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Posters

Takako Konoike, Res. Rev. J Mat. Sci. 2018, Volume 6
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Fabrication of micro/nano-crystals of organic Dirac fermion system: Nano-scale electro crystallization

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Statement of the Problem: Since the discovery of graphene, it attracted a great interest because the electrons in graphene behave like massless Dirac fermions. It shows anomalous behaviors resulting from the peculiar liner dispersion. It has been recognized that Dirac fermion system is also realized in organic conductor α-$(BEDT\text{-}TTF)_2I_3$ under high pressure. This system is composed of organic molecule BEDT-TTF and inorganic anions I_3. These molecules are stacked alternatively and forming a multi-layered structure of conducting and insulating layer, respectively. By taking advantage of its bulk nature, we have experimentally studied the physical properties of Dirac fermions in this compound. In high magnetic field, the characteristic edge state with spin current at the sample edges is theoretically predicted. By using the micro/nano crystals, which contains large amount of edges, we aimed to observe the evidence of the edge state of this system.

Methodology: Micro/nano crystal growth of α-$(BEDT\text{-}TTF)_2I_3$ is based on nano-scale electrocrystallization was carried out by using Nano-Wire Fabrication Kit, Iwata Glass Industrial Co., Ltd., The electrodes used in the crystal growth were made on a silicon substrate with 300 nm SiO_2. Platinum electrode was deposited on a masked substrate and 5 μm gap was made by photolithography. The substrate was set into a saturated THF solution of above two molecules. DC current was applied between the electrodes at 20°C in incubator during 24 h.

Findings: The typical crystal obtained by this method is shown in Figure 2. The shape of the grown micro-crystal resembles with that grown by usual electrocrystallization. The surface of the crystal is almost flat and specularly reflected suggesting that the crystal is high purity.

Conclusion: By using the nano-scale electro-crystallization, we could obtain high purity micro-crystals. We will study this micro-crystal to detect the evidence of the edge state and spin current.

Figure 1: Silicon substrate with platinum electrodes

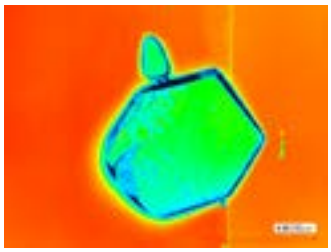

Figure 2: 3D laser microscope image of one of micro-crystal

Recent Publications:

1. Katayama S, Kobayashi A and Suzumura Y (2006) Pressure-induced zero-gap semiconducting state in organic conductor α-(BEDT-TTF) 2I3 salt. Journal of the Physical Society of Japan 75(5):054705.
2. Osada T, Uchida K and Konoike T (2011) Magneto transport of massless Dirac fermions in multilayer organic conductors. Journal of Physics 334: 012049.
3. Konoike T, Uchida K and Osada T (2012) Specific heat of the multilayered massless Dirac fermion system. Journal of the Physical Society of Japan 81:043601.
4. Konoike T, Sato M, Uchida K and Osada T (2013) Anomalous thermoelectric transport and giant Nernst effect in multilayered massless Dirac fermion system. Journal of the Physical Society of Japan 82(7):073601.

Biography

Takako Konoike has expertise in Evaluation and her passion in improving the various measurements under pressure and crystal growth of organic conductors, especially organic Dirac fermion system α-(BEDT-TTF) 2I3. We have measured the specific heat and thermo power of organic Dirac fermion System under high pressure. We have succeeded in obtaining the first experimental results of the specific heat of Dirac fermions and observing the giant Nernst effect reflecting the intrinsic nature of the zero-mode Landau level, which is characteristic of the Dirac fermion system. From these results, we can conclude that the high-purity organic crystal can provide an ideal testing ground for experimental studies of Dirac fermions.

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Notes:

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Synthesis by hydrogen reduction and characterization of CuNiCo with nanoparticles content

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Metals alloys are of great technological interest which may even increase if they are nanostructured. Also, it can be found in the literature, same proposed chemical synthesis methodologies obtain different kind of materials with nanocrystal particles content. Then, the main objective of this work was to obtain a CuNiCo alloy, by an alternative procedure capable of generating nanostructured grains, followed by its preliminary characterization. It has been done by dividing the process into two steps the first one is the thermal decomposition of a nitrate solution [$Cu(NO_3)_2$, $Ni(NO_3)_2$ and $Co(NO_3)_3$] aiming to obtain a homogeneous co-formed metal oxide. In the second step, these oxides are heated up to a desired temperature and kept in a reductive flow of hydrogen, leaving the CuNiCo alloy as final product. The applied reduction temperatures were 300°C and 900°C. The materials obtained after each step were characterized by scanning electron microscopy (SEM) and energy dispersive X-ray detector (EDS). As result of the first step, it was found that oxygen, Cu, Ni and Co were, as desired, homogeneously distributed, as shown in the SEM elemental mapping (Figure-1). The after reduction obtained material present different shape and particle size, depending on the applied reducing temperatures (Figure-2). The more circular and greater size observed at 900°C confirms an increased sintering occurrence at higher temperature and the EDS results indicate the expected composition for Co, Ni and Cu (Figure-3). The initial results given by transmission electron microscopy (TEM) have shown the presence of particles with spherical morphology and a homogeneous distribution of the elements, which are sharing the same crystal structure. Also, it was noted the presence of particles smaller than 100 nm in the CuNiCo alloy, as show in Figure-4 (bright and dark fields).

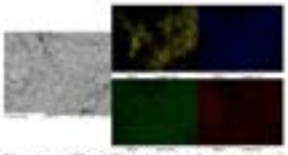

Figure-1: The SEM elemental mapping of co-formed oxides. X1000

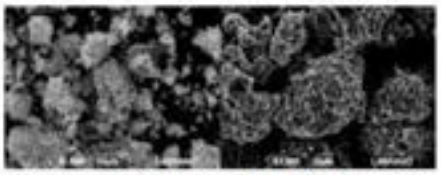

Figure-2: SEM images of CuNiCo alloy X1000. Reduction T a)300°C,b) T=900 °C.

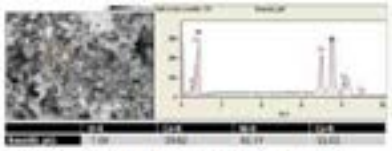

Figure-3: The EDS of CuNiCo alloy X10000. Reduction at T=300°C.

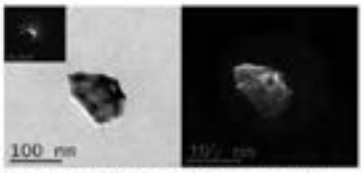

Figure-4: TEM observation of the alloy.

