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Scientific Tracks & Abstracts

Day 1

Anton Liopo et al., Res. Rev. J Mat. Sci. 2017
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Gold-based emerging nanomaterials for imaging and experimental cancer therapy

Anton Liopo[1, 2], **Katherinne I Requejo**[2], **Khaled Habiba**[1] and **Sunil Krishnan**[1]
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Gold nanoparticles of different shape and size have been designed and applied as contrast-enhancing agents for various imaging techniques: optical coherence tomography, fluorescence imaging, optical microscopy, photoacoustic imaging and sensing; and recently, for experimental cancer therapy as enhancers of thermal and radiation modes. In this presentation, we are focusing on different sides of gold nanorods (GNRs) applications, as well as their synthesis, functionalization, and specific targeting. The role of GNRs in comprehensive cancer diagnostics and treatment was analyzed and created the novel GNRs' modifications of wide-ranging aspects ratio, size with high yield and quality. The GNRs were assessed by their toxicity for altered categories, such as amount of gold, surface area, optical density of their solutions and number of particles. GNRs have been reviewed as contrast agents with near-infrared absorption as highly efficient transformers of light energy into heat. Here, we present the use of GNRs as plasmonic nanoparticles for selective photothermal therapy of human acute and chronicle leukemia cells using a near-infrared laser. We have investigated GNRs as potential enhancers of radiotherapy. We have demonstrated high impact of external surface chemistry, role of molecules size and thickness of surfactant layer for damage of cancer cells by electromagnetic radiation. GNRs were evaluated as theranostic agents for imaging, photothermal and radiation modalities. The results may impact pre-clinical GNRs' applications, molecular imaging, and quantitative sensing of biological analytes.

Biography

Anton Liopo has completed his PhD degree from the Institute of Physiology the National Academy of Science (NAS), Belarus. He later joined the Institute of Biochemistry of NAS of Belarus as Senior Scientist, Associate Professor, and eventually the Director of Government Program. After moving to the United States, he obtained trainings in Molecular Biology in Department of Internal Medicine and Nanotechnology of Center for Biomedical Engineering at the University of Texas, Medical Branch at Galveston. He worked as lead Scientist for Nanobiotechnology Program in TomoWave Laboratories Inc. Currently, he is doing investigations in Center for Radiation Oncology Research, UT MD Anderson Cancer Center, where he is aiming on novel nanocomposites for enhancement of cancer radio-therapy and he is also a Visiting Scientist in Department of Chemistry of Rice University. He is a regular reviewer and Member of several Editorial Boards of scientific journals and has more than 75 peer-reviewed publications, including monograph, book chapters and patents.

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Notes:

Jingyang Wang, Res. Rev. J Mat. Sci. 2017
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Strategic modification of nanostability for super thermal insulating materials

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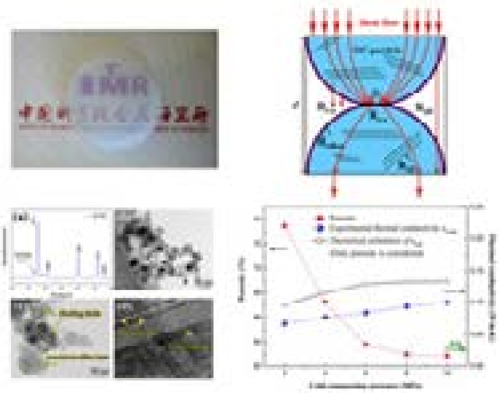
The critical challenge of current nanoscale oxide super thermal insulation materials, such as SiO_2 and Al_2O_3 nano-particle aggregates and their composites, is the critical trade-off between extremely low thermal conductivity and unsatisfied thermal stability (nanostability typically below 1100°C). It is crucially important to modify current materials and further discover novel candidates which could balance the two key properties. This presentation shows progresses on optimal thermal stability of modified Al_2O_3 nano-particle aggregate; and in addition, new candidates of super thermal insulation materials, such as nano-Si_3N_4 and nano-SiC, which are commonly believed as excellent heat conductors. Especially, the new nano-systems exhibited good nanostability up to 1500°C. The striking results incorporated superior sintering stability of structural ceramics as SiC and Si_3N_4 with multiple phonon scattering mechanisms in nano-materials. It is possible to put forward this novel concept to design and search new types of high temperature thermal insulation materials through nano-scale morphology engineering of structural ceramics with excellent thermal stability, regardless their high intrinsic lattice thermal conductivities.



Biography

Jingyang Wang is the Distinguished Professor and Division Head in the High-performance Ceramics Division at the Shenyang National Laboratory for Materials Science, China. He has been internationally recognized for his sustained contributions to innovative technology in processing bulk, low-dimensional and porous ceramics, and to fundamental understanding of multi-scale structure-property relationship of advanced structural ceramics. His works have extensively covered fundamental and technological developments of carbides, nitrides, oxynitrides, silicates, and hafnates for extreme environmental applications. He has published 185 peer-reviewed SCI papers (WoS H-index factor 38), holds 18 registered patents, and has delivered more than 50 keynote/invited lectures. He was the recipient of Acta Materialia Silver Medal (2016) and National Leading Talent of Young and Middle-aged Scientists (China, 2015), and served as the Chair-elect (2016) of Engineering Ceramic Division of The American Ceramic Society (ACerS) and the Program Chair of 41st ICACC hosted by ACerS in Florida.

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Moon-Ho Ham, Res. Rev. J Mat. Sci. 2017
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Engineering graphene and TMDCs for nanoelectronic device applications

Moon-Ho Ham
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Two-dimensional (2D) materials such as graphene and transition metal dichalcogenides (TMDCs) have unique physical and electrical properties. There is currently an interest in taking advantage of these properties for future electronic applications. In this talk, I will first introduce a modified chemical vapor deposition (CVD) technique to produce large-area, high-quality continuous monolayer graphene films from benzene on Cu at 100–300°C at ambient pressure. In this method, we extended the graphene growth step in the absence of residual oxidizing species by introducing pumping and purging cycles prior to growth. Further, Cu/graphene stacked interconnects are fabricated by directly synthesizing graphene onto Cu interconnects using this method, which show the improved electrical properties compared to Cu interconnects. In the second part, I will present a simple and facile route to reversible and controllable modulation of the electrical and optical properties of WS2 and MoS2 via hydrazine doping and sulfur annealing. Hydrazine treatment of TMDSs improves the field-effect mobilities and photo-responsivities of the devices. These changes are fully recovered via sulfur annealing. This may enable the fabrication of 2D electronic and optoelectronic devices with improved performance.

Biography

Moon-Ho Ham is an Associate Professor in the Department of Materials Science and Engineering at Gwangju Institute of Science and Technology (GIST), South Korea. He has received his BS and PhD degrees in Materials Science and Engineering at Yonsei University, South Korea. He was a Post-doctoral Associate in Chemical Engineering at Massachusetts Institute of Technology. His research focuses on nanomaterials including nanocarbon and 2D materials for nanoelectronic and energy applications.

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Ken Bosnick, Res. Rev. J Mat. Sci. 2017
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Nanocarbon composites for mechanical and barrier applications

Ken Bosnick
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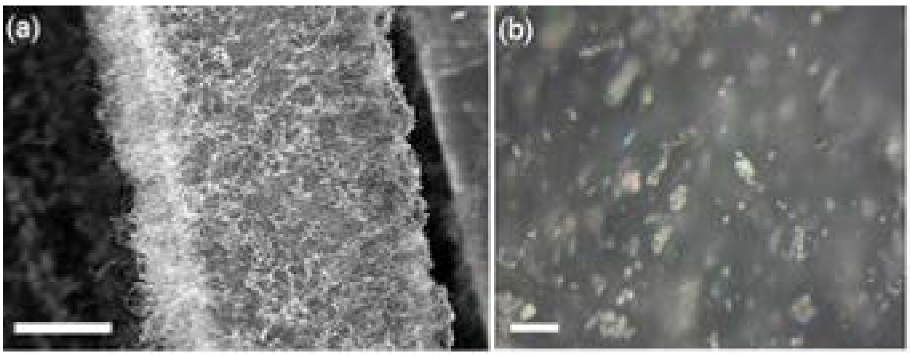
Nanoscale allotropes of carbon, including carbon nanotubes (CNTs) and graphene nanoplatelets (GNPs), show a great deal of promise as functional fillers in nanocomposite materials. The extreme linear aspect ratios, strong sp^2 carbon bonds, and high chemical stability all contribute to making CNTs ideal reinforcement fillers for mechanical applications. Conversely, the high aspect ratio planar nature of graphene and GNPs, along with their high impermeabilities, suggests applications as barrier materials. In this talk, we discuss our work on CNT – aluminum oxide (AO) composites for mechanical applications, including as ballistic armour, and GNP – polymer composites for high barrier applications, including oxygen barriers for food packaging and anti-corrosion coatings. CNT – AO hybrid structures are produced by depositing CNTs as conformal coatings on various AO materials, including powders and fabrics. The deposition is carried out in a large-volume chemical vapor deposition reactor, following a conformal catalyst deposition from solution or via an atomic layer deposition process. The CNT – AO hybrids are sintered into composite materials under high pressure and characterized for mechanical enhancements. Increase in fracture toughness of as high as 71% have been found from these CNT – AO composites. GNP materials are melt-processed with polyethylene (PE) and extruded into packaging films, which are characterized for their oxygen transmission rates. It is found that the GNP – PE films show comparable oxygen transmission rates to the neat PE films, indicating that further processing will be necessary to realize the desired enhancements. The GNP materials are also solution processed with epoxy (EP), cast onto steel substrates, and cured to form coatings. The efficacy of these coatings as anti-corrosion barriers is established by electrochemical and salt-fog corrosion tests. Early results suggest that the GNPs are enhancing the anti-corrosion performance of the EP films.



