# PRELIMINARY PROGRAM

**---Monday, October 4, 2010---**

**08:30**
Room: Prince of Wales (Conv-3rd Flr)
**Stream:** NANOMATERIALS
**Session:** Nanomaterials 1 (MONAM1)

Paper Start Time: 08:30
Paper No.: 5642
Paper Title: **KEYNOTE: Nanomaterials for Use in Medical Applications, in Particular Wound Dressings Using Nanocrystalline Silver**
*Robert Burrell; University of Alberta;*
Abstract currently not Avalable.

Paper Start Time: 09:20
Paper No.: 5566
Paper Title: **INVITED: Electrochemical Deposition of Organic-inorganic Nanocomposites for Biomedical Applications**
*Igor Zhitomirsky; McMasters University;*
Electrochemical methods have been developed for the deposition of composite films, containing biopolymers, inorganic nanoparticles, drugs and proteins. Chitosan films were deposited by cathodic electrodeposition. Composite films containing hydroxyapatite, silica, titania and other bioceramics, bioglass in a chitosan matrix were obtained as monolayers, multilayers or materials of graded composition. Hydroxyapatite-chitosan films showed preferred orientation of hydroxyapatite nanoparticles in the chitosan matrix, similar to the orientation of hydroxyapatite in natural bones. Multilayer films were obtained, containing organic and inorganic layers. The films provided corrosion protection of metallic implants in simulated body fluid solutions. It was found that heparin-chitosan films can be obtained using chitosan-heparin complexes. The addition of anionic heparin to cationic chitosan resulted in increasing cathodic deposition rate. Bovine serum albumin - chitosan films were obtained by cathodic deposition. It was shown that this method allows electrodeposition of composite films containing other proteins and enzymes in a chitosan matrix. The feasibility of anodic deposition of alginic acid and hyaluronic acid has been demonstrated. Composite films containing hydroxyapatite and other bioceramics, bioglass, heparin and bovine serum albumin in the matrix of alginic acid or hyaluronic acid were obtained as monolayers, multilayers or materials of graded composition. It was shown that electrodeposition can be used for the fabrication of biopolymer films containing carbon nanotubes and bioceramics. Compared to layer-by-layer self assembly, the electrochemical methods offer the advantages of high deposition rate, the possibility of fabrication of thick and uniform films on substrates of complex shape, rigid control of film microstructure and composition.

Paper Start Time: 09:45
Paper No.: 5304
Paper Title: **Preparation and Bioactivity Evaluation of Sol-gel Derived Magnesium-substittued Fluorapatite Nanocrystalline Powders**
*E. Mohammadi Zahrani; Department of Materials Engineering, University of British Columbia; M. H. Fathi, Department of Materials Engineering, Isfahan University of Technology; M. Kheradmanfard, Department of Materials Engineering, Isfahan University of Technology;*
In this study, Mg-doped fluorapatite(Mg-FA) nanopowders were prepared through a sol-gel technique and characterized. Designated degree of Mg2+ ions incorporation into the apatite structure was indicated by the x value in the general formula of (Ca10-xMgx (PO4)6F2),where x=0,0.25,0.5,0.75, and 1. XRD, SEM, AAS, FTIR and TEM techniques were utilized to characterize the synthesized nanopowders. In vitro bioactivity of the powders was evaluated in simulated body fluid. Powders had a crystallite size less than 100 nm. It was concluded that Mg-substitution could alter bioactivity and dissolution behavior of Mg-FA. These two parameters were proportional to magnesium content of the powders.

**08:30**
Room: Prince of Wales (Conv-3rd Flr)
**Stream:** NANOMATERIALS
**Session:** Nanomaterials - PRELIM

Paper Start Time: 08:30
Paper No.: 5512

Paper Title: **Formation of Nanocrystalline and Ultrafine-grained Structures in Disk-shaped Samples of Fe-0.15C and Interstitial-free (IF) Steels Produced by Ball Milling**
*Ata Dolatmoradi; University of Tehran; Mojtaba Asadi Rad, Sharif University of Technology; Kamran Dehghani, Amirkabir University of Technology; Jalil Vahdati Khaki, Ferdowsi University of Mashhad;*
Nanocrystalline structure formations produced by severe plastic deformation in Fe-0.15C with initial ferritic-pearlitic and IF steel with ferritic microstructures have been studied through microstructural observation and microhardness measurements. It was found that the nanocrystalline region first forms near the surface of samples due to localized severe deformation. It was also observed that the nanocrystallization rate of Fe-0.15C and IF steels and the deformed layer thickness in these two materials are different with similar milling conditions. The crystallite size and structural evolution of the samples during milling was studied by employing XRD and SEM.

