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S. Ono et al., Res. Rev. J Mat. Sci. 2017, 5:5
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Luminescence of morphologically-controlled calcium silicon nitride particles through combined techniques of ultrasonic spray pyrolysis and carbothermal reduction/nitridation

S. Ono[1], H. Kuwahara[2], H. Kuroe[2] and **K. Itatani[1]**
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The morphologically-controlled preparations of Eu^{2+}-doped calcium silicon nitride ($Ca_{2-x}EuxSi_5N_8$: x = 0.05) particles, i.e., the spherical and columnar particles, were conducted by combined techniques of ultrasonic spray pyrolysis and carbothermal reduction/ nitridation. Relating to the ultrasonic spray pyrolysis, the precursor oxides for $Ca_{2-x}EuxSi_5N_8$ particles were prepared by this technique at 600°C in air, using $Ca(NO_3)_2/Eu(NO_3)_3$ solution (total concentration: 2.86×10^{-2} mol·dm^{-3}) with suspended Si_3N_4 particles. The spray-pyrolyzed powder was further mixed with carbon, and carbothermally reduced in N_2 atmosphere. The spherical and columnar $Ca_{1.95}Eu_{0.05}Si_5N_8$ particles could be prepared by controlling the heating rate and temperature for carbothermal reduction/ nitridation. The spherical $Ca_{1.95}Eu_{0.05}Si_5N_8$ particles could be obtained when the spray-pyrolyzed powder (or precursor oxides) was heated to 1000°C at the rate of 30°C•min^{-1}and then to 1400°C for 2 h at the rate of 10°C•min^{-1}. On the other hand, the columnar $Ca_{1.95}Eu_{0.05}Si_5N_8$ particles could be obtained when the spray-pyrolyzed powder was heated to 1100°C at the rate of 30°C•min^{-1} and then to 1500°C for 2 h at the rate of 10°C•min^{-1}. The morphological control was conducted by the kinds of liquid phases formed during the heating process. The morphological control of $Ca_{1.95}Eu_{0.05}Si_5N_8$ particles could be achieved by the nitridation of spherical and columnar particles formed at 1000°C or 1100°C. The emission peaks of spherical and columnar $Ca_{1.95}Eu_{0.05}Si_5N_8$ particles appeared at 622 nm and 618 nm, respectively, under the excitation at 375 nm. Overall, the spherical and columnar $Ca_{1.95}Eu_{0.05}Si_5N_8$ particles could be formed by controlling the heating rate and temperatures for the carbothermal reduction/nitridation of spray pyrolyzed oxide powders. The spherical and columnar particles emitted the lights with the peak wavelength at 622 and 618 nm under excitation at 375 nm.

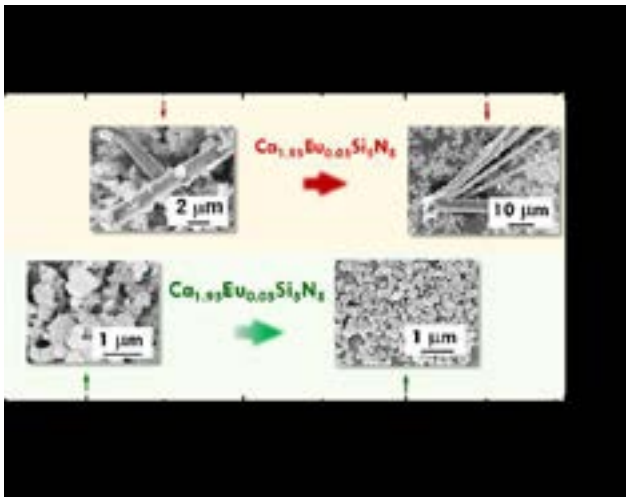

Figure1: *Morphological changes of particles with temperature*

Biography

Satoshi Ono is a student of Sophia graduate school. His research interest is preparation and characterization of Si_3N_4-containing nitride ceramics.

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Notes:

Yeonjeong Noh et al., Res. Rev. J Mat. Sci. 2017, 5:5
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Natural plant-derived polymer fabricated with sugar-containing hydroxyapatite for biocompatible bone-hemostasis

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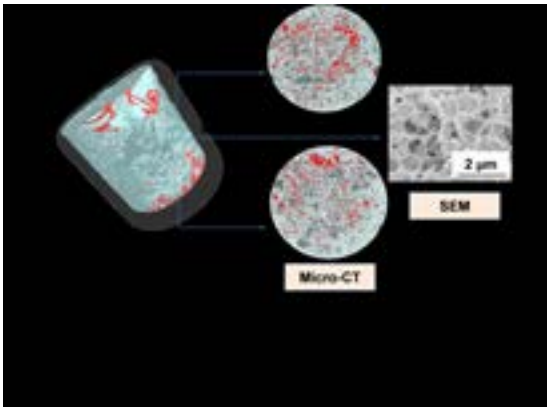
The preparation conditions of bone-hemostasis materials were examined using hydroxyapatite (Ca10(PO4)6(OH)2: HAp) and natural plant-derived polymer(guar gum(GG), locust bean gum(LBG) and sodium alginate(AG)). The starting gel was prepared by dissolving 2 mass% 80LBG-20GG and 2 mass% AG into deionized water heated at 60°C (80LBG-20GG/AG). The resulting gels were vigorously agitated with 20,000 rpm for 3 min. Further, the gel was immersed into 3 mass% phosporyl oligosaccharides of calcium (POs-Ca®50) solution at room temperature for 24 h. Then, the resulting gel was hydrothermally-treated 100°C for 5 h and freeze-dried at -50°C for 24 h to form s-HAp in the material. According to the X-ray diffractometry (XRD), Fourier transform infrared spectrometry (FT-IR) and confirmed by the terahertz spectroscopy, the resulting composite contained hydrolyzed materials of POs-Ca, i.e., the sugar-containing HAp (s-HAp), as well as LBG and GG. According to the micro-computed tomography (micro-CT) and differential thermal analysis and thermogravimetry (DTA-TG), 16.8% of HAp could be homogeneously dispersed within the porous composite material. The pore sizes were approximately 1 to 2 μm determined by scanning electron microscopy (SEM). The present 80LBG-20GG/AG/s-HAp composite showed the noted porosity (81%; the measurement by micro-CT), absorption of simulated body fluid (1426%), adhesive strength (28.1 N) and hemostat time (7.5 h; the measurement by using simulated blood). The composite is also expected to assist the osteogenesis with its s-HAp. Overall, the composite of s-HAp and natural plant-derived polymer seems to be a promising material for the bone hemostasis and regeneration.



Biography

Yeonjeong Noh is a student of Sophia graduate school. Her research interest is the fabrication of bone hemostasis and bone regenerate properties with natural plant-derived polymer fabricated with hydroxyapatite.

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Notes:

N. Akiyama et al., Res. Rev. J Mat. Sci. 2017, 5:5
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Encapsulation of oxynitride phosphors into sintered Li_2O-ZnO-B_2O_3-P_2O_5-CaF_2 glass body

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The conditions for the fabrication of transparent glass body in the Li_2O-ZnO-B_2O_3-P_2O_5-CaF_2 system were examined by a pressureless firing and subsequent oxygen-supplied hot isostatic pressing (O_2-HIP). The starting glass was prepared by melting the mixture of LiOH, ZnO, H_3BO_4, H_3PO_4 and CaF_2 at 1100°C in air, followed by quenching on copper plates cooled by liquid nitrogen. The glass powder compact was pressurelessly-fired at 370°C for 1 h in order to remove the open pores, and the subsequent O_2-HIP treatment at 370 °C for 24 h under the pressure of 130 MPa made the clear light transmission possible, regardless of the formation of $Ca_2P_2O_7$ on the surface. The glass body obtained by firing at 370˚C for 1 h and the subsequent O_2-HIP treatment at 370 °C for 24 h was hydrothermally-treated in water at 100˚C for 1 h, and found that the mass loss of this body was as low as 0.25%, showing excellent water resistance. When the oxynitride phosphors, i.e., blue-emitting $(La_{0.96}Ce_{0.04})_3Si_8O_4N_{11}$ and yellow-emitting $(Ca_{0.97}Eu_{0.03})Si_2O_2N_2$, were encapsulated into the glass, no peak shifts in the emission/excitation spectra were found, which demonstrated that no significant degradation of phosphors has occurred during the encapsulation operation. Pseudo-white light emission was observed by the equi-mass addition (total amount: 3 mass%) of $(La_{0.96}Ce_{0.04})_3Si_8O_4N_{11}$ and $(Ca_{0.97}Eu_{0.03})Si_2O_2N_2$. Overall, the transparent glass body could be fabricated by the pressureless firing and subsequent O_2-HIP treatment, and the phosphors were encapsulated into the glass without significant degradation.

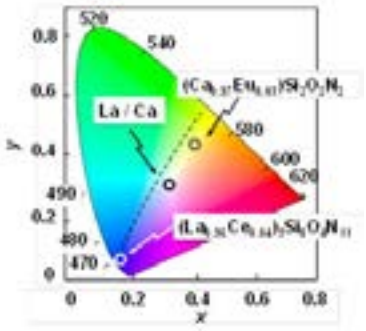

Figure1: *Chromaticity coordinate of glass body with (La0.96Ce0.04)3Si8O4N11 and (Ca0.97Eu0.03) Si2O2N2 addition□Excitation WL□370 nm□*

Biography

Nanako Akiyama is a student of Sophia graduate school. Her research interest is the luminescence properties of oxide, oxynitride and nitride phosphors, and the encapsulation technique of the phosphors in the glass.