Biography

E A Brochii completed Metallurgical Engineer (1975) and Master in Materials Engineering (1977) from Pontifical Catholic University of Rio de Janeiro (PUC-Rio). Doctorate (PhD) in Extractive Metallurgy from Imperial College of Science and Technology, London (1983). Since this year he has been at the Department of Chemical and Materials Engineering of PUC-Rio teaching and doing research focusing on the recovery of metals from mineral concentrates, and residues as well as synthesis, normaly including a thermodynamic/kinetics studies related to pyrometallurgy routes such as general types of roasting (ex: chlorination) and hydrogen reduction.

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Heeyeon Kim, Res. Rev. J Mat. Sci. 2018, Volume 6
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One-pot synthesis of hybrid nano particles for catalytic applications

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We have developed facile CVD techniques for the synthesis of metal hybrid nano-catalysts used for fuel cell or secondary battery. By using CVD technique, we can easily obtain the perfect catalytic structure and manipulate the microstructure of the nano metal catalysts. It is noteworthy that the conventional multi-step synthetic processes can be simplified into a single-step process or a sequential process by these processes. For the single-step CVD synthesis of Pt nano catalyst decorated with porous graphene shells, $MeCpPtMe_3$ was used as a precursor of Pt nano particles. For the synthesis of graphene shells, various hydrocarbon precursors such as acetylene, acetone or ethyl alcohol were used as precursors, which were vaporized and simultaneously flowed into the CVD reactor. For the low-temperature synthesis of bimetallic nano alloys for fuel cell electrode, we applied one-pot sequential CVD technique. For the synthesis of Pt-Co bimetallic nanoparticles, $MeCpPtMe_3$ was vaporized and flowed into a CVD reactor, where carbon black was placed as a support of Pt-Co bimetallic catalyst. For Co deposition, $CpCo(CO)_2$ was vaporized and flowed into the CVD chamber. Then, the Pt with Co nano particles deposited on carbon black was annealed for the synthesis of Pt_3Co bimetallic nanoparticles. By single step CVD technique, Pt with porous graphene shells were synthesized, which showed higher efficiency compared to bare Pt and maintaining long-term stability after extended potential cycling which is due to the protective effect of graphene shells. Also, our sequential CVD techniques for bimetallic Pt-Co nanocatalyst are efficient for the quick, simple and easy synthesis of optimal catalytic structure. This technique is very useful for lowering the synthetic temperature of metal alloys by more than 200°C compared to conventional processes.

Recent Publications

1. Tom Samuels, et al. (2017) Three-dimensional hybrid multi-layered graphene-CNT catalyst supports via rapid thermal annealing of nickel acetate. *Journal of Materials Chemistry A;* 21(5): 10457-10469.
2. D S Choi, et al. (2016) Low-temperature chemical vapor deposition synthesis of Pt-Co alloyed nanoparticles with enhanced oxygen reduction reaction catalysis. *Advanced Materials;* 28: 7115-7122.

Biography

Heeyeon Kim has completed her PhD in Chemical Engineering from Seoul National University. She is being working in Korea Institute of Energy Research since 2004. She has investigated nano metals, nano carbons and their hybrids for energy applications. The main applications of the metal-carbon hybrids are catalysts for low temperature fuel cell, the catalysts for hydrogen production, the CO_2 absorbents and the electrode material of secondary battery. The focus of her study is to develop cost-effective materials which improve the catalytic performance and concurrently maintain the long-term stability.

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Notes:

Tai-Horng Young, Res. Rev. J Mat. Sci. 2018, Volume 6
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Chitosan delaying human fibroblast senescence through down regulation of TGF-β signaling pathway

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This study evaluated the effect of chitosan, poly vinyl alcohol (PVA) and poly (2-hydroxyethyl methacrylate) (pHEMA) on delaying the human fibroblast senescence. Cells could form suspending multicellular spheroids on these biomaterials, but only chitosan was capable of decreasing the SA β-gal activity and increasing the proliferation ability of senescent fibroblasts. Therefore, in addition to the structure of multicellular spheroids, chitosan itself should play an important role in delaying fibroblast senescence. The main difference of senescence related protein expressions for cells cultured on chitosan, PVA and pHEMA occurred on the TGF-β signaling pathway. In addition to the intracellular TGF-β expression, the extracellular TGF-β expression was also down regulated. Chitosan with cationic amino structure was assumed to bind with anionic TGF-β by forming polyelectrolyte complexes. This assumption was demonstrated by directly adding chitosan into the medium to down regulate the cell TGF-β expression and further to delay cell senescence, indicating TGF-β signaling pathway was involved in the chitosan mediating fibroblast senescence process. Finally, the delaying cell senescence ability of chitosan increased with increasing the amount of amino groups in chitosan and its ionization degree. In summary, these results provide important information for considering the application of chitosan in the future cell therapy and regeneration medicine.

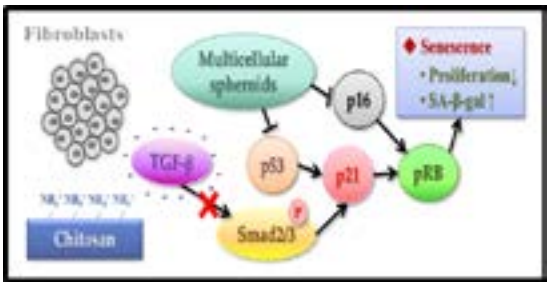

Figure: The diagram of chitosan affecting senescent-related pathways.

Recent Publications

1. C H Chang, D Mau-Hsu, K C Chen, C W Wei, C Y Chiu and T H Young (2018) Evaluation of digital real-time PCR assay as a molecular diagnostic tool for single-cell analysis. Scientific Reports 8(1):3432.
2. C W Tsai and T H Young (2016) CD44 expression trends of mesenchymal stem-derived cell, cancer cell and fibroblast spheroids on chitosan-coated surfaces. Pure and Applied Chemistry 88(9):843-852.
3. C W Tsai, Y T Kao, I N Chiang, J H Wang and T H Young (2015) Chitosan treatment delays the induction of senescence in human foreskin fibroblast strains. PLOS One 10(10): e0140747.
4. Y H Chen, S H Chang, T J Wang, I J Wang and T H Young (2013) Cell fractionation on pH-responsive chitosan surface. Biomaterials 34(4): 854-863.
5. P J Lou, M Y Chiu, C C Chou, B W Liao and T H Young (2010) The effect of poly (ethylene-co-vinyl alcohol) on senescence-associated alterations of human dermal fibroblasts. Biomaterials 31(7):1568-1577.

Biography

Tai-Horng Young is currently a Professor at National Taiwan University (NTU) in Taipei, Taiwan. Since 2000, he was a Full Professor at the Institute of Biomedical Engineering, National Taiwan University. He received several awards, including outstanding research award of National Science Council, and has been the Chair Professor of National Taiwan University since 2007. From 2008 to 2011, he served as the Director of Institute of Biomedical Engineering, National Taiwan University. He has been a member of many academic societies and has been selected as the President of Formosa Association of Regenerative Medicine (2012-2016).

