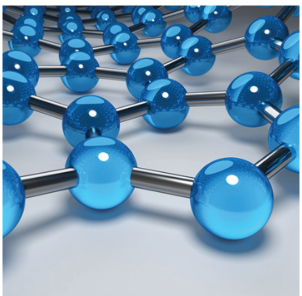
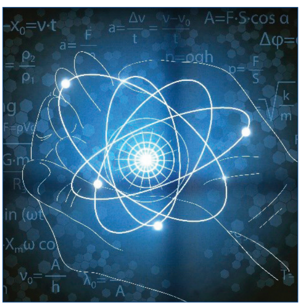
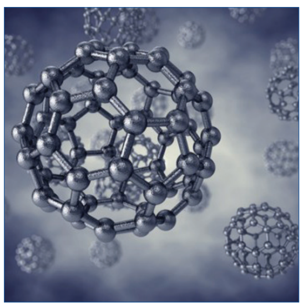
e-Poster

Biomaterials & Materials Physics 2019



2nd International Conference on

Biomaterials and Nanomaterials & Materials Physics and Materials Science

May 20-21, 2019 | Vienna, Austria

Production of cell concrete blocks using cocoa fatty acids and foundry wastes

Rudimar Pedro
Federal University of Rio Grande do Sul (UFRGS), Brazil

The northern region of the State of Rio Grande do Sul is an important metal / mechanic industrial pole, with an extensive and varied equipment portfolio, especially the manufacture of agricultural implements. In foundries s parts used in the manufacture of agricultural machinery a lot of sand are used, generating waste in accordance with standard NBR 10004/2004, which deals with the classification of solid waste as their potential risks to the environment and health waste sand is classified as class II A. This class includes non-hazardous and non-inert waste. Their environmentally sound disposal in controlled or sanitary landfills represents an important expense in the cost sheet and requires careful management for the generating industries that are directly responsible for incidents and accidents and co- responsible for possible future environmental liabilities, even with landfill toilets paid. Specifically, this work evaluated the possibility of using the casting sands in the manufacture of cellular foam blocks (BCCE), their inertization and consequent use as building blocks in civil construction. The production methodology will be based on models studied and already published in papers and scientific articles, laboratory tests and also in industrial format. In previous bench studies, after characterization of the casting sand as its grain size curve, DRX, DFX, the analysis of the foam composition, the particle size of the residue, the water content and the mixing time. The BCCE component materials are sandcast residue, collected in the KUHN DO BRASI industry, foam prepared with coconut fatty acids, drinking water quality and cement as a binding agent. In the bench tests, 36 test specimens, cylindrical in size, 50 mm in diameter per 100 mm in height, with different volumes of incorporated air, were divided into three groups. The samples were left for 28 days at room temperature, in the curing process, and after analysis for the compressive strength, density and distribution of the air bubbles.

e: rudimarpedro@yahoo.com.br

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Accepted Abstracts

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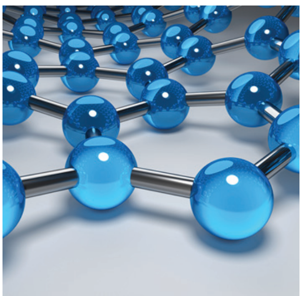

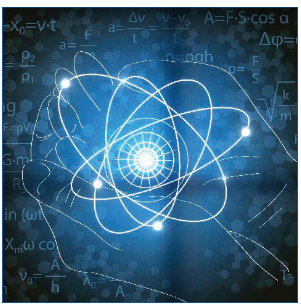

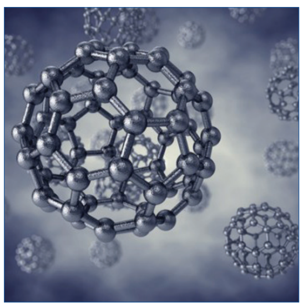

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Some critical problems of the mechanical behavior and performance of electronic and optical materials, assemblies and systems: Application of analytical ("mathematical") modeling