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Notes:

Arnas Naujokaitis et al., Res. Rev. J Mat. Sci. 2017, 5:5
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Electrochemical decoration of MoS2 nanoplatelet arrays with Pt quantum dots for high efficient water splitting

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Statement of the Problem: Water splitting via low-cost electrocatalysis is crucial for the development of clean energy from renewable sources.1 However, high cost of the prior Pt and Ir/Ru-based catalysts hinder their wide usage. Consequently, development of cost-effective electrocatalysts recently is of great significance. Currently, molybdenum disulfide (MoS_2) nanoplatelet arrays are extensively investigated as electrocatalysts for hydrogen evolution reaction (HER) in the acidic solutions proceeding preferentially at the exposed edge sites of MoS_2 nanosheets. In fact, MoS_2-based catalysts with increased active for HER sites, as well as doped with Ni and Co atoms, enhance HER efficiency.2 Nevertheless, they still demonstrate the HER efficiencies in times lower than at the surface of bulk Pt. The purpose of this study is to describe our experience of seeking markedly enhance the efficiency of MoS_2 electrocatalysts for HER throughout decoration with numerous Pt quantum dots (QDs). Methodology: Crystalline nanoplatelet-shaped MoS_2 arrays were formed at the surface of various substrates by hydrothermal synthesis. FE-SEM, HR-TEM, EDX analysis and cyclic voltammetry were employed. Findings: We have showed that a significant improvement of HER efficiency at the nanoplatelet MoS_2 substrates can be obtained via a simple decoration with extremely low amount of Pt QDs, ca 6.0 mg/cm^2, deposited both at the nanoplatelet edges and at the basal planes (Figure 1b). To the best of our knowledge, the reported by us decoration approach of MoS_2 nanoplatelets with Pt QDs and Nps3-5 has not been explored for superior improvement of HER efficiency. Conclusion & Significance: This work opens new further opportunities for significant improving the efficiency of HER at nanoplatelet MoS_2 substrates.

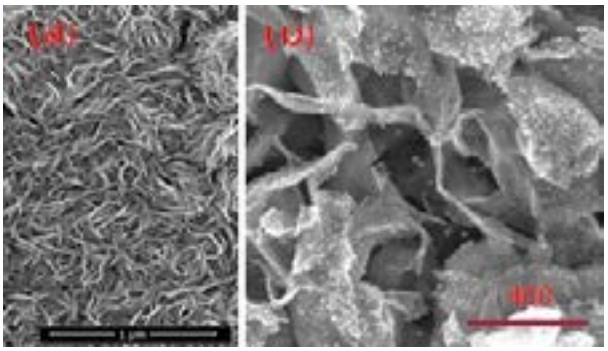

Figure1: *Top-side FESEM images of nanoplatelet MoS2 array before (a) and after (b) electrochemical decoration with plentiful amount of Pt QDs.*

Biography

Arnas Naujokaitis is a PhD student in Vilnius University and also working as junior scientific researcher at The National Centre of Physical and Technological Sciences (NCPTS). He already has decent experience in MoS_2 layers formation and characterization. As a result, there are three publications in this research. Another fields of interest are materials deposition, synthesis and growth techniques, also electron microscopy and material characterization methods.

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Notes:

Entesar Al-Hetlani et al., Res. Rev. J Mat. Sci. 2017, 5:5
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Detachable photocatalysts of anatase TiO_2 nanoparticles: Annulling surface charge for immediate photocatalyst separation

Entesar Al-Hetlani, Mohamed O. Amin and **Metwally Madkour**
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TiO_2 photocatalysis is commonly utilised in diverse applications such as environmental waste management, biomedical and energy fields. The present study demonstrates the effect of temperature on the characteristics of TiO_2 nanopraticles using XRD, XPS, DLS, UV-Vis, N_2 sorpometry and TEM techniques. The optimum surface area of the photocatalyst was obtained when it was prepared at 60 °C. Additionally, the TEM images showed semi-spherical morphology. Afterwards, rapid photodegradation of Rhodamine 6G dye (R6G) with efficiency of 92.5% at pH= 9.17 was accomplished using the optimised nanoparticles. The main focus of this study is to establish a new avenue that can be used to separate the photocatalyst from the reaction medium after the photodegradation experiment is completed. In this study, the photocatalyst was completely detached from the reaction medium in 3 minutes without utilisation of coagulant agents or magnetic nanoparticles. This was lucratively accomplished by adjusting the pH of the medium to match the isoelectric point (pHPZC) of the photocatalyst and annulling its surface charge, hence rapid sedimentation was observed, Figure 1. This new method has proven to be simple, rapid, and applicable to all types of photocatalysts on the industrial scale.

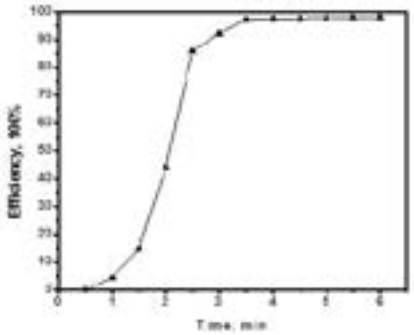

Figure: *The efficiency of TiO_2 sedimentation at pHPZC*

Biography

Entesar Al-Hetlani has obtained her PhD. in analytical chemistry from the University of Hull, UK in 2013. Currently, she is an assistant professor at Kuwait University. Her research interest focuses on nanomaterial synthesis and characterization for analytical applications such as areas of environmental and forensic analysis. In this work, the synthesis, characterization, application and isolation of photonanocatalyst namely, TiO_2 was achieved using a very simple and effective method. This method can subsequently be used to isolate any type of photonanocatalyst from a suspension regardless of the nature of the photonanocatalyst.

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Notes:

H. Murrieta-Sánchez et al., Res. Rev. J Mat. Sci. 2017, 5:5
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Luminescence of Mn^{2+} and Eu^{3+} doped zinc phosphate glass

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We report the photoluminescence (PL) of Mn^{2+} and Eu^{3+} doped zinc phosphate glass as melted. Raman and Energy-Dispersive X-ray Spectroscopy (EDS) were also used to get a better characterization. During the synthesis process the Mn^{2+} ions occupy tetrahedrally coordinated ($IVMn^{2+}$) sites in the glass, but also partially precipitate on octahedral sites ($VIMn^{2+}$) giving rise to the simultaneous green and red luminescence, due to the spin-forbidden 4T1(G)→6A1(S) and 4T1g(G)→6A1g(S) transitions in $IVMn^{2+}$ and $VIMn^{2+}$ respectively. Electron Paramagnetic Resonance (EPR) and lifetime measurements were also used to establish the presence of manganese ions in octahedral/tetrahedral coordination. The absorption transition 6A1(S) →4E(D) of Mn^{2+} centered at 350 nm can produce red luminescence, while the transition 6A1(S)→4A1(G) of Mn^{2+} centered at 409 nm produces a green and red dual luminescence that is dependent on manganese concentration in the glass, being the green luminescence the dominant one. On the other hand the presence of Eu^{3+} produces also a red luminescence around 612nm due to the transition 5D0 →7F2. The manganese and europium ions form next pairs whose interaction gives rise to an increase in the europium red emission and an energy transfer process between both ions.

Biography

Since he was a student his passion has been for Solid State Physics, in particular for magnetic and optical properties of impurity ions in solid materials. He has worked on these themes in several laboratories around the world: Centro Brasileiro de Pesquisas, Río de Janeiro and University of San Carlos, University of San Pablo both in Brazil. MIT, Boston, Mass. USA. Clarendon Laboratories, Oxford, England. Autonomus University of Madrid, Spain. Metropolitan University, México City and his home Universidad Nacional Autonoma de Mexico (UNAM). His work has been mainly on crystals such as LiNbO3, BiGeO, BiSiO, HfO2, Alkali Halides and recently on metaphosphate glasses impurified with a large variety of rare earth and transition metal ions. The results have been used to get knowledge about the structure of several crystal defects. The results have been published in more than 100 papers.

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Xavier Bidault et al., Res. Rev. J Mat. Sci. 2017, 5:5
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Impact of the granularity of a high-explosive material on its shock properties

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Recent experimental studies show that granularity has a substantial impact on the detonation behavior of high-explosive materials: under shock loading, a nanostructured one leads to smaller nanodiamonds than a microstructured one [1]. Moreover, simulations show that a porous energetic material undergoes an extra temperature rise related to the size of the pore/defect [2, 3]. Two aspects of this granularity, the surface energy and the porosity, are explored to investigate these different behaviors. From a model energetic material, the surface energy of nanoparticles with a radius from 2 nm up to 60 nm has been determined by means of Molecular Dynamics simulations using ReaxFF-lg potential [4]. Then, using the Rankine- Hugoniot relations and the equation of states of the corresponding bulk material [5], the contribution of this excess energy to the heating of the shock-compressed, nanostructured and porous material is determined, and compared to the compaction work needed to collapse its porosity. This allows evaluating the balance of these two aspects of granularity to the extra temperature rise under shock loading.

