcome multi drug resistance and site specific action without affecting other organs and tissues. The methodology adopted in this work shall be useful in improvement of quality of human health.

Keywords: keratin, response surface methodology, rutin, quercetin
EVALUATION OF IMMUNOTOXICITY OF NANOMATERIAL FOR SAFE GENE DELIVERY

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ABSTRACT

Nanomedicine is an emerging field with rapid advancement of nanotechnology and medicine. Polyethyleneimine (PEI) is a cationic polymer which is a known non-viral vector with a high transfection efficiency compared with other polymeric non-viral vectors. Even though, it has a high transfection efficiency, PEI shows relatively high toxicity. To overcome these problems, PEI coated iron oxide nanoparticles (PEI-IONPs) can be introduced. However, only a limited number of studies have been conducted to evaluate the biocompatibility of PEI-IONPs to date. Hence, the present study was carried out to assess the potential immunotoxicity of PEI, PEI-IONPs and IONPs and to understand the underlying mechanisms leading to adverse reactions. The cytokine milieu, interleukin IL-6, IL-10 and tumor necrosis factor (TNFα) were tested with sandwich ELISA after ex vivo exposure of rat bone marrow cells to PEI, PEI-IONP and IONP in 125, 250 and 500 µg mL⁻¹ concentrations. TNFα was significantly elevated while IL10 was significantly lowered in PEI treated cells compared to other treatments (GLM, p<0.05). Thus, an overall Th1 skewed immune response was detected in all treated cells with significantly high TNFα/IL10 ratio in PEI treated (F₂,₆=9.01, p=0.016) cells. Even though, proinflammatory mediators are activated by IO-PEI combination, the level of activation was significantly low compared to the PEI only treatment. Since, little impetus was directed towards designing nanomaterial of low immunogenicity, PEI-IONPs, may provide a better solution for safe gene delivery. However, further studies are warranted to establish the mechanisms of PEI, nanoparticles and cytokine interactions to understand their role in immunotoxicity.

Keywords: Nanoparticles, Cytokines, IL-6, IL-10, TNFα, PEI, iron oxide, ELISA
FACILE SYNTHESIS OF CONDUCTIVITY TUNABLE DIFFERENT COLORED CuS NANOPARTICLES ON CuSCN

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ABSTRACT

Synthesis of copper sulfide has drawn significant interest owing to their variations on stoichiometric composition, valence states, nanocrystal morphologies, complex structures and their different unique properties. The stoichiometric composition of copper sulfide varies in a wide range from Cu₂S at copper rich side to CuS₂ at the copper deficient side, such as CuS, Cu₁.₉₆S, Cu₁.₉₄S, Cu₁.₈S, Cu₇S₄ and CuS. In the copper-rich section, all the stable compounds of CuₓS are p-type semiconductor as the copper vacancies are within the lattice. CuS (Covellite) shows excellent metallic conductivity. Various morphologies of CuS such as nanowires, nanodisks, hollow spheres, and flower like structures have been reported by using different preparation methods, mostly by hydrothermal method.

In the present study, we synthesized conductivity tunable different colored CuS coated CuSCN particles in a single pot and ambient condition by a simple mixture of copper sulfate and sodium thiosulfate in the presence of triethyl amine hydrothiocyanate (THT). Mixture of copper sulfate and sodium thiosulfate without THT produce a blue colored micro sized spherical CuS particles having high resistivity. But with the presence of series of THT in the solution mixture, different colored and conducting CuS coated CuSCN composites are produced as shown in left part of the Figure 1. Production of CuSCN and CuS was confirmed by XRD analysis. Absorption spectrometry study confirmed that strong IR absorption is appeared for CuS coated CuSCN material compared to that by CuS (absence of THT) or CuSCN (adding 100 mL of THT) alone as shown in right part of the Figure 1. Also it is interesting to note that CuS coated CuSCN has higher conductivity than that by CuS or CuSCN alone. Lowest resistivity of 0.05 Ω cm was observed for annealed (250 °C) CuS coated CuSCN (adding 10 ml of THT) under nitrogen atmosphere.