Biography

Ken Bosnick is a Research Officer with the National Research Council (NRC) at the National Institute for Nanotechnology (NINT) in Edmonton, Canada. He is currently leading or contributing to a number of projects involving nanocomposites. He is leading a large cross-NRC collaborative project through NINT aimed at producing high-performing barrier films, such as for food packaging and anti-corrosion coating applications, by processing graphenic and cellulosic nanomaterials with polymers. He is also leading a smaller project at NINT concerned with producing smart materials capable of sensing meat spoilage. For the Security Materials Technology Program, he is developing new carbon nanotube/ceramic hybrids for processing into ceramic composites for armour applications, including conformal metallic catalyst deposition by atomic layer and chemical vapor techniques.

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Dongling M A, Res. Rev. J Mat. Sci. 2017
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Developing nanostructured materials for harvesting more photons

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Efficiently harvesting visible and near infrared (NIR) photons represents an attractive approach to improve the efficiency of solar-to-electricity conversion, solar-to-fuel conversion and photocatalysis. Plasmonic nanostructures with unique surface plasmon resonance have recently been explored for enhancing solar energy harvesting in the visible and NIR regimes. On the other hand, NIR quantum dots (QDs) with size tunable bandgaps and high potential for multiple exciton generation represent a class of promising materials for new generations of solar cells. In this talk, I will present our recent work on the synthesis of plasmonic nanostructures, NIR QDs, and related assemblies as well as their applications in solar cells, solar fuel and photocatalysis.

Biography

Dongling Ma is working as a full Professor at Institut National de la Recherche Scientifique (INRS), Canada. Her main research interest is in the development of various nanomaterials (e.g., quantum dots, catalytic nanoparticles, plasmonic nanostructures, and different types of nanohybrids) for applications in energy, catalysis, and biomedical sectors. Before joining INRS in July 2006, she was awarded Natural Sciences and Engineering Research Council Visiting Fellowships and worked at National Research Council of Canada from 2004 to 2006. She received her PhD degree from Rensselaer Polytechnic Institute (USA) in 2004.

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L Jiang, Res. Rev. J Mat. Sci. 2017
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Plasmon-enhanced optoelectronic devices based on metal nanostructures

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Plasmonics confine the light into nanoscale dimensions much beyond the diffraction limit by coupling the light with the surface collective oscillation of free electrons at the interface of the metal structure and the dielectric. The resonant collective oscillations give rise to an enhanced electron-magnetic field correlate with high density optical states. It modifies the light-matter interaction which results in enhanced absorption, emission or energy transfer. Hence, this photo-response mechanism makes the plasmonic structures to be an attractive study candidate to enhance the function of the optoelectronic devices, such as photodetector, solar cell, and light emitting diodes (LEDs). So far, it is still desirable to develop more unique plasmonic structures and explore their plasmon effects on devices performance to develop new-generated optoelectronic devices. Herein we introduced the research results of plasmon enhanced optoelectronic devices (photo detector, organic light emitting diode, sensors, etc.) by incorporation with different plasmonic nanostructures (zero-dimension, one-dimension or two-dimensional multiplexed plasmopnic nanostructures) and revealed the involved effective photon-management enhancement mechanism. The remarkable performance enhancement of the devices will guide the potential applications of plasmonic structures in next high-speed and high-density integrated optoelectronics and other plasmon assisted advanced devices.

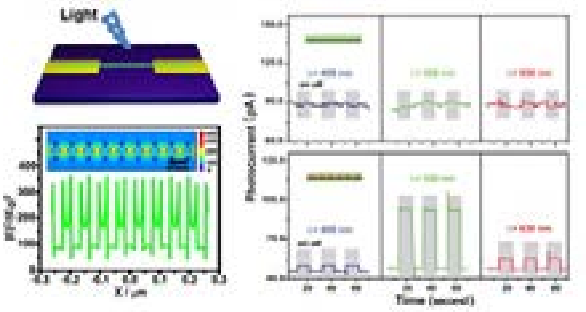

Fig1. The schematic diagram of optoelectronic device based on PPy nanowire embedded with a 1D Au nanoparticle.

Biography

L Jiang received her BSc and PhD degrees in Chemistry from Jilin University, Jilin, China, in 2000 and 2005, respectively. She was awarded the Alexander von Humboldt Research Fellowship in 2006 and worked at Physical Institute of Muenster University in Germany from 2006 to 2009. Then, she became a Senior Research Fellow in 2009 at the School of Materials Science and Engineering in Nanyang Technological University, Singapore. Currently, she is a Professor at Institute of Functional Nano & Soft Materials (FUNSOM), Soochow University, China, since 2012. She is mainly focused on the self-assembly of novel nano-structured materials, and optoelectronic complex devices. She has published over 50 SCI papers in high quality journals, such as *Acc. Chem. Res., Adv. Mater., Energy enviyon. Sci., ACS Nano, Adv. Funct. Mater.*, etc..

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Shao-Chin Tseng, Res. Rev. J Mat. Sci. 2017
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To explore nano world and material structure stress by X-ray nanoprobe at Taiwan photon source

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The X-ray nanoprobe (XNP) will open to all professors and researches, since 2017. The XNP provides versatile X-ray-based inspection technologies, including diffraction, absorption spectroscopy, imageology, and so on. Also, it will improve the analysis scale of inhomogeneous materials, tiny and diluted samples to the nanoscale. Moreover, the high- transmitted XNP can be used to inspect the "Nano World" like atomic arrangements, chemical and electronic configurations, which are widely adopted in the physics, chemistry, materials science, semiconductor devices, nanotechnologies, energy and environmental science, and earth science. Beside to the opening to the researchers, it is also important to improve the inspection and research strength of the XNP in the nanomaterials field, in order to increase the academic influence of the XNP and the Taiwan photon source. The primary experimental technique of XNP includes X-ray fluorescence spectroscopy (for the analysis in the depth-of-field distribution of elements), extended X-ray absorption spectroscopy (for the analysis in the electronic configuration and the atomic or molecular bonding length), excitation X-ray fluorescence spectroscopy (for the analysis in the recombination and transport of carriers), in-phase scanning X-ray imageology (the Fourier phase transform calculation can improve the space resolution down to 3 nm to 5 nm, and detect the stress distribution inside the nanostructures). The design XNP and the experimental applications will be reported.

Biography

Shao-Chin Tseng has completed his PhD from Department of Materials Science and Engineering, National Taiwan University. He is the Assistant Scientist of National Synchrotron Radiation Research Center. He studies on Nanotechnology, X-ray Nanoprobe, Optoelectronic Materials, Semiconductor Process and Biomedical Sensing. He has published more than 25 papers in reputed journals.

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Ganesh Kumar Mani, Res. Rev. J Mat. Sci. 2017
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Microneedle bio-sensor: Direct, label-free, real time detection of pH in biological cells

Ganesh Kumar Mani
Tokai University, Kanagawa, Japan

Acid–base homeostasis and pH regulation inside the body is precisely controlled by kidney, lungs and buffer systems, because even a minor change from the normal value could severely affect many organs. Blood and urine pH tests are common in day-to-day clinical trials without much effort. Still, there is great demand for *in-vivo* pH testing to understand more about body metabolism and to provide effective treatments during diagnosis. The detection of pH at the single-cell level is hoping for the great level of clinical importance for the early detection of many diseases like cancer, diabetes, etc. In this research work, we have fabricated a micro region pH sensor by series of processes like electrolytic polishing to create needle structure, deposition of electrode materials using RF magnetron sputtering for pH measurements and finally testing in various biological mediums. Working and reference electrodes were Ag/$AgIO_3$ and Sb/Sb_2O_3 deposited on microneedles under optimized deposition parameters. The structural, elemental and morphological properties were analyzed using XRD, XPS, EDS and FE-SEM. The fabricated tip of the microneedle probe is around 5 μM analyzed by FE-SEM which size is comparable with the biological cells. pH testing initially began with using fish egg and various biological cells. The obtained pH sensing results were adequate with theoretical values. Since the sensor works at micro region, the potential difference is easily disturbed by atmospheric anomalies. Hence, many steps have been taken to improve the stability of the sensor. Besides that, fabricated microneedle sensor ability is proved through *in-vivo* testing in mice cerebrospinal fluid (CSF) and bladder. The pH sensor reported here is totally reversible and results were reproducible after several routine tests.

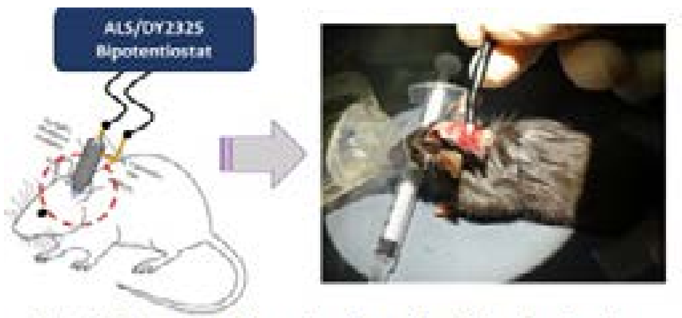

Fig. 1 Schematic of the microelectrode pH testing in mice cerebrospinal fluid

Biography

Ganesh Kumar Mani is a Researcher at Micro/Nano Technology Center, Tokai University, Japan. He has completed his PhD in Nano-Sensors Lab at Centre for Nanotechnology & Advanced Biomaterials (CeNTAB), Sastra University, Thanjavur, India. He published over 40 research papers in reputed international journals with the cumulative impact factor over 70 with a few papers under review. He is also one of the inventors in two patents titled “Low Concentration Ammonia Vapour Sensor” and “Acetaldehyde Sensor Using ZnO Nanoplatelets”. He has also delivered several keynote lectures, organized national and international conferences in various countries. His current research interests are fabrication and development of nanostructured (Nanospheres, Nanorods, Nanowires, Nanoplatelets, Nanosheets) thin film based gas/chemical sensors for predicting food quality, developing microfluidics based solid state pH/temperature/bio-sensors for biomedical applications and developing painless microneedles for healthcare applications, etc.