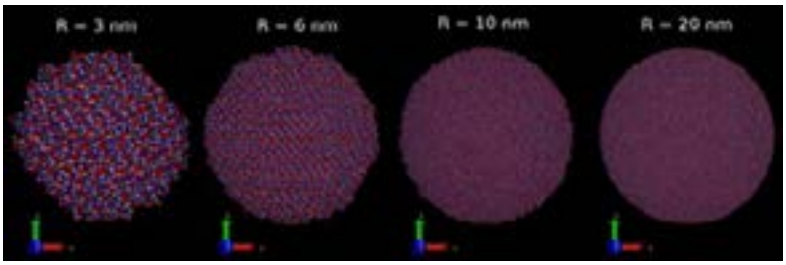

Figure1: Nanoparticles of the model energetic material

Biography

Xavier Bidault has his expertise in modeling and analysis of nanostructured materials by Molecular Dynamics. In order to study nanostructured optical fibers, the simple adaptive model that he developed during his Physics PhD allowed the simulations to reproduce for the first time the separation of phases of complex compositions in silica-based glasses, as experimentally observed. He now enlarges his skills to organic materials to understand how the granularity (surface energy and porosity) of a nanostructured energetic material impacts its reactivity under shock, with a focus on nanodiamond formation.

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Notes:

Ying Cheng et al., Res. Rev. J Mat. Sci. 2017, 5:5
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Green synthesized biocompatible anode in MFCs for sustainable wastewater treatments and energy recycling

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Statement of the Problem: The ever-increasing demand for energy and the growing water shortage are two major challenges all over the world. It is urgent to find environmentally sound methods for energy generation and waste disposal. Microbial fuel cells (MFCs) offer a clean and energy-conservative way for wastewater treatment and energy recycling. The performance of electrodes is the most important aspect in improving the power density and promoting the application of MFCs in large scales. Improving the anode configuration to enhance biocompatibility and accelerate electron shuttling is critical for efficient energy recovery in MFCs. Therefore, we aim to design an easy and eco-friendly synthesis process of nanomaterials for the modification of the electrode, eliminating the generation of hazardous substances while enhancing the productivity of MFC. Methodology: Graphene-based nanocomposite was coated using layer-by-layer assembly technique onto carbon brush anode then green reduced by Eucalyptus leaf extract. Findings: The green synthesized nanocomposite film affords larger surface roughness for microbial colonization. The modified anode achieved a 3.2-fold higher power density of 33.7 W/m^3 at a current density of 54.9 A/m^3 with a 75% shorter start period. Conclusion & Significance: The layer-by-layer structure of green reduced rGO/Au NPs film creates a high bacteria loading capacity, promotes intimate contact between the electricigens and anode surface and facilitates cell-anode interaction. Thereby the charge transfer efficiency in the process of electricity generation and power delivery is elevated. This green approach for designing biocompatible anode provides much potential for high-performance MFCs and efficient energy recovery. Finally, the increment in electrical conductivity and catalytic efficiency of anode guarantees its further applications in MFCs for sewage treatments.

Biography

Ying Cheng has her expertise in environmental remediation by nano-materials and by the biodegradation with microorganism. She developed novel functional nanomaterials by green synthesize with potential application in field remediation of contaminants. Besides, She has isolated several bacteria for the degradation of textile pollutions and organic contaminants. Functional biomaterials based on the immobilization of cells has been used in the removal of both textile pollutions and heavy metals. She aimed to integrate nano-material degradation with biodegradation for environmental remediation and the energy recycling and to understand the scientific issues for bio-nano interface.

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Jana Hlavata et al., Res. Rev. J Mat. Sci. 2017, 5:5
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Fibers made by centrifugal spinning technology

Jana Hlavata and **Eva Kuzelova Kostakova**
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Centrifugal spinning, Forcespinning¬TM or rotary jet spinning, all these names represent relatively new and simple technology that allows production of fibers by using only centrifugal forces. These forces are caused by high-speed rotation of the spinneret unit and are necessary for drawing polymeric jet and fiber formation. Two main ways of centrifugal spinning process depend on type of the spinneret unit. These are needle and needle-less technology. Besides that, it is possible to combine centrifugal forces with electric field to produce fibers by electro-centrifugal method. Fibers could be forming from solutions or melts as well. Centrifugal spinning has several advantages in comparison to electrospinning such as spinnability of liquid form of materials (polymeric solution/melt, ceramic, metal), larger range of spinnable materials (no requirements on conductivity of material) and higher production rate. Fibers are arranged in one direction and gathered on collector. This homogenous fiber layer could be used in many different applications, I.e. in biomedical area, tissue scaffolds, drug delivery systems, filtration, energy industry etc. Materials polycaprolactone (PCL), polyvinyl butyral (PVB), polyamide 6 (PA 6), polyvinyl alcohol (PVA), copolymer of polycaprolactone and lactid acid (PLC), collagen and other have previously been successfully spun. Forcespun fibers generally have wide distribution of their diameters. Big variability in spinning devices, used materials and process conditions lead to production of modified fibers, such as porous fibers, bicomponent fibers and even hybrid and inorganic fibers.

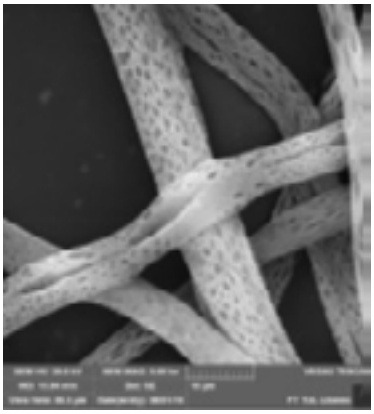

Figure1 *SEM picture of porous fibers made from PCL solution by needle-less way of centrifugal spinning technology. Fibers were produced at Department of Nonwovens and Nanofibrous Materials at Technical University of Liberec. Scale is 10 μm.*

Biography

Jana Hlavata is Ph.D. student at Department of Nonwovens and Nanofibrous Materials, Faculty of Textile Engineering at Technical University of Liberec, Czech Republic. She specializes in centrifugal spinning technology, especially in needle and needle-less way. Materials and modified fibers mentioned above have been successfully spun at two devices assembled at department. These devices are improved and upgrade according to her specifications and requirements. During her internship at University of Alabama at Birmingham she has been dealing with controlled morphology of porous fibers

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Radek Jirkovec et al., Res. Rev. J Mat. Sci. 2017, 5:5
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Preparation of composite scaffolds from micro / nano fibers and biocompatible hydrogels

Radek Jirkovec, Jakub Erben, and **Jiří Chvojka**
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This paper deals with the preparation of composite scaffolds composed of micro / nano fibers and biocompatible hydrogel. An experiment of this work was focused on finding a suitable material that could be suitably applied while enabling cell migration and proliferation. Only natural polymers for hydrogel formation were used for testing due to their biocompatibility, natural biodegradability and biological functions. Five materials were selected for testing: collagen, gelatin, agarose, agar and hyaluronic acid, which were applied to the micro / nano fibrous layer from biocompatible polycaprolactone. In the experiment itself, it was found that all materials could be applied without great difficulty, but subsequent in-vitro testing only enabled the collagen and hyaluronic acid hydrogel to allow cell proliferation and migration to fibrous material.

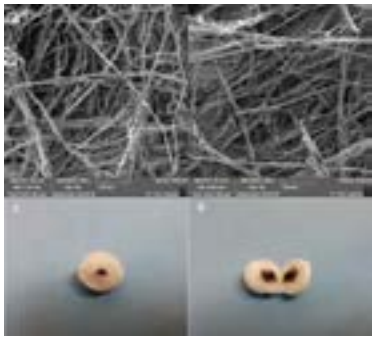

Figure1: *A – B) SEM pictures of micro/ nano fiber layer, C – D) Test of application with colored water to the center of the fiber layer*

Biography

Radek Jirkovec is a Ph.D. student at department of Nonwovens and Nanofibrous Materials at Technical University of Liberec, Czech Republic. His focus is bio-printing, hydrogels, preparation of scaffolds for tissue engineering. He has been working on these topics since his master's thesis and is currently expanding his knowledge of these topics in his dissertation.

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Notes:

Valentina Caba et al., Res. Rev. J Mat. Sci. 2017, 5:5
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Study of electrically conductive water-based polyurethane

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Electrically conductive polymers have shown great potential for several applications in electronic, environmental, and biomedical fields. In particular, polyurethane is used in electromagnetic shields1, in electrodes for capacitive deionization in the desalination process of brackish water4, and in electrodes for electrocardiography2 and electroencephalography monitoring3, and electrostimulation5. Conductive composite materials can be realized as compact (film) or porous (foam) layers, depending on the process. For polyurethane, literature reports different recipes depending on the final material features. This implies the use of a wide range of reagents and additives, and it goes against the tendency of manufacturing companies focusing on the reduction of chemical products and raw materials in their processes. The purpose of this study is the industrial development of electrically conductive water-based polyurethane, suitable both for foam and film casting. In this study, polyether, polyester, and polycarbonate based polyurethane is used and mixed with different cross-linkers and conductive fillers. Five different compounds in similar concentration are compared as cross-linkers. Different loadings of silver based conductive fillers are used. The foam is obtained by mechanical frothing from the mixture of components used for the film. Paper transfer coating process is used to realize both films and foams for testing. Different paper release materials are considered. Surface resistivity is measured by two-point probes method. Results show that the conductivity of the material depends on all the considered variables in different ways. The main contribution is given by the conductive filler loading, with a percolation threshold about 45% wt. The surface resistivity increases about three orders of magnitudes from film to foam. This loss of conductivity can be recovered by increasing the filler loading. The water-based conductive polyurethane prepared in this work, can be successfully realized in porous or compact layers by industrial process manufacturing, with a cost-saving formula using reduced number of components.