**10:30**
Room: Prince of Wales (Conv-3rd Flr)
**Stream:** NANOMATERIALS
**Session:** Nanomaterials 1 (MONAM2)

Paper Start Time: 10:30
Paper No.: 5525
Paper Title: **Nanoparticles for IC Manufacturing**
*Ken Cadien; University of Alberta; Zhenghe Xu, University of Alberta;*
Particles are usually thought of as defects in integrated ciruit (IC)manufacturing. However, today it is almost the 20th anniversary of the introduction of chemical mechanical polishing (CMP) to IC techology. One of the components of CMP is the use of a slurry to polish layers on a semiconductor wafer. Today slurries for CMP are a $700 million business. Slurries are typically an aqueous mixture of particles and several chemicals. The particles and chemicals depend on the application. In this talk the history of the use of nanopparticles in CMP will be reviewed, and examples of the affects of nanoparticle size on polish performance will presented. Techniques for cleaning wafers after CMP will also be presented.

Paper Start Time: 10:55
Paper No.: 5416
Paper Title: **Scale-dependent Nanomechanical Properties of CMP Polish Pads**
*Lucy Nolan; University of Alberta; Kimbery Tok, University of Alberta; Kenneth Cadien, University of Alberta;*
Chemical mechanical polishing (CMP) is unique amongst nanofabrication techniques in that it achieves a high degree of nanoscale topographic control whilst being regulated entirely on the macroscale. Understanding the role of size scale in CMP is therefore fundamental to its effective implementation. This work examines the nanomechanical properties of CMP polishing pads under loading by abrasive polishing particles of different sizes by replicating contact conditions with a nanoindenter and indentation tips of various sizes. The resulting scale-dependent maps of pad mechanical properties can be used to quantify the transfer of load from the polisher to the wafer, and to optimise the selection of polishing particle sizes.

**14:00**
Room: Prince of Wales (Conv-3rd Flr)
**Stream:** NANOMATERIALS
**Session:** Nanomaterials 2 (MONPM1)

Paper Start Time: 14:00
Paper No.: 5470
Paper Title: **KEYNOTE: Interfaces and Nanoparticles**
*C. Barry Carter; University of Connecticut; Joysyrya Basu, University of Connecticut;*
The present talk will consider some examples of TEM studies of nanoparticles, paying particular attention to how recent improvements in the instrumentation are improving the quality of the data that the TEM produces. Transmission Electron Microscopy is the essential tool for understanding nanoparticles. It can tell you about the structure and chemistry of specific nanoparticles and the local variations due to segregation or defects. Features such as interfaces within a nanoparticle, small facets on the surface, and local chances in chemistry, which may or may not involve local changes in structure, can each be examined with near atomic resolution. TEM can also bridge the length scale to more macroscopic features such as the distribution of nanoparticles: their clustering and alignment being particularly important. We can examine the surface coating of nanoparticles and other local changes in chemistry which we intentionally or accidentally induce. We can even examine how nanoparticles change in response to applied stimuli (in particular stress, heat, the electron beam or an applied voltage). Throughout the talk the emphasis will be on Ceramic Materials.