Figure 1.Image and absorption spectra (a) CuS (0- THT) film (b) CuS on CuSCN (10 mL THT) (c) CuS on CUSCN (25 mL THT) (d) CuS on CuSCN (50 mL-THT) (e) CuSCN only (100 mL THT).
EFFECT OF AGEING ON DEFECTS AND SURFACE YTTRIA CONCENTRATION OF 3Y-TZP CERAMICS

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ABSTRACT

Oxygen vacancy plays an important role on the stabilisation of tetragonal phases in zirconia ceramics. In this study, the effect of ageing on surface yttria concentration and defects of 3 mol% yttria tetragonal zirconia polycrystals (3Y-TZP) ceramic was studied. The zirconia powder was cold isostatically pressed (CIP) at 200 MPa, and the samples were initially heated to a first step temperature of 1400°C with constant heating rate 10°C/min and held for 1 minute. Then cool down to the second step temperature of 1200°C and maintained at that temperature for 2 hours. The XRF measurements were conducted at 20kV and 700μA on as-sintered and aged samples by using Orbis micro-XRF analyzer. 40 points were randomly selected on the surface to obtain average surface concentration. Photoluminescence studies were conducted using a photoluminescence spectroscope with helium-cadmium laser at a wavelength of 325 nm as the excitation source, and the phase content in the zirconia samples was measured using X-ray diffractometer. The low-temperature degradation study was conducted under autoclave condition containing superheated steam at 180°C and 10 bar vapour pressure for periods up to 100 hours. After 100 hours of aging, 41% tetragonal phase transformed into monoclinic phase. XRF results revealed that the surface yttria concentration reduces by ~ 0.2 mol% during 100 hours of aging. In photoluminescence spectra, a broad peak centered at 600 nm is observed. The emission spectra broaden after aging which can be correlated to increased defect concentration after aging.

Keywords: Y-TZP, XRF, Photoluminescence, sintering, ageing
EFFECT OF COMPLEXING AGENT ON THE FORMATION OF BiFeO₃ AND ITS PHOTOCATALYTIC PROPERTIES

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ABSTRACT

BiFeO₃ is the room temperature multiferroic with its ferroelectric transition temperature around 850 °C and antiferromagnetic Neel temperature around 370 °C. Besides its multiferroic properties, BiFeO₃ is also considered as suitable visible light photocatalyst due to its suitable band gap (< 2.8 eV). In the present work, BiFeO₃ is synthesized using different complexing agents like citric, tartaric and malic acid. The effect of complexing agents on the formation of BiFeO₃ is studied using X-ray diffraction. The absorption bands and band gap are determined using UV-visible spectroscopy. The photocatalytic activity of the samples is investigated under visible light by degrading the organic dye methylene blue.

Keywords: photocatalytic activity, multiferroic, complexing agents
OPTIMIZING THE PERFORMANCE OF CADMIUM SULFIDE COATED NANOPOROUS TITANIUM DIOXIDE / POLY (3-HEXYLTHIOPHENE) SOLAR CELLS

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ABSTRACT

This work reports a study of the effects of Cadmium Sulfide (CdS) interlayer on the performance of the Nanoporous Titanium dioxide (TiO$_2$)/Poly (3-hexylthiophene)(P3HT) solar cells. CdSnano layers with different thicknesses were successfully grown on TiO$_2$ nanoparticles by chemical bath deposition (CBD) technique with different deposition times. UV–Vis–NIR spectroscopic and Atomic Force Microscopic measurements were taken for studying optical and structural properties of Titanium dioxide (TiO$_2$)/Poly (3-hexylthiophene)(P3HT) nanocomposite film with varying CdS interlayer thicknesses while current-voltage (I–V) and external quantum efficiency (EQE) measurements were done for evaluating the corresponding devices. Overall efficiency is optimized when the CdS deposition time is 12 minutes which is consistent with AFM images as the images confirm the uniform distribution of chemical bath deposited CdS layer on porous TiO$_2$ until deposition time is 12 minutes. Roughness of CdS film decreased when the deposition time of CdS is increased further. The short-circuit current density ($J_{SC}$) and hence overall efficiency is declined when the CdS deposition time is more than 12 minutes. The increment of CdS deposition time showed a gradual decrement in the EQE spectra at 520 nm due to the lower polymer intake due to the CdS filled pores in TiO$_2$ electrode as confirmed by the AFM images. The reduction in the $J_{SC}$ may also be attributed to lowering interfacial area. On the other hand, a steady and continuous increment in the open circuit voltage ($V_{OC}$) were also observed with increased CdS deposition time and increased up to 0.81 V when the CdS layer deposition time was 24 minutes. This may attribute to the isolation of P3HT and TiO$_2$ interfaces and the higher built-in voltage at CdS – P3HT interface when to compare with TiO$_2$ – P3HT interface. An optimized CdS coated porous TiO$_2$/P3HT solar cell shows the overall efficiency of over 2.4 % under the illumination of 70 mW/cm$^2$ at A.M 1.5 conditions.