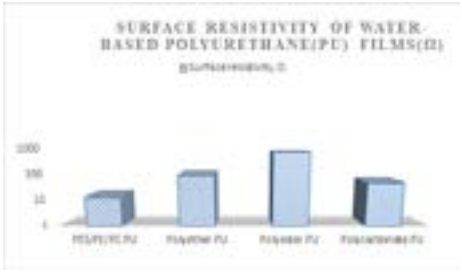

Figure1: *SEM images of the shell/core connection in A) sandwich structured, B) layered composite*

Biography

Valentina Caba has her expertise in waterborne and solventborne polyurethane coating. She has developed this formula of conductive polyurethane after years of experience in research and developing of polymer coating on paper release. The conductive polyurethane formula could be incorporated into the production of the textile coating, which leads to the broadening of synthetic leather application. With her interest in eco-friendly components she is looking for improvement of raw materials quality and the use of chemicals with low or zero volatile organic compounds.

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Notes:

Donata Kuczynska et al., Res. Rev. J Mat. Sci. 2017, 5:5
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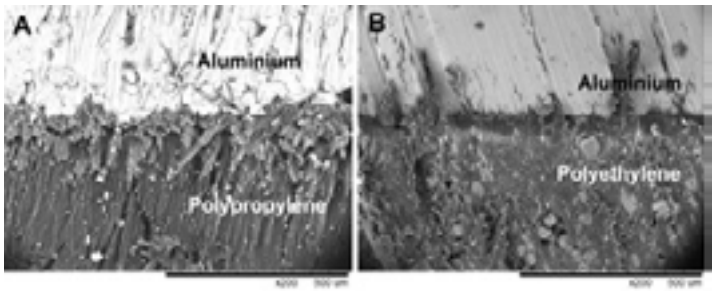
Study of the mechanical and surface properties of the composites commonly used in lightweight constructions

Donata Kuczynska, Agata Sotniczuk, Piotr Kwasniak, Jaroslaw Pura and **Halina Garbacz**
Warsaw University of Technology, Poland

Audiometric screening tests are carried out in lightweight, mobile capsules. In this case, compliance with specific environmental conditions, in particular acoustic, necessitates the selection of suitable sound absorbing materials. The assignment of the materials into the group of sound absorbing materials depends on the value of the absorption coefficient. Sound absorbing materials should have and absorption coefficient α>0,1 in any frequency, what can be achieved for materials characterized by both high porosity or high surface perforation. Materials of this type include, modern layered materials and sandwich structured as "honeycomb" type. In mentioned applications, the mechanical properties of these materials are also important in addition to the sound absorption properties. This study presents systematic comparison between commonly used and commercially available construction composites. Two of analyzed composites, layered and sandwich structured, are typically used as lightweight constructions elements, because of their unique properties and advantageous weight to flexural strength ratio. Both analyzed composites, exhibit high absorption of the sound. The analyzed composites were characterized in terms of mechanical and surface properties. Special emphasis was placed on the characteristic of the connection between composite structural components. For this purpose, the following methods were used: scanning electron microscopy, optical profilometry, contact angle measurements and 3-point bending. Presented systematic analysis will be useful to select appropriate materials for lightweight constructions. The main results if the study can be summarized in the following conclusions. 1) Both composites demonstrate that they are several times more rigid compared to commonly used polymer composites. 2) Comparative analysis revealed many times higher mechanical properties of the sandwich structured panels compared to layered composites. 3) Studies showed that layered composite is characterize by the absence of delimitation of the lightweight panel. The results show high potential of the analyzed composites as lightweight construction materials with simultaneous sound absorption.



Biography

Donata Kuczynska is a PhD student and has her expertise in evaluation of surface properties of the materials, especially in biomaterials. Her main interest is interaction of titanium surface with the plasma proteins (albumin and fibronectin) and cells. She deals with comprehensive characterization of the surface physicochemical properties such as: chemical composition, roughness, topography, wettability and surface free energy. She has experience in surface analysis techniques - AFM Atomic Force Microscopy, Optical Profilmetry, XPS Spectroscopy, Auger AES Spectroscopy and Fourier FTIR Spectroscopy. Currently she is working on laser surface texturing of titanium and its alloys

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Notes:

Marcin R. Zemla et al., Res. Rev. J Mat. Sci. 2017, 5:5
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The study of point defect properties of Fe-Cr alloys: First-principles calculations

Marcin R. Zemla[1], **Jan S. Wrobel**[1], **Tomasz Wejrzanowsk**[1], **Duc Nguyen-Manh**[2] and **Sergei L. Dudarev**[2]
[1]Warsaw University of Technology, Poland
[2]CCFE, Culham Science Centre, United Kingdom

Ferritic Fe-Cr steels are proposed as structural materials in fusion and fission nuclear power plants. To understand radiation damage effects in Fe-Cr alloys, it is necessary to investigate point defect properties, which are dependent on the concentration of Cr, the short-range ordering of alloy and the local environment of a defect. This kind of information, on the atomic level, can be derived from ab initio simulations. Spin-polarized density functional theory calculations are performed by using VASP code, with generalized gradient approximation (GGA) of Perdew-Burke-Ernzerhof (PBE) for exchange-correlation. Representative structures are generated using DFT-based Monte Carlo simulations [1]. The chemical potentials, formation energies and relaxation volumes of defects as well as changes of magnetic moments caused by the presence of point defects are studied as functions of the local environment, the short-range ordering and the concentration of Cr in Fe-Cr alloys.

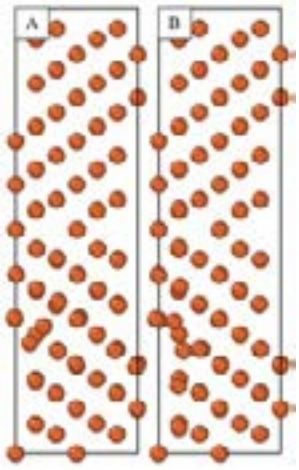

Figure1: *Σ3 GB with SIA Dumbbell on A – [100]; B – [110] direction.*

Biography

Marcin Zemla is a PhD student in Warsaw University of Technology and also MSc student in University of Warsaw. He has his expertise in first-principles calculations based on Density Functional Theory (DFT). He is mainly interested in defects interactions in Fe-Cr alloys, especially grain boundaries interactions. In his research he is using DFT implemented into VASP code. Currently he is studying Fe-Cr point defects into both bulk and grain boundary structures. Nevertheless, he works on it and develops a methodology also in another project, in which he recently published a paper DOI: 10.1039/C7CP03109B.

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Notes:

Agata Sotniczuk et al., Res. Rev. J Mat. Sci. 2017, 5:5
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Materials selection for modern and mobile medical constructions

Agata Sotniczuk, Donata Kuczynska, Piotr Kwasniak and **Halina Garbacz**
Warsaw University of Technology, Poland

Owing to the constant increasing of the number of people suffer hearing disorders, the demand for modern medical devices like mobile audiometric cabins is continues to grow. The opportunity to fold and relocate the cabin would allowed to examine greater number of population in distant places by the same equipment. Nevertheless the necessity of cabin mobility imposes special requirements on its construction The main requirement for constructive materials in case of mobile audiometric cabins is the high mechanical strength related to density which allowed for its mass reduction. Other properties like the high fatigue resistance, the great joining ability and high corrosion resistance in working conditions are also essential. Both titanium and aluminium alloys fulfil this requirements. Thus, the aluminium alloys, which are less expensive and possess better weldability, are the first choice for the mobile medical constructions. The precipitation strengthened 6xxx aluminium alloys have both satisfactory mechanical strength and weldability. The broad availability of semi-finished products made from 6xxx alloys is also a great advantage. Although mechanical properties of semi-products like yield or tensile strength are given in normalized worksheets, manufacturers data do not enclosed their anisotropy. The differences of mechanical properties on particular directions and on the elements thickness are connected with crystallographic and morphologic texture. In this study the homogeneity of the microstructure, texture and mechanical properties anisotropy of selected aluminium profiles with different shapes was investigated. For this purpose following tests were made: phase and texture analysis by XRD, microstructure analysis on different sections (OIM and SEM+EDS), static tensile tests and microhardness measurements. Obtained results are important due to its great influence on the construction mechanics. The elements of supporting structures work in the conditions of compression, shearing or bending. The anisotropy of its mechanical properties can lead to the contrary properties for different load conditions. There are no doubts that such results have to be taken into consideration during designing of the audiometric cabins construction.

Biography

Agata Sotniczuk is currently a PhD student at Faculty of Materials Science and Engineering, Warsaw University of Technology. In her work she focused on corrosion behavior of nanocrystalline metals, especially titanium and aluminium alloys. One of her main interest is the influence of microstructural defects, like dislocations and grain boundaries on the passive layer formation is solutions simulating body fluids. This subject was also a topic of her Master Thesis which was awarded the first price from the Polish Corrosion Society. Her main investigation tools are electrochemical tests (impedance and potentiodynamic) together with electron microscopes (SEM, TEM) for microstructure characterization.

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Notes:

Stanislav Nevyhosteny, Res. Rev. J Mat. Sci. 2017, 5:5
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Hybrid polymer nanofibers

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Owing to the constant increasing of the number of people suffer hearing disorders, the demand for modern medical devices like mobile audiometric cabins is continues to grow. The opportunity to fold and relocate the cabin would allowed to examine greater number of population in distant places by the same equipment. Nevertheless the necessity of cabin mobility imposes special requirements on its construction The main requirement for constructive materials in case of mobile audiometric cabins is the high mechanical strength related to density which allowed for its mass reduction. Other properties like the high fatigue resistance, the great joining ability and high corrosion resistance in working conditions are also essential. Both titanium and aluminium alloys fulfil this requirements. Thus, the aluminium alloys, which are less expensive and possess better weldability, are the first choice for the mobile medical constructions. The precipitation strengthened 6xxx aluminium alloys have both satisfactory mechanical strength and weldability. The broad availability of semi-finished products made from 6xxx alloys is also a great advantage. Although mechanical properties of semi-products like yield or tensile strength are given in normalized worksheets, manufacturers data do not enclosed their anisotropy. The differences of mechanical properties on particular directions and on the elements thickness are connected with crystallographic and morphologic texture. In this study the homogeneity of the microstructure, texture and mechanical properties anisotropy of selected aluminium profiles with different shapes was investigated. For this purpose following tests were made: phase and texture analysis by XRD, microstructure analysis on different sections (OIM and SEM+EDS), static tensile tests and microhardness measurements. Obtained results are important due to its great influence on the construction mechanics. The elements of supporting structures work in the conditions of compression, shearing or bending. The anisotropy of its mechanical properties can lead to the contrary properties for different load conditions. There are no doubts that such results have to be taken into consideration during designing of the audiometric cabins construction.