E Suhir
Portland State University, USA

Some critical problems of the mechanical behavior and performance of electronic and optical materials, assemblies and systems are addressed and discussed. It is shown that application of analytical modeling (always confirmed by finite-element-analyses) enables to reveal and explain the underlying physics associated with such, often non-obvious, always non-trivial and sometime even paradoxical, problems and situations. Most of the problems were encountered by the first author during his tenure with Bell Labs (basic research area, Murray Hill, NJ), University-of-California at Santa Cruz, Portland State University at Portland, OR, and small business innovative research (SBIR) ERS Co., USA. The following major problems are addressed: magnitude and distribution of the interfacial thermal stresses in adhesively bonded or soldered assemblies; incentive for using low modulus bonding materials and, in some cases, materials with low yield stress; assemblies bonded at the ends; incentive for using test specimens with transverse grooves in the bonded materials for lower and more uniformly distributed interfacial stresses; thermostatic compensation in temperature-sensitive devices using conventional materials (as opposite to ceramics with negative CTE); bow-free (temperature change insensitive) assemblies; thermal and lattice mismatch stresses in semiconductor crystal grown assemblies; ability to adequately mimic drop test conditions using shock testers; demonstration that the maximum acceleration is not always the adequate criterion of the dynamic strength of an electronic product, and that a static short-term load could be more damaging than the dynamic one; combined action of tensile and bending deformations of the PCBs subjected to drop tests and ability to obtain closed-form and even exact solutions for highly nonlinear shock-excited vibrations, such as, e.g., those taking place during drop tests on the board level; role of upper harmonics during drop tests; nonlinear response of the rocket PCB (with surface-mounted devices on it) to the sudden acceleration applied to its support contour; modeling situations, when the dynamic response of a linear or a non-linear electronic system subjected to a short-time loading can be substituted with an instantaneous impulse; stress relief in solder joints of the second level of interconnections (package to PCB) owing to larger stand-off heights of the solder joints; incentive for using inhomogeneous solder joint systems for lower thermally induced stresses; thermal stress in flexible electronics; ability to predict the threshold of the added transmission losses in jacketed (single coated) optical fibers using mechanical considerations; incentive for mechanical pre-stressing of accelerated test specimens subjected to thermal loading; ability to relieve stress in thermoelectric module designs using thinner and longer legs; reducing bending stress in optical fiber interconnects by properly rotating their ends; low-temperature micro-bending of long-haul dual-coated optical fibers; two-point bending of optical fiber specimens. It is concluded that all the three basic approaches in microelectronics and photonics materials science and engineering - analytical ("mathematical") modeling, numerical modeling (simulation) and experimental investigations - are equally important in understanding the physics of the materials behavior and in designing, on this basis, viable and reliable electronic devices and products. As to analytical modeling, it is a powerful tool that enables one to explain critical and often paradoxical situations in the behavior and performance of electronic materials and products, and to make a viable device into a reliable product.

e: suhire@aol.com

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Synthesis of disruptive technologies and innovations in nano-materials for economizing oil & gas operations

Indranil Roy[1,2], Ting Chen Roy[3], Ram Shenoy and **Jing Zhou[2]**
[1]UniPolar Technology Inc., USA
[2]Rice University, USA

Ultrafine grained (UFG) and bulk nano-crystalline (NC) alloys possess unique properties of high-strength, corrosion-resistance, making them ideal candidates for applications in demanding conditions, for example deployment in sour-hostile reservoirs. Conflicting data on mechanism(s) and corrosion behavior of nanomaterials have been published because of several factors, primarily due to limitations of experiments conducted in aggressive (high pressure and temperature (HPHT) caustic) environments. Here we present, our know-how around a large number of novel fabrication and processing techniques with controlled supply chain to tailor multi-functional properties of materials by manipulating materials microstructure at atomic scales to achieve combination of strength, ductility, fracture-toughness, corrosion resistance, among other properties with a focus on accelerated corrosion or dissolvability. Our lecture will encompass experiments exposing nano-materials to HPHT conditions to demystify conundrums current in literary domains. As concluding remarks, we will reflect on (a) our capabilities to synthesize disruptive technologies across industries, to increase the throughput of engineering operations, the basis of our competitive advantage (b) integrating nano-materials into areas of upstream oil and gas to economize.

