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Table Content:

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Evaluation of the inhibitory effect and cytotoxicity of some nanoparticles against bacterial isolates from burn infections

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Abstract

150 swabs were taken from different burns of patients admitted to Medical City Hospital and Al-Kindi Teaching Hospital. 128 swabs showed morphological examinations. The isolates were confirmed at the species level using Vitek2 compact system for skin diseases. The isolates under study were tested for sensitivity using the drill diffusion method. Nanoparticles were prepared by two methods, chemical synthesis and green synthesis, Aloe vera and aqueous extract of saffron (Crocus sativus L.). Bacteria were isolated by 60 isolates of Pseudomonas aeruginosa, (46.87%), followed by Staphylococcus aureus, with 38 isolates (12.28%), Klebsiella spp. with 20 isolates (15.62%), and the rest of the isolates were Escherichia coli, Enterobacter cloacae, Acinetobacter baumannii, Stenotrophomonas maltophilia, with three isolates for each type, i.e. (1.56%). S.aureus and Ps.aeruginosa were the most resistant bacteria to antibiotics, and it was found that substance nanoparticle prepared by Artificial roads nanoparticle. The percentage of Staph. aureus bacteria were (28.12%), while Ps. aeruginosa bacteria was (46.87%). The solutions were at concentrations of (100, 75, 50, 25) M%. It is noted that the highest inhibition concentration was (100) M%. As for the is Staph. aureus and Ps. aeruginosa bacteria isolate zone (48, 45) mm, respectively. It was found that the saffron of (45) mm in inhibiting the isolates of Gram-positive bacteria Staph. aureus. The success of Staph. aureus with nickel oxide with saffron at a rate of MIC. Invivo test animals, and the MBC the conducted two methods tests were, ZETA POTENTIAL, . Nanomaterials with a smaller size of 5-12nm called quantum dot were observed, and no agglomeration occurred in them. It was shown that the MTT toxicity assay for the solutions of the IC50 ratio for cancerous PC3, while for cellsand the substance is not toxic to the solution for treating S.aureus bacteria, and Ps.aeruginosa .

Keywords: Klebsiella pneumoniae, Staphylococcus epidermidis, Staphylococcus aureus, Enterobacter cloacae, Acinetobacter baumannii, Pseudomonas aeruginosa

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Optical Properties and Applications of Plasmonic-Metal Nanoparticles

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Abstract

Noble metal nanoparticles (NMNPs), thanks to their peculiar optical properties, have attracted great attention in recent decades in science and technology. In fact, new lithographic techniques as well as improved classical wet chemistry methods facilitate the synthesis of NMNPs of different sizes and shapes in various dielectric environments. Furthermore, the synthesis of these new structures deepens our understanding of crystal growth mechanisms and light-matter interaction. This work clearly and concisely describes the formation of NMNPs by the Kinetic Monte Carlo (KMC) method. The morphologies of the obtained nanoparticles are analyzed in terms of size and shape under different deposition conditions. The work also explores the potential of plasmonic properties of NMNPs, such as light absorption and scattering, for possible applications in medicine, energy and information, using both Mie theory and the discrete dipole approximation (DDA) method. The optical properties, particularly of gold (Au) and silver (Ag), are examined by studying their plasmonic properties and discussing their coupling effect. Simulation results show the appearance of absorption characteristic of the surface plasmon resonance. The analysis displays that the localized surface plasmon resonance (LSPR) of each structure can be tailored to near-infrared (NIR), NP size and shape, dielectric medium, as well as thickness and composition of the shell. The analysis demonstrates too that coated AgNPs are advantaged over other structures for imaging, sensing, and drug delivery applications. Finally, we briefly summarize the developed areas based on plasmonic properties, showing the advantages of noble nanoparticles and highlighting the challenges. The modeling approach presented here is suitable for plasmonic nanomaterials of arbitrary shapes, sizes, and compositions and is well fitted for the rational design of novel plasmon-assisted theranostic applications.

Keywords: Noble Metal Nanoparticles; DDA; KMC; Optical Properties; Plasmonic Applications

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Resveratrol-Loaded Solid Lipid Nanoparticles Reinforced Hyaluronic Hydrogel: Multitarget Strategy for Treatment of Diabetes-Related Periodontitis

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Abstract

This study investigates a new treatment for diabetic periodontitis using RSV-loaded solid lipid nanoparticles in a hyaluronic acid hydrogel (RSV@CLgel). RSV, known for its anti-inflammatory and bone-promoting effects, can improve macrophage balance, reduce inflammation, and support tissue healing. RSV@CLgel effectively lowers harmful cytokines, reduces oxidative stress, improves mitochondrial function, and boosts bone cell activity, making it a promising approach for managing diabetic periodontitis.