Keywords: hybrid solar cell, Titanium dioxide, P3HT, Cadmium Sulfide, chemical bath deposition
SYNTHESIZING MgO AND ZrO$_2$ NANOFIBRES BY ELECTROSPINNING


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**ABSTRACT**

One dimensional MgO and ZrO$_2$ nanofibres were successfully fabricated using the electrospinning method via a polyvinyl alcohol (PVA)/Mg(NO$_3$)$_2$ and PVA/ZrOCl$_2$.8H$_2$O based systems, respectively. Optimum electrospinning parameters such as viscosity, voltage, needle to collector distance and flow rate to fabricate nanofibres were investigated. Furthermore, modification of zirconia nanofibers in order to obtain hollow structures and doping with certain metal oxides were studied. Diameters of MgO and ZrO$_2$ fibres yielded to be 47-190 nm and 350-400 nm, respectively and it was confirmed with scanning electron microscopic (SEM) and energy dispersive x-ray (EDX) mapping. Furthermore, the crystalline lattice structure and surface roughness of fabricated nanofibres were evaluated using transmission electron microscopic-electron diffraction mode (TEM-SAED) and atomic force microscopy (AFM), respectively. As revealed from the UV-vis studies, fabricated MgO and ZrO$_2$ nanofibres exhibited excellent photocatalytic degradation activity against a widely used reactive dye. For instance, 80% and 34% of degradation efficiency of reactive dye (under 20 min of UV irradiation) was determined in the presence of synthesized MgO and ZrO$_2$ nanofibres, respectively. These results postulate that the ZrO$_2$ nanoparticles are not an efficient photocatalyst compared MgO nanoparticles. These photocatalytic MgO nanofibres show a great potential to be used in efficient treatment of industrial dye effluents, while ZrO$_2$ nanofibres can be used as a reinforcing filler to enhance the thermo-mechanical properties of thermoplastics and ceramics.

Keywords: electrospinning, zirconia, magnesia, nanofibers, photocatalysis
PHOTOCATALYTIC DEGRADATION OF WATER POLLUTANT CONGO RED BY ZnS NANOSTRUCTURES UNDER VISIBLE AND UV LIGHT IRRADIATION

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ABSTRACT

Semi-crystalline ZnS nanostructures were synthesized by refluxing substituted pyridine based Zinc(II) dithiocarbamate adduct ([ZnL₂Py], where ‘Py’ = 3-Hydroxypyridine and ‘L’ = Benzylhydrylpiperazine 1-carbodithioate) in the presence of octylamine, at 130°C for one hour. Synthesized ZnS nanostructures were characterized by Powder XRD, TEM and UV-Vis spectroscopy. Powder XRD spectra revealed cubic Sphalerite structure. Sheet like semi-crystalline cubic structure was confirmed by HRTEM and SAED analysis. Blue-shift in absorption maxima and increase in band gap as compared to bulk ZnS confirmed small size. Congo red, a diazo dye, extensively used in textile industry was completely removed from water using synthesized ZnS nanostructures as catalyst. Effect of influence of visible and UV light, catalyst concentration and exposure time on degradation was studied. UV-Vis spectra were analyzed to study the degradation process, involving destruction of N=N, benzene and naphthalene rings. Kinetic study of catalytic reaction using Langmuir–Hinshelwood (L–H) equation suggested pseudo-first order kinetics. After complete degradation of Congo red, no structural changes in powder XRD spectra of ZnS nanocatalyst were observed. This indicated the reusability of ZnS as nanocatalyst.

Keywords: ZnS, Congo red, Photocatalysis, Single source precursor, Zinc dithiocarbamate, dye degradation
ABSTRACT

Hydrogels are three dimensional structures properly formed by the physical or chemical cross linking of hydrophilic polymers. Natural polysaccharides based hydrogels marked their presence in several applications like food industry, biomedicine and cosmetics. Cellulose is an organic polymer and can be considered as the most inexhaustible source of matrix material for the formation of hydrogels. They can be obtained by chemical cross linking of water soluble cellulose derivatives using small bifunctional molecules as cross linkers. In the present work, cellulose hydrogels were synthesized by a “one-step” method using epichlorohydrin (ECH) as cross linker. An aqueous solution of NaOH/urea was used as the solvent for polysaccharide. Suitable amount of ECH was added drop wise and the mixture was heated at room temperature for one hour. The reaction product is neutralized with acetic acid for the recovery of transparent hydrogels with macro porous inner structure. Luminescent hydrogels were prepared by the incorporation of natural (fruit essence, plant extracts) / synthetic chromophores (quantum dots, organic dyes). Characterization studies were carried out by X-ray diffraction (XRD) technique, scanning electron microscopy (SEM) and infrared (IR) spectroscopy, UV-Visible spectroscopy and photo luminescence spectroscopic techniques. Solid state NMR technique has been adopted for identification, analysis and characterization and molecular mobility studies. The dilatational mechanism and oscillating properties of prepared gels under various external stimuli viz., temperature, pH, light and electric field has also been carried out and the results are briefly discussed.