Paper Start Time: 14:50
Paper No.: 5321
Paper Title: **INVITED: Hydrogen Sorption Cycling Kinetic Stability and Microstructure of Single-walled Carbon Nanotube (SWCNT) Magnesium Hydride (MgH2) Nanocomposites**
*Babak Shalchi Amirkhiz, University of Alberta and NINT NRC; Mohsen Danaie, University of Alberta and NINT NRC; Benoit Simard, Steacie Institute for Molecular Sciences (SIMS)-NRC; David Mitlin, University of Alberta and NINT NRC;*
We have examined co-milling with unpurified single-walled carbon nanotubes (SWCNT's) as a method to promote hydrogenation/dehydrogenation cycling kinetic stability in nanocrystalline magnesium hydride (MgH2). The synthesized material was a true nanocomposite consisting of MgH2 covered by highly defective SWCNT's coupled to catalytic metal nanoparticles and mixed with amorphous carbon. The nanocomposite was hydrogen sorption cycled at 300°C using a volumetric Sievert's type apparatus. Identically milled pure MgH2 was used as baseline. The microstructure of both materials was analyzed in detail using cryo-stage transmission electron microscopy (TEM) as well as other techniques. The nanocomposite shows markedly improved kinetic performance, both during initial post-milling desorption and during subsequent cycling. Activation energy analysis demonstrates that any catalytic effect due to the metallic nanoparticles is lost during cycling. Improved cycling performance is instead achieved as a result of the carbon allotropes preventing MgH2 particle agglomeration and sintering. Even after 35 absorption / desorption cycles the SWCNT's remain covering the MgH2 surfaces. Sorption cycling creates a dramatic difference in the particle size distributions between the nanocomposite system and the baseline, whereas the two were nearly identical at the onset of testing. In a separate experiment performed at more aggressive pressure conditions the nanocomposite received over 100 sorption cycles with fairly minor kinetic degradation.

**15:35**
Room: Prince of Wales (Conv-3rd Flr)
**Stream:** NANOMATERIALS
**Session:** Nanomaterials 2 (MONPM2)

Paper Start Time: 15:35
Paper No.: 5553
Paper Title: **INVITED: Nanocrystalline Cellular Materials**
*Glenn Hibbard; University of Toronto;*
New regions of material property space can be accessed by combining microstructural design at the nm-scale, with architectural design at the µm- or mm-scale. For example, the large strength increase associated with grain size reduction to below 50 nm has driven extensive research efforts into the development of nanocrystalline materials. For many potential structural applications, however, the density of a nanocrystalline material is just as important as its strength. In fact, reducing the density is more important than increasing the strength for certain weight specific materials performance indices and is especially critical for applying structural nanomaterials in the aerospace and automotive sectors. We have developed a new class of structural nanomaterial wherein the effective density of the parent metal is reduced by more than an order of magnitude by incorporating a periodic cellular architecture of open space. In one example a low density cellular nanocrystalline material was created by electroforming nanocrystalline Ni around a rapid prototyped acrylic photopolymer micro-truss. This new hybrid material combined the structural efficiency of micro-truss architectures with the ultra-high strength that can be achieved by grain size reduction to the nm-scale. This presentation will provide an overview of several new types of nanocrystalline cellular materials.

Paper Start Time: 16:00
Paper No.: 5417
Paper Title: **Electrospark Welding as a Method to Deposit and Freeform Nanostructured Materials**
*Jason Milligan, McGill University; Mathieu Brochu, McGill University; David W. Heard, McGill University;*
Freeforming of materials is a rapid prototyping process in which the deposited feedstock is built-up to the desired geometry in a near-net shape manner. Electrospark Welding (ESW) is a low heat-input, highenergy density, micro-welding process. The short pulse duration and high-pulse frequency, in combination with the small amount of material transferred during each pulse, results in the evolution of extremely rapid cooling rates, believed to approach 105-106 °C/s. This rapid solidification event results in the refinement of the microstructure to the nanostructured or amorphous level. This paper represents a summary of the capabilities of ESW to fabricate advanced materials possessing refined microstructure. In particular, results on the microstructural evolution obtainable for various wear-related systems will be presented. In addition, the feasibility of using the ESW process to freeform three-dimensional objects via multiple deposition passes will be presented and accompanied by a characterization of the properties of the freeformed component.

Paper Start Time: 16:25
Paper No.: 4768
Paper Title: **Development of Copper Matrix Composites by ODS Technique using Nano-Al2O3 Particles**

*Mostafa Amirjan; High Technology Institute; Hassan Abdoos, High Technology Institute; Hamid Khorsand, High Technology Institute; Mehdi Ashtari Mahini, High Technology Institute;*
Nano scale Al2O3 particle dispersion-strengthened copper alloy is produced by the internal oxidation. Properties measurements and microstructures observation of its hot extruded, cold drawn and annealed bars are conducted. The results show: Cu-Al2O3 alloy powder mixture has basically become a metallurgically bonded body after hot extruded at an extrusion ratio of 16:1. Tensile strengths sb of the cold-drawn bars with 65% and 90% cold work reach 468 and 495MPa, electrical conductivities reach 90% and 89%IACS, respectively. The cold-drawn bars can retain high strength even after annealed at 1030 for 0.5h.

