

## Nanomaterials and nanotechnology for composites: synthesis, structure, properties and new application opportunities

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### 1. EDITORIAL

The aim of this special issue is to bring cutting-edge research across the entire spectrum of Materials Science and Nanotechnology. This special issue involves combining and understanding of the physical principles demonstrated by composite materials, nanomaterials, biomaterials, technology of nanometre-scale objects and other materials technologies. Materials engineering gathers scientists and engineers from many different subjects, such as materials science, nanotechnology, microtechnology, ceramic, metal, polymer, composite technology, and structural materials. This special issue allows researchers, academicians and professionals from across the globe to discuss, communicate and promote advances in knowledge, research and practice in the fields of Materials Science and Nanomaterials. This special issue contains the following titles:

#### 1.1. Areca catechu as photovoltaic sensitizer for dye-sensitized solar cell (DSSC).

This paper reports on the optical and photovoltaic properties of a new type of natural dye sensitizer from the Areca catechu (Pinang fruits) of Malaysia. In this study, it evaluated the solvent type effects on this dye's photovoltaic efficiency. Absorption analysis showed an excellent capacity to stabilize the dye. Fourier-transform infrared spectra revealed the presence of hydroxyl and carboxylic functional groups in the extracted dye, which were shown to be responsible for imparting the stronger electronic coupling and rapid electron transfer upon interaction with TiO<sub>2</sub> surface. The spectral photoluminescence analysis of dye revealed that a broad photocurrent can be created by a narrowing bandgap. Results demonstrate that Areca catechu can be applied to DSSC. It is promising to achieve high cell efficiency, low-cost production and non-toxicity.

#### 1.2. Preparation of natural rubber -OMMT nanocomposites using mechanical mixing and acid free co-coagulation methods: effect of processing method on mechanical properties.

The development of rubber nanocomposites has been an area of scientific and industrial interest in the recent years, due to several improvements achieved in these materials. However, nanofiller like polar nanoclay is difficult to disperse in non-polar natural rubber, and hence it is difficult to achieve property improvements as expected by incorporating nanoclay using conventional rubber/latex processing methods. This paper introduces a novel method named acid free co-coagulation method stating from latex stage and in which a combined gelling agent

was used for rapid gelation and the nanoclay was modified for enhancement of compatibility with rubber. The nanocomposites exhibited exfoliated clay structures with minimum clay aggregation, and remarkable mechanical properties. The new method will be used in the field of materials engineering, in future, to prepare rubber nanocomposites with different nanofillers.

#### 1.3. Synthesis and characterization of single phase ZnO nanostructures via solvothermal method: influence of alkaline.

The paper seeks to synthesize and characterize single phase zinc oxide nanostructures using simple basic and readily available equipment to achieve high quality nanostructures negating very complex routes. The method employed in this study could be reproduced easily without considering sophisticated equipment. Besides, the conditions adopted in producing the high purity zinc oxide nanostructures in this study are advantageous to the conservation of high energy used to achieve some of these outcomes in some studies. Unique findings from the morphological and spectroscopic results from this study could be applicable to fields in energy, electronics and pharmaceutical industries. It is the hope of every research scientist to develop simple techniques in material engineering to meet the growing demands of the technological world.

#### 1.4. Effect of shrimp shell chitosan loading on antimicrobial, absorption and morphological properties of natural rubber composites reinforced with silica-chitosan hybrid filler.

Rice husk and shrimp shells from agricultural waste were value added by using to prepare hybrid filler between rice husk silica and shrimp shell chitosan. Latex solution method was successfully applied to obtain natural rubber composites reinforced with this hybrid filler. The antimicrobial, absorption, and morphological properties of the natural rubber composite films and cured composites were investigated by the Agar Diffusion Method, Water Absorption Test and Scanning Electron Microscopy (SEM), respectively. All of NR composites with the addition of shrimp shell chitosan show antimicrobial activity. The addition of only 5phr shrimp shell chitosan in NR composite exhibits the most efficient E. coli inhibition and the absorption properties suitable for use as wound dressing.