e: iroy@unipolartech.com

Microwave sintering of dental ceramics

Martin Pendola
SUNY Downstate Medical Center, USA

The use of ceramics in dentistry, and across the biomedical field, has been increasingly improving and expanding in the last years. Improvements in quality, versatility and mechanical properties have played a crucial role in the expansion of the indications and purposes of these materials in dentistry and many other fields. While much research to improve ceramics has been focused in the modification of the chemistry of the materials, the processing methods has not been dramatically modified in the last years. Sintering, a key process of the production of dental ceramics, has remained relatively unmodified over the years. Microwave sintering, a technology which is common for industrial settings (communications, industrial drying and heating), it is suitable for dental ceramics. The advantages of a volumetric heating reduce dramatically the processing times, and therefore, the energy consumption. The technology is easily adaptable and available in most of the markets, with a lot of possibilities for engineering a new generation of devices. The use of microwave sintering not only reduces the processing costs, as time and energy savings, but also offers a very attractive “side-effect”: the improvement of mechanical properties of the material, leading to an extension of the service life, which has a huge impact in the clinical performance for the patient. In this presentation, we will show the main characteristics of the process, and we will present the qualitative and quantitative results of our sintering protocols designed for dental ceramics processed using microwaves.

e: martinpendola@nyu.edu

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Artificial photosynthesis enabled by nature's blueprints and building blocks

Elena A Rozhkova
Argonne National Laboratory, USA

The biological use of the solar energy for syntheses of fuels from water and carbon dioxide has been inspiring researchers and engineers in their efforts to replace current exhaustible energy sources to renewable energy technologies. Environmentally friendly schemes of photocatalytic visible-light hydrogen production known as artificial photosynthesis along with inorganic semiconductor material also utilize biological structures, such as enzymes, machineries of whole microorganism, capable of light-harvesting, water splitting, carbon dioxide and proton reduction. We have been developing visible-light-driven nano-bio photocatalysts for hydrogen production based on non-covalent assemblies of the natural and synthetic membrane proton pump and TiO2 semiconductor nanoparticles. A natural membrane complex of retinal-containing proton pump bacteriorhodopsin (also known as purple membranes, PM) from the extremophile microorganism Halobacterium salinarum has been attracting an attention of researchers owing to its exceptional robustness, excellent photophysical properties, and structure−functional elegance. We demonstrated applicability of PMs in sunlight transformation systems constructed from TiO2, boosted with introduction of reduced graphene oxide rGO, or more recently, constructed as entirely synthetic PM – semiconductor architecture using cell-free synthetic biology approach. Merging nanotechnology and synthetic biology approaches allows for systemic manipulation at the nanoparticle−bio interface toward directed evolution of energy materials, novel catalytic systems and artificial life structures.

e: rozhkova@anl.gov

Discovery of dirac node lines in pure metals of beryllium and magnesium and their potential applications

Chen Xing Qiu
Shenyang National Laboratory for Materials Science, China

Beryllium is a simple alkali earth metal but has been the target of intensive studies for decades because of its unusual electron behaviors at surfaces. Puzzling aspects include severe deviations from the description of the nearly free electron picture, anomalously large electron-phonon coupling effect, and giant Friedal oscillations. The underlying origins for such anomalous surface electron behaviors have been under active debate, but with no consensus. Here, by means of first-principle calculations, we discover that this pure metal system, surprisingly, harbors the Dirac node line (DNL) that in turn helps to rationalize many of the existing puzzles. The DNL is featured by a closed line consisting of linear band crossings and its induced topological surface band agrees well with previous photoemission spectroscopy observation on Be (0001) surface. We further reveal that each of the elemental alkali earth metals of Mg, Ca, and Sr also harbors the DNL, and speculate that the fascinating topological property of DNL might naturally exist in other elemental metals as well.

e: xingqiu.chen@imr.ac.cn

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Disordered proteins: A new avenue towards hierarchical functional materials

