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5TH INTERNATIONAL CONFERENCE ON NANOMATERIALS, NANOFABRICATION AND NANOCHARACTERIZATION

(NANOMACH 2024)

Oludeniz, Turkiye

APRIL 18-24, 2024

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Mariana Ionita	University of Science and Technology Politehnica of Bucharest, Romania
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PLENARY SPEAKER

Id-843

Observing Nanostructures and Reactants During Catalysis by Correlative Surface Microscopy

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Introduction. Operando spectroscopy of catalytic reactions has been very successful in mechanistic studies.[1] However, as spectroscopy typically examines large areas/volumes, this averaging "smoothens out" local variations that may be critical to understand how a reaction proceeds. Furthermore, dynamics in catalyst structure, composition and adsorbate coverage may also go unnoticed by averaged spectral data. A straightforward way overcoming these limitations is to use correlative surface microsopy to directly "watch" ongoing catalytic reactions, i.e. to apply several microscopic and spectro-microscopic techniques to the same catalysts locations under identical reaction conditions.[2] Most of the methods herein not only image catalyst structure or composition, but also the adsorbed reactants, so that active and inactive states can be discerned (*kinetics by imaging)*, active regions identified and mechanisms elucidated.[3] Examples of real-time *in situ* imaging of H_2 oxidation are presented, covering meso-scale planar Rhodium surfaces and a single Rh nanoparticle (*single particle catalysis*).

Experimental/methodology. Different morphologies of Rh-based catalysts were employed: (i) planar polycrystalline Rh foil (exhibiting micrometre-sized domains of different surface orientation, enabling to directly examine structure-sensitivity); (ii) supported Rh powder particles (various sizes on ZrO_2 or Rh foil, enabling to directly reveal particle size and support effects); (iii) Rh nanotips (as small as 25 nm, serving as "single particles", enabling to directly observe facet-resolved reactivity). For planar catalysts, UV- and X-ray photoemission electron microscopy (UV- and X-PEEM), low energy electron microscopy (LEEM) and scanning photoelectron microscopy (SPEM) were used in a correlative approach, with resolution up to 3 nm. For the nanotips, field emission microscopy (FEM) and field ion microscopy (FIM) were applied.

Results and discussion. The direct, real-time and locally-resolved observation of H_2 oxidation on various Rh-based catalysts revealed a wealth of information and a variety of phenomena (some that had not been previously observed):

(i) the transition from the inactive to the active state via chemical waves, especially how hydrogen spreads via reaction fronts on different terminations of metallic and oxidic surfaces, and the coexistence of regions with different activity,[4]

(ii) the mechanism of oscillatory H_2 oxidation involving subsurface oxygen,[4]

(iii) how particle size, support and surface composition (decoration, SMSI) affect the local activity,[5]

(iv) whether different facets on a single Rh nanoparticle communicate via hydrogen diffusion or not (coupled monofrequential vs. (uncloupled) multifrequential oscillations),[6]

(v) detecting the active sites on a single particle via imaging water molecules,[6]

(vi) that chaos even exists at the nanoscale,[7]

(vii) how La modifies the reaction dynamics on a Rh nanotip.[8]

For videos of reactions on Rh foil and nanotips see the SI of the references. The experimental results were corroborated and rationalized by microkinetic modelling and density functional theory (DFT).

Keywords: Photoemission Electron Microscopy, Field Emission Microscopy, Rhodium, Hydrogen Oxidation, Reaction Fronts, Oscillations, Single Particle Catalysis

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INVITED SPEAKER

Id-841

Emerging Strategies in Bone Regeneration: From Scaffold to Tissue Regeneration

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Abstract: The overall objective of the current work is to provide bone reconstruction solution which merges cost-effective therapy with much improved regenerative efficiency than current treatment options used in the restoration of non-healing bone defects. The combination of cells and a material scaffold is traditionally the foundation upon which tissue engineering is built. Based on that approach several, 3D scaffolds potentially attractive for bone repair based on biopolymers (sodium alginate, chitosan, or gelatin), synthetic poly(vinyl alcohol) and graphene derivatives were proposed and investigated under the complex condition envisaged by real-life bone repair application. Our studies demonstrated that graphene derivatives act as a supporter of osteogenesis in virtue of two grounds, cell friendly chemistry and cell-detectable micromechanical stimuli distributed across the matrix. The advent of improved fabrication technologies, particularly 3D printing, has enabled the engineering of bone tissue for patient-specific healing. However, the biomaterials / inks based on natural polymers often fall short in terms of mechanical strength, scaffold integrity, and the induction of osteogenesis. Our research focused on developing novel printable formulations using our previous experience based on different biolopolymer e.g. gelatin/pectin polymeric matrix that integrate synergistic reinforcement effect graphene oxide (GO) and oxidized nanocellulose fibers (CNF). Using 3D printing technology and the aforementioned composite inks we fabricate bone-like scaffolds. The addition of GO to hydrogel inks enhanced not only the compressive modulus but also the printability and scaffold fidelity compared to the pure colloid-gelatin/pectin system. With its strong potential for 3D bioprinting, the sample containing 0.5% GO shown to have highest perspectives for bone tissue models and tissue engineering applications. The authors acknowledge the financial support from the Ministry of Research, Innovation and Digitization, Romania's National Recovery and Resilience Plan, project title Advanced & personalized solutions for bone regeneration and complications associated with multiple myeloma, contract 760093/23.05.2023.

Keywords: Bone substitute, 3D printing, graphene oxide, nanocomposite hydrogels, ink formulation

Acknowledgement: The authors acknowledge the financial support provided by a grant of the Ministry of Research, Innovation and Digitization, Romania's National Recovery and Resilience Plan, project title

Advanced & personalized solutions for bone regeneration and complications associated with multiple myeloma, CF 213/29.11.2022, contract 760093/23.05.2023.

INVITED SPEAKER

Id-842

Borophene as Bifunctional Electrocatalyst for Electrochemical Water Decomposition (HER/OER)

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Abstract: Electrochemical water splitting has huge potential for converting electricity into clean energy through electrode reactions. Exploring new active and stable electrocatalysts which operate in the same electrolyte for water splitting, hydrogen and oxygen evolution reactions (HER/OER), is important for many renewable energy conversion processes. Therefore, in our contribution, we tackle those issues and present novel and sustainable fabrication route of few layered borophene which has a potential to serve as bifunctional electrocatalyst in both OER and HER. We evaluated the overpotentials reached at j = 10 mA/cm2, Tafel slopes in respect to the commercial electrocatalysts (RuO2 and Pt/C in OER and HER, respectively). Additionally, the electrochemical and physical stability was confirmed during long-term measurements, with excellent potential retention at high current density. Detailed ex-situ spectroscopic and microscopic analyses of the electrocatalyst performed before, during and after electrochemical reactions allowed to provide first insights into the reactions mechanism. The proposed fabrication process of few layered borophene is facile, green, reproducible and scalable. Moreover, this contribution offers systematic and comprehensive study into electrocatalytic potential of this, still not deeply investigated, 2D member by experimental tools.

Keywords: 2D Nanomaterials, Borophene, Electrocatalysis, Energy Conversion, Hydrogen/Oxygen Evolution Reactions

Acknowledgements: This research has received funding from the National Science Centre (Poland) with grant OPUS21 number (2021/41/B/ST5/03279).

INVITED SPEAKER

Id-876

Anisometric Fe_3O_4 Nanoparticles as Versatile Theranostic Agents

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Abstract: Nanoparticles have attracted an enormous interest during the last decades due to their appealing properties which have led to countless applications in very widespread fields. Interestingly, the physicochemical properties of nanoparticles can be efficiently tuned by designing not only their size but also their shape. For biomedical applications, magnetic iron oxides, either magnetite (Fe_3O_4) or maghemite (γ-Fe_2O_3), are becoming the preferred material due to their excellent biocompatibility, biodegradability and relatively high magnetic moment. However, most of the research performed in maghemite/magnetite nanoparticles has been carried out on isotropic spherical particles. Here we present a rationally designed synthesis to obtain high quality anisometric Fe_3O_4 nanoparticles: nanocubes and nanorods. The nanoparticles have been synthesized over a wide range of sizes, i.e., nanocubes[1] of 10-90 nm in size and nanorods[2] of 12 up to 500 nm in length, with aspect ratios in the range 2-20. Below certain sizes both nanocubes and the nanorods show a great colloidal stability, even after transferring them to water. Moreover, they exhibit an excellent magnetic hyperthermia and NMR relaxivity performance (better than their spherical counterparts), making them excellent candidates for potential applications in nanotheranostics.[1,2] In addition, the Fe_3O_4 nanoparticles are outstanding heat mediators for photothermia in the near infrared biological windows (680-1350 nm),[3] with heating efficiencies similar to, or better than, the best photothermal agents. Moreover, the magnetic and optic anisotropies of the nanocubes and nanorods have been exploited for a relatively new approach for in situ local temperature sensing.