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Swayamdipta Bhaduri et al., Res. Rev. J Mat. Sci. 2017
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Bacteria can enhance mechanical strength of a porous medium

Swayamdipta Bhaduri, Aloke Kumar and **Carlo Montemagno**
University of Alberta, Canada

A class of bacterium, *S. pasteurii* can mediate the precipitation of calcium carbonate crystals under the right chemical environment. These crystals can enter a network of pores in a porous medium and cause clogging. As a result, the structure may gain strength significantly and exhibit superior mechanical properties. This is characterized by reduction in porosity, physical pore blockage and increase in elastic moduli. This concept may be extended to a wide array of applications like underground carbon storage and repairing fractures in fragile structures. In the present study, open foam sponges of two different grades were used as porous media mimics. We performed comprehensive material testing on samples before and after bacterial treatment and drew quantitative conclusions. We tested the samples under compressive and impact loads and characterized the modification in mechanical behavior due to pore clogging. Visual observation of the actual blockage process at the pore scale was performed using Scanning Electron Microscopy (SEM) and micro-CT scans. We noticed a significant change in mechanical properties. To conclude, this bacterium may be used as an agent to cause pore-clogging at the microscale and the idea applied to a range of applications.

Figure: The concept of Microbiologically Induced Calcite Precipitation as examined in the present work.

Biography

Swayamdipta Bhaduri is a PhD Candidate in Engineering at the Ingenuity Lab in the University of Alberta, Edmonton. He has been working on the several biological, chemical and physical aspects of the micro-scale fluid transport associated with Microbiologically Induced Calcite Precipitation (MICP) mediated by *S. pasteurii*. His expertise lies in the areas of nanofabrication, biomicrofluidics, and experimental fluid mechanics. He has an MS and a Bachelor's degree in Mechanical Engineering from the Indian Institute of Technology (IIT) and the National Institute of Technology (NIT) in India, respectively.

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Samuel Frimpong et al., Res. Rev. J Mat. Sci. 2017
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Tire rubber material characterization for effective structural and fatigue modeling and analysis

Samuel Frimpong, Wedam Nyaaba and **Bruno Kansake**
Missouri University of Science and Technology, USA

Rubber, in its natural state, has the consistency of a heavy viscous fluid with little to no use in structural applications. However, when vulcanized with sulfur, particulate fillers, silica and other strength inducing ingredients, cross-links are formed and the highly amorphous state of the rubber is transformed into an elastic solid. Thus, vulcanized rubber, in the absence of cords, is a nanocomposite. While added fillers give rubber enhanced performance characteristics (stiffness and toughness properties), their presence influence the dynamic and damping behavior of rubber in a very complex and disproportionate fashion. Numerical modeling of rubber behavior for predictive analysis remains a formidable challenge amidst successes achieved thus far. The object of this paper is to implement existing rubber material constitutive models in characterizing tensile strength and fatigue test data of rubber specimens extracted from an off-road mining truck tire. Specifically, the paper highlights modeling strategies for rubber strain softening, nonlinear viscoelasticity, strain-induced crystallization, and fatigue crack growth rate using spreadsheets, and commercially available material calibration codes. The novelty of the study lies in the calibration approach adopted for the fatigue characterization of the experimental data. An example problem to show how the characterized materials are used in a finite element analysis of a model tire is provided. The results obtained indicate enhanced durability in strain-crystallizing elastomers.

Biography

Samuel Frimpong has obtained his PhD in 1992 from University of Alberta and MS in 1988 from University of Zambia. He has obtained his Post-graduate Diploma in 1986 and BS in 1985 from KN University of Science and Tech. of Ghana. He guided over 30 PhD and MS graduates, published 1 book, 3 book chapters, over 200 refereed journal and conference papers and given over 200 presentations. He is a Member of the APLU Board on Natural Resources, Vice Chair of the Minerals and Energy Resources Division of NASULGC, and a Member of the College of Reviewers for Canada Foundation for Innovation and Canada Research Chairs Program and ASCE-UNESCO Scientific Committee on Emerging Energy Technologies (ASCE-UNESCO SCEET). He served 5 years as a Member of CDC-NIOSH Research Advisory Board, 4 years as Co-chair of ASCE-UNESCO SCEET and 2 years on Japan's Global Warming Research Consortium. He is currently the Editor-In-Chief of the *Journal of Powder Metallurgy and Mining* and Editorial Board Member for the *International Journal of Mining*, *Reclamation and Environment*. He is a Registered Professional Engineer and a member of the Canadian Institute of Mining, Metallurgy and Petroleum, American Society for Mining, Metallurgy and Exploration, American Society of Civil Engineers, and the Society for Modeling and Simulation International.

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Aman Ullah et al., Res. Rev. J Mat. Sci. 2017
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Rapid conversion of lipids into biopolymers and conjugates

Aman Ullah, Muhammad Arshad and **Shimiao Zhang**
University of Alberta, Canada

Solvent free conversion of canola oil and fatty acid methyl esters (FAME's) derived from canola oil and waste cooking oil under microwave irradiation demonstrated dramatically enhanced rates. The microwave-assisted reactions lead to the most valuable terminal olefins with enhanced yields, purities and dramatic shortening of reaction times. Various monomers/chemicals were prepared in high yield in very short time. The complete conversions were observed at temperatures as low as 50°C within less than five minutes. The products were characterized by GC-MS, GC-FID and NMR. The prepared monomers were further converted into biopolymer and characterized in detail. In another approach, amphiphilic ABA type PEG-Lipid conjugated macromolecules have been synthesized using the copper-catalyzed azide-alkyne cycloaddition commonly termed as "click chemistry. Characterization of the conjugates has been carried out with the help of 1H-NMR, FTIR and GPC. The conjugates were evaluated for the encapsulation and release of an anticonvulsant drug (carbamazepine) as a hydrophobic drug model in the study. The micellization, drug encapsulation and release behavior of macromolecules was investigated by dynamic light scattering (DLS), transmission electron microscope (TEM) and fluorescence spectroscopy. From the results, it has been concluded that the nanoparticles had different average sizes due to different ratio of hydrophilic contents in the conjugate backbone. The amphiphilic particle size and structure could be altered by changing the ratio of hydrophilic and hydrophobic contents. The *in vitro* drug encapsulations highlighted that all the drug-loaded micelles had spherical or near-spherical morphology. *In vitro* drug release study showed the controlled release of hydrophobic drug over a period of 50 hours. The results indicate that there is great potential of renewable lipid-based micelle nanoparticles to be used as hydrophobic drug carriers.

Biography

Aman Ullah received his PhD (with distinction) in Chemical Sciences and Technologies in 2010 at the University of Genova, Italy by working together at Southern Methodist University, USA. He is currently working as an Assistant Professor at the Department of Agricultural, Food and Nutritional Science, University of Alberta. He has published more than 25 papers in reputed journals and 3 patents/patent applications. He was named a Canadian Rising Star in Global Health by Grand Challenges Canada.

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Deok-Won Lee et al., Res. Rev. J Mat. Sci. 2017
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Hydroxyapatite–heparin–BMP-2 on modified titanium surfaces enhances the efficacy of bone formation and osseointegration: *In vitro* & *in vivo* study

Deok-Won Lee[1] and **Sung ok Hong** [2]
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Introduction: In the present study, surface-modified Ti samples with hydroxyapatite (HAp) and heparin (Hep) bone morphogenetic protein-2 (BMP-2) complex (Ti/HAp/Hep/BMP-2) were prepared and the effects of the samples on the enhancement of bone formation and osseointegration in-vitro and in-vivo were investigated, as compared to Ti/HAp and Ti/Hep/BMP-2.

Methods & Materials: Surface-modified titanium (Ti) samples with hydroxyapatite (HAp) and heparin (Hep)–bone morphogenetic protein-2 (BMP-2) complex (Ti/HAp/Hep/BMP-2) were prepared, and their efficacies on the enhancements of bone formation and osseointegration in-vitro and in-vivo were examined, and then compared to Ti/HAp and Ti/Hep/BMP-2. The modified surfaces were characterized by X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM) and contact angle goniometry.

Results: In-vitro studies revealed that MG-63 human osteosarcoma cell lines grown on Ti/HAp/Hep/BMP-2 increased the amounts of alkaline phosphatase (ALP) activity, calcium deposition and the levels of OCN mRNA gene expression as compared to those grown on Ti/HAp, Ti/Hep/BMP-2 or pristine Ti. Moreover, Ti/HAp/Hep/BMP-2 exhibited higher bone volume (BV), bone volume/tissue volume (BV/TV), removal torque value and bone–implant contact (BIC) than Ti/HAp, Ti/Hep/BMP-2 or pristine Ti *in vivo*. Histological evaluations showed that many desirable features of bone remodeling existed at the interface between Ti/HAp/Hep/BMP-2 and the host bone.

Conclusion: Consequently, Ti/HAp/Hep/BMP-2 may have potential for clinical use as dental or orthopedic implants.