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Yusuke Daiko et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Ag^+ ion emission from a sharp tip of Ag^+ ion conducting glass and Schottky-model analysis

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Ion implantation is one effective method for surface modification of materials and has been applied for various field including semiconductor industry and bio-technology. For example, proton (H^+) implantation, so called proton therapy, has recently used most often in the treatment of cancer, in which accelerated protons are irradiated directly to cancer cells. In general, discharge plasma (gas) or liquid (e.g., liquid gallium (Ga) focused ion beam (FIB)) has been utilized for an ion source. However, in these cases, side reactions (generation of radicals or various ions with different mass such as H_{2+} and H_{3+} etc.,) are unavoidable. Also, ion (particle) accelerators are huge and expensive. On the other hand, ion emission from solid electrolytes such as YSZ has also been considered. Hosono et al., showed that O^- ions exist inside cages of $12CaO{\cdot}7Al_2O_3$ (C12A7) crystal and they successfully observed O^- ion emission from the C12A7 by applying a high voltage. In the case of these ion emissions from solid electrolyte, one crucial aspect is its high ion conductivity and ion emission current increases with increasing ion conductivity of electrolyte. Compared with gas and liquid ion sources, ion emission mechanism of such solid-emitter is simple and almost ~100% of emitted ions are O^- ion in the case for C12A7. We have studied high ion conducting glasses and those applications for ion emission gun. One big advantage of glass is its good formability and we anticipate such ion conducting glasses can be applied for an emitter of ionic gun since the strength of the electric field is concentrated around the tip of the sharp edged glass emitter. Here we show preparation and emission properties of Ag^+ ions from a tip of Ag^+ ion conducting glass fiber. A good linear correlation was obtained between log (current) and square root of the voltage, suggesting the emission of Ag^+ ion from the tip of glass fiber is expressed by Schottky model.

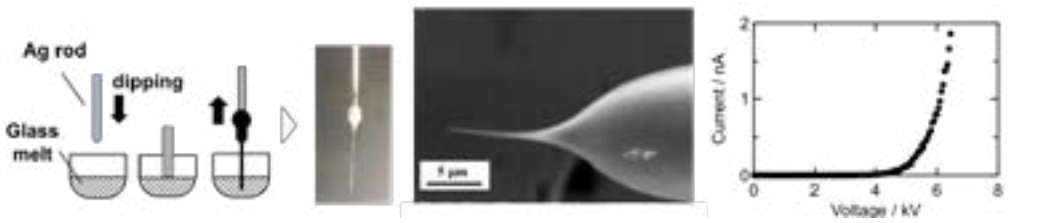

Figure: Schematic diagram of fiber preparation, SEM image of the fiber tip, and Ag^+ ion emission current as a function of voltage.

Biography

Yusuke Daiko has his expertise in ion conducting materials including glasses, ceramics and organic - inorganic hybrids. He received Donald R Ulrich Award 2013 from International Sol-Gel Society (ISGS) and; Awards for Advancements in Ceramic Science and Technology in 2013 from 67th Ceramic Society of Japan (CerSJ) for his research development about proton conducting glasses.

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Junzhe Dong et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Effect of electrolyte aging on the morphology and mechanical properties of anodic titanium dioxide

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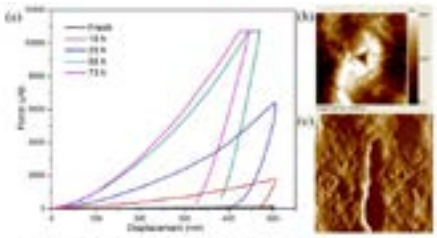
Titanium dioxide (TiO_2) has attracted extensive attention as multifunctional semiconductors in various applications, such as sensors, photocatalysis and medical devices. Electrochemical anodization is a simple and cost-effective way to produce one dimensional TiO_2 nanotubes with large surface area and tunable morphology. Recently great efforts have been made on understanding the formation mechanism behind the regular morphology and influencing anodization parameters. However, rare studies were reported focusing on the mechanical properties of anodic TiO_2, such as hardness, modulus and adhesion, which are vital to practical application of TiO_2. The purpose of this study is to explore the effect of electrolyte aging on the morphology and mechanical properties of anodic TiO_2 nanotube arrays. Electrochemical anodization of titanium foil was conducted in different aging electrolyte to produce regular self-organized TiO_2 nanotube arrays. Nano indentation test was then performed on as synthesized TiO_2 nanotube surface to measure their mechanical properties. The regularity of obtained TiO_2 nanotube improves in short aging electrolyte while deteriorates in long aging electrolyte with pore size decreasing from 146.58 nm to 46 nm. However, the hardness and reduced modulus increase with prolonging aging time as well as adhesion strength. The electrolyte aging has a significant role in the morphology and mechanical properties during titanium anodization. It improves the hardness, modulus and tribological behavior of anodic TiO_2 nanotube arrays, but reduces their pore size and surface area. Therefore, the proper aging time of electrolyte should be selected according to the specific applications.



Recent Publications

1. J Dong, et al. (2018) Enhancing photocatalytic activities of titanium dioxide via well-dispersed copper nanoparticles. Chemosphere 204:93-201.
2. D Ariyanti, L Mills, J Dong, et al. (2017) NaBH4 modified TiO_2: Defect site enhancement related to its photocatalytic activity. Materials Chemistry and Physics 199:571-576.
3. J Dong, et al. (2017) Patterned titania nano structures produced by electrochemical anodization of titanium sheet. International Journal of Modern Physics B 31:1744049.
4. J Dong et al. (2016) Self-organized ZnO nanorods prepared by anodization of zinc in NaOH electrolyte. RSC Advances 6:72968- 72974.
5. J Dong, R Ullal, J Han, S Wei, X Ouyang, J Dong and W Gao (2015) Partially crystallized TiO_2 for microwave. Journal of Materials Chemistry A 3:5285.

Biography

Junzhe Dong has completed his Bachelor's degree in Materials Physics at Southwest University, China in 2011. Then he went to Northwestern Polytechnical University, China for research project on Ti alloy deformation. He has completed his PhD in "Transition metal oxides and their applications" at University of Auckland, New Zealand. He has expertise in Micro and Nano Indentation Test, Electrochemical Anodization Technique, Raman Signal Enhancement and Photocatalysis.