Keywords: Anisometric Noparticles, Fe_3O_4, Theranostics, MRI, Hyperthermia.

INVITED SPEAKER

Id-881

Biomass-Derived Activated Carbons for Electrochemical Electrodes

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Abstract: Electrochemical capacitors, which known as supercapacitors, are a unique type of high-power devices being developed for a different type of applications as consumer electronics, medical devices, transportation and military defense systems. Activated carbon (AC) is a porous material with high surface area and can exhibit good adsorptive capacities. In this study, AC was obtained from fruit peel based on cucumber (CP) and tangereen (TP) peel at the Institute of Combustion Problems in the Laboratory of Synthesis of Carbon Nanomaterials in Flame.

The outer shell of the products (cucumber, tangereen) was washed with distilled water to remove contaminants. Then first dried at room temperature for 3-5 days, then dried in the oven until constant weight. The dried raw materials were ground in a mortar and pestle to a powder.

The resulting powder was carbonized at various temperature from 500 up to 700 C and activated with KOH which allows production of ACs with highly developed porosity.

The synthesized activated carbon powder was used as an active material for the electrodes of a two-electrode cell. To create the electrodes of the supercapacitor, a slurry consisting of 75% active material, 15% polyvinylidene fluoride (PVDF), 10% acetylene soot, N-Methylpyrrolidone (NMP) was prepared as a solvent. Stainless steel was used as a conductive substrate. As an electrolyte it was used 1 M KOH solution. The results of electrochemical measurements were obtained from CV tests in a three-electrode cell in the range -1–0.6 V vs. Ag/AgCl, using the full-contact Ti-mesh configuration.

The specific capacitance was calculated from the CV plots using the expression:

$$C = \frac{q}{v} = \frac{1}{v}\frac{\int_{E_1}^{E_2} i(E)dE}{E_2 - E_1} \qquad (1)$$

where C is capacitance, q is electric charge, v is the scan rate, E is voltage and i is current.

Electrochemical characteristics showed a high specific capacitance of 222 F/g and a Columbus efficiency of 93.7% at a gravimetric current density of 2000 mA/g. The obtained samples were characterized by physicochemical methods such as scanning electron microscope (SEM), Brunauer-Emmett-Teller (BET) analysis and energy-dispersive X-ray (EDX).

Key words: Biomass, Activated Carbon, Carbonized, Fruit Peel, Electrodes

Acknowledgements: The authors acknowledge the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No **AP19677415** Obtaining nanocomposites from food waste and creating electrode materials based on them for supercapacitors**)**.

INVITED SPEAKER

Id-893

Magnetic Nanolayered Systems with THz Emission Properties

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Abstract: Magnetic nanostructured and nanolayered systems are nowadays of great interest for spintronic devices. In that respect, one adjacent direction is represented by layered systems capable of emitting Terahertz (THz) radiation. THz radiation emitted by ferromagnetic/non-magnetic bilayers is a new emergent field in ultra-fast spin physics phenomena with a lot of potential for technological applications in the THz region of the electromagnetic spectrum. The role of antiferromagnetic layers in the THz emission process is widely investigated presently by the research community at the moment. The work deals with the fabrication of tri-layers in the form of Co/CoO/Pt and Ni/NiO/Pt aiming to develop magnetic performances and to probe the role of very thin antiferromagnetic interlayers like NiO and CoO in transporting ultrafast spin current. We first reveal the static magnetic properties of the samples by using temperature-dependent Squid magnetometry and then we quantify the dynamic properties with the help of ferromagnetic resonance spectroscopy. We probe magnetization reversal that has large exchange bias values and we extract enhanced damping values for the trilayers. THz time-domain spectroscopy examines the influence of the antiferromagnetic interlayer in the THz emission showing that especially the NiO interlayer has good abilities to transport spin current.

Keywords: Magnetic Nanostructures, Thz Emission, Spintronics.

INVITED SPEAKER

Id-898

Electrochemical Engineering TiO_2 Nanomaterials for Renewable Energy

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Abstract: TiO_2 nanotubes (TNTs) show great potential on renewable energy and environmental applications due to their unique dimensional and semiconductive characteristics. Electrochemical anodization of metallic Ti substrates is a simple way to prepare well-aligned TNTs. Compared with dense nanoparticles, TNTs facilitate charge transport along the tube direction while maintaining a high effective surface area, and thus suitable for a variety of applications such as sensors, water splitting, photovoltaic devices, CO_2 conversion, supercapacitors etc.

In order to form a well-aligned tubular structure with controlled morphology, a balance between oxidation and field-assisted dissolution has to be maintained by adjusting electrolyte concentration, temperature, anodic duration, ramp rate and applied potential. However, the nature of TNTs attached to an opaque Ti foil with a closed bottom end limits their feasibility for extensive applications. Therefore, suitable fabrication approaches that enable free-standing and flow through TNT membranes are desirable. In this work, we introduce the fabrication of free-standing and flow-through TNT membranes and their possible application for solar fuels/CO2 conversion.

Keywords: Titanium Dioxide, Nanotubes, Electrochemistry.

ORAL PRESENTATION

Id-845

Bulk Scale Fabrication of Few-Layered Borophene - A Combined Strategy

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Abstract: The field of nanotechnology and materials science has shown significant interest in the discovery of a new structure with a single-atom-thick sheet of boron called borophene. This theoretically predicted material belongs to a 2-dimensional quasi-planar world exhibits distinctive properties and substantial potential applications. One reason for the limited extent of borophene studies is because of the complexity of its synthetic routes involving either the delamination of bulk compounds or a bottom-up approach with a restricted yield caused by rich bonding configurations among the B atoms and its elaborate bulk structure. The objective of this contribution is to investigate the use of biocompatible and environmentally friendly intercalants in the ball mill (specifically, $C_{24}H_{39}NaO_{5}$-sodium cholate as a SC, NaCl-sodium chloride, and $CO(NH_{2})_{2}$-urea) in conjunction with ultrasound assisted liquid phase exfoliation (UA-LPE), leading to the production of a three-layered borophene sample. The characteristics such as particle dimensions, morphology, and organization of obtained material were evaluated. Hence, through this dual-step approach, we offer a scalable, straightforward, and environmentally friendly method for producing a bulk-scale and durable 3-layered borophene sample. This sample can be employed to assess its practical applications, which have been extensively elucidated in theoretical studies.

Keywords: Borophene, Fabriaction, 2D Material, Ball-Milling, Ultrasound Assisted Liquid Phase Exfoliation

ORAL PRESENTATION

Id-852

A Facile One-Pot Synthesis of Ag_2Te Nanoparticles and The Fabrication of Nanocomposites for The Removal of Chromium (VI) In Wastewater

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Abstract. The discharge of heavy metals into wastewater through industrial chemical processes and human activities has become a major issue to both aquatic and human lives [1]. Chromium is one of the heavy metal that is classified as a toxic pollutant that have harmful effects on human's life [2]. Several methods have been applied for the removal of Cr(VI) from wastewater systems. The sol-gel method has been used successfully for the preparation of crystalline PVA-Ag_2Te nanoparticles at room temperature using water as a solvent, PVA as a capping agent, sodium borohydride as a reducing agent, telerium, and silver nitrate as a source of silver. The synthesized PVA-Ag_2Te were then incorporated with chitosan to form the nanocomposites for the removal of Cr(VI) ions from wastewater. A blue shift in the wavelength was observed with an energy band gab between 2.76 eV and 2.82 eV when the PVA was added into the nanoparticles. The XRD patterns of the Ag_2Te projected a pure monoclinic phase whereas TEM images showed agglomerated spherical shaped particles that were improved when the stabilizer was introduced into the nanomaterial with the average particle sized between 8.77 to 9.12 nm. The adsorption process was able to verify that the parameters such as pH, contact time, and initial concentration had a huge impact on water treatment processes.