This study was supported by a grant from the National Research Foundation of Korea (NRF-2014R1A1A1002630 and NRF-2016R1A2B4014600)

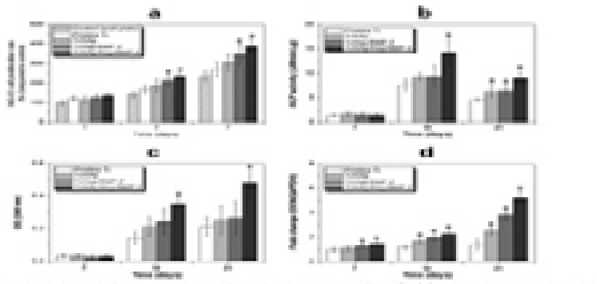

Figure 4. (a) In vitro cell proliferation rates of MG-63 cells cultured on pristine Ti, Ti/HAp, Ti/Hep/BMP-2 and Ti/HAp/Hep/BMP-2 samples for 1, 3 and 7 days of culture, as compared to that of MG-63 cells cultured on well-plate (control). (b) The levels of ALP activity; (c) the amounts of calcium deposition; and (d) the level of OCN mRNA expression on Ti/HAp, Ti/Hep/BMP-2 and Ti/HAp/Hep/BMP-2 samples cultured with MG-63 cells for 7, 14 and 21 days, as compared to those on pristine Ti. Error bars represent mean±SD (n=3); these experiments were repeated three times (*p<0.05)

Biography

Deok-Won Lee is an Oral and Maxillofacial Surgery Specialist and Associate Professor of Kyung Hee University College of Dentistry. His expertise is in treating and improving the oral and maxillofacial health and wellbeing of people. His research on dental implant materials creates new pathways for improving healthcare. He is continually building and investigating on adequate material for implantation through *in-vivo* and *in-vitro* models based on years of experience in research, evaluation, teaching and administration both in hospital and education institutions..

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DEM modeling of oil sands materials structures

Samuel Frimpong and **Eric Gbadam**
Missouri University of Science and Technology, USA

Oil sands are composite materials whose two dominant physical characteristics are the quartzose mineralogy and the large quantities of interstitial bitumen. The void spaces are also filled with a thin continuous net of water around the quartz grains with the remaining space occupied by dissolved gasses. An examination of thin sections and electron scanning micrographs reveals a typical particulate system, whose mechanical behavior can be modeled based on particle interactions (contacts) at the microscale. The oil sands formation exhibits mainly a dense, interpenetrative, uncemented structure with a large number of contacts per grain. Additionally, oil sand undergoes high dilation under low normal stresses. In this paper, the microstructural and micromechanical behavior of oil sands materials is studied and an appropriate and comprehensive contact model is identified to describe its nonlinear, anisotropic and time-dependent behavior. A 2-D discrete element method (DEM) is developed to model the oil sands structures using DEM software package, Particle Flow Code (PFC2D). The time-dependent behavior of the bitumen (consisting of bonded fine particles) is represented by a Burger's model. The quartz grains are modeled with irregular (subrounded and subangular) shape clumps (a rigid collection of disc bonded together). The thin-film of water surrounding the quartz grains is represented as a liquid bridge to determine the capillary force at the interface. The micromechanical model of the oil sand was developed with three different constitutive laws (force-displacement contact models) to represent the contact interactions of the constituents at the microscale. The paper provides theoretical foundations for understanding machine-ground interactions during excavation and for material behavior predictions. Understanding the microscopic behavior of oil sands materials would enhance long-term equipment design improvements and provide production engineers with higher equipment longevity and reliability for mine production and maintenance planning purpose.

Biography

Samuel Frimpong has obtained his PhD in 1992 from University of Alberta and MS in 1988 from University of Zambia. He has obtained his Post-graduate Diploma in 1986 and BS in 1985 from KN University of Science and Tech. of Ghana. He guided over 30 PhD and MS graduates, published 1 book, 3 book chapters, over 200 refereed journal and conference papers and given over 200 presentations. He is a Member of the APLU Board on Natural Resources, Vice Chair of the Minerals and Energy Resources Division of NASULGC, and a Member of the College of Reviewers for Canada Foundation for Innovation and Canada Research Chairs Program and ASCE-UNESCO Scientific Committee on Emerging Energy Technologies (ASCE-UNESCO SCEET). He served 5 years as a Member of CDC-NIOSH Research Advisory Board, 4 years as Co-chair of ASCE-UNESCO SCEET and 2 years on Japan's Global Warming Research Consortium. He is currently the Editor-In-Chief of the *Journal of Powder Metallurgy and Mining* and Editorial Board Member for the *International Journal of Mining, Reclamation and Environment*. He is a Registered Professional Engineer and a member of the Canadian Institute of Mining, Metallurgy and Petroleum, American Society for Mining, Metallurgy and Exploration, American Society of Civil Engineers, and the Society for Modeling and Simulation International.

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Deok-Won Lee et al., Res. Rev. J Mat. Sci. 2017
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Modifying titanium surfaces with nanosized hydroxyapatite and simvastatin to enhance bone formation and osseointegration

Deok-Won Lee[1] and **Sung okHong**[2]

[1]Kyung Hee University, South Korea

[2]Catholic Kwandong University, South Korea

Introduction: The aim of the present study is to evaluate whether coating pristine titanium (Ti) with nano-sized hydroxyapatite (HAp) and simvastatin could enhance bone formation and osseointegration *in-vitro* and *in-vivo* because, both HAp and simvastatin have the characteristic of osteogenetic induction.

Methods & Materials: Pristine Ti was sequentially surface-treated with NaOH,1,1-carbonyldiimidazole (CDI), β-cyclodextrin-immobilized HAp powders (-CD/HAp), and simvastatin before analysis using scanning electron microscopy (SEM), X-ray photoelectron microscopy (XPS), and static contact angle measurement.

Results: Simvastatin was released continually for 28 days. Modification of the Ti surface with nano-sized HAp and simvastatin (Ti/_-CD/HAp/Sim) discs enhanced the osteogenic differentiation of MC3T3-E1 cells *in-vitro*. Furthermore, Ti/-CD/HAp/Sim of screw type enhanced bone formation between the screw and the host bone, when the screw implanted to the proximal tibia and femoral head of rabbits.

Conclusion: These results suggest that surface modification of nanosized HAp and simvastatin are effective tools for developing attractive dental implants.

This study was supported by a grant from the National Research Foundation of Korea (NRF-2014R1A1A1002630 and NRF-2016R1A2B4014600)

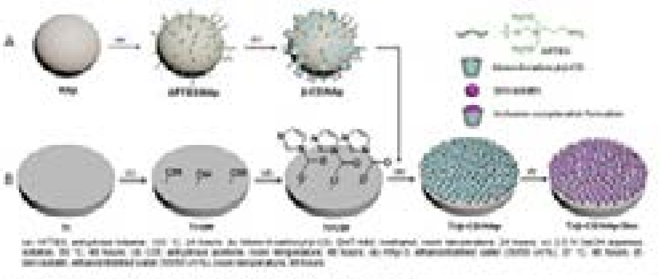

Fig. 1 Scheme of Ti/β -CD/HAp/Sim synthesis.

Biography

Deok-Won Lee is an Oral and Maxillofacial Surgery Specialist and Associate Professor of Kyung Hee University College of Dentistry. His expertise is in treating and improving the oral and maxillofacial health and wellbeing of people. His research on dental implant materials creates new pathways for improving healthcare. He is continually building and investigating on adequate material for implantation through *in-vivo* and *in-vitro* models based on years of experience in research, evaluation, teaching and administration both in hospital and education institutions.

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Notes:

Zhihao Yue, Res. Rev. J Mat. Sci. 2017
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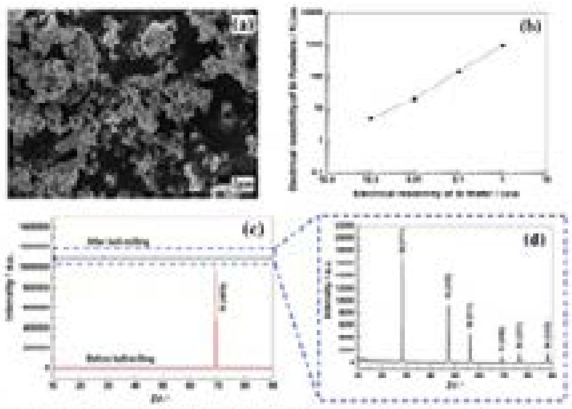
Nano-Si: With good performance in solar cells and lithium ion batteries

Zhihao Yue
Nanchang University, China

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 found 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.



Biography

Zhihao Yue has his expertise in using nano-silicon structures to improve the efficiency of silicon solar cell and the electrochemical properties of silicon anode materials in lithium ion batteries. He used cheaper metal nickel (compared with silver) as assisted metal to fabricate nanostructures on silicon surface and investigated its etching mechanism deeply, which is the first study about nickel-assisted chemical etching method for black silicon solar cells. Besides, he systematically studied the effect of intrinsic electrical resistivity of silicon materials on its performance in lithium ion batteries for the first time and found that silicon materials with lower electrical resistivity present better charge-discharge properties.

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Scientific Tracks & Abstracts
Day 2

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Suspension thermal sprayed nanocomposite WC-Co coatings: Nano-indentation assessment

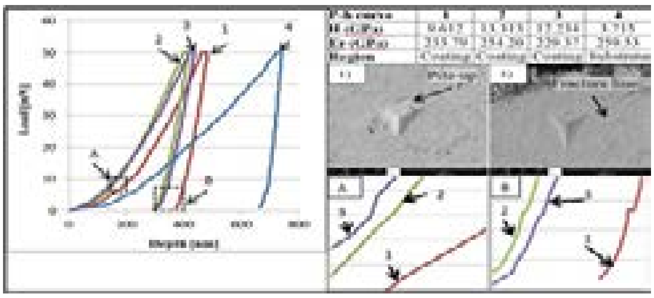
Matheus (Theo) F A Goosen[1], Omar Ali[2], Rehan Ahmed[1], Nadimul H Faisal[1], Nayef M Al-Anazi[1] and **Youssef O Elakwah[1]**
[1]Alfaisal University, KSA
[2]Heriot-Watt University, UK

Statement of the Problem: Nanoindentation of WC-12Co thermal spray coatings has been used to evaluate the elastic modulus and hardness of coating on the polished surface of the coatings. While there has been much progress overall, limited research has been reported on the deposition and evaluation of WC-cermet coatings. The aim of this study was to evaluate the microstructural and nanohardness characteristics of tungsten carbide-cobalt (WC-Co) cermet coatings deposited by liquid suspension spraying.