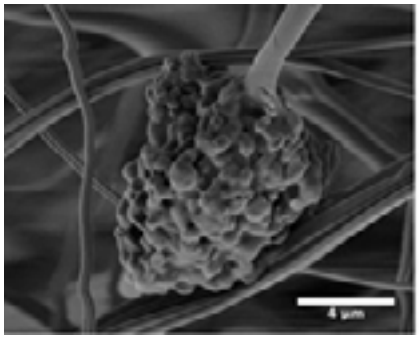

Figure 1 Praseodymium tungstate particle encapsulated in polyvinylbutyral fiber scale bar: 4um

Biography

Stanislav Nevyhosteny is a Ph.D. student at the department of nonwovens and nanofibrous materials, Faulty of textiles, Technical university of Liberec, Czech republic. He specializes in production of hybrid and inorganic nanofibers using the direct current and alternating current electrospinning. The main area of his research is hybrid nanocomposites for attenuating ionizing radiation. This is achieved through combination of inorganic and polymer chemistry.

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Notes:

Sanchayita Nag et al., Res. Rev. J Mat. Sci. 2017, 5:5
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One pot synthesis of acid doped polypyrrole and investigation of its visible light driven dye degradation and room temperature ferromagnetic properties

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In the present work, HCL- doped polypyrrole was prepared by the oxidative-polymerization [1] method. X-ray diffraction pattern depicts a broad amorphous peak centered around 2 = 23o, corresponding to scattering from the bare polymer chain [2].TEM images revealed the sheet like morphology of the sample. The visible light driven photo degradation of Rhodamine B (RhB) and Methylene Blue (MB) dyes were carried out to study the photocatalytic performance of the sample. Field dependent room temperature M-H behavior of the sample was also studied. In both cases, the sample showed 99.99% degradation of the dyes at around 25 minutes. The sample showed a trace of ferromagnetism at room temperature (RT-FM) with coercivity around 120 Oe and saturation magnetization around 1.5X10-^{3} emu/gm. For nonmagnetic polypyrrole, this observation is a bit striking. This phenomena may be correlated to the defect related ferromagnetism as generally observed in chemically synthesized graphene or its nanocomposites [3]. Simultaneously, in the case of conducting polymers, the process of doping (intercalation) breaks the double bond of the polymeric chain and produces a positively charged defect and a dangling bond. These two factors results the formation of a positive polaron. The ferromagnetic ordering of polarons may induce ferromagnetism into the sample.

Figure1: In situ polymerization of polypyrrole

Biography

Sanchayita Nag has expertise in synthesis and characterization of nano ferrites, along with synthesis of graphene and polymer based ferrite composites. Her major interest is mainly focused on the characterization of the synthesized materials for several possible applications like magnetic, photocatalytic as well as dielectric. Her continuous efforts in the concerned field have created new possibilities for the multifunctional applications of organic nanoferrite composites.

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Notes:

Madina Ryssakova et al., Res. Rev. J Mat. Sci. 2017, 5:5
DOI: 10.4172/2321-6212-C1-006

Catalytic oxidation of methane into methanol over copper exchanged ZSM-5 Zeolites

Madina Ryssakova[1], **F.R. García García**[1] and **Juan Maria Gonzalez Carballo**[2]
[1]The University of Edinburgh, UK
[2]Sasol Technology UK Ltd, UK

Methanol is one of the high potential products used as a key raw material to produce many other chemicals. Current industrial route for methanol production is a two-stage process including steam reforming of methane to synthesis gas and catalytic conversion of syngas to methanol. This method is considered as energy intensive and expensive. Therefore, investigation of technology for direct methane to methanol conversion (DMTM) will be an attractive alternative for conventional technology. In nature, materials such as methane monooxygenase (MMO) oxidizes methane by single step and Copper-Exchanged Zeolite Catalysts (Cu-ZSM-5) can mimic this exceptional activity of MMO. The main objective of this work was to investigate catalytic performance of Cu-ZSM-5 for DMTM under mild isothermal conditions. The methodology was to incorporate copper at framework positions of zeolite, characterize Cu-ZSM-5 and test its activity for DMTM. As Al atoms within zeolite framework are believed to play an important role in the nature of copper active sites, samples with different Si/Al ratios were employed to observe the effect of catalyst acidity on methanol production. The results on DMTM over Cu-ZSM-5 presented the formation methanol for all tested samples. Treatment of catalyst with air was found to be most favorable environment to form active copper clusters comparing with H2O and H2O/H2. and Cu-ZSM-5 with high Al content had a higher product yield. These findings confirm the activity of copper-oxo sites in ZSM-5 towards methane to methanol oxidation and role of zeolite acidity in catalyst performance.

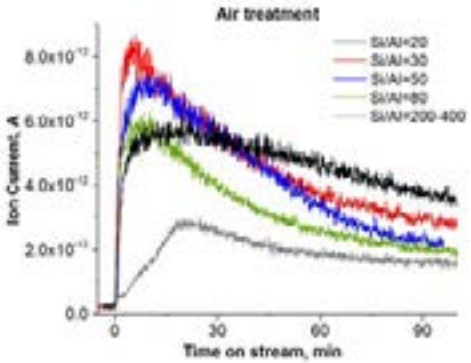

Figure1 *MS-detected signal of methanol after air treatment for five sample*

Biography

Madina Ryssakova is a master student in Advanced Chemical Engineering program at University of Edinburgh. Her dissertation project focuses on studying catalytic activity of Cu-ZSM-5 for direct methane to methanol conversion. She worked on this project under the supervision of Dr. Francisco Garcia Garcia (University of Edinburgh) and with cooperation of Sasol Technology Ltd. as a project industrial partner.

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Notes:

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Advanced Materials 2017

Mohamed O. Amin et al., Res. Rev. J Mat. Sci. 2017, 5:5
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Novel and versatile solid-state chemiluminescnce sensor based on TiO_2-$Ru(bpy)_3^{2+}$ nanoparticles for pharmaceutical drugs detection

Mohamed O. Amin, Entesar Al-Hetlani and **Metwally Madkour**
Kuwait University, Kuwait

This work describes a novel and versatile solid-state sensor for analytes detection using $Ru(bpy)_3^{2+}$-Ce(IV). Herein, we report the synthesis, characterization, optimization and application of a new type of hybrid nanoparticles (NPs). Mesoporous TiO_2-$Ru(bpy)_3^{2+}$ NPs were prepared using a modified sol-gel method by incorporating $Ru(bpy)_3^{2+}$ into the initial reaction mixture at various concentrations. The resultant bright orange precipitate was characterized via: TEM, N_2 sorpometry, ICP-OES, Raman and UV-Vis spectroscopy techniques. The concentration of $Ru(bpy)_3^{2+}$ complex in the NPs was quantified and its chemiluminescnce (CL) response was compared to the same concentration in the liquid phase using oxalate as model analyte. The results showed that this type of hybrid material exhibited higher CL signal compared to the liquid phase due to enlarged surface area of the hybrid NPs (~149.6 m^2/g). The amount of TiO_2-$Ru(bpy)_3^{2+}$. NPs and the effect of the oxidant flow rate were also investigated to optimize the CL signal. The optimized system was further used to detect oxalate and two pharmaceutical drugs; imipramine and promazine. The linearity of both drugs was in the range of 1-100 pM with limits of detection (LoD) of 0.1 and 0.5 pM, respectively. This approach is considered simple, low cost, facile and can be applied to a wide range of analytes.

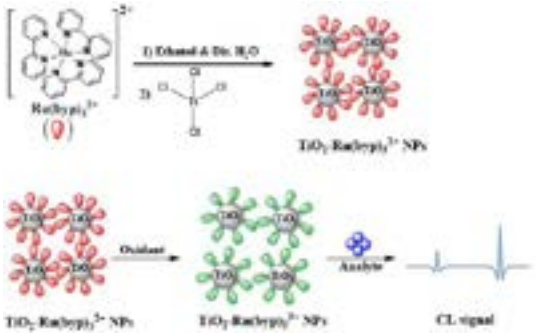

Figure1: *A schematic representation of the newly synthesised solid-state TiO2-Ru(bpy)32+ NPs as a new approach chemilunminescnce sensor for analyte detection*

Biography

Mohamed O. Amin is a graduate of Kuwait University and currently pursuing an MSc in medicinal chemistry. Despite being passionate about medicinal chemistry he is always looking for other research opportunities in other research laboratories in Kuwait University. This quest for knowledge and experience lead him to work in Dr. Al-Hetlani and Dr. Madkour laboratory and learn about nanomaterials synthesis, characterization and vast range of applications. He has published his first research paper in the area of photocataysis using TiO_2 NPs. Furthermore, He participated in using this type of nanomaterial as solid support for detection applications namely, chemiluminesscnce (CL) due to their large surface area. This work is the first of its kind in the area of solid state CL and was used for the detection of oxalic acid and two pharmaceutical compounds achieving enhanced LoD.