Keywords: Silver telerium, PVA, chitosan, nanocomposites, chromium (VI) ions, adsorption **Acknowledgment:** The authors would like to acknowledge the Vaal University of Technology and National Research Foundation (TTK13071722088: "Thuthuka Grant Holder") for funding this project.

ORAL PRESENTATION

Id-856

Fabrication of Conductive Coatings Based on Nickel@Silver Core@Shell Nanoparticles by Low-Temperature Sintering Methods

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Abstract. In the last years, the application of inks based on metallic nanoparticles (NPs) in the production of conductive films on flexible substrates as the route of production of flexible printed electronics has attracted much attention [1, 2]. The metallic inks for the fabrication of flexible printed electronics should be able to be sintered at low temperatures to produce highly conductive films on heat-sensitive substrates such as poly(ethylene terephthalate) (PET), poly(ethylene naphthalate) (PEN), and paper. Therefore, to avoid destroying the structure of such materials other alternative techniques of traditional high-temperature sintering methods of manufacturing of conductive flexible circuits and devices are required.

Therefore, our research was focused on the development of new methodologies for preparing printed conductive coatings based on nickel@silver (Ni@Ag) core@shell NPs by using chemical, and radiation-induced low-temperature sintering processes as promising alternatives to thermal sintering. The method of the formation of Ni NPs and their stabilization by the formation of the silver shell to form Ni@Ag NPs was developed. Such nanoparticles with an average size of 220 nm were utilized for the preparation of conductive inks. The applicability of the UV-Vis irradiation and chemical approach for the sintering of the deposited ink composed of Ni@Ag NPs was examined.

As the obtained results suggest, UV-Vis irradiation and chemical sintering are effective methods for obtaining conductive metallic coatings from NPs based inks. The lowest value of resistivity ~24 µΩ·cm was obtained after 90 minutes of irradiation. To the best of our knowledge, this is the first time when coatings composed of Ni@Ag NPs were sintered by UV-Vis irradiation and such low resistivity/high conductivity has been obtained. The calculated values of resistivity of such films after the chemical sintering were similar, about 30 µΩ·cm, to that obtained after the UV-Vis irradiation. The calculated conductivity of such coatings corresponds to 29-30% of that for a bulk nickel. In contrast to thermal sintering, UV-Vis irradiation, and chemical sintering process can be applied for the preparation of electronic tracks on heat-sensitive substrates like papers and plastics. In contrast to thermal sintering, UV-Vis irradiation and chemical sintering method are promising approach for the preparation of electronic tracks on heat-sensitive substrates, like papers and plastics.

Keywords: Core@Shell Nanoparticles, Metallic Ink, Printing Technology, Sintering Methods, Conductive Coatings.

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ORAL PRESENTATION

Id-860

Theranostic Nanocarriers to the Central Nervous System Therapies

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Abstract: Since our population is rapidly aging, prevention and treatment of various neurodegenerative diseases and brain damage being still primarily unresolved problems of contemporary medicine, require new technologies for diagnostics and therapeutics. One of the critical limitations in treating such complex disorders is the inefficient delivery of active substances through the blood-brain barrier (BBB). Most promising actives are poorly water-soluble or even in-soluble substances, which makes them challenging to deliver in water-based systems. Their poor bioavailability in biological fluids, toxicity, low therapeutic concentration, non-targeted delivery, and undesirable side effects result in low effectiveness in the treatment of neuro-disorders. Therefore, novel and effective drug delivery systems that can deliver selected actives to the central nervous system (CNS) are strongly desired.

Our main objective was the development of a new strategy to deliver actives across the blood-brain barrier (BBB) without imposing its normal function by utilizing multilayer theranostic nanocarriers, The polymeric nanocarriers were prepared using nanoemulsion template methods [1]. The method allowed the preparation of multilayer nanocarriers with a liquid core or a solid core. A selected neuroprotective substance e.g. FK506, Cyclosporine, or Carnosic acid was encapsulated into the polymeric nanocarriers. Such drug-loaded nanocarriers were further modified/functionalized for theranostics using the layer-by-layer approach. The multifunctional polyelectrolyte shells composed of poly-L-glutamic acid (PGA) and poly L-lysine or Gadolinium-labeled poly L-lysine (PLL-Gd), or Rhodamine-labeled poly-L-lysine (PLL-Rod) and PEGylated-PGA. The average size of obtained theranostic nanocarriers was 150 200 nm. Imaging properties of the developed nanocarriers were confirmed by MRI and spectrofluorimetry, whereas their biocompatibility and neuroprotective action of encapsulated neuroprotectant were evaluated using cell viability and toxicity assays in the SH-SY5Y human neuroblastoma cell line. The ability to cross BBB was confirmed in vitro model of a barrier with hCMEC/D3 cells The developed neuroprotectant-loaded theranostic nanosystems may be considered promising platforms for central nervous system (CNS) therapies.

Keywords: Theranostic, Nanocarriers, Multilayer, MRI, BBB, CNS.

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ORAL PRESENTATION

Id-909

Functionalization of the NiTi Shape Memory Alloy Surface by Innovative Hybrid Coatings

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Abstract: The aim of this study was to develop a surface modification for the NiTi shape memory alloy, ensuring its long-term viability in implant medicine. This objective was realized through the creation of innovative multifunctional hybrid layers, incorporating a nanometric molecular system of silver-rutile (Ag-TiO_2) renowned for its antibacterial properties, along with bioactive submicro- and nanosized hydroxyapatite (HAp). The production of multifunctional, continuous, and crack-free coatings was achieved using the electrophoretic deposition method (EPD) at 40V/3min and 20V/1 min for Ag-TiO_2 and Ag-TiO_2-HAp coatings, respectively.

Structural and morphological analyses, employing Raman spectrometry and scanning electron microscopy (SEM), provided comprehensive insights into the resulting coatings. The silver within the layers existed in the form of nanometric silver carbonates (Ag_2CO_3) and metallic nano silver. With the heat treatment temperature set at 800°C for 2 hours, based on DTA/TG results, dilatometric measurements, and high-temperature microscopy, a new generation of materials with a different structure compared to the initial nanopowders was created.

Investigations into the impact of heat treatment on structural changes within the layers revealed details. For the Ag-TiO_2 coating, the outermost layer primarily comprised rutile particles, while the interlayer featured compacted Ag, Ag_xO, non-stoichiometric titanium oxide Ti_yO_{1-2} particles, and a TiAg-related interphase. Crystallization of a new phase, grain growth, and the development of a rough, thin film between the agglomerates were observed. Particles with core-shell structures of carbon-layered silver were identified in both layers, resulting in a reduction in the thickness of the outer layer, ranging from approximately 1.2 to 2.2 μm.

In the case of Ag-TiO_2-HAp coatings, the composite layer, measuring 2 μm in thickness, comprised hydroxyapatite (HAp), apatite carbonate (CHAp), metallic silver, silver oxides, Ag@C, and rutile with a

defective structure. This unique structural characteristic significantly contributes to its heightened activity, impacting both bioactivity and biocompatibility properties.

Notably, the produced layers exhibited no cracks and showed no signs of delamination. The findings affirm the feasibility of creating a highly reactive layer on the NiTi alloy, holding potential significance in implantation medicine.

Keywords: Silver-Rutile Ag-TiO_2 Nanocomposite, Hydroxyapatite (HAp), Surface Modification.

Acknowledgement: This research was funded by the National Science Center in Poland (NCN), grant number 2020/39/D/ST5/01531.