Sherif Elsharkawy
King's College London, UK

There is growing evidence that intrinsically disordered proteins (IDPs) play a fundamental role in mineralization. IDPs contribute in intermolecular interactions at the protein–mineral interface. Here we report a protein-mediated mineralization process that takes advantage of disorder-order interplay using elastin-like recombinamers (ELRs) to program organic-inorganic interactions into hierarchically-ordered mineralized structures. During crosslinking process, ELRs self-assemble into a dense network of nanofibers and homogenously distributed three-dimensional (3D) ELR spherulites. Upon incubation in a solution supersaturated with respect to apatite, the materials comprise elongated apatite nanocrystals that are aligned and organized into microscopic prisms, which grow together into spherulite-like structures hundreds of microns in diameter. Given, the vast clinical need and potential impact of engineering more efficient materials to replace lost/diseased enamel, we conducted in vitro proof-of-concept studies to investigate the potential use of the hierarchical mineralized structures for dentin hypersensitivity as a mineralizing bandage to occlude exposed dentinal tubules. We confirmed that the hierarchically mineralized membranes grew, adhered, and conformed to the surface of the etched dental tissues. Integration between the hierarchical structures and the dental tissues was observed at the dentin-membrane interface, where the nanocrystals infiltrated and blocked dentinal tubules. The mineralized structures exhibited comparable acid resistance to dental enamel. Our approach takes advantage of the disordered nature of ELR molecules to trigger a supramolecularly organized organic framework capable of controllably templating the growth of apatite crystals at multiple length scales. This mechanism goes beyond biomimicry and opens up the possibility to not only modulate mineralization but also to explore ways of utilizing disorder-order interplay for the generation of functional materials. The study represents a potential strategy for complex materials design that may open opportunities for hard tissue repair and provide insights into the role of molecular disorder in human physiology and pathology.

e: sherif.elsharkawy@kcl.ac.uk

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Core-shell $SrTaO_2N$ nanowire photoanode for photoelectrochemical water oxidation

Adam Slabon
Tockholm University, Sweden

Solar fuel generation in the form of hydrogen derived directly from water represents an environment-friendly technology to obtain clean energy. Oxynitrides are promising candidates for photoanodes in water-splitting cells due to their tunable bandgaps and low cost. Especially quaternary oxynitrides exhibit small band gap values, between 1.8 and 2.3 eV, suggesting their potential for high solar-to-hydrogen efficiencies.

Light absorbers in a strongly anisotropic morphology, e.g. nanowires, enable to decouple the long axis responsible for high light harvesting from the orthogonal axis responsible for charge transport. This results in efficient light harvesting while simultaneously ensuring improved charge-carrier conductivity. Most nitrides and oxynitrides are usually obtained in the form of microcrystals by nitridation of a precursor oxide phase. Although Ta_3N_5 nanowires can be synthesized by nitridation of Ta2O5 nanowires, this method cannot be applied to quaternary oxynitrides.

The perovskite-related oxynitride $SrTaO_2N$ is a prospective photoanode candidate with favourable band-edge positions. We have synthesized $SrTaO_2N$ nanowires by hydrothermal synthesis on a tantalum substrate and nitridation under flowing ammonia and hydrogen. This is the first trial of a $SrTaO_2N$ photoanode based on nanowires.

e: adam.slabon@mmk.su.se

Biotolerability of intracortical microelectrodes

Eduardo Fernandez
University Miguel Hernández, Spain

There are different ways to profitably apply smart, i.e. stimuli responsive, polymers to the field of biomaterials. Shape memory polymers (SMPs) have a high potential for applications in minimally invasive surgical procedures allowing the design of devices that can modify their macroscopic properties when receiving a stimulus by the human body. Shape Memory Polyurethanes (SMPU) were investigated as promising candidate materials for the repair of bone defects and cerebral aneurism occlusion. Porous SMPU structures were fabricated by foaming processes and their potential biomedical application was evaluated. Thermo responsive polymers undergoing a "reverse" sol-gel transition can be used in Regenerative Medicine to develop smart cell culture surfaces from which to obtain intact cell sheets (Cell-Sheet Engineering, CSE). Recently, extrusion-based bioprinting of methylcellulose (MC)-based hydrogels was used to produce MC hydrogel rings onto which cells sheets were successfully obtained with murine embryonic fibroblasts and endothelial murine cells.

