Book of Abstracts
NANOMACH 2023

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International Conference on, Nanomaterials, Nanofabrication and Nanocharacterization (NANOMACH 2023)

Oludeniz - Turkey

April 13-19, 2023

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PLENARY SPEAKERS

ID-806

Magnetoplasmonic Nanodomes as a Novel Structure for Biomedical Applications

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Abstract- Advanced nanobiomedical applications have been traditionally based on chemically synthesized inorganic nanoparticles. Here we present a novel type of structure especially suited for diverse biomedical uses: magnetoplasmonic nanodomes. The nanodomes are composed of a combined, magnetic and plasmonic, hemispherical shell deposited onto 100 nm diameter polymer or dielectric beads. The variation of the materials and their thicknesses in the shell enables tuning both the optic and magnetic properties of the nanostructures. The very high plasmonic absorption of the nanodomes in the near infrared is used for very efficient local optical heating, i.e., photo-hyperthermia for cancer treatment. The nanodomes magnetic character allows to remotely manipulate them to easily regulate the level of photo-hyperthermia. Moreover, given their asymmetric shape they exhibit strong optic and magnetic anisotropies. Thus, the rotation of the nanodomes using alternating magnetic fields can easily tracked optically using their different absorption depending on the orientation. Since the rotation of the nanoparticles depends strongly on the viscosity of the medium, which in turn depends on the temperature, the optical tracking of the rotation can be used to accurately determine the local temperature around the nanodomes, i.e., nanothermometry. Combining the nanodomes efficient photo-hyperthermia with their nanothermometry capabilities, allows in-situ tracking the efficiency of photo-hyperthermia treatments. Moreover, the same nanodome concept can be extended to confer the beads with drug-loading capabilities, where the shell allows for remote controlled drug delivery, magnetic accumulation, or MRI tacking of the beads.

Keywords: nanoparticles, magnetoplasmonics, theranostics

INVITED SPEAKERS

ID-791

Rice Husk Derived Synthetic Zeolites and Nanocomposites: Synthesis and Characterization

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Abstract- Synthetic porous silica (RHS) powder with approximately 96-99% purity was extracted from rice husk (RH) by an acid treatment procedure using HCl to increase the yield and purity. The RHS was used as a silica source and converted to a sodium silicate solution using a 2M NaOH, while NaAlO2 was applied as an alumina source for the synthesis of zeolite. The reaction was performed hydrothermally in a stainless-steel autoclave reactor at 175^{o}C for 8 hours to produce a zeolitic phase of Analcime. Following that the zeolite was impregnated with 2wt.% silver nanoparticles (Ag NPs) via ion exchange and reduction reactions using $AgNO_3$ and $NaBH_4$. The synthesized zeolite and nanocomposite derived from RHS, referred to as RHZ and RHZ-Ag, were characterized by X-ray diffraction (XRD) and X-Ray fluorescence (XRF) spectroscopy, which confirmed the success of the synthesis and formation of phases. Images from scanning electron microscopy (SEM) and transmission electron microscopy (TEM) of RHZ and RHZ-Ag displayed spherical-like particles composed of polycrystal particles with acceptable size distribution. The particle size distribution of RHZ and RHS-Ag from a laser diffraction particle size analyzer was in the micrometer range, while the nitrogen adsorption indicated a high surface area and volume with a microporous structure.