ORAL PRESENTATION

Id-910

Phase Transformation in Ag-TiO2 Nanocomposites

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Abstract: Exploration of nanomaterials with distinctive properties for potential applications in regenerative medicine continues to be a focus of researchers. Titanium oxides, among the commonly employed nanomaterials for surface modification of metalic implants, have emerged prominently. Their growing significance as implant coatings stems from their ability to facilitate tissue integration and cell adhesion, pivotal for successful implantation. Moreover, the titanium oxide surfaces allow for modifications with elements like silver, renowned for its antibacterial properties. Application of nanomaterials in the surface modification of metallic implants often necessitates advanced surface engineering methods, involving treatment at elevated temperatures. Consequently, it becomes imperative to comprehensively characterize the structural changes, morphology, and properties of the coat-forming materials under such conditions.

In this work, chemically synthesized Ag-TiO_2 (silver-anatase and silver-rutile) nanocomposites were tested at elevated temperatures. HT-XRD was used to characterize phase transformations within the nanocomposites, particularly focusing on the titanium oxide phase transformations, and alterations in the unit cell parameters of individual phases. HT-Raman spectroscopy provided insights into the molecular and structural composition of the Ag-TiO_2 nanocomposites, allowing for a detailed characterization of their surface. These findings were then correlated with thermogravimetry measurements. To characterize the functional properties of the nanocomposites, it was crucial to determine their sintering temperature and dimensional changes during heating. Research utilizing a high-temperature microscope and dilatometry revealed that the maximum annealing temperature should not exceed 800°C to preserve the desired properties of the nanocomposites. This comprehensive analysis contributes valuable insights into the behavior of Ag-TiO_2 nanocomposites under elevated temperatures, offering a foundation for their potential applications.

Keywords: Ag-TiO_2, Sintering, High Temperature Phase Transformations

Acknowledgement: This research was funded by the National Science Center in Poland (NCN), grant number 2020/39/D/ST5/01531.

POSTER PRESENTATION

Id-848

Synthesis and Study Of Carboranyl-Containing α-Hydrindones and Their Immobilization on Iron Oxide Nanoparticles for Boron Neutron Capture Therapy

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Abstract: Boron neutron capture therapy (BNCT) is at the stage of active research and has great potential in the treatment of various types of cancer. This therapy is based on the use of drugs with the necessary number of boron isotope atoms ^{10}B, which can selectively accumulate in cancer cells. When neutrons are irradiated with boron atoms, a nuclear reaction occurs with the release of energy, which leads to the destruction of a cancer cell without affecting healthy tissue [1]. Currently, research is underway to develop new methods for delivering boron atoms to the tumor, including the use of magnetic nanoparticles or other carriers. Magnetic nanoparticles have high surface activity and can be functionalized for specific targeting of tumor cells. In addition, they can be controlled during the experiment using an external magnetic field, which makes it easy to control the delivery and concentration of the drug.

The aim of this study is the synthesis of carboranyl-containing derivatives of α-hydrindone and the immobilization of these substances onto Fe_3O_4 magnetic nanoparticles. Then, the cytotoxicity of the obtained products was determined in the MTT test and their biological activity was studied in tumor and normal tissues of mice.

The following substances were obtained during the synthesis: 2,3-(phenyl)-4-(isopropyl-*o*-carboranyl)hydrindone, potassium and sodium salts 2,3-(phenyl)-4-(isopropyl-*o*-carboranyl)hydrindone, 2,3-(phenyl)-4-(isopropyl-*o*-carboranyl)cyclopentylidene-morpholine, 2,3-(phenyl)-4-(isopropyl-*o*-carboranyl)cyclopentylidene-butylamine, 2,3-(phenyl)-4-(isopropyl-*o*-carboranyl)cyclopentylidene-methylamine, 2,3-(phenyl)-4-(isopropyl-*o*-carboranyl)cyclopentylidene-cyclohexylamine.

The results of the analysis showed that the above compounds demonstrate selective accumulation in tumor cells such as A549, HepG2 and MCF7, compared with normal fibroblasts of the EFM line. In tumors of Ehrlich's carcinoma vaccinated in mice, a high concentration of these compounds exceeding 30 mgk/g was recorded. In this regard, synthesized carboranyl-containing derivatives of α-hydrindone are potential antitumor drugs that can be used in boron neutron capture therapy of cancer.

Fe_3O_4 nanoparticles, the average size of which was 27 nm according to SEM data, were functionalized with silane, and then a polyelectrolyte layer was formed for further immobilization of carboranyl-containing α-hydrindones. Thus, modified Fe_3O_4 nanoparticles were obtained, the average size of which is 33 nm in accordance with SEM, and the hydrodynamic radius is 110 nm (DLS). The effect of cytotoxicity was evaluated on various cell lines: BxPC-3, PC-3 MCF-7, HepG2 and L929, human skin fibroblasts. It follows from the conducted studies that the obtained nanoparticles are most toxic to pancreatic cancer cells BxPC3 (IC50 22.23 micrograms/ml) [2].

Thus, the results obtained indicate that the carboranyl-containing α-hydrindones and modified Fe_3O_4 nanoparticles synthesized in the framework of this study are promising drugs for BNCT.

Keywords: Boron Neutron Capture Therapy; A-Hydrindones; Fe_3O_4 Nanoparticles; Synthesis; Drug Delivery.

POSTER PRESENTATION

Id-849

Magnetite Functionalized Nigella Sativa Seeds for The Uptake of Chromium(VI) and Lead(II) Ions from Synthetic Wastewater

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Abstract: The aim of the present study was to utilize pristine and magnetite-sucrose functionalized Nigella Sativa seeds as the adsorbents for the uptake of chromium(VI) and lead(II) ions from synthetic wastewater. Prestine Nigella Sativa seeds were labelled (PNS) and magnetite-sucrose functionalized Nigella Sativa seeds (FNS). The PNS and FNS composites were characterized by Fourier-transform infrared spectroscopy (FTIR), and X-ray powder diffraction (XRD). The FTIR analysis of both adsorbents revealed the presence of vibrations assigned to 1749 and 1739 cm-1 (-C=O) for ketonic group for both adsorbents. The amide (-NH) peak was observed at 1533 and 1527 cm-1 on FNS and PNS composites respectively whilst the carboxyl group (-COOH) were observed at 1408 cm-1 on both adsorbents. The XRD results of FNS and PNS composites showed a combination of spinel structure and y-Fe2O3 phase confirming the formation of iron oxide. The influence of operational conditions such as initial concentration, temperature, pH and contact time were determined in batch adsorption system. The kinetic data of Cr(VI) and Pb(II) ions on both adsorbents was described by pseudo-first order (PFO) model which suggested physisorption process. The sorption rate of Cr(VI) ions was quicker, it attained equilibrium in 20 min and the rate of Pb(II) ions was slow in 90 min. Freundlich isotherm described the mechanism of Pb(II) ions adsorption on PNS and FNS composites. Langmuir best fitted the uptake of Cr(VI) ions on PNS and FNS. The results for both adsorbents showed that the removal uptake of Pb(II) ions increased when the initial concentration was increased however, Cr(VI) uptake decreased when the initial concentration increased. The adsorption of Cr(VI) and Pb(II) ions on both adsorbents increased with temperature.

Keywords: Sorption, Sucrose, Nigella Sativa, Batch adsorption, Composite.

POSTER PRESENTATION

Id-850

Hemp Seed Nanoparticle Composites for Removing Lead, Methylene Blue, And Ibuprofen from an Aqueous Solution and Their Antimicrobial Towards Escherichia Coli and Staphylococcus Aureus

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Abstract: The WHO considers lead (Pb(II)), methylene blue (MB) and ibuprofen (IBU) as priority pollutants. At the same time, pathogenic Escherichia coli (E. coli) and Staphylococcus aureus (S. aureus) in contaminated water, kills millions of people annually. Removing these pollutants from water are necessary for human health and environmental concerns. This study aimed to use nanocomposites of hemp seeds as green adsorbents for multi-applications in water treatment and as anti-microbial agents. Binary nanoparticles (MnO/CuO and MnO/ZnO) were deposited on the surface of hemp seeds (HS). The composites were characterized by SEM, EDX, XRD, FTIR, TEM and BET. Isotherm studies indicated that the Freundlich model best described the adsorption based on heterogeneous surfaces involved in multilayer adsorption uptake and formation. The highest adsorption capacities were obtained with HS-MnO/CuO with, uptakes of 66.58, 68.95 and 21.50 mg/g for Pb(II), MB and IBU respectively. The contact time effect revealed that the process had two phases; phase 1, a rapid adsorption rate and phase 2, a slow increment due to the saturation of the active sites as contact time progressed. ΔHo values were (<40 kJ/mol) suggesting that the adsorption was controlled by physisorption which include π-π, electrostatic interactions and dipole-dipole (Van der Waals) forces. Furthermore, the ΔHo values were positive for Pb(II) and MB and negative for IBU. The adsorption trends for Pb(II) and MB increased with temperature increases while that of IBU decreased, indicating that the adsorption was endothermic for Pb(II) and MB and exothermic for IBU. The agar well diffusion showed that HS-MnO/CuO and HS-MnO/ZnO inhibited the growth if E. coli and S. aureus. The minimum inhibition concentration (MIC) values of HS-MnO/ZnO showed effectiveness at 6.25 and 1.56 µg/mL for both E. coli and S. aureus. The hemp-based composites were more effective than a commercial antibiotic (neomycin) which showed effectiveness at 12.5 and 6.25 µg/mL for E. coli and S. aureus.