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A Papadopoulou et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Magnetic carbon nano materials as matrices for the immobilization of cellulolytic enzymes

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[3]National University of Athens, Greece

The development of novel nano biocatalytic systems through the immobilization of enzymes on nanoscale materials has attracted much scientific interest and their potential use for applications in various industrial fields has been widely recognized. Among the different types of nanomaterials applied for this purpose, carbon-based materials, such as graphene oxide (GO), the oxidized derivative of graphene, and hierarchical porous carbons (HPC), which possess a multimodal pore size distribution of micro-, meso-, and macropores, have been used for enzyme immobilization. On the other hand, magnetic nanoparticles due to their high surface area, large surface-to-volume ratio and easy separation under external magnetic fields have been broadly utilized as carriers for enzyme immobilization. The functionalization of magnetic nanoparticles with carbon-based nanomaterials has recently attracted great interest as the resulting hybrid nanomaterials combine the properties of both building blocks. In the present study, we investigate the use of hybrid nanomaterials of magnetic iron nanoparticles with GO or HPC as nano supports for the immobilization of cellulolytic enzymes which could be applied to generate glucose feedstock using lignocellulosic biomass. The aim of this work focuses on the investigation of the effect of structural characteristics of hybrid GO and HPC magnetic nanoparticles on the catalytic behavior (activity, thermo stability and operational stability) of cellulolytic enzymes.

Recent Publications

1. I V Pavlidis, M Patila, U T Bornscheuer, D Gournis and H Stamatis (2014) Graphene-based nanobiocatalytic systems: recent advances and future prospects. Trends in Biotechnology 32(6):312-320.
2. G Orfanakis, M Patila, A V Catzikonstantinou, K-M Lyra, A Kouloumpis, P Katapodis, K Spyrou, A Paipetis, P Rudolf, D Gournis and H Stamatis (2018) Hybrid nanomaterials of magnetic iron nanoparticles and graphene oxide as matrices for the immobilization of beta-glucosidase: synthesis, characterization, and biocatalytic properties. Frontiers in Materials 5:1-11.
3. A A Papadopoulou, A Tzani, A C Polydera, P Katapodis, A Detsi, E Voutsas and H Stamatis (2017) Green bio transformations catalyzed by enzyme-inorganic hybrid nanoflowers in environmental friendly ionic solvents. Environmental Science and Pollution Research DOI: 10.1007/s11356-017-9271-3.

Biography

A Papadopoulou studied biology at the University of Ioannina, Greece. She has completed her Master of Science degree in Department of Chemistry at University of Ioannina. She has completed her PhD working in the area of Biocatalysis and Enzyme Technology in 2017. Her research focuses on the development of immobilized biocatalytic systems based on the use of solid supports such as nano matrices for the production of biofuels, high-added value products with prospects in food and pharmaceutical industry or for pollutants degradation.

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Notes:

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Surface texturing with slanted silicon nano pillars to reduce its optical reflectivity

Jun-Hyun Kim and **Chang-Koo Kim**
Ajou University, South Korea

Antireflective surfaces are useful in many applications such as solar cells, light emitting diodes and optical lens systems. Coating anti reflection layers is one of the ways to improve light trapping and decrease the optical reflectivity from the surface. By controlling the refractive index of the coating layer, the destructive interference of light minimizes the reflection. However, the use of hetero materials can limit the thermal stability and eventually the long-term reliability. The surface texturing is another way of producing antireflective surfaces. Surfaces with silicon pillars in various shapes have been shown to exhibit low reflectivity compared with bare surfaces. These pillars are mostly vertical. If the pillars are tilted from the surface normal, more light would be trapped between the pillars. This would result in lower reflectivity of the surfaces. The surface can be textured through either wet or dry etching. Wet chemical etching is very simple to operate, but only crystalline substrates can be used to obtain slanted structures in wet chemical etching. Dry etching using gaseous plasmas offers high aspect ratio structures due to its anisotropic etching characteristics. In a conventional plasma etching process, a sheath is formed along the surface of a substrate, irrespective of its angle. Therefore, simply tilting of a sample is not adequate for obtaining slanted etch profiles during conventional plasma etching. In this study, slanted silicon pillars at arbitrary angles were fabricated using the slanted plasma etching technique. Optical analysis of surfaces with silicon pillars was made to investigate their antireflection properties. It was shown that the reflectance of the surface with Si pillars was affected by the aspect ratio as well as the opening area of the pillars.

Recent Publications

1. Jun-Hyun Kim, Jeong Geun Bak, Kangtaek Lee and Chang-Koo Kim (2018) Control of the electrical resistivity of Ni-Cr wires using low pressure chemical vapor deposition of tin. Applied Surface Science 429:134-137.
2. Jun-Hyun Kim, Sung-Woon Cho and Chang-Koo Kim (2017) Angular dependence of Si_3N_4 etching in $C_4F_6/CH_2F_2/O_2$/Ar plasmas. Chemical Engineering and Technology 40(12):2251-2256.
3. Jun-Hyun Kim, Sung-Woon Cho, Chang Jin Park, Heeyeop Chae and Chang-Koo Kim (2017) Angular dependences of SiO_2 etch rates at different bias voltages in CF_4, C_2F_6, and C_4F_8 plasmas. Thin Solid Films 637:43-48.
4. Sung-Woon Cho, Jun-Hyun Kim, Hae-Min Lee, Heeyeop Chae and Chang-Koo Kim (2016) Super hydrophobic Si surfaces having microscale rod structures prepared in a plasma etching system. Surface and Coatings Technology 306:82-86.
5. Jun-Hyun Kim, Sung-Woon Cho, Doo Won Kang, Kyung Mi Lee, Chang Yong Baek, Hae-Min Lee and Chang-Koo Kim (2016) Electrical, structural, and morphological characteristics of dopantless tin oxide films prepared by low pressure chemical vapor deposition. Science of Advanced Materials 8(1):117-121.

Biography

Jun-Hyun Kim has completed his BS and MS degrees in Chemical Engineering at Ajou University, Suwon, South Korea in 2011 and 2013 respectively. He is currently a PhD candidate in Chemical Engineering at Ajou University. He has expertise in Plasma Processing, especially Plasma Etching.

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Simulation and development of counter weight casting

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[2]Dayananda Sagar University, India

There is renewed interest in sand casting components due to new technological developments and simulation techniques. Several researchers have developed algorithms and softwares to simulate casting process and predict defects such as porosity, blow holes, cracks and cold shuts. The objective of this paper is to obtain defect free counter weight casting (component) by best gating system based on flow simulation. CAD model of one such critical component counter weight is done in ADSTEFAN software where process parameters like weight, type and temperature of the molten metal and no-bake sand are given as input and flow simulations of three iterations of different gating systems to obtain defect free casting are performed. Actual castings for three gating systems are developed and results (defects) are compared. From first principle, the sizes of risers and flow offs are calculated with cross sections being either rectangular/cylindrical/conical shapes. Pressurized gating system is considered with a D: R: I (Down sprue: runner bar: Ingate) ratio is 1: 1.6: 0.9. Due to improper location of ingates and risers shrinkage formation is about 8-11% and 11-15% by volume in first and second iterations respectively. Installing of sleeve risers (at the point prone to casting defects) at hot spot where solidification ends results in reduction of volumetric shrinkage by 98%. Time taken to fill the mould cavity by molten metal is about 24-26 s for all three iterations. Visual inspection of actual counter weight casting of 1st and 2nd iteration showed the formation of shrinkages, cold shuts and surface blow holes and 3rd iteration showed no defects. Hence, third iteration gating system was recommended for manufacturing.