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Notes:

De Aza P.N et al., Res. Rev. J Mat. Sci. 2017, 5:5
DOI: 10.4172/2321-6212-C1-006

Microstructural, mineralogical and chemical characterization of a new 3D stratified Si-Ca-P porous scaffolds obtained by sol-gel and polymer replica method

De Aza P.N[4], Ros-Tárraga P[1], Murciano A,[2] Mazón P[2] and **Gehrke, S.A[3]**
[1]UCAM-Universidad Católica San Antonio de Murcia, Spain
[2]Universidad Miguel Hernández, Spain
[3]Biotecnos Research Center, Brasil
[4]Universidad Miguel Hernández Avda, Spain

Statement of the Problem: Tissue engineering is a science which studies different ways to achieve the regeneration of diseased tissues. To get it, this field uses scaffolds or porous extracellular 3D matrices, which allow cell migration, vascularization and nutrient diffusion. These matrices need to have the appropriate physical and biological properties such as pore size and structure, surface topography, chemical composition, mechanical strength and degradation rate. These characteristics are capable to induce optimal osteogenesis throughout the scaffolds. For this reason, and because they exhibit an appropriate bioactivity, ceramics are excellent candidates for developing these 3D scaffolds, avoiding the process of stress shielding. The aim of this research was to develop and characterize a novel stratified porous scaffold for future uses in bone tissue engineering. Methodology & Theoretical Orientation: In this study, a calcium silicophosphate porous scaffold, with nominal composition 29.32 wt% SiO_2 – 67.8 wt% CaO – 2.88 wt% P_2O_5, was produced using the sol-gel and polymer replication methods. Polyurethane sponges were used as templates which were impregnated with a homogeneous sol solution and sintered at 950ºC and 1400ºC during 8 hours. The characteristics of the 3D stratified porous scaffolds were investigated by Scanning Electron Microscopy, X-Ray Diffraction, Fourier Transform Infrared Spectrometry, Diametric Compression of Discs Test and Hg porosimetry techniques. Findings: The result showed highly porous stratified calcium silicophosphate scaffolds with micro and macropores interconnected. Also, the material has a diametrical strength dependent on the number of layers of the stratified scaffolds and the sintering temperature. Conclusion & Significance: A new methodology has been developed to obtain a stratified porous 3D ceramic at different temperatures, whose microstructural study has shown a highly interconnected porosity, with an average pore size between 375-400 μm and a Ca/P ratio of 13.09. For this reason, this methodology will allow us to create new customized materials according to the needs of each situation. We will be able to create materials with a high resistant core and high bioactivity coverings or vice versa, depending on the place where you would place the bone implant.

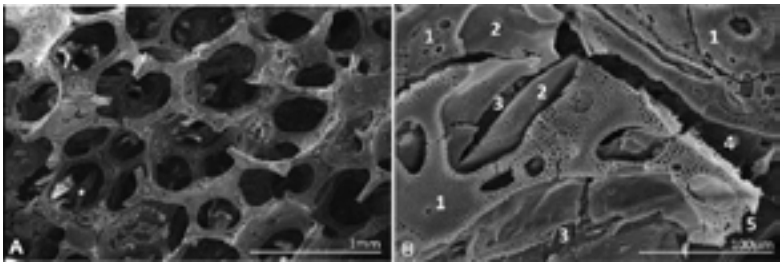

Fig1: *SEM micrographs of the 3D-1400 ceramics with a) 10 and c) 12 immersions in sol-solution (numbers are the latest five layers)*

Biography

Piedad N de Aza received her doctoral degree in Chemistry-Ceramic 1995. She did a postdoctoral stage at the IRC in Biomaterials at the Queen Mary College, University of London (U.K.) working on in vitro and in vivo behavior of bioceramics. At this moment, she is the Chair of the Materials Science, Optic and Electronic Technology Department, Professor of Materials Science and Metallurgical Engineering and Researcher at the Bioengineering Institute at the Miguel Hernandez de Elche University..

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Advanced Materials 2017

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Processing and characterization of Intercritically Austempered Ductile Iron (IADI)

Alan Druschitz, M. Ostrander, D.C. Fitzgerald and **R. Aristizabal**
Virginia Tech, USA

Intercritically austempered ductile iron (IADI) has a microstructure of well-formed graphite nodules in a matrix of ferrite and ausferrite. This microstructure produces a material that has better strength and ductility compared to ferrite/pearlite microstructures and better ductility, improved resistance to environmentally assisted cracking, and better machinability compared to fully ausferritic microstructures (conventional austempered ductile iron). The austenite in the ausferrite particles can undergo transformation induced plasticity but this transformation is a function of particle morphology and chemistry. This microstructure is also a challenge to produce in thick section sizes since the ability to produce ausferrite is a function of cooling rate and chemistry. The production and characterization of IADI will be discussed in an effort to encourage the further development of this material.

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Carbon nanostructures for energy storage applications

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Sustainable and renewable energy sources from hydropower, solar, and wind power are expected to release the heavy burdens on the current energy infrastructure and the environmental concerns. As these renewable energy sources such as solar and wind power are intermittent in nature, reliable electrochemical energy storage systems, mainly including rechargeable batteries and electrochemical capacitors, are purposely explored to promote efficient utilization of these energy sources and are a growing challenge. The development of high energy storage devices has been one of the most important research areas in recent years and relies mostly on the successful engineering of electrode materials. Carbon nanostructures such as carbon nanotubes (CNTs) and graphene have been full of surprises since their emergence and are intensively investigated for use as electrode materials in energy storage devices. Utilizing CNTs, graphene, and their composites for various energy storage applications such as Li-ion and L-S batteries, and supercapacitors are under scrutiny because of their improved electrochemical activity, cost effectiveness, environmental benign nature, and promising electrochemical performance. At present, we are working on our research strategies and efforts to employ carbon nanostructures for different energy storage applications including flexible and even stretchable electricity storage devices.

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Superionic conductor and semiconductor-ionic materials for advanced solid oxide fuel cell (SOFC): Challenges and opportunities

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[2]Hubei University, China

The superionic conductors (SC) have characteristics of highly disordered or liquid state of the mobile ions which can fastly transport through network channels, not individual ionic hopping. The SCs are used primarily as the electrolytes in solid oxide fuel cells (SOFCs) and widely for electrochemical devices. In a long history, the SOFC has been dominated by yttrium stabilized zirconia (YSZ) which is based on oxygen vacancy created in the structure and the O_2- transport phenomenon relies on the hopping of ions through a fluorite solid structure at high temperature (e.g. 1000°C). The YSZ is in principle not the SC. In order to develop advanced SOFCs for low enough temperatures and technical usefulness, Goodenough proposed the "Oxide-ion conductors by design" (1). However, the proposed structure and doping approach have put strong constraints for SOFC material design and development. Our approach is based on the superionic conduction mechanism on the ionic networking conduction to create the artificial liquid state and superionic channels through interfaces between a rigid solid phase, e.g. oxide-ion ceria structure and a 2nd phase which can be molten or soften at a suitable temperature ≤ 500°C. Typical examples are ceria-carbonate composite materials. These materials have successfully reached 0.1 S/cm at around 300°C (to be comparable to YSZ at 1000°C), resulting in great successes for low temperature SOFCs, e.g. more than 1000 mW/cm_2 at ≤ 500°C. Latest developments showed more advanced novel functional semiconductor-ionic materials (SIM) in which the ionic conductivity can be greatly enhanced by strongly correlation between electrons and ions. More interestingly, such SIMs can function for fuel cell anode, electrolyte and cathode, "Three in one" (2), thus creating single-layer electrolyte-free fuel cells (EFFCs) as a revolutionary breakthrough. Therefore, many new opportunities for SOFC R&D have been explored.

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Bioceramics and their applicability in dentistry

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Hegedus and Jozsef Bako
University of Debrecen, Hungary

Statement of the Problem: Different type of ceramic scaffold materials are widely used in dentistry, oral surgery and implantology. The most often used are hydroxyapatite (HA) and -tricalcium phosphate (ßTCP) bioactive modified scaffolds among the ceramic scaffolds. The appropriate mechanical properties, capable of supporting cell attachment and proliferation are critical parameters at the designing of a scaffold. Moreover, porosity, the mechanical integrity and effect of surface morphology on cell adhesion and proliferation are important parameters that must be examined in constructing the scaffold. The purpose of this study is to characterize and investigate the possible dental application of HA and ßTCP containing mesoporous silica based aerogel. Methodology & Theoretical Orientation: Modified aerogels with different HA/βTCP ratio were fabricated by sol-gel technology and supercritical drying in carbon dioxide at 80°C. In our in vitvo study the cytotoxicity of modified aerogel was analysed based on Alamar Blue assay (Invitrogen, USA) by using malignant osteosarcoma cell line (SAOS-2, ATCC® HFB- 85™, Rockville, MD, USA). The gene expression changes were measured with BMP-2, Runx2, TaqMan® assays (ABI, USA), normalized to the GAPDH level. In our in vivo experiments modified aerogels discs were implanted into the prepared rat calvaria defects to investigate the osteointegration around the inserted aerogels. The thickness of prepared histological bone section containing modified aerogel were under 10 micrometres and stained based on the haematoxylin-eosin (H&E) staining protocol. Findings: These measurements showed that modified aerogels are biocompatible and non-toxic for SAOS-2 cell type. The gene expression analysis showed that ßTCP and/or HA containing composites can trigger differentiation of SAOS-2 cells to osteoblasts, however, ßTCP containing aerogel looks more effective than the HA containing aerogel. In vivo experiments showed early signs of osteointegration after 1 month intervention. Conclusion & Significance: These materials showed promising properties to be useful scaffolds for bone regeneration.