Keywords: Adsorption; Lead; Methylene Blue; Ibuprofen; Escherichia Coli; Staphylococcus Aureus

POSTER PRESENTATION

Id-859

Influence of Microwave-Assisted Synthesis Temperature on the Formation and Properties of Hydroxyapatite

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Abstract: Hydroxyapatite (HAp) is a major component of mammalian hard tissues and natural phosphate mineral rocks. In recent decades, hydroxyapatite has attracted the attention of the scientific community due to its unique properties such as biocompatibility, hydrophilicity, functional groups, acidity, alkalinity, porosity, etc. Although, hydroxyapatite is highly investigated material, many of its properties and their dependency on the synthesis conditions are still not fully understood. For this reason, this work focuses on the influence of microwave assisted synthesis on the formation and properties of hydroxyapatite.

In this work, the influence of microwave-assisted synthesis temperature on the crystallization of hydroxyapatite was investigated. The mixtures of $CaCO_3$, $(NH_4)_2PO_4$, and H_2O, in which the molar ratio of calcium and phosphorus corresponded to hydroxyapatite was used for the synthesis. The synthesis was performed in a Monowave 300 (Anton Paar) microwave reactor for 2 h in a temperature range of 25–200 °C. Raw materials and synthesis products were characterised by X-ray fluorescence, X-ray diffraction, IR spectrum molecular absorption, nitrogen adsorption-desorption, and simultaneous thermal analysis methods.

In the first stage of the research, the possibility of hydroxyapatite formation in $CaCO_3$, $(NH_4)_2HPO_4$, and H_2O system was investigated. It was determined that hydroxyapatite formed at 100 °C and to remained stable under all experimental conditions. The intensity of diffraction peaks characteristic to hydroxyapatite increased while those of carbonate decreased by increasing the temperature of synthesis up to 180 °C. Further increment of synthesis temperature was not affected the amount of mentioned compounds. Also, it was observed that the duration of isothermal treatment at 180 °C did not have effect on the formation of hydroxyapatite. However, the temperature of synthesis strongly affects the properties of hydroxyapatite.

Keywords: Microwave, Synthesis, Hydroxyapatite.

POSTER PRESENTATION

Id-862

Fe_3O_4@Sio_2@ Zr(OH) Nanocomposite for the Removal of Pb^{2+} And Cd^{2+} Ions from Aqueous Solution

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Abstract: Superparamagnetic iron oxide nanoparticles are promising materials in emerging pollutants remediation due to their biocompatibility and easy surface modification. However, challenges of oxidation, agglomeration and surface defects impair their application. In this study, magnetic nanoparticles were synthesized via the co-precipitation method and coated with silica through the Stober route then followed by zirconium deposition onto MNP@SiO_2 to form MNP@SiO_2@Zr(OH). The synthesized materials were characterized using XRD, SEM, TEM, BET surface area, XPS and FTIR spectroscopy. Batch adsorption experiment for the removal of Pb^{2+} and Cd^{2+} such as effect of solution pH, adsorbent dose and initial concentration were examined. The particle we observed to be spherical in shape with particle sizes of be 11.76 and 9.15 nm for MNP@SiO_2 and MNP@SiO_2@Zr(OH), respectively. FTIR and XPS showed functional groups of magnetite and confirm the silica coating and the deposition of zirconium. Both adsorbents exhibited type IV adsorption isotherm with H3 type hysteresis loop. The optimum pH was found to be 6 with equilibrium time of 30 minutes for both materials and the adsorption kinetics suited pseudo second order model equilibrium data fitted Langmuir isotherm. Zirconium deposition onto MNP@SiO_2 enhance the adsorption capacity for the removal of Pb^{2+} and Cd^{2+}ions from aqueous solution due to the presence of a large hydroxyls group that can easily chelate with water and attract lead ions in aqueous solution.

Keyword: Magnetite, Nanoparticles, co-precipitation, Kinetics, Equilibrium studies

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POSTER PRESENTATION

Id-865

Study of Kesterite Cu_2ZnSnS_4 Nanopowder Oxidation by TGA/DTA/MS Measurements in the Flowing Oxygen Plus Argon (1:4 Vol.) Gas Mixture

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Abstract: Thermogravimetry (TGA) and differential thermal analysis (DTA) coupled with mass spectroscopy (MS) offer an opportunity to examine the susceptibility of semiconductor kesterite Cu_2ZnSnS_4 (potential photovoltaic applications) to oxidation at increased temperatures in the gas atmosphere containing oxygen. This aspect of kesterite behavior is essential from the point of view of its chemical robustness in the synthesis, storage, and application stages. The study included a pool of kesterite nanopowders made *via* the "wet" mechanochemically assisted synthesis method from different precursor systems [1]. The kesterite-type nanopowders consisted of both the as-prepared cubic polytypes (tentatively called prekesterites) and the thermally annealed at 500 ºC tetragonal polytypes (kesterites), only the latter showing semiconductor properties. The prekesterite nanopowders were found by TGA in the atmosphere of flowing argon/oxygen = 4/1 vol. mixture to exhibit initially a mass decrease up to *ca.* 450-500 ºC followed by a pronounced mass increase at 600-700 ºC, and a final mass decrease levelling up above 880-900 ºC at the 78-82 wt% of the initial mass. The mass decrease in the first stage was thought to originate mainly from both the loss of adsorbed water vapor and water of crystallization in the initially present oxidation by-products of hydrated metal sulfates, the loss of SO_3 from the thermally decomposed metal sulfates, and the loss of some contaminant carbon *via* CO_2 formation. The latter was an artefact of some contaminant carbon from the "wet" synthesis stage (use of xylene). The mass increase was associated with a strong exothermic effect shown by DTA, which could be reasonably correlated with the transient oxidation of sulfur S to $-SO_4$ groups and of Cu(+1) in kesterite to Cu(+2) in oxidation products (formally $Cu_2O+O_2 \rightarrow 2CuO$). The final mass decrease at the highest temperatures above 700 ºC was associated with the evolution of sulfur oxides, mainly SO_2, from the decomposition of the earlier formed metal sulfates. The annealed kesterite nanopowders showed similar TGA/DTA/MS traces but the respective temperature ranges were higher by a few to several tens of ºC supporting lower reactivity to oxidation compared to the related as-prepared prekesterites.

Keywords: Nanocrystalline Kesterite Semiconductor, Photovoltaics, Oxidation, Thermogravimetry, Differential Thermal Analysis, Mass Spectroscopy.

Acknowledgement: Study was funded by Polish NCN Grant No. 2020/37/B/ST5/00151.