Keywords: cellulose, hydrogels, luminescent, cross linking
THERMAL AND ELECTRICAL PROPERTIES OF NANO SIZE CONDUCTING POLYANILINE

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ABSTRACT

Semiconducting polymers have attracted considerable attention in the recent years for the fabrication of microelectronic devices due to their unique thermal, electrical, optical and magnetic properties. Among these the Polyaniline (PANI) possesses variety of properties including structural properties. One of the surprising quotations given by Prof. A.G. Mac-Diarmid is that “There are as many different types of PANI as there are people who synthesize it.” So here we synthesized the PANI Emaraldine form by chemical oxidation method with pH 3 by using Ammoniumper-disulphate as oxidizing agent and the particle size is identified as 80nm with help of XRD and SEM. The Differential Scanning Calorimetric (DSC) graph of this PANI is recorded from 50°C to 300°C at 20°C/min heat flow. The thermo graph shows two exothermal peaks at 97.07°C and at around 152°C. These peaks are attributed to the Glass transition temperature (Tg) and polymer degradation temperature. The final valley point (endothermic) around 175°C is attributed to the melting point (Tm) of polymer. The current–voltage (I-V) characteristic of polyaniline exhibits non-linear nature for PANI Emeraldine salt. In PANI polarans and bipolarans are produced due to doping of protonic acid. The non-ohmic behavior reveals that the contribution to charge transport is due to polarans and bipolarans in addition to free charge carriers. The relation between V and I may be expressed as I = A V^m The exponent “m” value is calculated from the slope of the V-I characteristic curve and it is equals to be 1.76. The curve of V^1.76 - I is linear, it clearly indicates that PANI is non-ohmic in nature.

Keywords: PANI, DSC, I-V characteristics, Polarans, Bipolarans.
GRAPHENE OXIDE-PLATINUM NANOCOMPOSITE FILMS FOR FORCE SENSOR APPLICATIONS

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ABSTRACT

Herein, we report the development of graphene oxide (GO)-platinum (Pt) nanocomposite films on Phynox alloy substrate for force sensor applications. The nanocomposite films (50 μm) were prepared on Phynox alloy cantilever substrate using drop cast method. The nanocomposites were prepared successfully by mixing the GO sheets and Pt nanoparticles in N-Methyl-2-Pyrrolidone (NMP) solution using ultrasonication process. The purpose of adding Pt metal nanoparticles into the GO sheets is to create novel nanocomposite with improved structural and functional properties. As-synthesized GO sheets and nanocomposites were characterized using field emission-scanning electron microscope (FE-SEM), X-ray diffraction (XRD) techniques for their surface and structural properties. We have carried out force versus resistance change experiment for GO-Pt nanocomposite films using micro-UTM. The nanocomposite film undergoes electrical resistance change upon the application of force due to its piezoresistive behavior. It has been observed that the resistance was linear up to 60 N and above 60 to 200 N, it was showing a different slope. The observed data was repeatable for successive three cycles of experiment. The calculated non-linearity for the first (0-60 N) and second part (60-200 N) was ~7.446% and 11.293 % FSO (full scale output) respectively. However, by the incorporation of micro controller, it is possible to obtain better linear fit for 0-200 N with minimal non-linearity. Additionally, the change of electrical resistance phenomenon of the nanocomposite films can also be used in chemical, biological, vibrational, pressure and displacement sensors.

Keywords: Graphene Oxide nanosheets, Pt metal nanoparticles, Nanocomposite films, Force Sensor, Piezoresistivity
PRECURSOR MEDIATED ONE-POT SYNTHESIS OF THE NANOSILVER RAINBOW: IMPLICATIONS FOR MORPHOLOGICAL EVOLUTION AND THE ENSUING PROPERTIES

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ABSTRACT

Physical and chemical properties of noble metal nanoparticles are governed by quantum confinement, and thus, is intimately related to the size and morphology of the nanostructures. Facile synthesis of stable nanostructures of various size and morphology therefore is of essence in utilizing nanoparticles in various technological manifestations. Silver nanoparticles for instance, indicate unique properties which allows them to be widely used in optoelectronics, catalysis, and spectroscopy etc, while their efficacy in a given circumstance is determined upon the properties ensued by the size and shape of the silver nanoparticles concerned. Existing methods of preparation, however, is limited in applicability owing to various reasons including the use of harsh reducing conditions and stability of the resulting nanoparticles. Hence, there is a strong need to develop novel and facile synthetic routes to silver nanoparticles of various size and morphology. Here, we have developed a novel one-pot synthetic approach for silver nanoparticles which are yellow, orange, red, violet, purple and blue in color: a phenomenon directly attributable to the variations in nanoparticle size and shape. Previous attempts of similar nature have been realized by the variation of the reducing agents and/or their concentrations. Interestingly, here we manifest the changes in the nanostructures by the simple variation of the precursor metal ion concentration, while maintaining the reducing agent and auxiliary chemical concentrations constant. A comprehensive morphological investigations of the said particles are currently in progress and it is likely that these stable nanostructures will make way for novel and exciting applications of silver nanoparticles.