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Third generation solar cells from laboratory to factory; Developing a scale-up route for perovskite solar cells to turn 'Buildings into Power Stations'

David Worsley and Trystan Watson
Hubei University, China

Whilst the photovoltaic performance of perovskite solar cells continues to increase, technology developments are also progressing in the area of printing and processing in order to realise large scale manufacture. Possible methods for both depositing the layer stack and its subsequent heating are numerous; to deliver a working and scalable device stack can require a hybrid approach where multiple techniques are employed. This paper introduces a series of technology developments required to enable the continuous fabrication of perovskite solar cells at commercial scale. These include (i) achieving appropriate crystallisation dynamics of the perovskite layer by tuning the printing process, substrate temperature and post processing and (ii) addressing the bottlenecks in manufacture such as reducing annealing times to seconds instead of hours to ensure compatibility with a continuous manufacturing environment and (iii) Choosing the right substrate, glass, metal or plastic that is suitable for the appropriate application A layer by layer approach to coating deposition will be presented including the mechanism and process parameters required to successfully deposit the entire device stack via screen printing, slot die coating or a hybrid of both on glass and metal substrates. The application of building integrated PV to novel steel framed buildings will be used as an example of where printed PV can potentially transform the built environment into a net positive energy producer.

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Epitaxial growth of 2D heterostructures toward pristine TMDs

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This abstract summarizes some of our research activities concerning the growth and nanofabrication of 2D materials. TMDs are prone to rapid oxidation in air, presenting a critical roadblock in practical device applications. Here, we attempt to address the issue of oxidation of TMDs and find conditions for growing oxidation-free TMDs, which will mark a milestone for the coordinated improvement in their applications. To this end, we study chemical vapor deposition (CVD)-growth and extensive material characterization to provide deeper understanding of the role of other 2D substrates in the prevention of interior defects in TMDs and, thus, uncover the conditions for anti-oxidation. For the growth, we explore a direct/epitaxial growth process of 2D crystals. Our growth method permits the growth of transition metal dichalcogenides (TMDs) on the 'contacted' areas only, enabling fabrication of in-phase 2D heterostructures. This method facilitates localized, patterned, single crystalline or large-scale polycrystalline monolayers of MoS2, WS2, WSe2 and MoSe2. With this technique, we furthermore show the epitaxial growth of TMDs on hBN and graphene and vertical/lateral heterostructures of TMDs, uniquely forming in-phase 2D heterostructures. We examine the resulting quality and integrity of several heterostructure combinations using Raman, low temperature PL, XPS and SAED characterization, before and after oxidation. This research provides a detailed look into the oxidation and anti-oxidation behaviors of TMDs, which corroborates the role of underlying 2D layers in the prevention of interior defects in TMDs. If the technique could be developed to be highly reliable and high fidelity it could have a large impact on the future research and commercializability of TMD-based devices.

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Dual-faced nano-mushrooms for tri-functional single cell diagnosis and drug delivery

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Here we introduce a monodispersed mushroom-like fluorescent nanoparticle with dual-faces and tri-functions for SERS-active Raman sensing, fluorescence detecting, cancer marker targeting, and drug carrying and delivering inside a cell. A one-step oxygen plasma process was employed to tailor commercial-available fluorescent PS beads into corrugated hemispheres and simultaneously modify the entire surface with carboxylic groups, and then a gold film was coated on the corrugated hemisphere for SEARs. Sulfo-NHS-SS-biotin disulfide linker and anti-CD44 monoclonal antibody could be modified simultaneously onto the top gold surfaces and bottom carboxyl groups through Au-S and peptide bonds, respectively. In exploiting the dual-module surface, highly selective modifications were performed to the Au-S bond using thiols and/or the peptide bond using a dehydration reaction between –COOH and $–NH_2$. For applications in cancer, the DFPSBs were modified by attaching anti-CD44 antibody (on the carboxylated polystyrene) and a sulfo-NHS-SS-biotin disulfide linker (onto the amine or gold surface). The anti-CD44-modified DFPSBs can be utilized to target cancer cells (such as HeLa and MCF-7) with CD44 over-expressed. For drug delivery, a relatively weak covalent bond in the disulfide linker has the advantage of being capable of cleavage via reduction. The disulfide cleavage, dividing one R-SS-R into two R-SH molecules, occurs with cell cytoplasm environment. In the intracellular space, the cell regulatory mechanism can retain the redox equilibrium; consequently, the disulfide linker-modified DFPSBs act as vehicles releasing their load inside the cell membrane. Therefore, surface-modified DFPSBs can integrate three functions on the nanoparticles for biomedical applications.

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Transparent semiconductors: Synthesis, properties and applications

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In many applications such as special-effect advertisement and displays on window glass, optically transparent or invisible electronics are needed. Transparent oxide semiconductors (TOSs) are fundamentally important for realizing such advanced applications. To be transparent optically, the material needs to be of wide band gap of 3 eV and above. Such a wide gap is typically for an insulator, as conducting metals have almost no band gaps. Therefore, it is necessary to generate shallow level defects serving as donor or acceptor for making the material conductive. One of the most challenging and difficult parts of the TSOs work is the fabrication of highly conductive p-type TSOs and compound semiconductors, whose success can lead to new generation devices and applications. The p-type TSOs we have fabricated successfully include Cu-Al-O, ZnO, and Cu_2O, etc. The n-type TSOs and TCOs we have successfully fabricated include nanostructured or/and amorphous ZnO, SnO_2, IZO (indium zinc oxide), and ITO (indium tin oxide) thin films. Transparent p-n junction diodes have also been succeeded and investigated. In this talk, I will introduce transparent semiconductor, and use indium zinc oxide, zinc oxide, copper aluminum oxide as example to introduce various concept and parameters affecting optical transmittance and electrical conductance. The fabrication of the material will be introduced. Various characterization methods will be described for the determination of different important parameters. The properties of the material prepared under different conditions will be analyzed and discussed.

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Nano-Si: With good performance in solar cells and lithium ion batteries

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We have done much work about silicon (Si) in solar cells and lithium ion batteries (LIBs). In the aspect of solar cell, we used silver (Ag) -assisted chemical etching method to fabricate black silicon solar cells with efficiency over 18% in 2013 and large-scale production was carried out. Besides, nickel, which is cheaper than Ag, was used as assisted metal to fabricate black silicon structure for the first time and surface reflectance of 1.59% was obtained. In the aspect of LIBs, we used Si powders made from broken Si wafers with different electrical resistivity in semiconductor industry as anode material in LIBs. We find out that Si powders made from Si wafers with lower electrical resistivity show better electrochemical performance (higher capacity, and better rate performance) in LIBs. Therefore, broken Si wafers in semiconductor industry should be classified according to their electrical resistivity, which can be convenient for being used as anode raw materials for LIBs.

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High conductivity polymer electrode for flexible electronic devices

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Conducting polymers hold the great advantages of light weight, excellent mechanical flexibility, easy-processing, controllable physical and chemical properties, have been attracting tremendous attention for the application in electronic devices. Among them, poly(3,4- ethylenedioxythiophene (PEDOT)-based materials have been extensively studied due to its excellent air, thermal stability, and high transparency in the visible spectral region and tunable conductivity from 10-4 to 103 S/cm.The commercially available PEDOT- based aqueous formulation, PEDOT:PSS, has been widely used in organic electronic devices as the electrodes to replace expensive and brittle indium tin oxide (ITO) or metals because of the easy processing. Recently, we performed studies on the wetting property, conductivity and novel film fabrication methods of PEDOT:PSS and their applications on energy conversion and storage devices. Research achievements are listed partly as following: (1) a nonionic surfactant (PEG-TmDD) was reported to improve the wetting property and conductivity of PEDOT:PSS. Vacuum-free organic solar cells with the PEDOT:PSS solution doped with 4.0% PEG-TmDD as an efficient top electrode demonstrate a fill factor of 60% and a power conversion efficiency of 4.1% using P3HT:ICBA as the active layer. (2) A novel scalable strategy is developed to prepare highly conductive thick polymer films (HCT-PEDOT:PSS).Organic solar cells with laminated HCT-PEDOT:PSS exhibit comparable performance to the Ag top electrodes. Flexible super-capacitors based on HCT-PEDOT:PSS display a high performance that greatly outperforms previous reported values. (3) Flexible transparent PEDOT:PSS electrode with a conductivity of 2673 S/cm was fabricated and applied to all-plastic organic solar cells and semi-transparent super-capacitors. (4) Vacuum free Integrated device based on organic solar cell and capacitor has been successfully fabricated in our recent work by employing highly conductive PEDOT:PSS electrode. Although many research results have been achieved in recent years, efforts need to be paid on enhancing its conductive properties in terms of the practical applications.