Methodology: Commercially available WC-Co coating powder was milled and water based suspension was produced as feedstock for the thermal spray coating process. Microstructural evaluations of WC-Co cermet coatings included XRD (X-Ray Diffraction) and SEM (Scanning Electron Microscopy). Post spraying nanomechanical evaluations were conducted using a Berkovich nanoindenter.

Findings: Results indicated relatively higher modulus but lower hardness of suspension coatings. The load displacement curves during nanoindentation were characteristic of the complex coating microstructure showing signs of microcracking and pile-up. The load displacement (P-h) curves along with the SEM images of indents for S-HVOF (suspension high velocity oxyfuel) coating illustrated evidence of sink-in and pile-up of material around the indent contact residual impression during the nano-indentation process. There was some indication of microcracking during indentation as well.

Conclusions: A comparison of S-HVOF and conventional HVOF coatings points toward phase transformations occurring in the suspension spraying which led to nanocrystalline or amorphous phases. The elastic modulus of S-HVOF coatings was on average higher than the conventional HVOF coating. The load displacement curves show features which are consistent with the complex coating microstructure with evidence of micro-cracking and pile-up.



Biography

Mattheus (Theo) F A Goosen has played key roles in the development of new start up academic institutions. For the past nine years he has held the position of founding Associate Vice President for Research & Graduate Studies at Alfaisal University a private start-up non-profit institution in Riyadh, Saudi Arabia. He has obtained a Doctoral degree in Chemical & Biomedical Engineering from University of Toronto, Canada in 1981. He has more than 180 publications to his credit including over 133 refereed journal papers, 45 conference papers, 10 edited books and 10 patents. His H-index is over 47 and has over 8000 citations on Google Scholar. On Scopus he has 133 publications with over 4000 citations. His research interests are in the areas of renewable energy, desalination, sustainable development, membrane separations, spray coating technology and biomaterials.

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Krzysztof Z Sokalski, Res. Rev. J Mat. Sci. 2017
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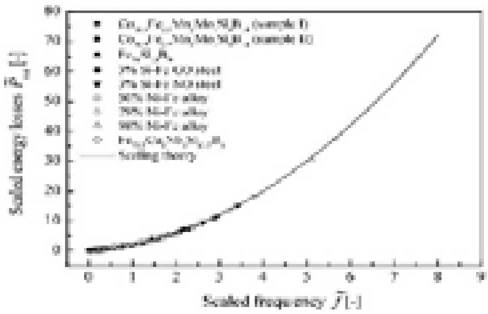
Scaling a way for revealing self-similar features of materials and new applications

Krzysztof Z Sokalski
Czestochowa University of Technology, Poland

Certain features of certain materials are self-similar. This phenomenon is recognizable by scaling of measurement data corresponding to the considered self-similar feature. To perform scaling, we apply notion of homogenous function in general sense. For two independent variables such a function reads $P(f,B)=B^{\beta} F(f/B^{\alpha})$, where P is a considered magnitude, α and β are scaling exponents, F(·) is an arbitrary continuous function, where α, β and F(·) have to be determined by the measurement data. Definition of P(f,B) enables us to transform all characteristics P(f,B) to the one universal function of the one variable: $P(f,B)/ B^{\beta} =F(f/B^{\alpha})$. This effect is so called the data collapse and can be applied for comparison of measurement, data measured in different laboratories, which enable us to estimate quality of each laboratory series. Another application of the data collapse is compression of large experimental data. If the considered data are produced by a self-similar system then one can store them in a form of continuous curve. The data collapse enables us to introduce an absolute dimensionless characteristic: $P = f\bullet (f+1)$, where P and f are dimensionless P and f, respectively. This characteristic divide $\{P, f\}$ space into the two independent subspaces of material's characteristics. Finally, the scaling supplemented by pseudo-equation of states plays basic role in creation of algorithms for designing of modern materials. The presented results are based on experimental data of soft magnetic materials and soft magnetic composites. Where, P (f,B) is density of power loss, f is frequency of the field's modulation and B is maximum of magnetic induction. One can apply this simple mathematics to any self-similar object. However, ultimately one must say that the degree of success achieved when applying the scaling depends on the property of the data. The data must obey the scaling.



Biography

Krzysztof Z Sokalski has a vast Research Experience (some events) from Dec. 1999 – Aug. 2016. He works as a Research Director at Czestochowa University of Technology, Institute of Computer Sciences Czestochowa, Poland from Oct. 1994 to Sep. 2002. He served as Professor in Full at Jagiellonian University, Institute of Physics, Cracow, Poland and Visiting Scientist of Integrability of Quantum Systems at Utrecht University, Institute for Theoretical Physics Utrecht, Netherlands. From Jul. 1988 to Sep. 1988, he served a Visiting Scientist of Dynamical Critical Phenomena at University Utrecht, Institute for Theoretical Physics and from served as Visiting Professor teaching Phase Transitions and Critical Phenomena for PhD students at the Rockefeller University, New York City, United States Laboratory of Mathematical Physics. From Feb. 1988 to Oct. 1994, he worked as Professor (Associate), Head of Soft Condensed Matter Department, Jagiellonian University, Institute of Physics, Krakow, Poland.

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Notes:

Etsuji Ohmura, Res. Rev. J Mat. Sci. 2017
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Laser assist break of hard and brittle materials

Etsuji Ohmura
Osaka University, Japan

When laser beam with a high energy density is irradiated onto a material, the energy of the beam is converted into thermal energy by absorption, and the temperature rises locally. Thermal diffusion occurs due to a steep temperature gradient. However, as the thermal diffusion time and the thermal diffusion length are very short, a phase change such as fusion, evaporation, sublimation, occurs instantly because energy is added locally in a very short time. The thermal stress caused by this temperature gradient is large and as a result, hard and brittle materials that are difficult to process by mechanical processing can be processed by non-contact processing. Two examples of laser assist break of hard and brittle materials are introduced here. (1) Stealth dicing of the silicon wafer: A permeable nanosecond pulse laser is focused into the interior of a silicon wafer and scanned in the horizontal direction, causing a belt-shaped modified layer to be formed in the wafer. Applying tensile stress perpendicularly to this modified-layer separates the silicon wafer very easily into individual chips. This method is called "stealth dicing (SD)". In order to establish a more highly reliable dicing technology and investigate the optimum processing conditions, the formation mechanism of the internal modified layer was studied. (2) Laser scribing of glass: Glass sheet is used for flat panel displays, and laser scribing is being used as the separation process. We conducted thermal stress analysis and crack propagation analysis in order to clarify the processing phenomena and control factor.

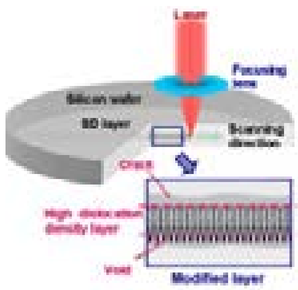

Figure 1. Schematic illustration of "laser process" in Stealth Dicing (SD).

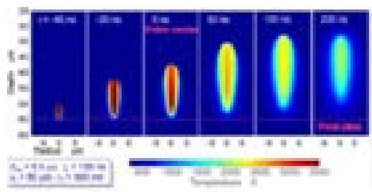

Figure 2: Time variation of temperature distribution obtained by heat conduction analysis considering the temperature dependence of the absorption coefficient.

Figure 3: Schematic of SD layer formation estimated by heat conduction analysis (left) and confocal scanning IR laser microscopy image before division (right).

Biography

Etsuji Ohmura is a Professor of Osaka University. His main field of research is intelligent laser processing systems, especially theoretical analysis and computer simulation to gain deeper understanding of the complicated physical phenomena in laser material processing, influence of laser optics, and nonlinear optical phenomena.

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Notes:

Ki-Soo Lim, Res. Rev. J Mat. Sci. 2017
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Self-organized periodic nanostructures on the surfaces of semiconductors and dielectrics by scanning femtosecond laser pulses

Ki-Soo Lim
Chungbuk National University, Korea

We report the self-formed nanogratings on the surfaces of semiconductors (ZnO and GaN) and dielectric materials (fused silica, borate glass, $LiTaO_3$, $LiVO_3$, sapphire) prepared by scanning focused femtosecond laser pulses at 800 nm with a repetition rate of 1 kHz. Laser fluence range for nanograting self-formation is very narrow. We found that series of periodic-structure orientation is perpendicular to the linear laser polarization. The period of grating structures on the dielectric surface depends on laser power and scans speed and increases in the range of 200~300 nm with scan speed and laser pulse energy. In contrast, GaN shows about 600 nm period in the same power range as the dielectric materials. Its period decreases to 450 nm when the laser power is reduced ten times. It also has much lower laser ablation threshold than dielectrics and ZnO, indicating characteristics of metal-like nanogratings due to its high plasma density, large thermal conductivity, and multiphoton absorption coefficients at 800 nm. Emission from nanograting area of sapphire indicates the existence of oxygen vacancies. Figure 1 shows the nanograting structure formed by scanning femtosecond laser pulses at 40 μm/s speed on the surfaces of $LiVO_3$ and ZnO with 0.13 and 0.09 mW power respectively. For applications, surface nanostructures can be used to improve out-coupling of light in LED. Material absorption can be also significantly enhanced due to surface nanostructures produced by fs-laser pulse processing, applicable to sensing and solar cells.