Keywords: nanosilver, nanoparticles, rainbow, shape, size, control
EFFECT OF SINTERING ON YTTRIA DISTRIBUTION OF 3Y-TZP CERAMICS

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ABSTRACT

Yttria concentration plays an important role in properties and ageing of 3 mol% yttria tetragonal zirconia polycrystals (3Y-TZP) ceramics. In this study, the effect of sintering atmosphere and temperature on surface yttria concentration of 3Y-TZP ceramic was studied. The 3Y-TZP ceramic powder was die pressed followed by cold isostatic pressing at 200 MPa and then sintered at air and argon gas atmosphere. Sintering was performed with different temperatures 1400°C and 1500°C for 2 hours. Yttria concentration was measured by using HORIBA scientific XGT-5200 X-ray analytical microscope. Twenty different places of the sample was analyzed using 15kV, 30kV and 50 kV as the X-ray tube voltage to analyze the elemental composition at different depths of the samples. Studies shows that, average yttria concentration increased with increasing X-ray tube voltage. Hence yttria concentration of the sintered sample is increased from surface to interior. On the other hand, surface yttria concentration decreased with increasing sintering temperature from 1400 to 1500°C. However, sintering atmosphere has a relatively weak influence on the surface yttria concentration.

Keywords: Y-TZP, XRF, Yttria distribution, sintering
CARBON QUANTUM DOTS-ADSORBED ZIRCONIA NANOPARTICLES AS EFFICIENT PHOTOCATALYST


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ABSTRACT

A new type of efficient photocatalyst was synthesized by adsorbing carbon quantum dots into zirconia (ZrO$_2$) nanoparticles. In the synthesis method, carbon quantum dots were synthesized by calcining 1 M ammonium citrate solution (10 mL) at 180 °C for 3 h. The obtained brown colour solid was ground well and then, 1 mg of the solid was dissolved in 10 mL of absolute ethanol. This C dots-dissolved solution emitted green colour under UV light. Previously synthesized ZrO$_2$ nanoparticles were added into the reaction mixture and sonicated for 5 minutes in order to adsorb carbon quantum dots into ZrO$_2$ nanoparticles. The final product was characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), Raman spectroscopy and Fourier transformed infrared spectroscopy (FTIR). Based on characterization results, C quantum dots-adsorbed ZrO$_2$ (CQDZ) was in spherical morphology with average particle size of 10 nm. The photocatalytic activity of synthesized material was investigated by dispersing 0.05 g of the material in 10 mL of 10 ppm methylene blue (MB) solutions followed by UV irradiation with 10 minute time intervals. The final concentrations of each MB solution were measured using UV-vis spectrophotometry. The photocatalytic degradation efficiencies were 66.5%, 76.5%, 84.3% and 95.0% under UV-irradiation of 10, 20, 30 and 40 minutes respectively. Under the same experimental conditions, only 34% of MB was degraded by bare ZrO$_2$ nanoparticles under 40 minutes of UV irradiation. Therefore, the synthesized CQDZ exhibits a high efficiency and has an outstanding potential as a photocatalyst for dye waste degradation during the water purification process.

Keywords: Zirconia nanoparticles, carbon quantum dots, photocatalysis
ABSTRACT

The great demand for artificial materials to be used to substitute portions or functions of the skeletal system for the long or short term has motivated the investigation with diverse types of materials. In the ceramic group, the most are those based on calcium phosphate due to their great biocompatibility with bone tissue, demonstrated in numerous preclinical and clinical experiences.

In this research paper, new cement, monocalcium phosphate monohydrate (MCPM), calcium oxide (CaO) and tricalcium phosphate (β-TCP) were designed and studied, including in their formulations as additives, surfactants, sodium hydrogen phosphate and as an antibiotic, ceftriaxone.

According to the proposed design of the eight formulations S7 and S8 had no cohesion and therefore were not characterized. A cohesive cement was obtained and after 7 days, according to the transformations indicates that it hasn’t reacted completely and that the possible results will be a mixture of dicalcium phosphate dehydrate (DCPD) and calcium deficient hydroxyapatite (CDHA). The indirect method using the apparent density to measure the porosity was not so effective in that the expected values were not obtained. The delivery of antibiotic of these materials was in the range of 25 - 45 % after 7 days.