Keywords: rice husk ash, zeolite, nanocomposite, silver nanopartcile, analcime

INVITED SPEAKERS

ID-822

Magnetic Semiconductor Nanocrystals based on Oxide Compounds

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Abstract- At present magnetic semiconductor nanocrystals became one of the most intensively studied materials due to the high practical significance. I will focus on ZnO and ZrO_2 due to the their extraordinary physicochemical properties and wide range of applications. Much interest in these semiconductor oxides results mainly from their unique properties: wide band-gap, good optoelectronic properties, non-toxicity and biocompatibility. To increase the applicability of ZnO and ZrO_2 the doping with TM is used. Inorganic magnetic nanomaterials are important due to a number of potential practical applications in many fields, for example: biotechnology, medical diagnostics, addressed drug delivery, cancer treatment, high density data storage, magnetic sensors. The magnetic properties of magnetic nanoparticles differ from the properties of their bulk counterparts and are mainly determined by size effects and surface effects. In particular, as a size effect, one can expect to observe the superparamagnetism. The superparamagnetic particles are of great interest due to the applications in biomedicine, e.g., magnetic hyperthermia. I will discuss recent results of magnetic and structural studies of nanocrystalline ZnO and ZrO_2 doped with: Mn, Fe, Co, Ni in addition to the technological issues, different methods and conditions of wet chemical synthesis. I will show that the magnetic properties of nanoscopic semiconductor oxides depend strongly on the method and conditions of sample preparation. Various magnetic properties are observed: paramagnetic, ferrimagnetic, superparamagnetic, spin glass-like. It is necessary to correlate magnetic studies with accurate structural investigations to determine the origin of the observed magnetic properties and to get to know the nature of magnetic interactions in these compounds. It will be demonstrated that the solubility of TM in nanoscopic oxides: ZnO and ZrO_2, obtained by chemical synthesis methods, is limited. It will be shown that a very extensive characterization is required to understand the magnetic properties of nanoscopic semiconductive oxides. Going outside the classical characterization methods: the use of the micro-Raman method and the Mössbauer spectroscopy method, as well as the performance of dynamic magnetic measurements, allows to determine the origin of magnetic properties. An important element of the research is the application of the technique of dynamic magnetic measurements, which allows distinguishing superparamagnetic behavior from the behavior of the spin-glass type.

Keywords: magnetic oxide semiconductors, ZnO nanoparticles, ZrO_2 nanoparticles

INVITED SPEAKERS

ID-825

First Principles Studies 2D Mo(S,Te)2 Alloys Adsorbed on Sapphire and Graphite, and Sandwiched between Graphene Layers, and 2D (AL,Sc)N Alloys on Sapphire

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Abstract- First principles studies, were performed for a 2D, three atom thick monolayer of the Transition Metal Dichalcogenide (TMD) alloy Mo(S,Te)2: adsorbed on an Al-terminated (0001)-sapphire surface; sandwiched between two layers of graphene; and adsorbed on a graphite substrate. Bulk composition dependent binding energies band-gaps, and partial phase diagrams, were calculated, using the cluster expansion method. Although the 3D-Mo(S,Te)2 alloy system has a phase diagram that is dominated by S-rich:Te-rich phase separation, the 2D-system adsorbed on sapphire, or graphite, or sandwiched between two layers of graphene is predicted to exhibit S:Te-ordering. The sandwiched system appears to exhibit continuous (2'nd order) transitions to the disordered state at T~600K. The adsorbed systems appear to exhibit low-T (T<400K) transitions to that may be 1'st or 2'nd-order, plus extended 2-level order-disorder up to T~1000K. The 2-level ordering occurs because of the symmetry reduction imposed by the substrate vs. vacuum, whereas in the sandwich there is a mirror plane through the Mo-atoms. These results indicate that synthesis on a sapphire substrate or graphite is favorable for band-gap engineering, in which a continuous single phase solid solution allows continuous band-gap tuning, as a function of bulk composition. Whereas, bulk TMD-synthesis followed by exfoliation favors the formation of two-phase mixtures. The 2D-(Al,Sc)N-alloy was studied in bulk, and as a 2D-alloy on Al-terminated sapphire. Both half-unit cell (2-atoms thick) and unit cell (4-atoms-thick) 2D-alloys were considered. As for the TMD-systems, phase separation is predicted for bulk systems, but ordering is predicted for adsorbed 2D-alloys. These results suggest that improved ferroelectric properties can be achieved in 2D-(Al,Sc)N-alloys that are adsorbed on sapphire, relative to bulk solid solutions.