POSTER PRESENTATION

Id-866

TGA/DTA/MS Insight Into Decomposition of Semiconductor Kesterite Cu_2ZnSnS_4 Nanopowders Prepared via Mechanochemically-Assisted Synthesis Method from In-Situ Made Zn/Sn Copper Alloys

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Abstract: A new mechanochemically-assisted synthesis route to the kesterite Cu_2ZnSnS_4 nanopowders *via* copper alloys was recently developed in our group [1]. The raw nanopowder from the synthesis is a cubic polytype (tentatively called prekesterite) that upon annealing at 500 ºC in a neutral gas atmosphere is converted to the tetragonal polytype (kesterite), only the latter showing semiconductor properties. Thermogravimetry (TGA)/differential thermal analysis (DTA) under argon up to 1000 ºC, which is combined with mass spectroscopy (MS), are used to analyze a potential evolution of such oxygen-containing gases as water vapor H_2O, carbon dioxide CO_2, and sulfur oxides SO_2/SO_3. Some of these compounds can be linked to the kesterite nanopowder vulnerability to oxidation when adventitiously exposed to ambient air. The TGA/DTA/MS data for the as-prepared prekesterite support a sample mass decrease of some 15 wt% up to *ca.* 500 ºC followed by slower mass changes of several wt% up to 800 ºC, and ending at 1000 ºC with mass drop down to *ca.* 70 wt% of the intial mass. The mass changes for the annealed kesterite are qualitatively very similar but significantly smaller, *i.e*., some 7 wt% to 500 ºC, 2 wt% up to 800 ºC, and 80 wt% remaining at the final temperature of 1000 ºC. This is consistent with the higher robustness of the better-crystallized tetragonal kesterite *vs.* the related cubic prekesterite. Mass spectroscopy for both nanopowders confirms the evolution of H_2O (adsorbed and from decomposition of hydrated metal sulfates), CO_2 (oxidation of carbon remnants from synthesis, possibly, by evolving SO_3 according to $C + 2SO_3 \rightarrow CO_2 + 2SO_2$), and SO_2/SO_3 (decomposition of metal sulfates and carbon post-reaction gases). The study, supported also by XRD and FT-IR spectroscopy, is consistent with a significant reactivity of both kesterite polytype nanopowders in ambient air resulting in the formation of the hydrated metal sulfates. It also provides the compound's range of thermal stability at *ca.* 500-700 ºC.

Keywords: Nanocrystalline Kesterite Semiconductor, Photovoltaics, Chemical And Thermal Stability, Thermogravimetry, Differential Thermal Analysis, Mass Spectroscopy.

Acknowledgement: Study was funded by Polish NCN Grant No. 2020/37/B/ST5/00151.

POSTER PRESENTATION

Id-882

Studies of Porous Carbons Based on Orange Peel

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Abstract: Currently, the topic of waste-free technology is very relevant. The use of agricultural by-products such as banana peels, orange and tangerine peels, potato and rice husks, papaya wood, corn leaves, tea leaves powder, lalang (imperata cylindrical extract) leaf powder in various fields has primarily economic and environmental advantages. Every year, tons of orange, banana and potato peels are thrown away and thrown into the garbage as useless materials and it is very important and necessary to find a use for these wastes as waste management is now becoming a very serious environmental issue. These wastes are inexpensive, non-hazardous and environmentally friendly biomaterials that can be used as adsorbents in the treatment of heavy metals from wastewater and for energy storage.

To conduct the experiment, oranges were purchased from the market of Almaty (Kazakhstan). The outer shell of the products was washed with distilled water to remove dirt, the orange peel was first dried at room temperature for 3-5 days, then dried in an oven until constant weight. The dried materials were ground using a mortar and pestle to a powdery state. The resulting powder was activated and then carbonized. The crushed orange sample was soaked in excess of 0.3 M KOH for 2 hours at room temperature. Activated samples were washed with distilled water until pH = 7. The samples were then filtered and air dried. To obtain activated carbon, samples from orange peel were carbonized at a temperature of 800 ºC for 1 hour in an inert environment.

After chemical activation, the carbon material has the following parameters: specific surface area - 819.76 m^2/g, specific pore volume 0.351 cm^3/g.

The resulting activated carbon was successfully used in water purification from heavy metals such as Pb^{2+} and Zn^{2+} with extraction rates up to 99.96% and 99.83%, and adsorption capacity up to 9.98 mg/g and 9.99 mg/g. The high specific surface area, combined with low cost and environmental friendliness, expands the use of orange peel in the field of water purification from heavy metals, as well as for the creation of electrodes (anode and cathode) for supercapacitors.

Keywords: Waste, Porous, Carbon, Orange Peel, Adsorption.

Acknowledgements: The authors acknowledge the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No AP19677415 Obtaining nanocomposites from food waste and creating electrode materials based on them for supercapacitors).

POSTER PRESENTATION

Id-885

Innovative Multilayer Holographic Labels with Integrated Passive Uhf Rfid Technology and Temperature Sensing As Anti-Counterfeiting Elements

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Abstract. Counterfeiting poses a significant and evolving challenge across global markets, transcending various industries such as pharmaceuticals, electronics, fashion, and automotive sectors [1]. The proliferation of counterfeit goods not only inflicts substantial economic losses on legitimate businesses but also jeopardizes public health and safety [2]. Counterfeit products, ranging from substandard medications to imitation electronic components, can have severe consequences, including compromised efficacy, safety hazards, and potential life-threatening outcomes [3].

In response to the escalating threat of counterfeiting, the state of the art in anti-counterfeiting technologies has seen a constant evolution. Traditional methods, such as holograms and security labels, have been augmented with cutting-edge technologies to create more robust and sophisticated solutions. The integration of radio frequency identification (RFID) technology has been a notable advancement [4], enabling real-time tracking and authentication of products throughout the supply chain.

The primary focus is on the integration of anti-counterfeit labels that utilize a combination of passive ultra-high frequency (UHF) radio frequency identification (RFID) technology and temperature sensors. The overarching goal is to establish a comprehensive solution that enables real-time authentication and verification of storage conditions throughout the entire supply chain.

The main idea lies in the integration of sophisticated anti-counterfeit labels featuring a multilayer holographic design. This design, utilizing a thin film of zinc sulphide, sets itself apart from conventional metallized film substrates, serving as an effective deterrent against counterfeiting when applied to product surfaces or packaging. Our approach involves the incorporation of anti-counterfeit labels featuring passive ultra-high frequency (UHF) radio frequency identification (RFID) technology, coupled with a temperature sensor. This comprehensive solution facilitates real-time authentication and verification of storage conditions throughout the supply chain. In this research, we unveil an innovative technology for crafting a multilayer holographic label with elevated security measures and refined optical properties. Notably, the label is crafted on a thin film of zinc sulphide, creating a semi-transparent holographic film distinct from traditional metallized film substrates used for diffractive optical elements. Applicable to product surfaces or packaging, this label serves as a robust deterrent against counterfeiting.

The developed multi-layer structure integrates various components, including an attractive holographic background, intricate nanotext elements, dynamic holographic features, and a seamlessly integrated passive UHF RFID antenna. Moreover, the RFID assembly incorporates an embedded temperature sensor synergistically integrated with the antenna structure. Leveraging the unique properties of the semi-transparent holographic film, the RFID antenna proficiently transmits electromagnetic signals through the tag, significantly expanding its range. The convergence of holographic security features, passive UHF RFID technology, and integrated temperature sensing marks a remarkable advancement in anti-counterfeiting measures, contributing to enhanced product authenticity and quality assurance. The harmonious integration of these elements within the multi-layer label structure epitomizes a seamless blend of security, functionality, and real-time monitoring. Consequently, this innovative solution holds the promise of bolstering consumer protection and fortifying supply chain integrity across diverse industries.

Keywords: anti-counterfeiting, holographic labels, RFID Technology, temperature sensor, nanotext elements.

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POSTER PRESENTATION

Id-891

On The Mechanism of Self-Oscillations of Current in Semiconductor Resonant Tunneling Nanostructures

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Abstract: The negative differential conductivity (NDC) region in the I-V characteristics of semiconductor quantum well (QW) resonant tunneling structures indicates the current instability in a thin applied voltage range where extremely interesting and surprising phenomena emerge. The self-oscillations of current in a MHz frequency range were detected in the III-V semiconductor weakly-coupled superlattices (SLs) [1] and double-barrier resonant tunneling diodes (DBRTDs) [2] biased in the NDC region. The current hysteresis caused by the carrier trapping in miniband states is present in the NDC region of the I-V characteristics of these QW nanostructures. The terahertz (THz) optical signal modulated with self-oscillation frequency was detected with a superconducting bolometer from these QW nanostructures biased into self-oscillation regime. The electroluminescence (EL) spectra of a 30-period GaAs/AlGaAs (28/10 nm) SL demonstrate two intensive photon emission lines at 12 and 18 THz corresponding to the intersubband energy spacing of E_5-E_4 ~50 meV and E_6-E_5 ~70 meV, respectively. Each EL line is accompanied by sidebands on a distance of about 1 THz (of 4 meV) from the EL line maximum. It was proposed that the sideband emergence is caused by cyclic dynamics of miniband level energy. That is, during a period of self-oscillations of current the miniband level energy is shifted-up and -down due to the cyclic process of carrier capture and release in the QW.