The degradation study in vitro demonstrated that the addition of surfactant and the accelerant did not offer a positive result at least in the time of study.

Keywords: biomaterials, cement, biocompatibility, drug delivery
STRATAGEM TO ENHANCE THE CATALYTIC PERFORMANCE OF CuS NANOSTRUCTURES FOR ORGANIC TRANSFORMATION

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ABSTRACT

Copper sulfide nanoparticles (CuS NPs) were synthesized by the thermolysis of new copper(II) dithiocarbamate single source precursor in the presence of ethylenediamine (en) and octylamine (oa) as solvents. The CuS NPs were characterized by UV-Vis spectroscopy and XRD. A band gap of 2.3 eV {CuS-(oa)} and 1.93 eV {CuS-(en)} was assessed from the UV-Vis spectrum. The XRD pattern of CuS-(oa) and CuS-(en) depicts the hexagonal and cubic phases of CuS NPs, respectively. The catalytic potential of CuS-(oa) for nitrophenol transformation to aminophenol was explored by UV-Vis spectroscopy. Different Thermodynamic parameters namely apparent rate constant $k_{\text{app}}$, activation energy, heat of formation, Gibb’s free energy, Turnover frequency (TOF) and entropy change were calculated using Arrhenius and Erying equations. Furthermore, it was noted that the catalytic activity follows the Langmuir Hinshelwood adsorption model and the activity was tremendously increased with rise in temperature or using aqueous NiCl$_2$·6H$_2$O as co-catalyst. More importantly, the TOF value, a parameter for catalytic efficacy, was found comparable to that of the noble metals (Au, Ag and Pt).

Keywords: single source precursor method, nanoparticles, copper sulfide, catalysis, economical co-catalyst, nitrophenol reduction
V-I CHARACTERISTICS AND HALL EFFECT STUDIES OF NANOSIZE POLYANILINE/TiO$_2$

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ABSTRACT

Transport properties (V-I characteristics and Hall Effect studies) of Polyaniline, core-shell structured TiO$_2$/Polyaniline nanocomposites are studied at room temperature. The V-I characteristic of conducting polyaniline salt form follows non-ohmic relation. Here charge conduction is not only carried by free carriers (electron & hole) such as in intrinsic semiconductors but also is carried by the formation of polarons and bipolarons. V-I measurements were also performed on the TiO$_2$ /PANI core-shell structured nano-composite. The V-I characteristics results imply that additional current transport mechanism dominate in the composite. Current-voltage characteristics of PANI and PANI/TiO$_2$ can be expressed as $I = KV^m$ The exponent $m$ is -1 for Emeraldine base form, 1.66 for PANI (ES) form and 1.76 for PANI/TiO$_2$. The Hall Effect studies are providing valuable information regarding nature of the charge carriers, Hall Voltage, Hall Coefficient ($R_H$), carrier density ($n$) and carrier mobility ($\mu$) of the material. In application part Polyaniline and TiO$_2$ hetero-junction have been fabricated for rectification. The V-I characteristics of PANI/TiO$_2$ rectifier indicate P-N junction formation between PANI and TiO$_2$, which is becoming a potential material for molecular electronic devices.

Keywords: TiO$_2$/Polyaniline core-shell structure, V-I characteristics, hall effect studies, rectifier
ABSTRACT

Among the conducting polymers, Polyaniline (PANI) is a promising material with high environmental stability and electrical conductivity. It is a unique polymer which can be synthesized with tunable electrical conductivity; one of the prominent quotations given by Prof. A.G. MacDiarmid is that “There are as many different types of PANI as there are people who synthesize it”. Similarly there has been a great deal of interest in making polyaniline-based inorganic-organic nanocomposites because the impregnation of inorganic materials into a polyaniline matrix can introduce new properties to polymers as well as to the inorganic materials. Here we synthesized TiO$_2$ and Polyaniline/TiO$_2$ nonocompistes by sol-gel and in-situ. Chemical polimarization of aniline with ammonium peroxide as oxidant. We established the core-shell structure morphology between TiO$_2$ and Polyanile with help of XRD, SEM, TEM, Small angle neutron scattering (SANS) and Dynamic Light scattering (DLS). These results indicate that the polyaniline shell is formed with around 19nm shell thickness on the 55 nm TiO$_2$ nanoparticles.