Keywords: 2D-alloys, TMD, Mo(S,Te)2, (Al,Sc)N, order/disorder, ferroelectricity

INVITED SPEAKERS

ID-831

Predicting the Gas Permeability and Selectivity of Mixed-matrix Membranes

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Abstract- Recent years have seen a tremendous development in the development of mixed-matrix membranes (MMMs) for gas separation. A typical MMM consists of a polymer matrix in which nanoparticles are integrated in order to modify its properties. Many studies have investigated the use of nanoparticles embedded in polymeric membranes and have examined their impact on the permeation properties in addition to other properties such as hydrophilicity, fouling resistance, chemical stability, mechanical strength and antibacterial effect. There exists an increasing number of nanoparticles that are used in MMMs: quantum dots, metalloids and metal oxide-based nanoparticles, metallic organic frameworks (MOFs), carbon-based nanomaterials (activated carbon, fullerenes, carbon nanotubes and graphene oxides), montmorillonite nanoclay, etc. This presentation will focus on the use of permeable and impermeable nanoparticles to modulate the permeability of a permeating gas across thin mixed-matrix membranes under ideal conditions. Results, obtained by solving numerically by finite differences the Fick's second law of diffusion or via Monte Carlo simulations, will examine the impact of the permeability and the solubility of the nanoparticle fillers on the effective permeability of MMMs. The effective gas permeability, obtained under ideal conditions, can be used to diagnose the reasons for the departure from the expected trends frequently observed in the literature. In addition, the membrane selectivity can be estimated for the permeation of gas mixtures through MMMs.

Keywords: mixed-matrix membranes, gas permeation, nanoparticle fillers, permeability, selectivity

INVITED SPEAKERS

ID-832

Nanofluids: The State of the Art and Future Outlook

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Abstract- Efficient thermal management has been a critical aspect of the operations of multi-component systems of any size, from miniaturized chips to nuclear reactors. Solar cells, for example, do not like the excess heat, which is referred to as parasitic conduction, resulting in decrease of the quality factor and efficiency of energy conversion. Improvement of thermal management/cooling efficiency has long been an engineering problem, which has been approached from revising flow geometries, integrating extended surfaces, optimizing flow conditions, to name a few. Although those approaches work, working fluid characteristics is another dimension to be upgraded. Classical working fluids have in fact been upgraded to nanofluids by dispersing nanoparticles in them, to exhibit tunable thermophysical properties including thermal conductivity, viscosity, absorptivity, to name a few. After nanofluids were named in 1995 by Choi and Eastman due to their pioneering work at Argonne National Laboratories (USA), there have been numerous works/ researches on these new class of working fluids due to their enhanced thermal conductivities, heat transfer coefficients, and overall system efficiencies. More recently, the gains (mostly the thermal aspects) in the presence of nanofluids have been questioned mainly in the framework of operating costs (mostly the hydrodynamic aspects), switching costs (by replacement of the current heat transfer fluids with nanofluids) and handling challenges (temporal instabilities, difficulties in the control of phases), among other application-specific issues. While the nanofluids heat transfer literature has still been inconclusive about the future projection of nanofluids as replacements of pure fluids, these materials also hold potential in areas that do not relate to heat transfer procedures such as in microfluidics (where fluids are confined into microscale flow channels) and biomedical applications (antibacterial/ antimicrobial properties, drug delivery), among others. In this talk, the state-of-the art of nanofluids heat transfer (targeted to convective heat transfer systems) will be given. Main conclusions about the system performance of nanofluids as reported by lab-scale researches will be put forward, and possible reasons of discrepancies/ disagreements between theoretical and experimental assessments will be outlined. Nanofluids heat transfer discussion will be accompanied by a review of the recent efforts on drop-on-demand microfluidics with nanofluids as nanoparticle-rich media, which is among the areas where nanofluids use is not particularly hindered by the challenges stated above. These discussions will be followed by an overview of patents and utility models on nanofluids, to reflect their scalability state in the commercialization path. In conclusion, this talk aims to present both the advantages of nanofluids along with the blocks in front of them

to their scaled-up use, as well as share and discuss the points to strengthen for efficient and application-targeted uses of the nanofluids know-how developed so far.

Keywords: nanofluids, nanomaterials, energy, microfluidics.

INVITED SPEAKERS

ID-839

Emerging Strategies in Bone Regeneration

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Abstract- The overall objective of the current work is to improve health in society by introducing unique approaches to bone regenerative medicine that not only improve implementation of existing cell / bone substitute therapy for the serious complication of non-union bone fractures, but provide holistic transition from conventional regenerative medicine to integrative, personalized regenerative medicine. We aim 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 provided by a grant of the Ministry of National Education, Executive Unit for the Financing of Higher Education, Research, Development and Innovation (UEFISCDI), project number PCE 103/2022.