e: e.fernandez@umh.es

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At the interface between nitride compounds and quantum materials

Alberta Bonanni
Johannes Kepler University Linz, Austria

Semiconductor nitride compounds own their relevance, not only to state-of-the-art applications in opto- and high-power-electronics, but also to a number of features particularly attractive for spintronics and spin-orbitronics, enabling, e.g., spin-charge interconversion via spin-orbit coupling associated with inversion asymmetry and leading to a sizable Rashba field and piezoelectric properties. Through the addition of magnetic dopants fostering the formation of magnetic complexes or driving the system to the state of a condensed magnetic semiconductor, these materials open wide perspectives in both fundamental and application-oriented research.

An overview is provided here on how, by controlling the fabrication parameters and establishing a comprehensive protocol of characterization involving also synchrotron-radiation-based methods, we have unraveled and can now control a number of relevant features of these systems. Particularly significant in this context is the generation of pure spin current at room temperature in nitride-based bilayers, pointing at these systems as efficient spin current generators. Besides controlling the self-aggregation and performance of embedded functional magnetic nanocrystals and of optically active complexes, we have proved that the magnetization of dilute III-nitrides doped with transition metals may be controlled electrically. In this way, the piezoelectricity of wurtzite semiconductors and electrical magnetization switching have been bridged. Prospects for proximity-induced topological superconductivity in heterostructures combining graded and Rashba III-nitrides with layered s-wave superconductors are also discussed.

e: alberta.bonanni@jku.at

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Influencing parameters and temperature impact on the fatigue crack growth behaviour of rubbers

Bernd Schrittesser
Polymer Competence Center Leoben GmbH, Austria

The unique mechanical properties of rubbers make them suitable for applications in which cyclic loadings are involved. In this loading condition, failure is mainly related to fatigue and therefore the understanding of the phenomena connected to it results fundamental for a reliable lifetime prediction of rubber products. In the field of elastomeric materials, one of the main approaches followed for fatigue life prediction is the crack growth approach. This is based on the study of the growth of pre-existing cracks up to end of service life using tearing energy as fracture mechanical parameter. The fatigue behaviour of rubbers is influenced by a large number of parameters, which can be related to the mechanical history, environmental conditions and rubber formulation. In order to investigate more into details how the fatigue crack growth behaviour is influenced by the different involved parameters, pure shear specimens were loaded cyclically at different loading conditions and mechanical histories. A camera system was implemented for crack growth detection and the surface temperature was recorded using an IR sensor. A detailed investigation of the influence of different parameters was hence carried out. In particular, the influence of waveform, load and displacement control, mechanical history, frequency and temperature were studied in detail. Moreover, the heat build-up during cyclic loading was further investigated, by monitoring the surface temperature through an IR camera. The aim of this research is to provide a further description of fatigue crack growth in rubbers by defining the influence of different parameters involved during cyclic loading. From a deeper understanding of these influences, models that can supply more accurate lifetime predictions could be developed.

e: Bernd.Schrittesser@pccl.at

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Strontium Aluminate based aerogel phosphors for the enhanced afterglow properties

Gaganpreet Kaur Behrh
ETH Zurich, Switzerland

Owing to the excellent afterglow properties of SrAl2O4:Eu2+Dy3+, there have been several efforts put into the synthesis of this material. Conventionally, this was synthesized via solid state method to obtain bulk scale materials. Recently, nanoscale-based Strontium Aluminates have also grabbed the attention of many researchers. This is due to the size induced changes in the structural, optical and electrical properties of the nanophosphors. However, there is some controversy in the literature with the context of phosphorescence for this material. Some of the groups strongly believe that the afterglow enhances for the nanoscale materials in comparison to the bulk ones due to the confinement of most activators at the surface and enhanced trap depth reasons. On the other hand, there are other groups which suppose that quenching of luminescence occurs for such nanomaterials due to enhanced number of defects. To clearly understand the current controversy and enhance further the afterglow properties, we decided to assemble these nanoscale materials and form it into 3D mesoporous solids or aerogels. Aerogels are expected to ameliorate the phosphorescence of this material as they are highly porous (giving rise to mid gap states, hence better afterglow), along with the higher surface area (leading to better absorption properties, henceforth emission). Considering these advantages, SrAl2O4:Eu2+Dy3+ based aerogels will be synthesized and post-processed to obtain high quantum yield nanophosphors.