**---Tuesday October 5, 2010---**

**08:30**
Room: Prince of Wales (Conv-3rd Flr)
**Stream:** NANOMATERIALS
**Session:** Nanomaterials 3 (TUESAM1)

Paper Start Time: 08:30
Paper No.: 5641
Paper Title: **KEYNOTE: Advanced High Performance Coatings, Surfaces, and Catalysts for Extreme-operating Environments and Energy-related Applications**
*Steve Petrone; Quantiam Technologies Inc.;*
Abstract currently not available.

Paper Start Time: 09:20
Paper No.: 5413
Paper Title: **INVITED: Fabrication of Al-containing Nanostructured Stainless Steel for Improved oxidation Resistance**
*Abdulaziz Almathami, McGill University; Mathieu Brochu, McGill University;*
Austenitic Stainless Steels (SS) provide excellent resistance to corrosion and oxidation and modification in the chemical composition accompanied by reduction of the grain size can provide enhanced resistance to corrosion and oxidation. In this presentation, results on the fabrication, consolidation and oxidation resistance of three nanostructured SS, namely 316LSS, 316LSS-2wt%Al and 316LSS-6wt%Al will be presented. In particular, the design of an Al-containing alloy for oxide selectivity will be described. Also, the strain induced phase transformation mechanism occurring during the fabrication of the nanostructured feedstock will be highlighted and the relation between the crystal structure stability and grain size during deposition will be discussed. Moreover, the oxidation resistance of the coatings will be presented, both in term of oxidation kinetics and microstructural evolution of the scale forming at the surface.

Paper Start Time: 09:45
Paper No.: 5545
Paper Title: **INVITED: Nanostructured Arranged Catalysts for Hydrotreating**
*John A. Nychka; University of Alberta; Jadid E. Samad, University of Alberta; Kalen Jensen, University of Alberta; Natalia Semagina, University of Alberta;*
In general, many Canadian industries are progressing toward less expensive and smaller environmental footprint technologies, in particular the fine chemicals and energy industry. Catalysis has played a major role in achieving cleaner and economically viable solutions for countless applications, whilst reducing environmental impact. We have been developing a new nanostructured arranged catalyst, suitable for applications in three-phase structured hydrogenation reactors, which offers decreased energy and hydrogen consumption. The discussion will entail the process development of said catalyst through the use of inexpensive and simple manufacturing techniques aimed at industrial applications. Performance of the catalyst will also be discussed.

**10:30**
Room: Prince of Wales (Conv-3rd Flr)
**Stream:** NANOMATERIALS
**Session:** Nanomaterials 3 (TUESAM2)

Paper Start Time: 10:30
Paper No.: 5283
Paper Title: **Research on the Sintering Process of Mullite-corundum Insulating Materials with Nano Crystals**
*Daoyuan Yang; Zhengzhou University; Juan Wu, Zhengzhou University; Kai Zhu, Zhengzhou University; Huiyu Yuan, Zhengzhou*

*University; Bo Xu, Zhengzhou University;*
Mullite- corundum insulation ceramic with nano crystals in matrix was fabricated by gel-casting process. The results showed that the volatilization temperature of organisms was 285°C~ 600°C, there was no glass phase appeared in specimens; The mullization was began at 1000°C, along with the raise of temperature, the quantity of mullite increased, especially during 1200°C~ 1400°C; when the temperature was up to 1550°C, mullite became the main crystal phase and there were also some corundum in the specimens; The specimen matrix sintered at 1550°C was consisted of nano crystals 80nm in length and 10~20nm in diameter.

Paper Start Time: 10:55
Paper No.: 5286
Paper Title: **In-situ Synthesis of Carbon Nano-phase Reinforced SiC/Si3N4 by Catalytic Cracking of Polysilazane**
*Shujing Li; Wuhan University of Science and Technology; Lei Zhao, Wuhan University of Science and Technology; Guofei Wang, Wuhan University of Science and Technology; Yuanbing Li, Wuhan University of Science and Technology;*
By catalytic cracking in-situ reaction SiC/Si3N4 composite ceramics were synthesized using polysilazane preceramic polymer, carbon nano-reinforcement phase were also synthesized by in-situ reaction. The effects of thermal racking temperatures and the kinds of catalyst on microstructure and shape of SiC/Si3N4 composite ceramics were investigated. The results indicated that crystallization temperature of SiC/Si3N4 composite ceramics decreased with catalytic cracking of catalysts, and carbon nano-phase was produced via in-situ reaction. Its caused the matrix and nano-phase complexed and decentralized, Moreover, carbon nano-phase reinforced SiC/Si3N4 composite ceramics has been generation.