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

REGULAR SESSIONS

ID-800

Antimicrobial Nanocellulose-based Porous Microparticles as an Alternative to Toxic Nano-biocides

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Abstract- With the growing awareness of bacterial and viral infections, antimicrobial materials have become increasingly important in many areas of application. We have developed a novel cellulose based microporous particles, that exhibits an effective (against a broad spectrum of bacteria and fungal species) and long lasting antimicrobial properties. As such they can serve as an alternative to nano-biocides such as metal (e.g. silver) oxides and other engineered nanomaterials which are limited by their toxicity for human and environment. The microparticles are made from cellulose nanofibrils that are surface functionalized in a way to form a micro-sized network structure that can catch bacteria / fungi by multi-targeted (ionic and hydrophobic) non-specific modes of action and prevent them from growing. Such microparticles are robust enough to remain stable during stronger mechanical loading (as e.g. during mixing, extrusion or coating processing etc.), so they can be used as a functional additives to a formulations that can be easy applied to different surfaces, thus given an antibacterial/fungal protection properties to textiles, food packaging materials, composites, filters / membranes, as an examples. As high water stable they can be also applied as scavengers of different harmful molecules (e.g. pesticides, in/organic anions, dyes, pharmaceuticals) from industrial / wastewater / meteoric waters.

The research was funded by Slovenia Research Agency (Project no. L2-7576 and research program P2-0424).

REGULAR SESSIONS

ID-819

Cellulose-based Electrocatalysts for Water Splitting

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Abstract- Major concerns have been raised about the global energy future. The rapid need for more sustainable energy origin has made the researcher look for different, more green resources. Hence, various technologies have been deeply investigated, from which electricity generated from water during water splitting process is expected to displace the widespread use of coal. During the water-splitting two main half-reactions occur on both electrodes: (i) hydrogen evolution reaction (HER) at the cathode and (ii) oxygen evolution reaction (OER) at the anode (HER: $2\ H_2O + 2e^- \rightarrow 2OH^- + H_2$; OER: $2\ H_2O \rightarrow O_2 + 4H^+ + 4e^-$), from which OER is the more energy-consuming step due to the four-electron reaction. This results in OER being the sluggish kinetic step. Therefore, the investigation of electrocatalysts, especially towards OER, is crucial. In this work, cellulose fibers after carbonization and activation processes have been used. Such actions allowed to obtain carbonaceous material with a developed microporous structure, and its specific surface area was up to 3 000 m^2/g. As the prepared platform was subsequently used for the deposition of nickel phosphide nanoparticles. Different nickel phosphides (Ni_xP_y) structures with a variety of x/y ratios and shapes have been investigated. The combination of highly porous material and Ni_xP_y nanoparticles have allowed obtaining highly efficient electrocatalysts. The preparation methods allowed to obtain uniform coverage of Ni_xP_y to carbon platform, which results in improved electrochemical activity. Then, prepared materials have been tested for oxygen evolution reaction (OER). Several tests have been conducted to determine electrochemical activity, such as linear sweep voltammetry (LSV), electrochemical impedance spectroscopy (EIS), Tafel dependency, or stability tests. Also, turnover frequency and electrochemical specific area have been established. Compared to commercial RuO_2 and Pt, which are considered the best electrocatalysts, the prepared materials exhibit similar or even better properties. For example, the overpotential value for NiP_2 has decreased by 40 mV toward OER and Tafel slope value has decreased by ~35%. Considering the easy access to raw materials and their relatively low cost, as well as reduced energy demand during the electrochemical process of water splitting can be concluded that the combination of carbon material and nickel phosphide are a class of considerable electrocatalysts towards HER and OER reaction.