Keywords: Polyaniline, TiO2, Nanocomposite, SEM, TEM, SANS, DLS
INTERACTIONS OF GOLD NANOPARTICLES WITH LIPID MEMBRANES-A UV/VISIBLE AND FTIR SPECTROSCOPY STUDY

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ABSTRACT

Small Unilamellar gold nanoparticles loaded dipalmitoylphosphatidylcholine (DPPC) lipid liposomes were prepared by extrusion method. The presence of gold nanoparticles in the bilayers was clearly seen by Transmission Electron Micrograph (TEM). These liposomes were characterized by UV-Visible and Fourier Transform Infrared (FTIR) spectroscopic techniques. The stability of the nanoparticles was determined by UV-Visible spectroscopy. The effect of gold nanoparticles on lipid phase behavior and bilayer fluidity was characterized by FTIR spectroscopy. In the FTIR spectroscopy, these liposomes were subjected to different temperatures and revealed that there is a significant change in the \( \text{CH}_2 \) stretching bands indicating that gold nanoparticles made conformational changes in the acyl chains of phospholipids. From this study we gain knowledge on how nanoparticles interact with lipid membranes which further may open the door to understand gold nanoparticles delivery in various diagnostic and therapeutic applications.

Keywords: Liposomes, DPPC, UV-Vis, TEM, FTIR, Nanoparticles
VIRTUAL PRESENTATIONS
AN EFFECTIVE TREATMENT APPROACH OF T-CELL INDUCED AUTOIMMUNE DIABETES THROUGH SITAGLIPTIN – ANTI-CD4 IMMUNONANO CONJUGATES IN BALB/C MICE

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ABSTRACT

Antibodies are an important, naturally occurring part of the immune system that can specifically bind to the cell surface of an “encroacher” in to the system. Type 1 diabetes mellitus (T1DM) is believed to be due to the autoimmune destruction of β-cells by auto reactive T lymphocytes. Anti-CD4 monoclonal antibodies have evidenced selective depletion of T lymphocytes. Drug delivery using antibody-drug conjugates (ADCs) has been gaining importance in the recent years. Insulin is regulated by Glucagon-Like Peptide-1 hormone (GLP-1) which also stimulates β-cell proliferation. However, considering the limited half-life of GLP-1 hormone due to rapid degradation by DPP-IV enzyme; employing a DPP-IV-inhibitor might increase the half-life of GLP-1. In the present study Sitagliptin(SP) loaded PLGA Nano particles (NP) were prepared and characterized. The average size observed was 115nm which was further conjugated by Thiolation of free carboxyl groups on nanoparticles crosslinking them with Sulfo-MBS cross linkers. This Nano immuno drug conjugate was screened in Balb/C mice subjected to inducediabetogenic spleen cells adoptively. Anti-CD4 mAb conjugated Sitagliptin Nanoparticles (SPNPs)treated mice revealed significant decrease in the Blood glucose level (P < 0.001), oral glucose tolerance, while there was a significant increase in the levels of insulin and active GLP-1 levels during OGTT (P < 0.001). Moreover, a significant decrease in the levels of cytokines and restoration of β cell mass was observed in mice treated with Anti-CD4 mAb SPNPs compared to negative control.

Keywords: Antibody drug conjugates (ADC), Anti-CD4, GLP-1, SPNPs and DPP IV Inhibitors
IN VITRO EVALUATION OF NOVEL LOVASTATIN LOADED NANOEMULSION GEL FOR THE TREATMENT OF OSTEOPOROSIS

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ABSTRACT

In the present study, nanoemulsion gel of lovastatin was prepared and characterized to be applied transdermally for the treatment of osteoporosis. The solubility of lovastatin in various oils, surfactants, and co-surfactants was determined in order to find the optimal components for the development of nanoemulsions. Further, the pseudoternary phase diagrams were constructed to identify the nanoemulsification region for the selected systems. The nanoemulsions obtained were subjected to stability studies (heating cooling cycle, freeze-thaw cycle and centrifugation) and dilution test. The stable formulations were evaluated for their droplet size, polydispersity index, zeta potential, and transmission electron microscopy (TEM). The selected formulations were incorporated into carbopol 934 gel matrix. Further, the in vitro permeation behaviour of selected formulations through rat skin was investigated and compared with conventional formulations (suspension and emulsion). The selected nanoemulsion formulations were composed of labrafac PG as oil, tween 80 as surfactant, transcutol as co-surfactant and water as the aqueous phase. The optimized nanoemulsion formulations mean droplet size was 360 nm. The optimized nanoemulsion was incorporated into 0.5% Carbopol 934 polymer and viscosity of the gel ranged from 444000-449000 cps. The amount permeated per unit area of nanoemulsion gel formulations was found significantly higher than the conventional formulations. In conclusion, the nanoemulsion gel was successfully developed for transdermal delivery of lovastatin.