The proposed mechanism has been confirmed by measurements of the optical response from a GaAs/AlAs (2/4/2.3 nm) DBRTD biased within the current hysteresis region of the I-V characteristic. The pulsed two-photon coherent emission (of 1 THz) was detected from a DBRTD biased into self-oscillation regime [2]. In the applied voltage range (less than 1 V) the electron tunneling is occurred through the lowest miniband level in the QW. The two-photon pulsed THz emission in a period of self-oscillations of current directly showed that the first THz pulse is triggered due to the inelastic scattering of tunneling electron energy by miniband states, shifting-up the miniband level to higher energy value. The second pulse is triggered when the miniband states are emptied, getting back the miniband level to its stable state in the QW. Therefore, the THz photon emission from the semiconductor resonant tunneling nanostructures occurs due the cyclic process of charging and discharging of the QW.

Keywords: Semiconductors, Resonant Tunneling, Self-Oscillations Of Current, Terahertz Photon Emission.

POSTER PRESENTATION

Id-894

Temperature-Dependent Phase Evolution in FePtNbB Nano-Composite Alloys

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Abstract: A quaternary Fe-Pt-Nb-B alloy has been fabricated by melt spinning method with the purpose or formation of crystallographically coherent multiple magnetic phases, emerging from the same metastable precursor, as well as to investigate the phase interactions and the influence on their coupling on magnetic performances. For this purpose extended structural and magnetic investigations were undertaken by making use of X-ray diffraction, transmission electron microscopy, ^{57}Fe Mössbauer spectroscopy as well as magnetic measurements using SQUID magnetometry. It was documented that there are intermediate metastable phases forming during primary crystallization, in intermediate stages of annealing and growth-dominated mode is encountered for the secondary crystallization stage, upon annealing at 700°C and 800°C where fcc Fe3Pt and fct Fe2B polycrystalline are formed. The Mössbauer investigations have documented rigorously the hyperfine parameters of each of the observed phases. The fcc A1 FePt phase was shown to exhibit a peculiar para to ferromagnetic transition, and this transition has been proven to occur gradually between 300K and 77K. The magnetic measurements allowed us to identify the annealing at 700°C as optimal for obtaining good magnetic features and coercivity has been proven to fit well within the random anisotropy model. These results show good perspectives for use in applications where the magnetic state must be tuned to be either para- or ferromagnetic at certain operating temperatures.

Keywords: Magnetic Multiphase Materials, ^{57}Fe Mössbauer Spectroscopy, Melt Spun Ribbons.

POSTER PRESENTATION

Id-906

Mapping Nanometer Deformation of an Impinging Droplet on a Soft Substrate by Interferometric Nanostrain Sensor

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Abstract: We developed a novel shear & pressure stress field measurement technique utilizing a blanket of micro-scale thin film mirror integrated with a digital holographic microscopic interferometry (DHMI), capable of mapping 2D nanometer scale (~1.8nm) substrate deformation induced by normal and shear stresses over a large flat or curved surface. In this work, we engaged the above-mentioned sensor to investigate the impingement process of droplets on soft substrate surface, including deformation that consists of a dimple due to Laplace pressure and a wetting ridge formed by surface tension. There has been an extensive effort to investigate interaction of droplets with soft substrate; however, non-equilibrium soft wetting is less understood, particularly the wetting process upon the initial contact of droplet with the substrate. Three different stages were investigated: (A) initial droplet impingement onto the surface, (B) formation, and (C) breaking of the liquid bridge. In Stage A, repeating 'stick-growth, and slip-shrink' phenomena were observed, in which both the dimple and ridge height increased during contact line sticking and decreased during contact line slipping. In Stage B, a steady decrease for both the dimple and ridge height is observed when the liquid bridge is formed. Finally, bridge breaking brought a large oscillation in the surface deformation that persisted for approximately 40ms, representing capillary wave interactions with the soft substrate.

Keywords: Nanometer Deformation, Shear & Pressure Sensor, Interaction Of Droplets, Non-Equilibrium Soft Wetting With Soft Substrate,

POSTER PRESENTATION

Id-911

Effectiveness of Surface- Structure of Acrylic Acid-Grafted Pine-Magnetite Bio-Nanocomposites in the Removal Of Methylene Blue

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Abstract: This work systematically probes the surface structure-property relationship of acrylic acid-grafted pine-magnetite bionanocomposites and its effect on the adsorption of cationic dyes from water using methylene blue (MB) as a model pollutant. The work further investigates the effect of coupling pinecone dust with magnetite nanoparticles and further grafting of pine magnetite composite (PMC) with acrylic acid on the adsorptive mechanism of the resultant bionanocomposites as well as its stability under reuse. The pine magnetite (PMC) and acrylic acid grafted pine magnetite composite (GAA) were probed for structural morphology and surface properties using various surface characterization instrumental techniques. Strong chemical interactions between pinecone magnetite and acrylic acid were demonstrated for these unique bionanocomposites. Subtle differences in size were found, i.e. smaller particle sizes (Ave = 13.0 nm) for GAA and slightly larger for PMC (Ave = 14.0 nm) while larger surface area, pore volume and pore diameter (59.9 $m^2.g^{-1}$, 0.2254 $cm^3.g^{-1}$ and 28.14) were found for GAA compared to PMC. Grafting acrylic acid was shown by XPS to form polyacrylic acid on the surface of the bionanocomposites and thus capping the surface groups. These characteristics coupled with the point of zero charge for GAA (pH_{pzc} = 6.8) were critical in enhancing the efficiency of GAA adsorption of MB at pH 12 and further enable GAA to have a higher desorption efficiency of up to 99.7% after four cycles of washing with HCl. The adsorption kinetics and isotherm studies indicated that the adsorption process follows pseudo second order kinetics and Langmuir isotherm. The adsorbent also showed improvement in the adsorption capacity and reusability promising to be used for removal of dyes in an industrial scale. GAA and MB mechanism was confirmed by intra particle diffusion. The overall performance of the GAA bionanocomposites is hinged on the formation of polyacrylic acid on the surface, its structural morphology, and the enhanced surface properties. The plant-based materials (lignin and cellulose) provide an environment rich with surface groups for the attachment of the magnetite nanoparticles while the polyacrylic acid stabilizes the magnetite onto the pinecone nanoparticles while reducing point-of-zero charge for increased adsorption of cationic species.

Keywords: Bio-Nanocomposites, Acrylic Acid, Grafting, Pinecone, Magnetite

POSTER PRESENTATION

Id-912

Comparative Electrochemical Properties of Polyaniline/Carbon Quantum Dots Nanocomposites Modified Screen-Printed Carbon and Gold Electrodes

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Abstract. In this study, carbon quantum dots (Cdots) synthesized from a pencil graphite precursor using a bottom-up method were incorporated into polyaniline (PANI) to form Cdots-PANI nanocomposite. Cdots, PANI and Cdots-PANI nanocomposites were characterized using the Fourier-Transform infrared spectroscopy (FT-IR), UV-visible spectroscopy (UV-vis), X-ray diffraction (XRD) spectroscopy, scanning electron microscopy (SEM), and transmission electron microscopy (TEM). Electrochemical characterization of Cdots, PANI and Cdots-PANI nanocomposites was done with screen-printed carbon electrodes (SPCE) and screen-printed gold electrodes (SPAuE) modified with the nanomaterials and the nanocomposites. The electrochemical properties of the as-synthesized nanomaterials and the nanocomposite were investigated with cyclic voltammetry (CV) in 10 mM $K_3[\mathrm{Fe(CN)}_6]$ solution using the bare screen-printed electrodes and the modified electrodes. The modified electrodes gave higher anodic peak current (Ipa) responses in the redox probe than the bare electrodes. The SPCE-Cdots-PANI nanocomposite modified electrode exhibited better redox potentials, faster electron transfer kinetics, larger surface area, and greater stability than the bare electrodes and the other modified electrodes. The outstanding electrochemical properties of SPCE-Cdots/PANI underscores its potentials as a sensitive electrochemical sensor for a wide range of analytes.