Keywords: electrochemisty, metal phosphide, cellulose

POSTER SESSIONS

ID-799

Structural, Electrical and Optical Properties of Transparent Conductive Oxides Thin films (TCOs) based on Al doped ZnO Nanoparticles for CIGS Solar Cells

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Abstract- The aim of this work is to optimize the thickness from 100 nm to 300 nm and doping ration between 1 at% and 2 at% of Al doped zinc oxide thin films deposit on soda lime glass substrate by sputtering RF-magnetron. The realization and characterization of the TCO based on Al doped ZnO nanoparticles to design a high-performance nanostructured optical window intended for photovoltaic applications generally found in the technology of second generation thin-film solar cells based on Cu (In, Ga) Se2 (CIGS) or amorphous silicon require the choice of a purely experimental approach for the optimization of the protocol for synthesizing the Al doped ZnO nanoparticles and an original experimental protocol to develop nanostructured thin films by RF sputtering from the synthesized nanoparticles. Crystal structure, optoelectronic and morphological properties of thin films were investigated by using XRD, SEM, UV-Vis-NIR. The XRD results showed that the films were polycrystalline textured, preferentially oriented along the (002) crystallographic direction normal to the film surface. The SEM images showed that the films have smooth and uniform surface with small ZnO grains. The crystallite size was found to be 27,5 nm. The films show within the visible wavelength region an optical transmittance of more than 90% and an electrical resistivity of 2×10^{-4} Ω.cm for the optimum. From optical measurements, the band gap energy value varies from 3.3 to 3.5 eV.

Keywords: nanoparticles, sputtering, TCO, thin films, solar cell

POSTER SESSIONS

ID-808

The Influence of SiO_2 Additive on the Mayenite Formation Process and Its Hydration Properties

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Abstract- Mayenite ($C_{12}A_7$) has been recently stimulating research interest because of its superior accelerator effect-rapid hardening activity [1], oxygen mobility, ionic conductivity and catalytic properties in comparison with other calcium aluminates [2, 3]. The application of mayenite depends on the employed method of synthesis and of quantity-intercalated ions. In previous work [4], it was observed, that in unstirred $CaO–Al_2O_3–H_2O$ suspensions, when CaO/Al_2O_3 molar ratio of primary mixture was equal to 2.8, after 4 h of isothermal curing at 130 ºC temperature katoite was formed. It is worth mentioning, that synthetic katoite at 350 °C temperature fully recrystallized to mayenite. Meanwhile, to the best of our knowledge, no data has been published, and it is still completely unknown how intercalated SiO_2 in mayenite structure affect them hydration properties. This work aimed to determine the formation (from synthetic – precursor) and hydration properties of pure mayenite and mayenite with intercalated SiO_2. The synthesis was carried out in unstirred suspensions, when molar ratios of the primary mixtures were $CaO/(Al_2O_3+SiO_2)$ = 2.8, and SiO_2= 0 or 0.25. The solution to solid ratio of the suspension was equal to 10:1. The synthesis was carried out under hydrothermal conditions at 130 °C temperature for 1 h. The calorimeter (TAM Air III) was used to investigate the heat evolution rate of mayenite hydration process. It was determined that, in the pure system after 1 h of isothermal curing at 130 °C, katoite was formed. It was estimated that SiO_2 additive react and enter into the structure of katoite. It was observed that SiO_2 additive had no influence on products (katoite) thermal stability, because in both system, at 350 °C temperature synthetic katoite fully decomposed to mayenite. It was observed that SiO_2 additive slows down the first reaction of mayenite samples because the maximum heat evolution rate decreased from 1.1 W/g (pure mayenite) to 0.04 W/g (mayenite with SiO_2 additive). Also, this additive prolongs the onset of the reaction which begins: after 0.01 h (pure mayenite) and 0.25 h (mayenite with SiO_2 additive). The highest amount of the total heat (after 2 h) was reached with the hydration of pure mayenite sample (~500 J/g), while the mayenite with SiO_2 additive showed lower value ~275 J/g. These results confirmed that the SiO_2 additive has influence on the mayenite hydration properties. The products were characterized using X-ray powder diffraction, simultaneous thermal analysis.
This research was funded by a grant (No. S-MIP-21-4) assigned by the Research Council of Lithuania.