Keywords: Lovastatin, nanoemulsion gel, osteoporosis
DEVELOPING AN ALGORITHM TO IDENTIFY MINERALS IN MINERAL SAND USING DIGITAL IMAGE PROCESSING TECHNIQUES


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ABSTRACT

Mineral identification is one of the challenge in mineral industry using automated processes. The conventional methods are time consuming, costly, high labour intensive. Quick image capturing, detection of color and physical size, analysis in short time made image processing methods superior over conventional analysis methods. This method was developed to determine the percentage of minerals of raw sand using Digital Image Processing techniques. Pulmudei beach, Sri Lanka was the source for the sand samples and a method was developed to identify mineral percentages. Ilmenite, Garnet, and Quartz have been used for this analysis. Algorithm developed using Matlab software that can determine each mineral percentage of a particular area. HSV (Hue, Saturation, Value) colour space was the basis since the computer technologies have capable enough to differentiate color definitions. Grains can be differentiated using their differing reflectance. Non overlapping samples were analyzed and background was differentiated from the minerals by using HSV values. By analyzing the pixels, area occupied by the minerals was determined and using weight to area relationship, the weight percentage of minerals was identified. Validation was carried out and using the statics accuracy was estimated. 25 samples were introduced to the coded software and results were obtained. Those results were subjected to hypothesis test between measured weight mean and mean weight which was obtained from developed algorithm and analyzed using Minitab software. Hypothesis test conformed that there is no significance difference between two means.

Keywords: mineral identification, digital image processing, HSV Value
NANOPOROUS CAPSULES AS POTENTIAL TRANSPORTER FOR ANTICANCER DRUGS AND CANCER THERAPEUTICS

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ABSTRACT

Novel polymeric micro and nanoporous capsules are taking a potential role as payload for anticancer drugs and nanomedicines for drug delivery and cancer theranostics. The polymers for biomedical and biotechnological applications are chosen based on various key properties like biocompatibility, biodegradability, surface tension, hydrophobic, hydrophilic nature, self-assembly and net-work formation capabilities. The synthesis of polymeric micro and nano scale porous capsules is followed through various approaches such as ring-opening polymerization, polymer re-precipitation, emulsion, and self-assembly of polymer materials etc. The polymers like PCL and PLGA has been used to design the nanoporous capsules to load the anticancer drugs such as DOX and MTX. These nanoporous capsules used as potential transporter to release anticancer drug molecules site/tumor specifically. The polymeric nanoporous capsules with size ~ 200 to 300 nm (in diameter) has been engineered and used to develop nanoformulations for cancer therapeutics. The chronic myeloid leukemia (CML) K562 cells used for cell based studies like cell viability, cell proliferation, apoptosis and cell cycle with and without nanoformulations. Synthesis of block co-polymer of (PLGA-\textit{b}-PCL) and development of porous capsules were characterized by FTIR, SEM, FE-SEM, AFM, BET, TEM, DSC, TGA, FC (FACS) MTT assay etc.

Keywords: polymeric, nanoporous, capsules, cancer, nanoformulations
FABRICATION OF NOVEL GUM KONDAGOGU-CHITOSAN FILM CONTAINING GREEN SYNTHESIZED SILVER NANOPARTICLE FOR TISSUE ENGINEERING APPLICATIONS

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ABSTRACT

A novel biosheet has been prepared by blending Gum kondagogu with Chitosan containing microwave assisted green synthesized silver nanoparticles. The optical property, morphology, and structure of silver nanoparticle was characterized by using UV-Visible spectroscopy, Transmission Electron Microscope (TEM), Dynamic Light Scattering (DLS) and X-ray Diffraction (XRD). The result showed the formation of silver nanoparticle in size range of 50-60 nm. The synthesized composite biosheet was physically characterized by scanning electron microscopy (SEM) images, and entrapment of silver nanoparticle was confirmed by Energy-dispersive X-ray spectroscopy (EDX). The FTIR study showed a characteristic peak of each component proves the compatibility of the blend. Thermal stability was confirmed by Thermogravimetric analysis (TGA) and antimicrobial activities was studied with S. Aureus and E-Coli. The NIH 3T3 cell lines studies showed it’s highly biocompatibility in nature. In conclusion, synthesized biosheet may be a potential candidate for tissue engineering applications.

Keywords: Gum kondagogu, Chitosan, silver nanoparticle, microwave synthesis
ABSTRACT

In this paper research is collected on the properties of high K-dielectric constant and also a comparison is drawn between different high K dielectric. In this paper electrical characterization C-V, J-V, Leakage current density Vs EOT are performed. The impact on the electrical characteristics such as Inductance, quality factor vs frequency arises due to the surface preparation of the material Germanium. This paper discussed the different properties such as physical properties and electrical properties of MOS or Metal oxide semiconductors. It also gives an overview of the limitation and the advantages of the two technologies namely HBT and CMOS.

Keywords: HBT, CMOS, EOT