Recent Publications

1. K Koushik (2018) Design, Impact, Simulation Studies of Tubular Chassis of an all-terrain Vehicle Metals, Materials and Manufacturing Conference held in Singapore March 12-13th 2018, I: 10.5176/2251-1857_M318.12.
2. K Koushik and Nataraj J R (2018) Impact studies of Roll cage of All Terrain Vehicle. International Journal of Engineering, Global Science and Technical Forum.

Biography

K Koushik is pursuing his 3rd year Mechanical Engineering at R V College, Bangalore, India. He is currently working as a Chassis Engineer in Team Helios Racing. He is also working on alloy materials for high temperature applications. He has presented his technical paper on Chassis of an ATV at M3 2018 Conference, Singapore.

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Notes:

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Study of fragmentation and ultrasonic flow impacts of several metal-based alloys

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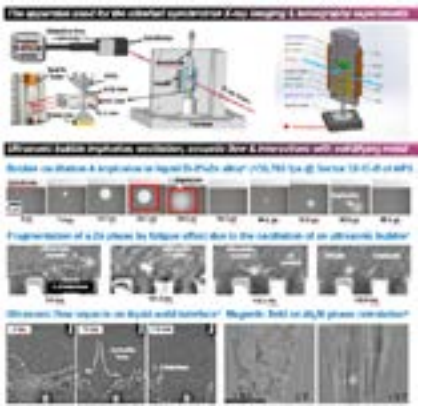
We present a number of highlight cases in our recent projects funded by the Royal Society and the EPSRC. Our focus is to study in real-time and *in-situ* dynamic evolution of solidification microstructures under ultrasonic waves and pulse magnetic fields. We have used the speciality beamlines from the Diamond Light Source, Advanced Photon Source, European Synchrotron Radiation Facility, and Swiss Light Source for our studies and worked closely with the relevant beamline scientists. We also used high performance supercomputer, viper, housed at Hull University to process and analyse the many hundreds of TB data acquired from the experiments. Our research demonstrates that real-time and *in-situ* visualisation of the dynamic microstructural evolution is absolutely essential for elucidating some of the ambiguities or missing links in the classical theories concerning the solidification processes of metal alloys. Real-time evidence shows that the shock wave created at ultrasonic bubble implosion and the pinch stresses produced by the electromagnetic pulse are very effective in causing the fragmentation of dendrites or intermetallic phases, promoting greatly the grain multiplication effect and therefore enhancing grain refinement.



Recent Publications

1. B Wang and J Mi (2018) Ultrafast synchrotron X-ray imaging studies of microstructure fragmentation in solidification under ultrasound. Acta Materialia, 144:505-515.
2. F Wang and J Mi (2017) A synchrotron X-radiography study of the fragmentation and refinement of primary intermetallic particles in an Al-35 Cu alloy induced by ultrasonic melt processing. Acta Materialia 142-153.

Biography

Abdulrahman Sumayli is a PhD student in Advanced Materials group in the School of Engineering and Computer Science at University of Hull. He is pursuing his PhD studies. His research is funded by Saudi Arabian Cultural Burea in London. He has completed his Bachelor's degree at King Abdulaziz University in Mechanical Engineering and Master's degree in Advanced Mechanical Engineering at Sheffield University. His PhD research is focused on "Corrosion resistance of Bulk Glasses Metallic (BMGs) amorphous alloys and the likelihood to use them as biocompatible materials".

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Jie Chen et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Effect of epoxidized cardanol on poly (vinyl chloride) as secondary plasticizer

Jie Chen and **Ke Li**
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An epoxidized cardanol plasticizer derived from cardanol was synthesized and characterized by Fourier transform infrared (FTIR), 1H nuclear magnetic resonance (^{1}H-NMR) and ^{13}C nuclear magnetic resonance (^{13}C-NMR). Effects of the epoxidized cardanol used as secondary plasticizer for dioctyl phthalate (DOP) in PVC blends were studied. Dynamic mechanical analysis (DMA), tensile test and thermogravimetric analysis (TGA) of PVC films plasticized with different content of epoxidized cardanol were investigated. The results indicated that the percent elongation increases with increasing epoxidized cardanol content. The epoxidized cardanol had better thermal stability than cardanol, the 10% weight loss (T_{10}) and 50% weight loss (T_{50}) of which enhanced from 218.73 to 259.53°C and 248.50 to 312.53°C and the plasticized films showed the thermal stability increased with increasing the content of epoxidized cardanol. When 8 phr DOP was replaced with epoxidized cardanol, the T_{10} and T_{50} increased by 9.58°C and 5.53°C respectively. The properties of volatility and extraction resistance of plasticizers were tested and showed similar or higher stability in those properties than that of DOP. Surface characterization of films by FTIR was also investigated.

Recent Publications

1. Jie C and Ke L (2018) Synthesis of Tung-oil-based triglycidyl ester plasticizer and its effects on poly (vinyl chloride) soft films. ACS Sustainable Chemistry & Engineering 6:642–651.
2. Jie C (2018) Synthesis and application of a novel environmental $C_2$6 diglycidyl ester plasticizer based on castor oil for poly (vinyl chloride). Journal of Materials Science 53(12):8909-8920.
3. Jie C and Ke L (2016) Synthesis and application of a novel environmental plasticizer based on cardanol for poly (vinyl chloride). Journal of the Taiwan Institute of Chemical Engineers 65:488-497.
4. Jie C (2016) Thermal behavior of epoxidized cardanol diethyl phosphate as novel renewable plasticizer for poly (vinyl chloride). Polymer Degradation and Stability 126:58-64.
5. Jie C (2015) A Novel Bio based Plasticizer of Epoxidized Cardanol Glycidyl Ether: synthesis and application in Soft Poly (vinyl chloride) Films. RSC Advances 5(69):56171-56180.

Biography

Jie Chen has completed her PhD at Beijing Forestry University. She has published more than 30 papers in reputed journals.