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Atomically resolved structure of luminescent $ZnkIn_2O_{3+k}$

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Indium zinc oxides (IZOs) have attracted the interest due to their physical properties and high chemical stability. These materials constitute a large field of research due to its applications as transparent electrodes in transistors, flat panel displays, solar cells, sensors and photocatalysis properties. In this work, several terms of the homologous series $ZnkIn2O_3^+k$ with $3\leq k\leq 13$ materials were prepared by the ceramic method. The microstructure of the materials has been elucidated by means of X-ray Diffraction (XRD), high-resolution transmission electron microscopy (HRTEM and STEM) and Raman spectroscopy. Additionally, luminescence properties were measured by cathodoluminescence in a scanning electron microscope. The structure can described based on a hexagonal symmetry, with R-3m space group for those terms with odd k, and P63/mmc for k even, although overlap of the diffraction maxima occurs for higher members of the series. HRTEM images show these materials are formed by the ordered intergrowth of layers of InO_2- octahedral sharing edges with InZnkOk+1+ blocks stacked perpendicularly to the c-axis of the crystal, where zinc and indium occupy tetrahedral and trigonal bipyramid sites. The existence of extended defects such as twins, dislocations and disordered intergrowths were also observed. TEM in High Angle Annular Dark Field (HAADF) and Annular Bright Field (ABF) modes show the indium and zinc distribution along [1-10] and [010] zones axes. The characteristic modulation of this homologous series (a zigzag pattern) is also visualized. Cathodoluminescence (CL) measurements show the existence of a main emission band centered at 1.75 eV, associated to Zn vacancies. The variation of the intensity and width of the band depends on the chemical composition of the material. These results suggest that physical properties can be tailored for technological applications depending on the material composition.

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Three-Dimensionally gradient harmonic structure design for high performance structural materials

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The Harmonic Structure (HS) is an innovative nano-micro scale materials design, which gives outstanding mechanical properties to structural metallic materials. In general, homogeneous and ultra-fine grain (UFG) structure enables the materials high strength. However, such a "Homo" and "UFG" does not, usually, satisfy the need to be both strong and ductile, due to the plastic instability in the early stage of the deformation. As opposed to such a "Homo and UFG", "HS" has a heterogeneous microstructure consisting of bimodal grain size together with a controlled and specific topological distribution of fine and coarse grains. In other words, the HS is heterogeneous on nano- and micro- but homogeneous on macro-scales. In the present work, the HS design has been applied to pure metals and alloys via a powder metallurgy route consisting of controlled surface severe plastic deformation of the corresponding powders, and subsequent consolidation. At a macro-scale, the HS materials exhibited superior combination of strength and ductility as compared to their homogeneous microstructure counterparts. Fig.1 demonstrates the comparison of mechanical properties of various metals and alloys with HS and their coarse-grained (CG) counterparts. It can be clearly noted that the normalized yield strength of the HS metals and alloys was considerably higher as compared to their CG counterparts. Since the area under the stress-strain curve is considered as a representation of the toughness of a material, the HS materials also exhibited improved toughness. These results clearly demonstrate that the HS design leads to improved mechanical properties in most of the metals and alloys which indicate that the HS metallic material would also result in improved performance in service. This behavior was essentially related to the ability of the HS to promote the uniform distribution of strain during plastic deformation, leading to improved mechanical properties by avoiding or delaying localized plastic instability.

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Synthesis of porous gold nanostructures by controlled transmetallation reaction through a biological membrane

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Sacrificial template method using silver nanoparticles (AgNPs) of different shapes based on a simple galvanic replacement reaction (GRR) or transmetallation reaction (TM reaction) has been developed by several research groups to produce hollow gold nanostructures with tunable porosity and chemical composition1-4. Porous gold nanospheres could be successfully produced at room temperature by the controlled TM reaction between Ag nanospheres and $HAuCl_4$ in aqueous medium through a dialysis membrane5. The formation of porous gold nanostructures through TM reaction involving sacrificial silver nanoparticles and Au_3^+ ions ($HAuCl_4$) controlled using a biological membrane (BM) is discussed in the talk. The formation of porous gold nanoparticles (Porous AuNPs) via TM reaction is monitored using UV-Vis absorption spectra. High resolution transmission electron microscopy (HRTEM) and field emission scanning electron microscopy (FESEM) confirms the formation of porous nanostructures. Energy dispersive spectroscopy (EDS) indicates the presence of only gold in the nanostructures. The potential of porous gold nanostructures synthesized using a simple room temperature process using a biological membrane in imaging is demonstrated using fluorescence microscopy of certain biological samples.

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A study of strain-induced martensite characteristics of austenitic stainless steels

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Statement of the Problem: In order to understand the formation of strain-induced martensite (SIM) of austenitic stainless steels, phase textures were investigated both before and after static and cyclic loading, namely plastic deformation is made intentionally. Moreover, in-situ measurements of the strain-induced martensitic transformation that takes place during tensile loading at room temperature were performed. Even in the low plastic strain regime, with loading to yield stress, the SIM transformation occurred. However, the area fraction of the martensite formation did not increase significantly even when the sample was loaded to the ultimate tensile strength. On the other hand, by the cyclic loading, the area fraction of the martensite formation increases significantly when the maximum cyclic load is more than 80%UTS. In other word, the SIM formation is apparently absent when the samples are loaded with less than 70%UTS, although those samples are fractured completely. No clear frequency effect (1Hz vs. 30Hz) is detected. With the analysis, two different SIM characteristics were clarified following plastic deformation. The martensitic structures were obtained in the twin deformation and slip bands. The severity of martensite formation increased with increasing C content. It was found that martensite was formed mainly in austenitic stainless steel lacking Mo, whereas a high Mo content led to a strong martensite structure, i.e., a weak martensite. The formation of martensite occurred from austenite viamartensite, and was related to the slip deformation. The Mo element in austenitic stainless steel had high slip resistance (or stress-induced martensite transformation), due to the large size of the Mo atom. This resulted in the creation of weak martensite. The phase structures of the strained austenitic stainless steels were interpreted using a proposed, i.e., the martensitic transformations.

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Thermodynamics and kinetics of competitive crystallization pathways during devitrification of Al-Sm amorphous alloys

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Amorphous alloys of Al-Sm exhibit competitive devitrification behavior upon reheating, involving competition between multiple metastable phases. These include large-unit-cell phases with cubic, hexagonal, and tetragonal symmetry, along with more conventional stable and metastable compounds of the AlxSm variety. Phase selection during crystallization is strongly path dependent, owing to effects of non-crystalline ordering and the role of diffusion and chemical partitioning in the morphological dynamics. In this work, devitrification kinetics are investigated and quantified using high energy X-ray diffraction, thermal analysis, and electron microscopy. Measurements are related to system thermodynamics in the highly driven regime highlighting principles of selection. Growth mechanisms are investigated in detail, with particular attention to chemical partitioning associated with the initial crystallization front. Implications with respect to other Al-RE (rare-earth) systems are also discussed. This work was supported by the U.S. Department of Energy, Office of Basic Energy Science, Division of Materials Sciences and Engineering. The research was performed at the Ames Laboratory, operated for the U.S. Department of Energy by Iowa State University under Contract No. DE-AC02-07CH11358.

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Classical and quantum light generation with nitride-based semiconductor nanostructures

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Group III-nitride semiconductor based low-dimensional nanostructures have attracted a lot of attention owing to their unique optical characteristics and their versatile classical and quantum photonic applications. Here, we present various nitride-based quantum nanostructures grown on pyramidal, annular, columnar, and tapered structures as a template. First, we demonstrated multi-color and broadband visible light emitting diodes (LEDs) based on GaN hexagonal nano-pyramid and hexagonal annular structures. The pyramid LEDs emit a broad-band spectrum originated from quantum dots (QDs), quantum wires, and quantum wells (QWs) with different emission wavelengths, which are formed at the tops, edges, and sidewalls of the pyramids, respectively. The annular and double concentric truncated pyramidal LEDs provide broad-band, white light generation from the QWs formed on various planes. Red-color emission using InGaN/GaN double heterostructures on GaN nano-pyramid structures was also observed. Second, GaN-based rod structures were directly grown on Si substrates without using any catalysts or mask processing and then InGaN/GaN multiple QWs were deposited on the surface of GaN rods. By using tapered GaN/InGaN core–shell QW semiconductor rods having a large gradient in their bandgap energy along their growth direction, highly asymmetric photonic diode behavior was observed with low scattering loss. Third, we developed a dislocation-eliminating top-down chemical vapor etching method for fabricating high-quality GaN nanostructures. InGaN-based single QD arrays were formed on obelisk-shaped GaN nanostructures by growing an ultrathin QW layer. Ultrafast and high efficiency single photon generation was demonstrated by virtue of spontaneous formation of single QD on the apex of tapered GaN nanostructures. Moreover, a broad spectrum of the entire visible range was achieved by growing multiple QW structure with various QW thicknesses on the obelisk-shaped GaN nanostructures. . Fourth, we demonstrate a novel approach of the self-aligned deterministic coupling of single QDs to nanofocused plasmonic modes. Site-controlled InGaN QD array was grown by selective growth method using metal-organic chemical vapor deposition, and then a silver film was deposited on the single QD array. Using this approach, we achieved strong spontaneous emission enhancement as high as ~ 22 of QDs over a wide spectral range. Furthermore, we found that the majority of the extracted light from the quantum dot is guided toward the bottom of the pyramid with high directionality. Nanopyramid structures were detached from a substrate and the far-field radiation pattern was measured using Fourier microscopy, thus demonstrating great potential of this structure in various applications [5]. Finally, the hybrid nature of exciton polaritons opens up possibilities for developing a new concept nonlinear photonic device. We developed a novel polariton system resulting from strong coupling between a two-dimensional exciton and whispering gallery mode photon using a core–shell hexagonal wire with GaN/InGaN multiple QW. This approach overcomes the major hurdles in the implementation of practical solid-state quantum devices and shows great promise for various applications including quantum cryptography, quantum logic gates, integrated on-chip nano-emitters, and energy-harvesting devices.

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