e: gaganpreet.behrh@empa.ch

Novel nanofluid based on water-loaded delafossite $CuAlO_2$ nanowires: Structural and thermal properties

Haya Alhummiany
University of Jeddah, Saudi Arabia

Ultra-high cooling performance is a crucial requirement of many thermomechanical systems, such as microelectronic devices, engine cooling systems, nuclear power systems, chemical reactors, and refrigeration systems. Recent experimental results reveal the potential thermal properties of suspended nanometallic in conventional fluids. In this study, the facile synthesis of one-dimensional delafossite $CuAlO_2$ nanowires by microwave hydrothermal treatment was presented. A novel type of nanofluid consisting of $CuAlO_2$ nanowires suspended in distilled water at various volume fractions (0.0, 0.2, 0.4, and 0.6 wt.%) was successfully synthesized using an easily scalable sonication method. The microstructures of as-synthesized $CuAlO_2$ were investigated by adopting X-ray diffraction (XRD), energy dispersive X-ray spectroscopy (EDS), transmission electron microscopy (TEM), and field-emission scanning electron microscopy (FESEM). Furthermore, the thermal conductivity and specific heat capacity of water-loaded nanofluid were measured at different volume fractions and temperatures. The results reveal a significant increase in thermal conductivity with increasing $CuAlO_2$ loading levels and temperatures. The obtained results propound the fact that water-loaded delafossite $CuAlO_2$ nanowires-based nanofluid is a promising candidate for future industrial applications.

e: Haalhummiany@uj.edu.sa

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Influence of polyacrylamide hydrogel stiffness on podocyte morphology, phenotype and mechanical properties

Maya Abdallah
University of Montpellier, France

Chronic kidney disease (CKD) is characterized by a gradual decline in renal function that progresses toward end-stage renal disease (ESRD). Podocytes are highly specialized glomerular epithelial cells, which form with the glomerular basement membrane (GBM) and capillary endothelium, the glomerular filtration barrier (GFB). GBM is an extracellular matrix (ECM) that acts as a mechanical support and provides biophysical signals that control normal podocytes behavior in the process of glomerular filtration. Thus, the modulus of elasticity E or stiffness of “ECM” represents an essential characteristic that controls podocyte functions. The biophysical properties of hydrolyzed Polyacrylamide (PAAm) gels resemble to in vivo ECM and thus provide an opportunity to be applied as ECM-like membranes to study cellular behaviors. Therefore, hydrolyzed PAAm hydrogels were investigated for their potential use as new ECM-like constructs to engineer a basement membrane that form with cultured human podocytes a functional glomerular-like filtration barrier. Such ECM-like polyacrylamide hydrogel construct will provide the unique opportunity of understanding in an in vivo-like setting podocyte cells biological responses by controlling the physical properties of the PAAm membranes. In this work, several PAAm hydrogel layers were prepared by changing the crosslinker concentration. The macromolecular microstructure and stiffness were evaluated by Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM) techniques respectively. Accordingly, the mechanical properties and the polymeric network porosity can be effectively controlled by modulating the crosslinker concentration as well as the swelling degree. Moreover, modulating gel stiffness significantly influenced podocyte behavior including morphology, actin cytoskeleton reorganization. In conclusion, podocytes response to the variation of the mechanical properties of the membranes correlated with the hydrogel’s stiffness. This work addresses the complexity of podocytes behavior which will further enhance our knowledge to develop a kidney-on-chip model much needed to study kidney function in both health and disease states.

e: maya.abdallah@etu.umontpellier.fr

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