Keywords: Periodontitis, Resveratrol, Solid Lipid Nanoparticles, Hyaluronic Acid Hydrogel, An-ti-inflammatory Therapy, Antioxidant Therapy, Bone Regeneration, Controlled Drug Delivery

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Modular assembly of metamaterial using light gradient forces

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Abstract

This work explores the feasibility of assembling metamaterials using the light gradient force in a Standing Wave Optical Trap (SWOT). A tightly focused laser beam, reflected from its focal plane, creates a 1D array of traps through the intensity gradient in the standing wave pattern. Which, when time-shared across a 2D lattice, creates a 3D array of traps. Traps, formed in a microfluidic device, were populated with commercially available monodispersed dielectric and metallic nanoparticles (NPs). NPs were then anchored in position by photopolymerizing a hydrogel scaffold creating a voxel. Voxels were then stitched together using step-and-repeat method to produce metamaterials of any size, although imperfectly. For practical handling, the matrix can be stiffened by vitrifying the hydrogel scaffold using Tetraethyl Orthosilicate. The NP size and position in the array were estimated using fluorescent confocal microscopy along with iterative deconvolution in MATLAB. Results show that the mean separation of NPs along the optical axis is 322 nm for 860 nm trapping laser, in-line with the separation between successive antinodes of the standing wave in water (. Compared to a Gaussian beam, a pseudo-Bessel beam produced a larger and more regular array along the optical axis due to its longer focal length and shorter healing distance. The minimum registration error within a voxel (nm) was limited by Brownian motion, while the minimum error between voxels (nm) was likely affected by Brownian motion and repeatability of the microscope stage. Finally, the optical performance of the metamaterials was tested using dark-field, cross-polarized reflection spectroscopy, and compared with finite element simulations using COMSOL which showed evidence of a resonance peak. Interestingly, while the line-shape from an array of polystyrene NPs was symmetric, an array of rutile NPs was not, which may indicate Fano resonance. Despite structural defects, reflection spectroscopy revealed a resonance.

Keywords: Metamaterials; Standing Wave Optical Trap; Nanoparticle

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Surface Roughness of Nano Powder Mixed with Different Dielectrics

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Abstract

The titanium alloy wire electric discharge unit is the subject of this investigation. It might be seen as an effort to advance response variable models. The purpose of comparison According to The Electrical Discharge Machine for Wires approach, a response surface is employed with a particular kind of water, and one of those is a nanoparticle (AL_2O_3) at a percentage of water, the rate of surface roughness is the same in both situations (4mg). The pilot plant is based on the Minitab 18 concept, and the research offers six essential components. The advanced model test results showing the applicability and validity of the advanced design of the RSM were conducted using ANOVA. The ideal parameter settings are ultimately discovered.

Keywords:SR, Minitab18, RSM, Al_2O_3

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Environmental impact of nanofibers produced by electrospinning technology

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Abstract

Nanotechnology has attracted the world and researchers' attention to lot of applications and at the same time to sustainability. Based on that, this article has combined in its discussion two important points represented in nanotechnology, specifically nanofibers produced by electrospinning technology, in addition to the impact of these fibers on the environment and the negative effects of these fibers and technology on sustainable development.

This research presents an introduction that talks about nanofibers and electrospinning, then the concept of environmental impact in brief, in addition to environmental concerns regarding the use of electrospinning technology and the environmental impact of nanofibers, including on human, animal and plant health, and part of the legal aspect of working in this field.

Keywords: Environmental impact, nanofibers, electrospinning, sustainable

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Preparation, Characterization of silver nanoparticles and their interaction with the hydrazine molecule in aqueous medium

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Abstract

In this work, we have prepared the silver nanoparticles using the hydrazine method at ambient temperature. These nanoparticles were characterized by XRD and SEM and their catalytic performances have been tested in the decomposition of hydrazine at different temperatures. The results obtained suggest that the silver nanoparticles are successfully synthesized by this method and their estimated average size is of 42 nm. These nanoparticles obtained present a great reactivity in the decomposition of N_2H_4, and their catalytic activity depends strongly on temperature, where it increases with the increase of the temperature. The kinetic study leads to a zero-order compared to hydrazine concentration, which is in agreement with the results found on the palladium nanoparticles for the same reaction. The activation energy of this reaction onto the silver particles was found in the range of 66.5 to 88.6 kJ/mol. These values obtained in this study are in good agreement with the results observed for the nanoparticles of platinum and palladium used as catalysts for the same reaction.