Keywords: Carbon Quantum Dots, Polyaniline, Cyclic Voltammetry, Screen-Printed Electrode.

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POSTER PRESENTATION

Id-913

Fabrication of Polymer Nanocomposites with Tunable Mechanical and Functional Properties via Stereolithography

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Abstract: Stereolithography, as a type of additive manufacturing processes, enables the fabrication of products in complicated and tailored shapes with customizable properties and provides a novel approach for material design and engineering. While the relatively limited availability of commercial resins delays the wider use of the technology, incorporation of nanoparticles into the resins has recently been adapted as a common strategy to enhance the mechanical and functional properties obtainable at the end of the process. In this study, nanocomposites of acrylic based photopolymers with silver nanoparticles were fabricated via stereolithography. The starting resin formulations contained varying amounts of silver nitrate, ranging from 0.1 to 3%, which were then converted into metallic silver nanoparticles by the UV irradiation used for cross-linking reaction of the photo-active resin during the printing process. Experiments were conducted to assess the effects of the addition of silver nitrate on the curing reactions and mechanical characteristics of the specimens. The optical properties of the formulations and printed specimens were evaluated using UV-visible spectroscopy. Tensile and bending tests were conducted to comprehend the dependency of mechanical properties on the silver nitrate addition. Scanning electron microscope was employed to examine the fractured surfaces of the nanocomposite specimens, providing insights into their fracture mechanisms. This study demonstrated the feasibility of stereolithographic 3D printing of composite specimens containing silver nanoparticles. The incorporation of silver nitrate was observed to affect the curing reactions and properties of the printed specimens. The nanocomposite specimens containing silver nanoparticles displayed antibacterial properties.

Keywords: Stereolithography, Nanocomposite, Silver Nanoparticles

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POSTER PRESENTATION

Id-915

Development of Multilayer Magnetic Thin Film Sensor Structures by Magnetron Sputtering

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Abstract: The use of flexible and transparent (light-permeable) polymer substrates instead of Silicon substrates, which are widely used in magnetic sensors to be prepared within this study. The reason for this is that polymer substrates have been used in many academic and industrial applications in recent years. Polyethylene Terephthalate (PET) structures are one of the most notable among the flexible polymer substrates that have been widely used. The widespread use of these structures in flexible and organic electronic studies has paved the way for them to come to life in many industrial applications. In this study, we worked on cleaning process of different PET substrates. After that, we coated Platinium at 10W to each other (all of their thickess are about 10 nm) in Ultra High Vacuum by Magnetron Sputtering Deposition Techniques. Finally, we did magnetic characterizations as angular dependent by MOKE (Magneto-Optical Kerr Effect) at room temperature.

Keywords: Thin Films, Magnetic Material, Magnetic Sensor.

POSTER PRESENTATION

Id-916

Covalent Functionalization of Laser Induced Graphene Sheets for Biosensor Applications

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Abstract: In our study, LIG was synthesized by lasing commercially available PI (Kapton Polyimide Film) with a Universal Laser Systems XLS10MWH laser platform. And then, to increase the activity of surface carboxyl groups, LIG was immersed in a mixture of 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide hydrochloride (EDC)+ N-succinimide (NHS) in phosphate-buffered saline (PBS) at room temperature. The LIG surface was only cleaned with ethanol and deionized water, respectively. Scanning Electron Microscopy equipped with Bruker energy dispersive X-ray spectrometer (SEM/EDS - Philips XL 30 SFEG) was used for microstructure characterization of LIG. X-ray diffraction (XRD - Japan Rigaku D-max RINT 2200 X-ray diffractometer with Cu-Kα radiation) was used to analyze the crystal structure of LIG. X-ray photoelectron spectroscopy (XPS - Phoibos 100, SPECS GmbH) measurements were employed to examine the chemical composition of LIG and to demonstrate the successful carboxyl functionalities on LIG surface.

Keywords: Laser Induced Graphene, EDC, NHS, XPS

ALL SUBMISSIONS & TOPICS

Topic	Submission
1 - 2d/Graphene	842 - Borophene As Bifunctional Electrocatalyst For Electrochemical Water Decomposition (Her/Oer) 845 - Bulk Scale Fabrication Of Few-Layered Borophene - A Combined Strategy
2 - Nanomedicine	841 - Emerging Strategies In Bone Regeneration: From Scaffold To Tissue Regeneration 848 - Synthesis And Study Of Carboranyl-Containing A-Hydrindones And Their Immobilization On Iron Oxide Nanoparticles For Boron Neutron Capture Therapy 853 - Multifunctionalized Porous Silica-Based Nanomaterials For Protection Of Health
4 - Nanocatalysis	843 - Observing Nanostructures And Reactants During Catalysis By Correlative Surface Microscopy
5 - Nanocomposites	849 - Magnetite Functionalized Nigella Sativa Seeds For The Uptake Of Chromium(Vi) And Lead(Ii) Ions From Synthetic Wastewater 850 - Hemp Seed Nanoparticle Composites For Removing Lead, Methylene Blue, And Ibuprofen From An Aqueous Solution And Their Antimicrobial Towards Escherichia Coli And Staphylococcus Aureus 852 - A Facile One-Pot Synthesis Of Ag2te Nanoparticles And The Fabrication Of Nanocomposites For The Removal Of Chromium (Vi) In Wastewater 881 - Biomass-Derived Activated Carbons For Electrochemical Electrodes 882 - Studies Of Porous Carbons Based On Orange Peel

	909 - Functionalization Of The Niti Shape Memory Alloy Surface By Innovative Hybrid Coatings (Oral) 910 - Phase Transformation In Ag-Tio2 Nanocomposites 911 - Effectiveness Of Surface- Structure Of Acrylic Acid-Grafted Pine-Magnetite Bionanocomposites In The Removal 912 - Comparative Electrochemical Properties Of Polyaniline/Carbon Quantum Dots Nanocomposites Modified Screen-Printed Carbon And Gold Electrodes 913 - Fabrication Of Polymer Nanocomposites With Tunable Mechanical And Functional Properties Via Stereolithography
7 - Nanoparticles	862 - Fe3o4@Sio2@ Zr(Oh) Nanocomposite For The Removal Of Pb2+ And Cd2+ Ions From Aqueous Solution. 898 - Electrochemical Engineering Tio2 Nanomaterials For Renewable Energy 906 - Mapping Nanometer Deformation Of An Impinging Droplet On A Soft Substrate By Interferometric Nanostrain Sensor
9 - Nanoelectronics	893 - Magnetic Nanolayered Systems With Thz Emission Properties
12 - Functional Nanomater	856 - Fabrication Of Conductive Coatings Based On Nickel@Silver Core@Shell Nanoparticles By Low-Temperature Sintering Methods 859 - Influence Of Microwave-Assisted Synthesis Temperature On The Formation And Properties Of Hydroxyapatite 865 - Study Of Kesterite Cu2znsns4 Nanopowder Oxidation By Tga/Dta/Ms Measurements In The Flowing Oxygen Plus Argon (1:4 Vol.) Gas Mixture 866 - Tga/Dta/Ms Insight Into Decomposition Of Semiconductor Kesterite Cu2znsns4 Nanopowders Prepared Via Mechanochemically-Assisted Synthesis Method From In-Situ Made Zn/Sn Copper Alloys 894 - Thermally Activated Phase Evolution In Feptnbb Nano-Composite Alloys

29 - Optical Lithograrpy	885 - Innovative Multilayer Holographic Labels With Integrated Passive Uhf Rfid Technology And Temperature Sensing As Anti-Counterfeiting Elements
48 - Spectroscopic Method	915 - Development Of Multilayer Magnetic Thin Film Sensor Structures By Magnetron Sputtering