Paper Start Time: 11:20
Paper No.: 5665
Paper Title: **Effect of Nano-particles in Matrix on Strength of Porous Mullite-corundum Ceramic**
*Daoyuan Yang; Zhengzhou University; Juan Wu, Zhengzhou University; Kai Zhu, Zhengzhou University; Huiyu Yuan, Zhengzhou University; Bo Xu, Zhengzhou University*
Mullite- corundum porous ceramic was fabricated by gel- casting process. The performance testing results showed that flexural strength and compressive strength was respectively 1.5MPa and 2.17Mpa when bulk density of the specimen was 0.4g/cm3; the microstructure analysis showed that the matrix, which was compact generally, was consisted of needle like particles, which regular arranged to form a layer of nanometer matrix. According to Budiansky self- coordination theory, we built a calculation model to analyze the strength of specimens, and inference both the decreased grains size and porosity were extremely effective methods to improve both strength and toughness of material matrix.

**14:00**
Room: Prince of Wales (Conv-3rd Flr)
**Stream:** NANOMATERIALS
**Session:** Nanomaterials 4 (TUESPM1)

Paper Start Time: 14:00
Paper No.: 5296
Paper Title: **Synthesize of Cordierite-Si3N4 Composite Using Nano Silicon Particles**
*Farnaz Sharafi; Islamic Azad University, Najafabad Branch; A. A. Nourbakhsh, Islamic Azad University, Shahreza Branch; M. Jafari, Islamic Azad University, Najafabad Branch;*
In the preset study the influence of particle size distribution and amounts of nano silicon particles on formation of silicon nitride (Si3N4) in matrix of cordierite by solid-state reaction were investigated. According to obtained results, it was found that precipitation of Si3N4 has considerable effects on mechanical strength even at high temperatures. On the other hand, sintering temperature and nano-size additives were effective in controlling pores' size and microstructure. Additionally, microstructrual investigations conducted by SEM showed that generation of bonds created by nano size silicon particles resulted in enhancing the mechanical properties of cordierite especially thermal shock resistance.

Paper Start Time: 14:25
Paper No.: 5172
Paper Title: **Application of Modified Nanodiamonds in Greasings**
*Gennady Selyutin, Institute of Chemistry & Chemical Technology SB RAS, Alexey Puzyr, Institute of Biophysics SB RAS , Vladimir Voroshilov, Institute of Chemistry & Chemical Technology SB RAS , Vladimir Sergeevich Bondar, Institute of Biophysics SB RAS;*
The technology of producing nanodiamonds from products of explosive synthesis was developed. Modified nanodiamonds with narrow distribution in the sizes possess a high colloidal stability in sols and are capable to create in oils steady suspensions. Introduction of nanodiamond particles in greasings leads to reduction of contact deterioration in pairs of a friction, reduction of temperature in friction

units. In some cases negative deterioration of contacting surfaces is observed. On a friction surface the additional layer of 4-7 µ by thickness is formed. This layer consists of products of oil oxidizing destruction, has a pores with the sizes approximately of 0.5 µ, well keeps oil, does not leave without damage of the basic metal. Fields of application are the engines of cars; transmission of cars; reducing gear, the bearings of friction and swings; the refrigeration units; any equipment with element of friction.

Paper Start Time: 14:50
Paper No.: 5242
Paper Title: **Effects of Nano and Micro TiO2 Powders on Morphology and Mechanical Properties of Polyurethane Foam**
*Iman Raoofian; Ferdowsi University of Mashhad; Mojtaba Zebarjad, Ferdowsi University of Mashhad; Abdolkarim Sajjadi, Ferdowsi University of Mashhad;*
Nanotechnology is extensively progressing and penetrating into all branches of engineering sciences. In this research TiO2 powders in nano and micro sizes were separately applied with different percentages into a semi rigid polyurethane foam. Also two different compositions were opted for polyurethane foam to study the effect of matrix composition either. The goal was to compare the effect of particle size on microstructure and compression mechanical properties of polyurethane foam. Nano powders was applied into the polyol component by using heat in an ultrasonic device. On the other hand micro-sized powders was only applied by stirring in the polyol component. Compression tests were applied and resulted into a dramatic advancement for nano-sized composites in comparison with the micro-sized ones. SEM pictures showed a developing evolution of microstructure into a homogeneous porosity by using nano-sized particles. In addition TGA test was used to determine the heat resistance property of the polymeric composite foam.