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Jianyan Ding et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Eu^{2+}/Eu^{3+}-activated nitride based red phosphors with narrow emission band for white light emitting diodes

Jianyan Ding, Xufeng Zhou and **Yuhua Wang**
Lanzhou University, China

The rare earth Eu^{2+}/Eu^{3+} ions have been widely used to act as activator for phosphors, especially red phosphors. Compared with oxide, Eu^{2+} activated nitride based phosphors commonly present broad excitation band and red emission light due to the larger crystal field splitting and higher nephelauxetic resulting from N^{3-} ions. The compact host lattices produced by the edge or face shared (Al, Si) N_4 tetrahedrons present excellent thermal stability and high bright red emission light. However, its broad emission band resulted from 4f-5d transitions of Eu^{2+} ions leads to low color purity. Different from Eu^{2+} ions, Eu^{3+} activated phosphors can emit a sharp red emission light due to its f-f transitions, but sharp excitation band limits their application. For solving this problem, the charge transfer band of Eu^{3+}-N^{3-} in α-$M_3B_2N_4$ (M=Ca, Sr) and Li_2SiN_2 has been investigated in our work. Meanwhile, Eu^{2+} activated $Ca_5Si_2Al_2N_8$ has also been displayed for comparison. The results show that Eu^{2+} or Eu^{3+} activated phosphors have its own advantages and disadvantages, which also indicates their different application in WLEDs and FEWs.

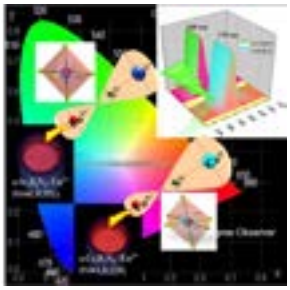

Figure: Eu^{3+} activated nitride red phosphors of α-M3B2N4 (M = Ca, Sr) with broad excitation band of Eu^{3+}-N^{-}.

Recent Publications

1. Ding J, Li Y, Wu Q et al. (2015) Novel red and green emitting Li 2 SiN 2: Eu $^{3+}$/Tb $^{3+}$ phosphors with a broad charge transfer band. Journal of Materials Chemistry C 3(33):8542-8549.
2. Ding J, Wu Q, Li Y, et al. (2016) Eu^{2+}-activated $Ca_5Si_2Al_2N_8$ – A novel nitridoalumosilicate red phosphor containing the special polyhedron of separated corner-shared [Al_2N_6] and [Si_2N_6]. Chemical Engineering Journal 302: 466-474.
3. Ding J, You H, Wang Y, et al. (2018) Site occupation and energy transfer of Ce^{3+}-activated lithium nitridosilicate $Li_2SrSi_2N_4$ with broad-yellow-light-emitting property and excellent thermal stability. Journal of Materials Chemistry C 6(13):3435-3444.
4. Ding J, Wu Q, Li Y, et al. (2017) α-$M_3B_2N_4$ (M= Ca, Sr): Eu^{3+}: a nitride-based red phosphor with a sharp emission line and broad excitation band used for WLED. The Journal of Physical Chemistry C 121(18): 10102-10111.
5. Ding J, Wu Q, Li Y, et al. (2016) Self-Activated Yellow Light Emitting Phosphors of α, β-$Ca_3B_2N_4$ with Long Afterglow Properties. Inorganic Chemistry 55(21):10990-10998.

Biography

Jianyan Ding has expertise in Physics and Materials Science. At present, his main research interest is focused on nitride based red phosphors used for white light emitting diodes (WLEDs). In order to realize the red phosphors, several nitride based phosphors activated by Eu^{3+}/Eu^{2+} have been reported by him. The red phosphors with narrow emission band and broad excitation band have been realized. However, there are still some problems need to be resolved, such as: thermal stability, quantum efficiency and preparation condition. In the future work, Eu^{3+}/Eu^{2+} activated nitride based red phosphors would be improved through investigating the relationship between luminescence properties and crystal or electron structure.

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Xufeng Zhou et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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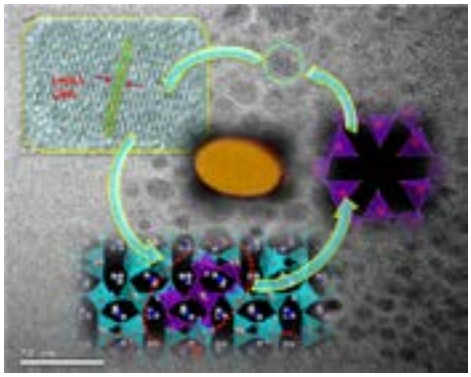
$K_4CaGe_3O_9:Mn^{2+}, Yb^{3+}$: A novel orange-emitting long persistent luminescence phosphor with special nano structure

Xufeng Zhou and **Yuhua Wang**
Lanzhou University, China

A novel germanate based orange emitting long persistent luminescence (PersL) phosphor: $K_4CaGe_3O_9$(KCGO):Mn^{2+},Yb^{3+} has been successfully synthesized by the solid-state reaction. The special nano structures of KCGO:Mn^{2+} and KCGO:Mn^{2+},Yb^{3+} were indicated by transmission electron microscope (TEM) images that block particles of these samples and consists of many irregular spherical nano-particles and the size of these spherical particles is less than 10 nm. This special nano structure exist many defects and could provide precondition for the PersL properties of KCGO:Mn^{2+}. Furthermore, after co-doping with Yb^{3+}, the PersL properties have been effectively improved due to the new traps with high concentration caused by the nonequivalent substitution of Yb^{3+}. With the optimum doping concentration and sufficient excitation with UV light, the after glow of KCGO:0.02Mn^{2+},0.015Yb^{3+} can persist over 5 h above the recognizable intensity level (0.32 mcd/m^2). Both fluorescence and phosphorescence spectra of KCGO:Mn^{2+},Yb^{3+} exhibit only one broad emission band, which belongs to the $^4T_1(G)$-$^6A_1(S)$ transitions of Mn^{2+}. In addition, with the help of thermoluminescence (TL) curves, the processes and possible mechanism are studied and discussed.



Recent Publications

1. Xufeng Zhou et al. (2018) Structure, bandgap, photoluminescence evolution and thermal stability improved of Sr replacement apatite phosphors $Ca_{10-x}Sr_x(PO_4)6F_2$: Eu^{2+}(x=4, 6, 8). Dyes and Pigments, 152: 75-84.
2. Xufeng Zhou et al. (2018) $K_4CaGe_3O_9:Mn^{2+}, Yb^{3+}$: A novel orange-emitting long persistent luminescence phosphor with special nano structure. Journal of Materials Chemistry C 6:7353-7360.

Biography

Xufeng Zhou is a PhD student at Lanzhou University. His main research direction is solid luminescence material.