Keywords: mayenite, hydration properties, SiO_2 additive

POSTER SESSIONS

ID-815

Laminar 2D Mordenite and ZSM5 Zeolites

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Abstract- Zeolite catalysts are an important means of improving productivity and quality in industrial chemical processes. Research interest is currently shifting from the preparation and modification of three-dimensional (3D) zeolites to two-dimensional (2D) zeolites. With further study of 2D zeolites, their properties and structure are gradually being elucidated, and they are widely used in catalysis, adsorption, mixture separation, and other industries. Two-dimensional zeolites combine the crystal structures of zeolites with the unique morphology of their lamellar structures, which are formed when the lamellae are pillared to give them structural strength. Such materials with hierarchical bimodal porosity not only increase the rate of diffusion of reaction components, but also provide access to active sites for bulky molecules, and create more active sites for the catalytic reaction system. Two-dimensional nanomaterials consisting of layers with a zeolite structure in two dimensions, and with a single unit cell thickness (~ 2-3 nm) in the third, represent a new type of zeolite material. Extremely thin in one direction crystal sections in 2D zeolites create a large outer surface area (up to 50% of the total surface area compared to ~2% in micron-sized 3D zeolite) and expose most of their active sites on the outer surfaces. It is this feature of their structure that provides favorable effects for the adsorption of bulk molecules and the efficiency of their interaction with these centers during the catalytic reaction. In this study, we report the synthesis of two different zeolite materials (mordenite and MFI) with 2D morphology; they were modified at the stage prior to the final calcination, to ensure the pillaring of nanoparticles of silicon dioxide between the layers. CTAB was used as a mesoporogenic agent; and modifications using the pillaring process were carried out with the diffusion of TEOS into organic layers and its subsequent hydrolysis. The samples were analyzed using various methods such as X-ray diffraction, N2 adsorption-desorption, and transmission electron microscopy (TEM) to find out their structure, textural properties, and morphology. The results showed mesoporous materials with plate spacing d of about 4.3-4.5 nm, better textural properties than conventional bulk zeolites, and a significantly more defined layer structure after the pillar formation process.

Keywords: 2D zeolites, mordenite, ZSM5

POSTER SESSIONS

ID-834

Characterization of Dental Materials and Pathologically Altered Tissues in Their Vicinity

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Abstract- In the present work, an ex vivo study of the mechanical and microgeometrical properties of fillings made of the composite material (light-curing, radiopaque Estelite Flow Quick, Tokuyama dental, Japan) and the glass ionomer cement (Vitremer, 3M ESPE, USA), the enamel surrounding these fillings, dentine in their vicinity (i.e., dentine adjacent to the dentine-enamel junction as close as possible to the fillings), as well as sound dentine and enamel on the opposite medial side of the tooth is carried out to evaluate the efficacy of the application of dental materials. According to a similar scheme, a study was made of the mechanical and microgeometrical properties of enamel modified by the infiltrant (Icon, DMG Chemisch-Pharmazeutische, Germany) and dentine in its vicinity, as well as sound dentine and enamel on the opposite medial side of the tooth (on two samples). Nanoindentation was used to determine the mechanical properties of fillings and tissues, and atomic force microscopy was used to calculate the microgeometrical characteristics. An overview of tooth crowns after sample preparation, marking areas of interest, as well as each measurement of mechanical properties was accompanied by images from optical and scanning electron microscopes. In the experimental procedure the four human molars were extracted from patients for orthodontic indications in the dental department of the Rostov State Medical University clinic, Rostov-on-Don, Russia. The local independent ethical committee of Rostov State Medical University approved the study (extract 14/21 dated September 23, 2021), the patients provided informed consent. A filling made of a composite material was found to be more preferable for use in dentistry than a filling made of glass ionomer cement due to the greater proximity of mechanical proper-ties (for example, Young's modulus and indentation hardness of the latter are more than 10 and 8 times lower, respectively, than for sound enamel, and creep is ~ 1.8 times higher), less likely to lose adhesion at the enamel interface, and contains fewer internal structure artifacts. The mechanical properties of enamel after infiltration were close to those of the sound enamel. Changes in the microgeometrical characteristics of the samples after infiltration indicate that the polymer infiltrant successfully penetrated the tissue. However, more research should be conducted

towards better understanding of the ability of the infiltrant to penetrate into the tissues in different tooth areas.