**15:35**
Room: Prince of Wales (Conv-3rd Flr)
**Stream:** NANOMATERIALS
**Session:** Nanomaterials 4 (TUESPM2)

Paper Start Time: 15:35
Paper No.: 5243
Paper Title: **Thermal Properties of an Insulating Porous Nano SiO2 Composite Coating**
*Iman Raoofian; Ferdowsi University of Mashhad; Mojtaba Zebarjad, Ferdowsi University of Mashhad; Abdolkarim Sajjadi, Ferdowsi University of Mashhad; Nafise Ebrahimi, Ferdowsi University of Mashhad; Hadi Nasiri, Ferdowsi University of Mashhad; Behrooz Naderi, Samen Co.;*
Nowadays saving energy is a matter of concern and worldwide studies are being done to reproduce energy or control the loss of it. Coatings can play an important role in this issue. In the presenting research, the trial was to reach an insulating paint with high porosity which may be exposed to a hot source. The coating is composed of polyamide epoxy as the matrix and SiO2 nano particles as the secondary phase with low heat transfer coefficient. Polystyrene granules were applied as an efficient blowing agent. As polystyrene react to polyamide epoxy, the granules were covered by a thin layer of wax. Therefore the reaction is retarded and the foaming agent can generate a homogeneous porous matrix. In addition the presence of nano SiO2 particles resulted into a water repellant coating and accordingly to possession of a high corrosion resistance property. Salt spray test was applied for identifying the corrosion resistance of the coating. Conduction heat transfer test was accomplished on standard cylindrical samples; also TGA test was performed to determine the resistance of the coating to direct heating.

Paper Start Time: 16:00
Paper No.: 5452
Paper Title: **Study the Corrosion Properties of Nanostructured Interstitial Free Steel**
*Maryam Hosseini; Amir Kabir University of Technology; Kamran Dehghani, Amir Kabir university of Technology;*
The aim of present work is to examine the performance of interstitial free steel nanostructure, exposed to corrosive atmosphere. In order to achieve nanocrystalline surface layer, the surface of interstitial free steel (used as car bodies) is severely deformed by wire-brushing at ambient temperature. The nanostructure of surface layers of the IF steel developed by severe plastic deformation (SPD) was verified by means of SEM, AFM and XRD. Nanocrystalline layers with the grain sizes ranging from 30 to 150 nm were observed close to the surface of all the severely plastic deformed specimens. Finally, after creating nanostructures in the surface of IF steel, their corrosion properties were investigated and compared with conventional structure. The performance against atmospheric corrosion was evaluated by means of microscopy techniques and corrosion rate measurements. The majority of the experiments in the laboratory have been carried out in chambers with controlled relative humidity, temperature, time and pollutants (mainly chloride ions and So2). In the above conditions, the nanostructured IF steel exhibited significantly higher corrosion resistance than that of conventional structure of IF steel.

# PRELIMINARY PROGRAM

Paper Start Time: 16:25
Paper No.: 5391
Paper Title: **Growth, Structural and Optical Characterization of Tin Doped ZnO Nanosheets**
*Syed Ghazanfar Hussain Ahmad, King Faisal University, Abdullah Aljaafari, Dr, King Faisal University;*
We are working on synthesis of pure and doped ZnO nanostructures of diverse morphologies under controlled manner. We have synthesized tin doped ZnO nanosheets on silicon (111) substrate by thermal evaporation and transport method in high deposition yield. The samples were grown in a single step catalyst-free process. The nanosheets were characterized by Fe-SEM, EDS, XRD, FT-IR and PL spectroscopy. These nanostructures are novel in a sense that they might be used as nano-chemical and bio sensor technology, due to their large surface to volume ratio with tunable electrical and optical properties by simply adjusting the ratio between their components.