Keywords: Silver nanoparticles, reduction, catalytic activity, hydrazine decomposition

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Anticancer Activity of Poly acetal /Chitosan Gold Nanocomposite

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Abstract

In this research, poly acetal has been prepared from the reaction of poly vinyl alcohol with para flouro benzaldehyde. The solution casting process was used to create the polymer blends of poly acetal and Chitosan. Using onion peel extract as a reducing agent, the gold nanoparticles (AuNPs) were created. Nanocomposites were prepared by solution casting by mixing poly acetal /Chitosan /Au,nano particles with different ratios. The AuNPs were characterized through XRD analysis and FESEM microscopy. The poly acetal/Chitosan, polymer blends and nano composites were characterized by FTIR, FESEM, DSC and TGA. FTIR has been used to analyze poly acetal, which confirms its production by displaying a new band of absorption at 1105 cm-1 due to the (O-C-O). The thermal stability of the generated polymer blends and nanocomposites is confirmed by DSC and TGA; in comparison to blends, nanocomposites have demonstrated good performance in suppressing lung cancer cell lines.

Keywords: Anti-cancer cell line, PVA, Chitosan, Polyacetal, Nanocomposite

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Sol-Gel Protein Stabilization toward Rainbow and White Lighting Devices

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Abstract

Fluorescent proteins (FPs) are widely recognized as a paradigm for sustainable materials in photonics and optoelectronics. However, their stabilization under non-physiological environments and harsh operating conditions remains a significant challenge. Among the FP-stabilization methods, the classical sol-gel approach is the most effective but less versatile, as most proteins and enzymes are easily degraded due to the multi-step processes, use of surfactants, and mixed water/organic solvents in extreme pH conditions. Herein, sol-gel chemistry with archetypal FPs (mGreenLantern; mCherry) is revisited, simplifying the method to a one-pot, surfactant-free process conducted in aqueous media (phosphate-buffered saline, pH 7.4). The synthesis mechanism involves the direct reaction of carboxylic groups on the FP surface with the silica precursor, generating a positively charged FP intermediate that serves as a seed for the formation of size-controlled mesoporous FP@SiO2 nanoparticles. Green-/red-emissive (single-FP component) and dual-emissive (multi-FP component; kinetic studies not required) FP@SiO2 nanoparticles are prepared without affecting the photoluminescence or stability of the FPs (>6 months) under dry storage and in organic solvent suspensions. Finally, FP@SiO2 color filters are applied to rainbow and white bio-hybrid light-emitting diodes, featuring up to 15-fold enhanced stability without reducing luminous efficacy compared to references with native FPs. Overall, this work demonstrates an easy, versatile, and effective FP-stabilization method using FP@SiO2, paving the way for sustainable protein-based lighting applications.

Keywords: Fluorescent Proteins, Sol-gel Chemistry, FP@SiO_2 Nanoparticles, Bio-hybrid LEDs, Protein Stabilization

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Effect of nano SiC and micro SiC particles on hardness profile and corrosion properties of aluminum alloy AA6061-T6 through friction stir processing

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Abstract

Surface composites produced by friction stir processing (FSP) demonstrate higher mechanical characteristics, wear, and corrosion resistance than unreinforced aluminum alloys. In this study, the incorporation of nano- and micron-sized silicon carbide (SiC) particles within the AA6061-T6 Al alloy surface was carried out by establishing many holes at the surface that were filled with those particles to synthesize surface aluminum matrix composites (AMCs). FSP was performed at the best parameters, which included a tool rotational speed of 1460 rpm, a traverse speed of 75 mm/min, and two passes along the same track to ensure uniform particle distribution and surface composite formation. The results showed that the nano SiC and micro SiC particles improved the grain refinement of the AA6061-T6 matrix via FSP and enhanced the hardness values, which were attributed to the grain refinement and uniform distribution of SiC particles in the stir zone. The results revealed that the microhardness of FSPed composite with nano SiC was higher than that with the addition of micro SiC particles. The FSPed composite with SiC nanoparticles showed the best corrosion resistance (80.15% improvement in CR) compared to composites with SiC microparticles and FSPed samples after electrochemical corrosion tests in 3.5 wt% NaCl solution.