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Xiaofeng Zhang et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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A composite of MnO_2 coated with graphene by galvanostatic electrodeposition and its highly active and stable catalysis for oxygen reduction reaction

Xiaofeng Zhang, Zhongshui Li and **Shen Lin**
Fujian Normal University, China

The development of efficient, low-cost and stable electrocatalysts as the alternative to platinum for the oxygen reduction reaction (ORR) plays key roles in several important energy storage and conversion technologies, such as fuel cells, metal-air batteries [1]. Manganese oxides (MnOx) have been widely investigated as a promising non-precious catalyst for ORR because of its abundance, low cost, environmental friendliness. Nevertheless, their practical applications of these materials are greatly impeded by its lower energetic efficiencies which is primarily ascribed to their poor conductivity and relatively lower amount of catalytically active sites. Moreover, MnOx catalysts are prone to aggregating in recycling use, which may further decrease the ORR catalytic activity and stability [2]. Herein, a composite consisting of spherical MnO_2 coated with reduced graphene oxide (MnO_2@RGO) has been prepared by step galvanostatic electrodeposition (Figure 1). Firstly, MnO_2 is deposited on the electrode surface by anodic galvanostatic method by the following process $Mn^{2+} + 2H_2O \rightarrow MnOOH + e^- + 3H^+ \rightarrow MnO_2 + 4H^+ + 2e^-$. And then a three-dimensional composite of reduced graphene oxide (RGO) coating MnO_2 is obtained through cathodic galvanostatic reduction of GO to RGO. The formed core-shell structure not only prevent graphene sheets from damage caused by pressure of MnOx on the surface of graphene, which may thereby maximizing the catalyst conductivity extremely [3], but also reduce the agglomeration of MnOx particles. In addition, owing to the larger specific surface area of graphene on the outer layer and its stronger electron-donating ability than MnO_2, the as-prepared composite is easier to adsorb and activate O_2 [4]. To the best of our knowledge, few research reports have been involved on the galvanostatic preparation of MnO_2-graphene core-shell composite and its application for ORR hitherto.

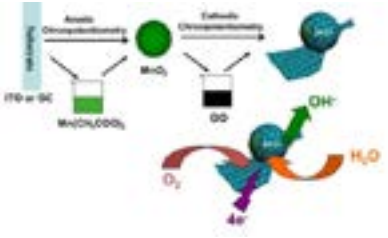

Figure 1 Schematic preparation and O_2 electroreduction of the MnO_2@RGO catalyst.

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2. Lei K, Han X, Hu Y, Liu X, Cong L, Cheng F, Chen J (2015) Chemical etching of manganese oxides for electrocatalytic oxygen reduction reaction. Chemical Communications 51: 11599-11602.
3. Sun M, Liu H, Liu Y, Qu J, Li J (2015) Graphene-based transition metal oxide nanocomposites for the oxygen reduction reaction. Nanoscale 7: 1250-1269.
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Biography

Xiaofeng Zhang graduated with PhD in chemistry from Fujian Normal University (P.R. China) in 2016. She is under the supervision of Prof. Shen Lin, majoring in physical chemistry and materials chemistry. Her scientific interests focus on non-precious metal oxides/graphene composites and their catalytic properties of oxygen reduction.

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Meshal S Aljohani et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Ni-based nanowire co-catalysts integrated with a Si photoanode for efficient water oxidation

Meshal S Aljohani, Talal Aljohani, Abduljalil Aljadani, Mohammed Althehaiban and **Bandar Alotaibi**
King Abdulaziz City for Science and Technology, Saudi Arabia

Photoelectrochemical water splitting is a sustainable pathway to produce clean hydrogen fuel. Due to the slow kinetics of the oxidation evolution reaction (OER), the realization of an efficient photoanode remains a great challenge. To lower the overpotential (η) for OER, crystalized and amorphous metal oxides integrated with photoanodes have been recently utilized as excellent co-catalysts. Considering the high cost of noble metal oxide catalysts due to their scarcity, such as IrO_2 and RuO_2, earth-abundant transition metal oxides, such as Ni-based nanowire electrocatalysts, hold promises for cost-effective and yet efficient water splitting. Compared to the limitation in charge extraction capability and light blocking of the conventional particle-based co-catalysts, the flexibility of engineering the morphology and the surface properties of templated Ni-based nanowire co-catalyts is enormous. That is, highly-ordered templated Ni-based nanowire co-catalyts can be advantageous for their light trapping, large surface-to-volume ratio, rapid carrier extractions, anti-reflection properties besides lowering the overpotential (η). We demonstrate that engineering the morphology of templated Ni-based nanowire co-catalysts on Si photoanode can lead to efficient OER. We shall further show that optimizing the surface properties of the nanowire co-catalysts by incorporating other divalent metal dopants such as Co and Fe can lead to efficient and stable water oxidation with low overpotential. In this work, Ni-based nanowires arrays are deposited electrochemically and physically on various substrates using ultrathin anodic aluminum oxide (AAO) template. The length, diameter and thickness of nanowires can be varied depending on the pores' dimensions and thickness of the AAO membrane leading to controllable co-catalysts morphology. Shown in figure is the scanning electron microscopy (SEM) image of pristine NiO nanowires deposited electrochemically on ITO substrate. We shall further show that by optimizing the surface charge properties through the deposition techniques and incorporating Co and Fe dopants, the overpotential for OER can be substantially reduced. Full electrochemical properties using three-electrode configuration in NaOH electrolyte will be presented. Further elemental and structural properties of the nanowire co-catalysts shall be thoroughly discussed. In brief, the use of such nanowire co-catalysts integrated with Si photoanode for high efficient and stable photoelectrochemical water splitting shall be demonstrated. This detailed study confirms that the morphology and surface Ni-based nanowire co-catalysts doped with Co and Fe can lead to lower OER overpotential.

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2. Sulaiman I Al-Mayman, Meshal S Al-Johani, Mohamed Mokhtar Mohamed, Yousef S Al-Zeghayer, Shahid M Ramay, Abdulrahman S Al-Awadi and Moustafa A Soliman (2017) TiO_2-ZnO photocatalysts synthesized by sol-gel auto-ignition technique for hydrogen production. International Journal of Hydrogen Energy 42(8):5016-5025.
3. Sulaiman Al-Mayman, Meshal Al-Johani, Kirill Borisevich, Naif Al-Abbadi, Abdullah Al-Musa, Andrey Krauklis and Pavel Stanovoi (2018) Syngas production at methane decomposition in the plasma of atmospheric pressure high-voltage discharge. Heat transfer Research 49:12.

Biography

Meshal S Aljohani has been working as an Academic Researcher at King Abdulaziz City for Science and Technology since 2016. He has completed his Master's degree in Chemical Engineering at King Saud University in 2015. His Master's thesis is entitled as "Photocatalytic production of hydrogen from ethanol-water solution using TiO_2-ZnO." He is currently working on "Fabrication of solar water-splitting device project" collaboration with the University of Cambridge, which is aiming to produce hydrogen from renewable energy sources. His current work focuses on oxides and perovskite-based materials to achieve highly efficient and stable solar fuel with low cost and high scalability.