This work was supported by the Russian Science Foundation grant grant No. 22-19-00732, https://rscf.ru/en/project/22-19-00732/. The research was carried out at the Nanocenter of the Research and Education Center “Materials” of Don State Technical University (https://nano.donstu.ru/).

Keywords: composite filling, glass-ionomer cement, infiltration, nanoindentation, scanning electron microscopy, atomic force microscopy, tooth

POSTER SESSIONS

ID-835

Theoretical and Experimental Study of Nanoindentation of Thin Coatings

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Abstract- Mathematical model of nanoindentation of a coating-substrate system is presented. The model is based on an analytical solution of a contact problem of elasticity theory for a half-space with a functionally graded coating or piecewise homogeneous coating. Young’s modulus and Poisson’s ratio assumed to vary with depth according to arbitrary independent laws. The contact problem is reduced to solution of a singular integral equation which is solved using the approximated analytical method which is effective for coatings of any thickness. Nanoindentation experiments are carried out for a series of coating-substrate systems. Correlation between the theoretical and experimental results are provided. An accuracy of mathematical model is analyzed. This research was supported by the Russian Science Foundation (RSF) through grant no. 19-19-00444.

Keywords: contact, indentation, model, functionally graded materials, coating, analytical method

POSTER SESSIONS

ID-836

Simplified Analytical Solution for Contact Problems on Indentation for a FGM-coated Solid

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Abstract- Contact problems on indentation of a coated elastic solid are considered. The coating is assumed to be layered or continuously inhomogeneous in depth. The problems are considered in a 2D plane or axisymmetric formulations. Different punch geometries are considered. The problems are reduced to solution of dual integral equations. Kernel transforms are approximated by a specially designed functions which make it possible to obtain their approximated analytical solutions. Using a simplified one-parameter approximations these solutions are simplified to a form convenient for engineering calculations. Explicit analytical expressions for a distribution of contact stresses, indentation depth and stiffness are obtained. Accuracy of these expressions are analyzed in dependence on the characteristic geometric parameter of the problems. Numerical results illustrating the features of indentation of coated solids are provided. This research was supported by the Russian Science Foundation (RSF) through grant no. 22-49-08014.

Keywords: contact, indentation, model, functionally graded materials, coating, analytical method

ALL SUBMISSIONS & TOPICS

Topics	Submissions
Nanoparticles/ Nanofibers/ Nanowires/ Nanotubes/ Nanosheets	Id 806 - Magnetoplasmonic Nanodomes As a Novel Structure for Biomedical Applications
Nanocomposites	Id 791 - Rice husk derived synthetic zeolites and nanocomposites: synthesis and characterization
	Id 822 - Magnetic semiconductor nanocrystals based on oxide compounds
	Id 808 - The influence of SiO2 additive on the mayenite formation process and its hydration properties
	Id 835 - Theoretical and experimental study of nanoindentation of thin coatings
	Id 836 - Simplified Analytical Solution for Contact Problems On Indentation For A FGM-Coated Solid
2D Materials including Graphene	Id 815 - Laminar 2D Mordenite and ZSM5 Zeolites
	Id 825 - First Principles Studies 2D Mo(S,Te)2 alloys adsorbed on Sapphire and Graphite, and sandwiched between Graphene layers, and 2D (AL,Sc)N alloys on Sapphire.
Computational Nanotechnology	Id 831 - Predicting the Gas Permeability and Selectivity Of Mixed-Matrix Membranes

Nanofluids	Id 832 - Nanofluids: The State of the Art and Future Outlook
Nanobiotechnology	Id 839 - Emerging Strategies in Bone Regeneration
Functional Nanomaterials	Id 800 - Antimicrobial nanocellulose-based porous microparticles as an alternative to toxic nano-biocides
Nanocatalysis	Id 819 - Cellulose-based Electrocatalysts for Water Splitting
Radio Frequency Sputtering	Id 799 - Structural, Electrical and Optical Properties of Transparent Conductive Oxides Thin films (TCOs) based on Al doped ZnO nanoparticles for CIGS solar cells
Nanomedicine	Id 834 - Characterization of Dental Materials and Pathologically Altered Tissues in Their Vicinity