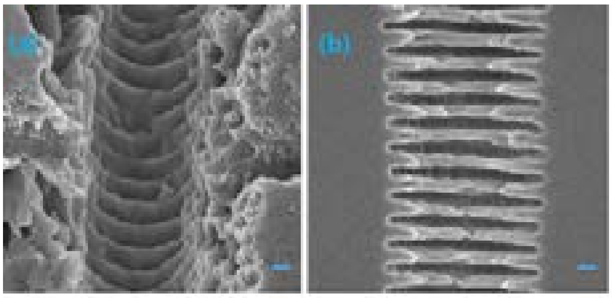

Figure 1. SEM images of self-formed nanogratings on the surfaces of $LiVO_3$ dielectric (a) and ZnO semiconductor (b). Scale bar: 200 nm.

Biography

Ki-Soo Lim is a Professor of Physics Department at Chungbuk National University, South Korea. He has been working on Laser Spectroscopy of rare-earth ion doped crystals, glasses, glass-ceramics, and semiconductors. He also studied 3-D bit or holographic data storage in glass, photopolymers and photovoltaic materials. His recent interests and achievements include precipitation and optical properties of glass-ceramics containing fluoride nanocrystals, and micro-nanostructure fabrication on the surface of dielectric materials and polymers by femtosecond laser. He received his BS and MS degrees in Physics at Seoul National University in 1977 and 1980 respectively. He then did his PhD in Physics at University of Connecticut, USA and worked at University of Georgia as a Research Associate. He joined Chungbuk National University in 1990 after working at Korea Standard Research Institute..

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Haruhiko Morito, Res. Rev. J Mat. Sci. 2017
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Crystal growth of Na-Si clathrates by the flux method

Haruhiko Morito
Tohoku University, Japan

Introduction: Si clathrate compounds have been widely studied due to their unique open-framework structures of Si polyhedrons. Two types of Si clathrates encapsulating Na atoms have been known: type I (Na_8Si_{46}) and type II (Na_xSi_{136}, $0 < x \le 24$). These Na-Si clathrates have been generally synthesized by thermal decomposition of a Na-Si binary compound, Na_4Si_4, at 673–823 K under high-vacuum conditions ($< 10^{-2}$ Pa), and the obtained samples were in the form of powder with a particle size in the micrometer range.

Purpose: The purpose of this study is the crystal growth of the type I and type II Na-Si clathrates by using a Na-Sn flux.

Experiment: The starting material of a mixture of Na, Na4Si4, and Na15Sn4 was prepared by heating Na, Si, and Sn (molar ratio, Na/Si/Sn = 6:2:1) at 1173 K in Ar atmosphere. The mixture was heated at 673–873 K for 6–24 hours in the container with a temperature gradient. After heating, air-sensitive compounds in the samples, such as Na-Sn compounds, were reacted with ethanol, and the water-soluble reactants were removed by washing with water. Sn present in the products or formed by the ethanol treatment was removed by dissolution in a dilute nitric acid aqueous solution.

Results: The single crystals of type I clathrate were crystallized due to the evaporation of Na from the Na-Sn-Si solution at 673–773 K. Most of the single crystals had sizes of several hundred micrometers to 1 mm, and the maximum size reached to about 3 mm. Heating the starting mixture at 823–873 K resulted in the crystal growth of the type II clathrate. The single crystals having {111} habit planes grew up to about 2 mm in size.

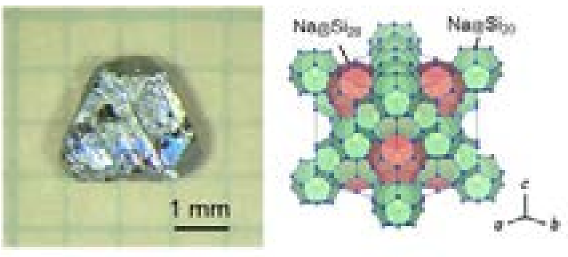

Figure 1: Single crystal (left) and the crystal structure (right) of type II Na-Si clathrate.

Biography

Haruhiko Morito has his expertise in Material Science and Engineering. The main objective of his research is to develop an emerging material which has a new function and new physical properties. In particular, he has developed new functional ceramics containing alkali metals. He has also developed a new crystal growth process based on the binary phase diagram of sodium and silicon. He has synthesized various silicon-based materials by the sodium flux method.

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Isaac D Adebiyi, Res. Rev. J Mat. Sci. 2017
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Microstructure and surface properties of Ti-6Al-4V cold spray coated with SiC-based cermet

Isaac D Adebiyi
Vaal University of Technology, South Africa

Statement of the Problem: A more ubiquitous application of Ti-6Al-4V in the aerospace industry has been hindered by its poor set of surface properties. The cold spray coating (CSC) process is suitable for improvements in the surface properties but the process is very complex, and highly dependent and sensitive to small changes in its many process parameters. Moreover, the CSC is also very selective of the choice of powder materials. The choice is not only based on application requirements but also on plastic deformability of the powder.

Methodology & Theoretical Orientation: This investigation presents a mathematical identification of the optimum process parameters by using a constitutive equation to solve the continuity, momentum and the energy equations governing the flow of fluid through the low-pressure cold spray nozzle. A CFD analysis is performed to determine the input temperature that will yield the calculated velocity by using the meshing tool of solid works to analyse the distribution of velocity, temperature, and pressure in the cold spray nozzle and predict their exit values. The optimum parameters were used to deposit a SiC-based cermet on Ti-6Al-4V. The microstructure and phase evolution in the coatings were studied; porosity was measured using ImageJ analysis software; the hardness was measured using Vickers hardness tester; adhesion test was performed according to ASTM C633-1; and the dry sliding wear behaviour was studied in a ball-on-disc configuration using a load of 25 N at a frequency of 5 Hz.

Findings: Results showed that the initial phases in the feedstock powder were retained in the coatings. No detrimental phase transformation, decomposition and/or decarburization of the SiC. There was peak shift between the phases in the feedstock powder that of the coatings. This is traced to impact-induced micro-straining, amorphization and grain refinement. Good adhesion strength and improvements in hardness and wear resistance were obtained in the coated samples although with a higher coefficient of friction which is traceable to higher strength and lack of micro films in the coating.

Conclusion & Significance: The improved surface properties of the coating will lengthen the lifespan of the expensive Ti-6Al-4V alloy, leading to significant cost savings for the aerospace industry.

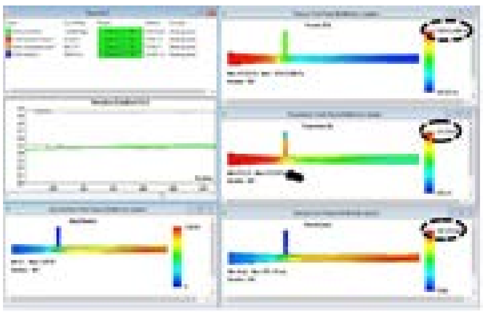

Figure 1: CFD Predictions of the Exit Velocity at 723 K

Biography

Isaac D Adebiyi D is a Lecturer in the Department of Metallurgical Engineering, Vaal University of Technology, Vandebijlpark, South Africa. He holds a Doctoral degree in Metallurgical Engineering with specialization in new materials development. His research interests include surface modification of engineering materials (Laser Materials Processing, Cold Spray Coating, High Velocity Oxy Fuel Coating, etc.), additive manufacturing, computational fluid dynamics modelling and simulation, tribology and wear mitigation, process optimization, alloy design and physical metallurgy of alloys, microstructure and phase evolution studies, multifunctional coatings development, and development of smart and advanced materials. He received an award for Innovation and Excellence in the use of stainless-steel by the Southern Africa Stainless-steel Development Association. He has authored many publications and has chaired plenary section and moderated international conference.

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Mohd Farooq Wani, Res. Rev. J Mat. Sci. 2017
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High temperature tribological behavior of AISI D2 against AISI 52100 and alumina

Mohd Farooq Wani
National Institute of Technology Srinagar, India

In cold forming, die materials are subjected to severe wear because of high contact temperature and pressure. D2 steel is used as die material for cold forming applications. However, its friction and wear properties have not been studied fully under high stress and high temperature conditions. Friction and wear behavior of D2 steel against AISI 52100 and Alumina have been studied under dry sliding conditions in temperature range of RT – 150°C, using ball-on-disc universal tribometer. For sliding distance test the wear rate of D2 with AISI 52100 is less than the Alumina for entire range at 150°C. The wear volume of D2 steel increases with the increase in sliding distance from 200 m to 1000 m against AISI 52100 and Alumina. For D2 steel, highest coefficient of friction (μ) 0.751 and 0.754 against AISI 52100 and Alumina was obtained at 5 N, whereas minimum μ of 0.32 and 0.43 against AISI 52100 and Alumina was obtained at 25 N, these tests were carried out at 150°C. For temperature test, highest coefficient of friction (μ) of 0.92 and 0.7671 against AISI 52100 and Alumina was obtained at 50°C, whereas minimum μ of 0.77 and 0.52 against AISI 52100 and Alumina was obtained at RT. Optical microscopy, SEM, EDXA and 3D profilometery have been used to understand the friction and wear mechanism of tribopair. From these observations it is concluded that wear of D2 steel is minimum for particular range of load and temperature. The results obtained are useful for designers and engineers working in the field of cold forming.

Biography

Mohd Farooq Wani has expertise in the Field of Life Cycle Engineering Design and Tribology. He possesses 35 years of teaching and research experience at UG, PG and PhD level. His concept of sustainability design of mechanical systems through innovative tribological applications is unique contribution in the development of sustainability design of mechanical systems. He has guided more than 50 theses at PG level in the Field of Tribology and Life Cycle and has successfully guided 6 PhD theses in the Field of Tribology and LCD. He has published 50 research papers in international journals and more than 40 publications in international conference proceedings.