Keywords: AA6061-T6 alloy; corrosion résistance; friction stir processing; surface composites; SiC particles

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Phthalocyanine-based Nanostructures

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Abstract

Phthalocyanines are a heterocyclic group of macromolecules consisting of four indole units. Their unique architecture makes structural alteration possible through the addition of diverse groups on the phthalocyanine periphery and/or the insertion of different metal cations in the ring center. Due to excellent electron transfer, these systems exhibit outstanding electrical, optical, and physical properties. Also, they are chemically and thermally stable therefore they can be suitable for a wide range of high-tech and scientific applications such as energy, non-linear optics, photodynamic therapy, electronics as well as dyes/pigments. Recently, the possibility and advantages of phthalocyanines' utility as modifying groups to refine the efficiency of nanomaterials have been interesting to researchers. Some studies have reported the synthetic procedure for some new phthalocyanine-based nanostructures and studied their biological, electrochemical, and anti-cancer features. According to the results, surficial modification of metal-based nanostructures improved significantly the antibacterial, antioxidant, and anticancer activities of unmodified nanomaterials. Besides, the functionalization of carbon-based nanomaterials with metal phthalocyanines improved the individual electrochemical and energy storage properties of the phthalocyanines and the unmodified nanostructures. There is a vacancy for phthalocyanine-modified nanomaterials in the literature and novel studies can hopefully help with this deficiency in the future. This study aims to represent some of the achievements in this field.

Keywords: Phthalocyanine; antibacterial; antimicrobial; nanomaterials; drug

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Role of Silver in Creating Oxygen Vacancies in CeO2 for Enhanced Effluent Degradation and CO2 Reduction to Methanol

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Abstract

Photocatalytic CO2 reduction using sunlight is emerging as one of the efficient green approaches to revive the environment from greenhouse gases. CeO2 and Ce0.95Ag0.05O2 QDs were prepared by co-precipitation method and characterized by XRD, FTIR, SEM, TEM and XPS techniques. CeO2 as well as Ce0.95Ag0.05O2 QDs show cubic fluorite structure indicating formation of solid solution. The addition of Ag in CeO2 extends absorption to the visible region. Ce0.95Ag0.05O2 QDs exhibited enhanced photoactivity for the degradation of dye effluents (96%) as compared to pristine (10%) after120 min of solar irradiation. The photoactivity can be attributed to the conversion of Ce+3 to Ce+4 cycle of CeO2 and the Introduction of defects such as oxygen vacancies acts as an electron trap thereby enhancing the photocatalytic activity. CO2 from the vehicular exhaust was converted to methanol using CeO2 and Ce0.95Ag0.05O2 QDs under sunlight which show selectivity for the formation of methanol. 184 µmol/g/h of methanol was produced by Ce0.95Ag0.05O2 QDs compared to CeO2 alone. Ag doped CeO2 QDs is a promising photocatalytic material for the reduction of CO2 to green fuel like methanol.

Keywords: Photocatalytic CO_2 Reduction, CeO_2 Quantum Dots, Ag Doping, Methanol Production, Solar Irradiation

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Surfactant-modified zeolitic rock functionalized with iron nanoparticles for arsenate adsorption from aqueous solutions

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Abstract

The high concentration of arsenic in groundwater is a global health concern. While activated carbon and other conventional adsorbents effectively remove arsenic, their cost and regeneration challenges require exploring alternative materials. This study evaluates the arsenate adsorption capacity of surfactant-modified zeolite (SMZ) that has been functionalized with iron nanoparticles (FeNPs). A natural clinoptilolite-type zeolite from Hidalgo, Mexico, was homo-ionized using NaCl (Ze-Na). FeNPs were synthesized from $FeSO_4$ using the microwave method and then modified with a cationic surfactant (HDTMA-Br) to create the surfactant-modified zeolitic rock functionalized with FeNPs (Ze-NPs). SEM-EDX characterization confirmed an increase in carbon and iron content after modification. Batch adsorption experiments revealed that Ze-Na exhibited minimal As(V) adsorption, whereas Ze-NPs reached equilibrium in 12 hours with a maximum capacity of 4.16 mg/g. The solution pH significantly affected adsorption, with optimal removal occurring at pH 4 and 9. These results demonstrate that surfactant modification and functionalization with iron nanoparticles enhance the zeolite's ability to adsorb arsenate effectively.

Keywords: Zeolite; Iron Nanoparticles; Surfactant; Arsenic

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Arc-Discharge Methodology: Synthesis and Characterization of Carbon Nanotubes

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Abstract

Carbon nanotubes have emerged as a highly researched field due to their unique capabilities at the nano scale level. Elaboration and characterizing these materials is essential for better interpretation of their properties. In this context, the electric arc discharge method was chosen as the method for the production of carbon nanotubes (CNTs), as it has several advantages over other methods of CNT production. It is a simple and inexpensive method, and it can be used to produce a variety of CNTs. Various techniques were used for studying CNTs powder, including X ray diffraction (XRD), Scanning Electron Microscopy (SEM), and Optical Microscope. XRD offers crystallographic details such as crystal size, purity, and structure that can be immensely beneficial when examined together with other properties obtained through SEM observation. In addition, another characterization tool, it's the optical microscope that provides information on the size, shape and distribution of carbon nanotubes. The applications of CNTs are diverse and unmatched, we can mention several, for example, the possible applications of these properties come within the province of nanoelectronic, also, carbon nanotubes can be incorporated into a polymer coating to improve the corrosion protection properties.