#### 1.5. The effect of viscosities of various coating solutions on the physical, mechanical and morphological properties of kenaf/epoxy composites.

Natural fibres especially kenaf can exhibit excellent tensile properties. However, the actual potential of these fibres is

commonly not achieved in fibre-reinforced composites due to low in dispersion, low compatibility and surface adhesion, and shape and stiffness inconsistency. This research aiming to provide a solution to the issues by employing a simple and practical coating treatment that suit macro-scale requirement of lignocellulosic industries. This manuscript explores the effect of various viscosities of coating treatment and the immersion time by analysing the maximum fibre-matrix interaction and composites deformation at a specific modulus and tensile Poisson's ratio. The acetone's amount used to change the viscosity play a vital role where the highest amount gave the optimum viscosity which able to overcome the issues and improved the overall composites' properties.

#### 1.6. Study of the magnetic properties of Zn doped Cobalt ferrite ( $\text{CoZn}_x\text{Fe}_{2-x}\text{O}_4$ ).

In this paper we studied the magnetic properties of Zn doped cobalt ferrite for different Zn concentration prepared by conventional solid state double sintering method. We observed the porosity of the samples using Scanning Electron Microscope. Magnetic measurement reveals that Curie temperature increases up to  $x = 0.1$  then decreases for further concentration. We measured frequency dependent real and imaginary part of the permeability. From the measurement maximum quality factor and minimum loss factor were observed for  $x = 0.1$ . Magnetization curve shows that maximum value of saturation magnetization was observed for  $x = 0.1$ . These magnetic properties are useful for various applications such as high frequency devices, gas or humidity sensors etc. Our studies reveal that our produced samples may be useful for these kind of applications which are widely used in material engineering.

#### 1.7. Silver nanoprisms/graphene oxide/silicon nanowires composites for R6G surface-enhanced raman spectroscopy sensor

Surface enhanced Raman scattering (SERS) is an important analytical tool for the opto-chemical detection of molecules. The enhancement is commonly achieved by combining plasmonic nanomaterials with patterned or roughened supporting substrates

of high surface area for increased light scattering and molecule adsorption. In this work, silicon nanowires (SiNWs) of different morphologies have been prepared by metal-assisted chemical etching technique. To produce highly sensitive and stable SERS devices, we have integrated graphene oxide (GO) layer sandwiched between the AgNPr and the SiNWs to serve as nanogaps and a protective coating for the silver nanoparticles from oxidation. High SERS response was demonstrated by AgNPr/GO/SiNWs compared to AgNPr/Si sensor for R6G detection. SERS efficiency of  $6.1 \times 10^{10}$  was accomplished for AgNPr/GO/SiNWs composites.

#### 1.8. Preparation and characterization of nanocellulose from sugarcane bagasse

Nowadays, the demand for materials from renewable resources, such as biomass from agricultural wastes, to produce the desired materials are of grate interested. Nanocellulose is a natural nanomaterial which can be extracted from plant such as wood, flax, hemp, jute ramie, rice straws, coconut coir, cassava bagasse, corn cob, and sugarcane bagasse. This is due to renewable resources, environmentally friendly, low density, nontoxicity, and high biodegradability. The use of renewable resources as natural nanomaterials is one way of adding value to agricultural waste. Nanocellulose having low density greatly reducing erosion in the processing machine, safe for biodegradable and cheaper. It's can be used as reinforcement material in several applications such as energy-harvesting materials, optical applications, printing applications, food packaging, and organic composite materials. In addition, nanocellulose has very good physical and chemical properties such as high strength, excellent stiffness, high modulus, low axial thermal expansion, and high surface area. In this study, nanocellulose particle was extracted from sugarcane bagasse by alkali and bleaching treatment for removed amorphous lignin and hemicellulose. Bleached cellulose was performed hydrolysis by sulfuric acid. The effects of hydrolysis time and temperature on particle size, chemical structure, crystallinity and thermal stability of nanocelluloses were studied.



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