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Tengyuan Zhang, Res. Rev. J Mat. Sci. 2017
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Facile fabrication of hybrid copper-fiber conductive features with enhanced durability and ultra-low sheet resistance for low-cost high-performance paper-based electronics

Tengyuan Zhang
Western University, Canada

The accelerating arrival of the Internet of Things (IoT) era creates huge demand for low-cost, high-performance paper electronics. However, fabricating highly conductive circuit on low-cost cellulose paper is challenging due to its high roughness and resolution loss caused by capillary effect. To address these challenges, we propose a scalable, cost-effective method to fabricate high-performance electronics on regular cellulose paper. Taking advantage of the unique porous structure of cellulose paper, we activate the three-dimensional electroless deposition of copper for fast generation of the hybrid copper-fiber highly conductive structure. Currently, the sheet resistance of most PE product is 50 mΩ/sq. With the technology mentioned above, 5 mΩ/sq (10 times better) can be easily achieved with low cost and high resolution (100 microns feature size). Thanks to its unique copper-fiber hybrid structure, both the physical and electrical properties are greatly enhanced for wider variety of applications. To demonstrate its promising application, a functional battery-free energy harvesting device and a high-performance planar antenna for RFID were fabricated and tested using the proposed method.

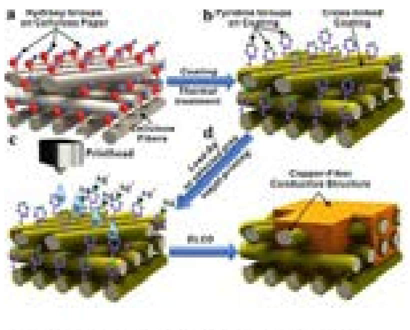

Figure 1. Fabrication process of a copper-fiber conductive structure on cellulose paper.

Biography

Tengyuan Zhang is currently a PhD Candidate of Mechanical & Materials Engineering in Western University, London, Ontario. His research explores printed flexible and stretchable electronics. Based on his research, he co-founded Nectro Inc. in 2015 with the goal of developing novel nano-materials and bringing them to people's life. He was awarded the Vanier Canada Graduate Scholarship in 2015 and won the Doctoral Excellence Research Award in 2016. Now, he looks to combine cutting-edge nanotechnology and advanced chemical/material science to find a robust, low-cost solution for manufacturing high-performance, high-resolution flexible and stretchable electronics.

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Scientific Tracks & Abstracts

Day 3

Klaus G Nickel et al., Res. Rev. J Mat. Sci. 2017
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The potential of improving building construction materials by a biomimetic approach

Klaus G Nickel[1], **Katharina Klang**[1], **Christoph Lauer**[1], **NicuToader**[2] and **Werner Sobek**[2]
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The design of spines from some reef inhabiting sea urchins (*Heterocentrotus mamilatus, Phyllacanthus imperialis*) has shown to be responsible for high energy dissipation during compressive straining. It is shown that unusually high stresses are required to compress the material, which fails in a "graceful" manner during an overall straining of several tens of percent. The principal behind the mechanism involves the layering/gradation/ordering of pore space within a basically brittle material (Calcite). We will show the details of the structures and the results of the characterization by uniaxial compression and pin indentation. The natural material has a hierarchical design including a structuring on the nano-scale to prevent a failure by simple cleavage. It would therefore be difficult to scale up all structural features of this brittle material. We will discuss how improvements of material can nonetheless be implemented by abstracting only the more macroscopic features and choosing a suitable material. First efforts to apply this biomimetic principle to concrete as a modification of functional graded concretes confirm the effectiveness in construction materials. The design is not only beneficial for failure tolerance in cases of impacting objects, but improves at the same time thermal insulation properties and lowers the total weight of constructions. The concrete was realized by spraying and slip casting methods. We will also present a recently developed alternative method for the manufacture of 3D concrete constructions ("hydroplotting"), which allows the realization of very detailed designs.

Fig. 1: A sea urchin spine (colored) in compression test displaying the "graceful failure" behaviour

Biography

Klaus G Nickel is Professor of Applied Mineralogy at the Faculty of Science of the University of Tübingen. His career involved a Dipl-Geol. from the University of Mainz (D), a PhD from the University of Tasmania (Hobart, AUS) and research positions at Max-Planck-Institutes (for Chemistry, Mainz, and Metals Research, Stuttgart). His main research interest is in materials science in the field of Advanced Ceramics and Composites. The research covers processing, characterisation and evaluation of technical ceramics, typically alumina and zirconia in the oxides and carbon, carbides, nitrides, borides on the non-oxide side. His particular expertise exists in the chemical property evaluation (oxidation and corrosion). Other research goals are phase relations, mechanical properties and bionics of biomaterials and ceramics.

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Notes:

David Kennedy, Res. Rev. J Mat. Sci. 2017
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Quantifying the biological fate of nanosilver

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With a growing number of high precision tools for studying biological systems, it is important to develop traceable quantitative methods that result in accurate measurements. Because biological systems are both complex and fluxional, context is vitally important for such measurements in order for them to be accurate. Correlation of measurements through space and time can provide such quantitative assessments. Metallic nanoparticles pose many challenges for measurement in cellular systems. The metal can interfere with the detection method and the particles can change in size and shape over time and in association with different biological molecules. At the National Research Council, we seek to correlate detailed physical characterization of silver nanoparticles with biological measurements to generate methods for measuring the impact of nanosilver on different cell types and quantifying the specific interactions of nanosilver with biological molecules. Correlating changes in nanoparticles over time in biological fluids helps to provide an understanding of nanoparticle behaviour and results in higher reproducibility of observed biological endpoints. Surface coatings play a pivotal role in recognition of the particles by cellular receptors suggesting active transport plays a critical role in the nanosilver life cycle. Physical and chemical differences between silver nanoparticles and changes that occur in biological test media can be correlated to toxicity, and different mechanisms for toxicity are apparent. Uptake rates and localization is also different between different cell lines. Uptake and localization of particles provides evidence that nanosilver should not be treated as a single material but should be studied as an array of materials with different properties in different biological systems.

Biography

David Kennedy is an expert in Biological Inorganic Chemistry with nearly a decade of experience working at the nano-bio interface. He currently works in the areas of nano- and bio-metrology at the National Research Council Canada. Previously, he has also held posts in Chemical Biology, Molecular Imaging and Nanomedicine both at the NRC and MPI in Berlin, Germany. Currently, he is focused on building new tools for standardizing measurements of nanomaterials in biological systems. This also includes the use of new nanobiomaterials used to mimic living tissues. Research in his lab also partners across several other government organizations including Health Canada, Environment Canada and the Canadian Food Inspection Agency, as well as several different parts of the NRC.

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Photochromic organic field-effect transistors: Molecules, device properties and laser patterning of circuits

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We developed an optically controllable organic field transistor (OFET) by employing photochromic diarylethene (DAE) molecules as a transistor channel layer. DAE molecules are known to undergo photochromic reaction, i.e., reversible conformational change between closed- and open-ring isomers by alternating ultraviolet (UV) and visible (VIS) light irradiation. We found that the drain current in the DAE-based OFET also showed reversible change accompanied by this conformational change; the closed-ring isomer produced by UV light exhibited a transistor operation under appropriate gate and drain bias voltages, meanwhile the open-ring isomer produced by VIS light showed no drain current. As a result, a remarkably high on/off ratio of 1,000 was achieved. The drain current modulation can be attributed to the drastic transformation in the π-conjugation system in association with the photo-isomerization. These results present two important messages. The first one is that this compound has dual properties: organic semiconductor and photochromism. The second is that a phase transition between semiconductor and insulator can be induced by light irradiation. Based on these achievements, we demonstrate laser drawing of one-dimensional (1D) channels on an OFET with a photochromic DAE layer. The main findings are: i) a number of 1D channels can be written and erased repeatedly in the DAE layer by scanning UV and VIS focused laser spots alternately between the source and drain electrodes, ii) the conductivity of the 1D channel can be controlled by the illumination conditions, and iii) it is possible to draw an analogue adder circuit by optically writing 1D channels so as to overlap a portion of the channels and perform optical summing operations by local laser illumination on the respective channels. These findings will open new possibilities of various optically reconfigurable low-dimensional organic transistor circuits, which are not possible with conventional thin film OFETs.

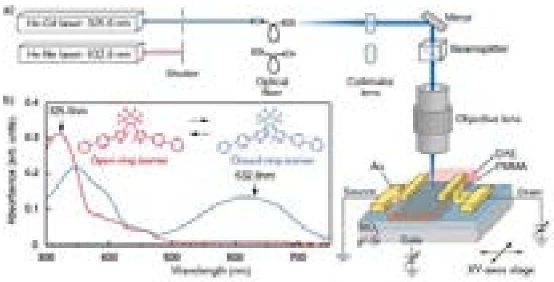

Fig.1 Molecule, absorption spectra, and experimental setup for laser drawing of 1D transistor channels

Biography

Yutaka Wakayama has served as a Research Engineer at Asahi Glass Company from 1989 to 1994. He was a research staff member at Tanaka Solid Junction Project, ERATO, JST from 1994 to 1998 and received his PhD degree from University of Tsukuba in 1998. After working as a Post-doctoral fellow at Max-Planck Institute for Microstructure Physics, Germany in 1998-1999, he has joined National Institute for Materials Science (NIMS) in 1999. At present, he belongs to International Center for Materials Nanoarchitectonics (WPI-MANA) of NIMS. His current research interests are self- and directed-assemblies of molecules, functional organic field-effect transistors and molecular nano-electronics.

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Md. Shafiul Azam et al., Res. Rev. J Mat. Sci. 2017
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A bioinspired strategy for immobilizing silver nanoparticles towards the synthesis of antimicrobial paper

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Statement of the Problem: Antimicrobial materials based on various nanoparticles has attracted huge attention in last few decades because of the cheapness, easiness to use, and effectiveness in preventing annexation and proliferation of microbes on material surfaces. Paper has been used in many applications as a matrix to carry the nanoparticles due to its high porosity, considerable mechanical strength, and high availability. Silver nanoparticles (AgNPs) have widely been used as antibacterial/antifungal agents in a varied range of consumer products because of their large active surface area. However, effective methods for immobilizing AgNPs on cellulose paper or similar surfaces for various applications are inadequately advanced.