Keywords: CNTs; Electric Arc- Discharge; XRD; SEM; Optical Microscope

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Iron-Doped Graphene via CVD: Tailoring Magnetic Properties for Advanced Spintronics and Data Storage Devices

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Abstract

The synthesis of iron-doped graphene (Fe-doped graphene) via Chemical Vapor Deposition (CVD) has garnered significant attention due to its potential applications in spintronics and magnetic storage devices. This study presents the synthesis of graphene doped with 3%, 4%, and 6% (Fe) using the CVD technique. The magnetic properties of the Fe-doped graphene were thoroughly investigated, revealing enhanced ferromagnetic behavior with increasing iron content. The Fe-doped graphene samples exhibited notable ferromagnetic properties, including increased saturation magnetization (Ms), remanent magnetization (Mr), and coercivity (Hc). The saturation magnetization values were found to be proportional to the iron doping levels, indicating a stronger magnetic response with higher Fe concentrations. Specifically, the 6% Fe-doped graphene showed the highest Ms, suggesting a more substantial ferromagnetic interaction compared to the 3% and 4% Fe-doped samples. The hysteresis loops of the Fe-doped graphene confirmed the presence of ferromagnetic ordering at room temperature. The remanent magnetization and coercivity also increased with higher Fe doping levels, demonstrating improved magnetic stability and potential for memory storage applications. The unique magnetic properties of Fe-doped graphene make it a promising candidate for various applications, including spintronic devices, magnetic sensors, and advanced data storage technologies. This study highlights the potential of CVD-synthesized Fe-doped graphene in enhancing the performance of next-generation magnetic and electronic devices.

Keywords: Graphene ; CVD; Graphene doped Fe; Magnetic Properties

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In-Vivo Study of the Palladium Nanoparticles

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Abstract

Nanobiotechnology is a subfield of nanotechnology that focuses on developing nanosized materials within biologically active complexes. It has emerged as a result of the fusion of bioscience and nanoscale innovations. Scientists have developed nanocomposite materials and nano-based nanoparticles, which are environmentally friendly and durable. Nanoparticles derived from bacteria, fungi, and plants offer numerous applications in biology. The production of nanoparticles requires finding a suitable solvent and reducer. This study demonstrates an environmentally friendly natural generation of palladium nanoparticles (PdNPs) from the Rosa damascena flower extract employed with palladium chloride precursor. The nanoparticles were investigated and characterized employed various techniques. The synthesis of palladium nanoparticles was characterized in this study as straightforward, cost-effective, and non-toxic. This work used Rosa damascena flower extract to efficiently decrease ions to palladium nanoparticles. The biogenic synthesis of palladium nanoparticles (PdNPs) is studied using UV-Visible spectrophotometry, Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), and transmission electron microscopy (TEM). The surface plasmon resonance peak was observed at 364 nm during the UV-visible investigation of biologically synthesized palladium nanoparticles. The diameter of the produced palladium nanoparticles was around 50 nm and exhibited a spherical and cubic morphology. Anti-inflammatory activities have been conducted employed a rat model. These studies indicate the result that the flower extract of R. damascena was gave weak results in front of standard drug. Indomethacine used as standard drug shown best results on the reduction of the swelling produced by Carrageenan into hind paws of the rat. Edema was induced in all groups of animals employed through carrageenan injection into the hind paws. Edema was observed after 30 minutes in the control group of animals and treated group with sample and standard drug group.

Keywords: Nanobiotechnology, Palladium Nanoparticles, Rosa damascena, Green Synthesis, Anti-inflammatory Activity

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Dual-Action Adsorbent: High-Efficiency Fluoride Removal with Antibacterial Properties for Water Treatment

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Abstract

The adsorptive removal of fluoride from water has gained significant attention as an effective strategy to achieve safe fluoride levels, leveraging various nanomaterials. This study explores the synthesis of metal ion-substituted hydroxyapatite nanoparticles and their application in fluoride removal under natural conditions, eliminating the need for pH adjustments. We investigated the influence of mono-metal and bi-metallic substitutions on fluoride removal efficiency. The selected metal ions not only enhanced fluoride adsorption but also imparted antibacterial properties, showcasing a dual functional benefit. The physicochemical characteristics of the synthesized nanomaterials were thoroughly analyzed using advanced techniques such as X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), Brunauer-Emmett-Teller (BET) surface area analysis, transmission electron microscopy (TEM), and X-ray photoelectron spectroscopy (XPS) to elucidate the structure-activity relationship. Fluoride concentrations ranging from 2 to 2000 ppm were systematically studied. The performance of the most efficient nanoadsorbent was evaluated with real water samples from diverse regions of Andhra Pradesh and Karnataka, achieving 100% fluoride removal efficacy. Column experiments, incorporating the nanoadsorbents with glass beads, further confirmed this efficiency. Comprehensive adsorption modeling and kinetic studies were conducted to clarify the underlying mechanisms governing the selectivity of these nanomaterials. This study underscores the promising potential of these dual-function nanoadsorbents for commercial water purification applications, paving the way for innovative solutions in nanotechnology and environmental remediation.

Keywords: Fluoride removal; Nanomaterials; Metal Ion-Substituted Hydroxyapatite; Antibacterial Activity; Adsorption Kinetics; Water Purification

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Sol gel synthesis of titania xerogels doped with copper, iron, zinc and hydroxyapatite and their application in the electrophotocatalytic decolorization of acid black 1

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Abstract

The discharge of dyes into bodies of water generates problems in aquatic life and in humans. It can generate genotoxic effects, dermatitis problems, among others. Photocatalysis and photoelectrocatalysis mediated by TiO2 are redox processes at the semiconductor – electrolyte interface or solution, where the absorption threshold of TiO2 is at 388 nm. Titania doped with copper, zinc or iron generates the rectification phenomenon that prevents electron-hole recombination and can improve the photocatalytic properties of TiO2 by generating interbands. On the other hand, photoelectrocatalysis is a way to increase the separation of charge carriers. There are some disadvantages compared to photocatalysis, where suspensions of millimeter-sized xerogels but formed from nanometric conglomerates are used, since when supporting the semiconductor, surface area is lost; while the application of a potential to the photocatalytic system (photoelectrocatalysis) helps the separation of charges such that the photo-oxidation rate increases by using a lower overpotential, which suggests a lower activation energy. In this work, ZnO-CuO-TiO2 and Fe2O3-CuO-TiO2 nanomaterials were synthesized through the single-step sol-gel process and used for the catalytic and photocatalytic degradation of the acid black dye 1, which has good photo stability, and presents degradation problems due to conventional water treatment processes. Photocatalysis shows a higher reaction speed (decolorization in minutes), while decolorization by photoelectrocatalysis takes place in hours due to the loss of surface area in the supported nanomaterials used in photoelectrocatalysis. which is why it is intended to investigate all the factors that cause the coloration generated by the byproducts to be persistent in photoelectrocatalysis.

Keywords: Photocatalysis, Photoelectrocatalysis, TiO_2 Doping, Dye Degradation, Sol-gel Synthesis

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Toxicological and Histological Efficacy of Nano Formulation of Some Insecticides and Essential Oils Against 4th Instar Larva of Cotton Leaf Worm and Male Rats

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Abstract

The cotton leafworm, Spodoptera littoralis, represents a significant agricultural challenge. This study compared Nanoemulsions to traditional methods for testing toxicity of insecticides chlorpyrifos and chlorfenapyr, as well as natural emulsions eugenol and peppermint oil. It also assessed kidney function (Urea and Creatinine) and histological impacts on rat liver and kidney. Chlorpyrifos showed higher toxicity than chlorfenapyr, with LC50 values of 0.0044% versus 0.037%. Nano-chlorfenapyr outperformed nano-chlorpyrifos, with LC50 values of 0.0005% and 0.0036% after 24 hr. Nano-chlorpyrifos was 8.8 times stronger than the chlorpyrifos, while nano-chlorfenapyr showed a 10.28-fold increase. Nano-eugenol and nano-peppermint were 1.46 and 1.43-fold more effective than eugenol and peppermint. Nano-chlorpyrifos inhibited S. littoralis AChE 1.4 times more than chlorpyrifos, while nano-chlorfenapyr showed 1.43 times greater inhibition. Nano-peppermint inhibited AChE at 36.16%, exceeding peppermint 31.91%. Nano-eugenol had 32.41% inhibition versus eugenol's 26.12%. For ATPase, nano-chlorpyrifos inhibited 1.2 times more than chlorpyrifos, while chlorfenapyr had the highest inhibition at 54.95%, with its nanoform at 57.47%. Peppermint inhibited ATPase more than eugenol, with nanoforms showing greater inhibition: 39.16% for eugenol and 49.54% for peppermint. The study assessed AChE, ATPase activity, and urea and creatinine levels in male rats after 28 days. Chlorpyrifos and chlorfenapyr showed stronger AChE inhibition at 4.21 and 3.91 µmol/min/mg protein, while eugenol and peppermint had lower rates. Chlorpyrifos resulted in higher ATPase inhibition at 71.8%, compared to 50.4% for its nanoformulation. Chlorfenapyr also led to the highest urea level (101.63 mg/dl), followed by chlorpyrifos (95.22 mg/dl). Eugenol and peppermint didn't significantly change creatinine levels but increased urea, indicating potential kidney issues Histological analysis of male Wistar rat kidneys revealed renal toxicity from both conventional and nanoformulated treatments, suggesting significant histomorphological changes. Essential oils show potential as alternatives to insecticides. The nanoformulated chlorpyrifos of chlorfenapyr was effective against S. littoralis larvae, enabling application at lower concentrations.