Methodology & Theoretical Orientation: By exploiting a novel and simple mussel-inspired strategy, here, we present our method for immobilizing AgNPs on paper. First, we modified cellulose paper with dopamine molecules by a simple, efficient, and environmentally friendly approach. The dopamine molecules possess excellent adhesion and strong coordination with metal substrates through catechol groups offering a potentially robust interface between AgNPs and organic structure of paper. Next, AgNPs are deposited onto the paper by simply immersing dopamine modified paper in silver salt solution to attain the antimicrobial properties.

Findings: The SEM study of the synthesized antimicrobial papers confirmed that the loading of AgNPs was time dependent and the average size of the nanoparticles became 50-60 nm after 12 hours of deposition time. FTIR and XPS analysis of the paper modified at each step revealed the introduction of new functional groups through the synthesis. The mechanical strength of the paper measured as similar as fresh filter paper by using a universal testing machine will also be presented.

Conclusion & Significance: The paper decorated with AgNPs showed excellent antimicrobial activity against highly virulent and multiple antibiotics resistant Gram positive and Gram negative bacteria. It also showed antifungal activity against some extremely virulent fungal species.

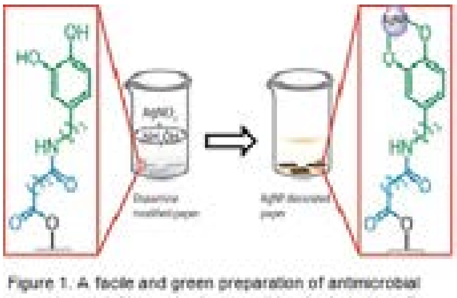

Figure 1. A facile and green preparation of antimicrobial paper by exploiting a simple mussel-inspired strategy for immobilizing AgNPs onto cellulose paper.

Biography

Md. Shafiul Azam is the Principal Investigator of a materials and surface chemistry research group in the Department of Chemistry at Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh. His multidisciplinary research is focused on the development of new multifunctional materials for energy, health and environment. Multicomponent hybrid materials for achieving increased complexity and functionality in nanoparticles have attracted enormous attention from researchers. These nanomaterials are composed of discrete domains of different components and thus can exhibit the properties of different components in the same assembly. In his group, they synthesize surface-tailored, size-controlled inorganic nanoparticles and polymeric materials as well as investigate their properties and potential applications.

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L Shoko et al., Res. Rev. J Mat. Sci. 2017
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Effects of the chemical composition of coal tar pitch on the baking zone temperature in Soderberg electrode systems

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Coal can be converted to different chemical products through processes such destructive distillation. The destructive distillation of coal yields coke as the main product with by-products such as coal tar pitch (CTP). CTP has a wide range of applications especially in the carbon processing industries with typical applications including manufacture of anodes used in many electrochemical processes as well as Soderberg electrodes used in electric arc furnaces. This paper presents results from a study carried out to establish the baking isotherm temperature of coal tar pitch during thermal treatment. Thermomechanical analysis (TMA) was used to measure the dimensional changes which take place in pitch in the baking zone during thermal treatment. Elemental analysis, Fourier Transform Infra-Red (FT-IR) and Nuclear Magnetic Resonance Spectroscopy were used to evaluate the chemical composition of different raw and thermally treated coal tar pitch samples. The results from this study demonstrated that the baking isotherm temperature of coal tar pitch is the same irrespective of the chemical composition and origin of the coal tar pitch. In addition to that, the results also indicated that the coal tar pitches shrunk approximately 12% if exposed to temperatures above the baking isotherm temperature up to 1300°C.

Biography

L Shoko has completed his PhD in Chemistry from North West University (South Africa) in 2014. He is currently working as a Senior Research Technologist in the Department of Chemical Engineering at the Vaal University of Technology. His thesis was focused on the study of effects of chemical composition of coal tar pitch on dimensional changes during graphitization. He is currently working on a project that involves producing activated carbon from coal tar pitch and its application in removal of phenols from waste water.

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Sang-Wook Han et al., Res. Rev. J Mat. Sci. 2017
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Growth, structural and electrical properties of VO_2/ZnO nanostructures

Sang-Wook Han, In-Hui Hwang, Zhenlan Jin and **Chang-In Park**
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VO_2 is a typical metal-insulator-transition (MIT) material with the bandgap of ~0.7 eV and the Tc of ~ 70ºC. VO_2 is transparent and dark below and above the Tc, so that it can be applicable for smart windows by controlling the temperature. VO_2 nanoparticles in a metallic phase block and scatter sunlight. The scattered sunlight by VO_2 nanoparticles can be used in solar cells. We examined the local structural and electrical properties from VO_2/ZnO nanostructures by using the simultaneous measurements of X-ray absorption fine structure (XAFS) and resistance. The structural and electrical properties of VO_2 depend on the length of ZnO nanorods underneath VO_2. Direct comparison of simultaneously-measured resistance and XAFS from the VO_2 demonstrates that the transitions of structures, local density of the V 3d orbital states, and resistance occurred in sequence during heating, whereas the properties changed simultaneously during cooling. XAFS reveals a substantial increase of Debye-Waller factors, particularly, V-V pairs along the {111} direction in the metallic phase. XAFS results indicate that soft phonon above Tc plays a critical role in the collapse of a small band gap of VO_2. The local structural and the electrical properties of VO_2/ZnO nanorods are considerably sensitive to the interface of VO_2/ZnO as well as the length of ZnO nanorods. The interface properties of VO_2 hetero-structures should be considered for its applications to smart windows and solar cells.

Biography

Sang-Wook Han has published over 70 research papers in Solid State Physics, Nanoscience, and Nanotechnology and given over 30 invited lectures. His major research field is the micro-structural and chemical property characterizations of nanomaterials using X-ray absorption fine structure (XAFS) and nanomaterial applications including sensors, battery, and solar cells.

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Temperature-dependent hard X-ray excited optical luminescence to study the optical properties of the ZnO microwires

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The advantages of using synchrotron radiation as the excitation source are that the tunable X-ray energy allows the preferential excitation of the elements through the X-ray absorption edges, and a suitable time structure of the synchrotron can be used to study the dynamics of luminescence of the materials. We developed the synchrotron based hard X-ray excited optical luminescence (XEOL) and time-resolved X-ray excited optical luminescence (TR-XEOL) at the X-ray Nanoprobe (XNP) facility at Taiwan Photon Source (TPS). In parallel to the construction of the XNP endstation, demonstrative XEOL experiments were conducted by unfocused X-ray beam at Taiwan Light Source (TLS). The low temperature (4.2K) and temperature-dependent XEOL with X-ray excited energy below, at and above the Zn K-edge (9.659 keV) were used to obtain the further information of the optical mechanisms of the ZnO microwires. The temperature-dependent XEOL behavior of the ZnO microwires with X-ray energy at 9.67 keV was shown in Figure 1. The free A excitons, donor bound excitons and their phonon replicas can be seen unambiguously at low temperatures. The design of the XEOL and TR-XEOL at XNP and the demonstrative experimental results will be reported.

Biography

Bi-Hsuan Lin has completed his PhD from Department of Photonics and Institute of Electro-Optical Engineering, National Chiao Tung University, Hsinchu, Taiwan and Post-doctoral studies from European Synchrotron Radiation Facility (ESRF) for one year. Currently, he works at National Synchrotron Radiation Research Center as the Assistant Research Scientist. He is participating in the construction and commission of the X-ray nanoprobe beamlime at Taiwan Photo Source (TPS), and is responsible for development of the XEOL and TR-XEOL.

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High temperature sliding wear of Inconel 718 against silicon nitride and alumina

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In closed cycle gas turbine, turbine blades are subjected to severe wear because of high contact temperature and pressure. Inconel 718 is used as a blade material for closed cycle gas turbine applications; however, its friction and wear properties have been studied fully under high stress and high temperature conditions. Friction and wear behavior of Inconel 718 against silicon nitride and alumina have been studied under dry sliding conditions in temperature range of 40-500°C using ball-on-disc universal tribometer. For sliding distance test the wear rate of Inconel 718 with alumina is less than silicon nitride for the entire range at 500°C. The wear volume of Inconel 718 increases with the increase in sliding distance increases from 200 m to 1000 m against alumina and silicon nitride. For Inconel 718 highest coefficient of friction (μ) of 0.88 and 0.52 against alumina and silicon nitride was obtained at 10 N, whereas minimum μ of 0.45 and 0.40 against alumina and silicon nitride was obtained at 20 N, these tests carried out at 500°C. For temperature test highest coefficient of friction (μ) 0.75 at 400°C and lowest μ 0.46 at 200°C against silicon nitride whereas highest coefficient of friction (μ) 0.88 at 200°C and lowest μ 0.54 at 500°C against alumina. Optical microscopy, SEM, EDXA, and 3-D profilometery have been used to understand the friction and wear mechanism of tribopair. From these observations it is concluded that wear of Inconel 718 is minimum

Biography

Mohd Farooq Wani has expertise in the Field of Life Cycle Engineering Design and Tribology. He possesses 35 years of teaching and research experience at UG, PG and PhD level. His concept of sustainability design of mechanical systems through innovative tribological applications is unique contribution in the development of sustainability design of mechanical systems. He has guided more than 50 theses at PG level in the Field of Tribology and Life Cycle and has successfully guided 6 PhD theses in the Field of Tribology and LCD. He has published 50 research papers in international journals and more than 40 publications in international conference proceedings.

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