Keywords: Insecticides, Essential oils, Nanoemulsion, common formulation. Histological parameters, *Spodoptera littoralis*

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A Comparative Study on Sulphonated Titanium dioxide loaded Sulphonated Polystyrene Ethylene Butylene Polystyrene and Sulphonated Polyether Ether Ketone membranes for long term MFC operation

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Abstract

The present research introduces sustainable green energy production by the bioelectrochemical reaction of a biodegradable substrate in a fabricated Microbial Fuel Cell (MFC) stack comprising five units. The MFC stack investigated for its scalability and sustainability using high ionic conductive and low oxygen mass transfer nanocomposite membranes, namely Sulphonated Titanium dioxide (S-TiO_2) loaded Sulphonated Poly Ether Ether Ketone (SPEEK) and Sulphonated Polystyrene Ethylene Butylene Polystyrene (SPSEBS). A maximum power density of 654 ± 3.2 mW m^{-2} was obtained by SPSEBS + 7.5 wt% S-TiO_2, whereas 642 ± 2.4 mW m^{-2} was recorded for SPEEK + 7.5 wt% S-TiO_2 and 615± 1.2 mW m^{-2} from Nafion 117. From the results obtained, SPSEBS + 7.5 wt% S-TiO_2 which showed comparatively maximum performance in terms of power production, longevity, and ion exchange capacity. This present work compares two non-fluorinated, environmentally stable polymers combating the controversies faced with pre-existing Nafion for efficient MFC performance for long term operation. Additionally, biofilm developed on the surface of the membrane after 6 months of MFC operation was also morphologically analyzed using SEM and phylogenetic analysis was constructed using MEGA X software to determine the dominant phyla responsible for the electricity production.

Keywords: Sewage wastewater; Microbial fuel cell; Nanocomposite; Power density; Tubular MFC; Six Month Operation

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A Study of the Effect of Graphene on the Mechanical Property of CuAlNi Shape Memory Alloy

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Abstract

Compared to NiTi alloys, CuAlNi Shape Memory Alloy (SMA) is less expensive, easier to make, and suitable for high-temperature applications. CuAlNi SMA's mechanical characteristics are subpar. From literature, Shape memory alloys are enhanced mechanically by the addition of alloying components. Graphene is extremely strong. It's robust and incredibly light. When added to CuAlNi shape memory alloys in the right way, graphene's intriguing features should improve the mechanical properties of the alloy. This research investigated the consequence of adding graphene (C) on the mechanical hardness of CuNiAl Shape Memory Alloy. The elements' mass fraction for a SMA is as follows, based on literature: Cu = 0.843; Al = 0.119; Ni = 0.038. Along with Densities of Cu = 8.96 g/cm3, Al = 2.7 g/cm3, and Ni = 8.9 g/cm3. Rule of mixing elements was applied in the preparation of the samples. The casting process of metal creation was deployed to manufacture the alloy. The hardness values of the alloy were determined using Rockwell Hardness machine. It has diamond Indenter Kgf 150. Plotting the hardness values against samples A, B, C, and D, reveals that sample B has the highest hardness value. The graph suggests that the addition of graphene to the alloy enhanced its mechanical property, or hardness value. The samples' surface morphologies were examined using a scanning electron microscope (SEM). The results show an increased mechanical characteristics and hardness which are attributed to the presence of secondary black compounds that are related to graphene, according to microstructure study conducted using the scanning electron microscope (SEM). CuAlNi SMA have many applications, including in the automotive and aerospace industries, to name a couple.

Keywords: mechanical properties; shape memory alloy; fatigue life; CuAlNi; CuAlNiC

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Enhanced Properties of Chrysotile Asbestos Fiber Reinforced Geopolymer Bricks

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Abstract

Clay and pozzolanic materials of different grades were mined and processed by first crushing them and then grinding them as raw materials to very fine powders. These powders were then calcined separately at different temperature levels ranging from 550 degrees Celsius to 850 degrees Celsius. The materials were also characterised before and after pyro processing using the XRF, XRD and PSD. One molar solution of Na OH and KOH were prepared and mixed with various proportions of the geopolymer materials. Chrysotile asbestos fibres of different furnish designs were also prepared. These fibres which provide reinforcement to the geopolymer are then mixed with the various grades of geopolymer materials according to the chosen mix designs. The resulting mix design is then first passed through a slow speed mixer and then through a high-speed mixer. The rheology of the product gradually changed from being a dry powder to be a liquid paste after mixing at high speed with the chrysotile fibre providing the reinforcement. The liquid paste was then used to produce bricks using a vibration mechanism and the top moving part of the brick making machine as the compaction mechanism. Properties of the chrysotile fibre reinforced bricks were tested at 2 days, 7days, 14 days and 28days for compressive strengths, tensile strengths, corrosion resistance and resistance to acid attack. The results of the asbestos fibre reinforced geopolymer cement bricks were found to have 100% improved properties with regards to compressive strengths, tensile strengths, corrosion resistance and resistance to acid attack when compared to ordinary refractory bricks. This chrysotile asbestos fibre reinforced geo-polymer bricks can be used to replace current refractory bricks used in high temperature environments.

Keywords: chrysotile asbestos, geopolymer cement, mechanical properties, acid resistance, thermal stability

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Predictive Optimisation Model for Commercial Geopolymer Cement Manufacturing

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Abstract

Our invention/ paper relates to the use of a kaolin source material that is mixed with a pozzolanic material in the absence of water, to form a geopolymer cement binder material. It relates to the industrial scale processes that these two major materials go through as they are prepared by special manufacturing processes to obtain optimised raw material constituent materials first and then when they mixed by large scale/commercial processes to obtain products of uniform quality. A geopolymer cement product capable of achieving a compressive strength of 104 Mpa with a compressive strength after a chemical attack of 100.74 Mpa and a thermal expansion of 0,2mm can be achieved after producing the input raw materials into this GPC cement at a Pyro processing temperature of 681 Degrees Celsius resulting in an aluminium material phase of 4.01 and silica to alumina ratio of 2.26. This product should be ground to a particle surface area of 6863 parts/cm2 with an alkali activator of 18,78%.

Keywords: metakaolin, pozzolanic materials, geopolymer cement, material phase, optimisation

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Efficiency and Concentration Quenching of Manganese Luminescence in $Zn_{1-x}Mn_xS$ and $Zn_{1-x}Mn_xSe$ nanoparticles

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Abstract

Systematic Monte Carlo calculations were carried out to describe experimental transients of manganese luminescence in $Zn_{1-x}Mn_xS$ and $Zn_{1-x}Mn_xSe$ nanoparticles, with Mn^{2+} molar concentration x being from 0.001 up to 0.5, nanoparticle size − down to 1.36 nm and time range from sub-nanoseconds to tens of milliseconds – that were grown by different growth technology. Monte Carlo method with one adjustable and one scaling parameter was applied basing on the luminescence quenching by defects (killer-centers). Extensive simulation of the luminescence transients under increasing x has shown that energy transfer between Mn^{2+}-ions (migration) was negligible. Besides, manganese excitation dynamics is significantly simplified by geometrical restriction of nanoparticle size d, and mainly controlled by intrinsic decay rate. When $d \le 1/\sqrt[3]{C_k}$, C_k - killer-center concentration, the quenching contribution vanishes and manganese luminosity increases. There is the luminosity maximum for each nanoparticle size dependent on Mn^{2+} molar concentration x, that is reached at $x \approx 0.01 - 0.06$ for $d \in [1.6 - 3$ nm]. Calculation of killer-center concentration dependence $C_k(x)$ shows rise upon x increase that undergoes a kind of saturation. This reveals cation self-organization of the mixed crystals when two sub-lattices of ZnS (Se) and MnS(Se) co-exist.

Keywords: Zn1-xMnxS nanoparticles; Zn1-xMnxSe nanoparticles; luminescence efficiency; quenching; migration; Monte Carlo