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Zhongshui Li et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Facile synthesis of laminated porous WS2/C composite and its electrocatalysis for oxygen reduction reaction

Zhongshui Li, HuoDi Huang, Xiaofeng Zhang and **Shen Lin**
Fujian Normal University, China

The Vulcan XC-72R supported WS2 nanocomposite (WS2/C)was prepared by solid reaction process combined with sonication. The as-prepared WS2/C nanocomposite presents a laminated porous structure by SEM and TEM characterization. The electrochemical experiments show that the onset potential and the limiting-current density of WS2/C is 0.78 V and 4.99 mA cm^{-2}, respectively, which is much higher than that of WS2 (3.12 mA cm^{-2}) and Vulcan XC-72R (2.79 mA cm^{-2}). The number of transfer electrons in ORR at the WS2/C nanocomposite electrode is 3.70, which is close to four-electron process. Besides, the current density of WS2/C nanocomposites remained at 90% after 20000 s, indicating its superior electrochemical stability. All these facts reveal that the as-prepared WS2/C nanocomposite can be regarded as a promising cathode ORR catalyst for fuel cell.

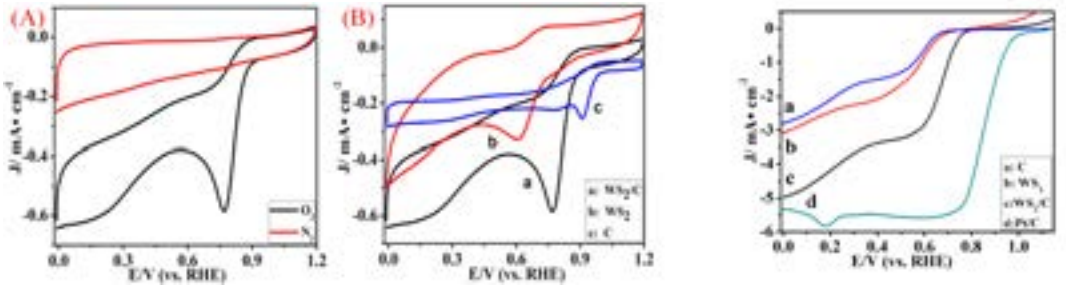

Fig.1 Cyclic voltammograms of WS2/C (A) and different modified electrodes(B) in 0.1 M KOH solution at Scan rate of 30 mV s^{-1}.
Fig.2 ORR polarization curves of different modified electrodein 0.1 M KOH saturated with O_2 at a rotating rate of 1600 rpm.

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1. Yang Z, Nie H, Chen X, Chen X, Huang S. Recent progress in doped carbon nanomaterials as effective cathode catalysts for fuel cell oxygen reduction reaction. J Power Sources 2013; 236(16):238-249.
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4. Illathvalappil R, Unni S M, Kurungot S. Layer-separated MoS_2 bearing reduced graphene oxide formed by an in situ intercalation-cum-anchoring route mediated by $Co(OH)_2$ as a Pt-free electrocatalyst for oxygen reduction. Nanoscale 2015; 7(40):16729-36.
5. Huodi Huang, Xiaofeng Zhang, Yi Zhang, Baohua Huang, Jiannan Cai and Shen Lin* Facile Synthesis of Laminated Porous WS2/C Composite and Its Electrocatalysis for Oxygen Reduction Reaction Int J Hydrogen Energy 43(2018),8290-8297.

Biography

Xiaofeng Zhang graduated with PhD in chemistry from Fujian Normal University (P.R. China) in 2016. She is under the supervision of Prof. Shen Lin, majoring in physical chemistry and materials chemistry. Her scientific interests focus on non-precious metal oxides/graphene composites and their catalytic properties of oxygen reduction.

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Daniel Li et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Controlled antibiotic-loaded, drug-eluting implants for osteomyelitis

Daniel Li[1, 2], Yaoyi Huang[2], Hong Shen[2], Yunlong Ma[2], Decheng Wu[2] and **Yuanzheng Ma[2]**
[1]Northwestern University, USA
[2]309th Hospital of the PLA, China

Bone infections are disastrous complications associated with orthopaedic implants such as prosthetic joints and fracture fixation devices. Local inflammation results osteolysis and destruction of the surrounding soft tissues. Management of such infections remains a significant challenge to clinicians, especially given the global rising prevalence of total joint arthroplasty. Current treatment regimens involve surgical debridement along with a prolonged course of antibiotics, which lacks bacterial and risks systematic toxicity to the patient. The efficacy of localized drug delivery, such as antibiotic-infused bone cement, is limited due to having only an initial burst release effect without a controlled, sustainable release profile. The ability to load antibiotics within a hydrogel scaffold to act as a drug delivery mechanism demonstrates promise in addressing this issue. In this study, we describe the fabrication of a vancomycin-loaded, polyethylene glycol (PEG) based hydrogel film covalently attached to titanium implant surfaces. Alginate microspheres were incorporated into the hydrogel to better control the rate of drug release. Specifically, this attenuates the initial burst release and delivers the drug at a more uniform rate by inhibiting hydrogel swelling. The resulting implants proved to be biocompatible and demonstrated minimal burst release, offering a consistent rate of drug elution for approximately four weeks *in vitro*. The rate of drug release could also be controlled by adjusting the amount of vancomycin loaded and hydrogel thickness. Material analysis characterized vancomycin dispersion kinematics as a function of the fabrication process. Antibiotic-loaded hydrogel coatings for titanium implants offer a unique drug delivery mechanism that maintains a sustained rate of drug release. *In vivo* studies are necessary to determine biodegradative properties of the material and the extent of antimicrobial activity against targeted organisms.

Recent Publications

1. Butler B A, Fitz D W, Lawton C D, Li D, Balderama E S and Stover M D (2018) Early diagnosis of septic arthritis in immunecompromised patients. Journal of Orthopaedic Science 23(3):542-545.
2. Li D, Pengfei L, Linfeng F, Huang Y, Yang F, Mei X and Wu D (2017) The immobilization of antibiotic-loaded polymeric coatings on osteoarticular ti implants for the prevention of bone infections. Biomaterials Science 5(11):2337–2346.
3. Li D, Li L, Ma Y, Zhuang Y, Li D, Shen H, Wang X, Yang F, Ma Y and Wu D (2017) Dopamine-assisted fixation of drug-loaded polymeric multilayers to osteoarticular implants for tuberculosis therapy. Biomaterials Science 5(4)730-740.
4. Kuiken T A, Bennet B A, Sharkey T, Ivy A D, Li D and Peabody T D (2017) Novel intramedullary device for lengthening transfemoral residual limbs. Journal of Orthopaedic Surgery and Research 12:53.
5. Fu S, Rossero J, Chen C, Alzgheir R, Li D and Takoudis C (2017) On the wetting behavior of ceria thin films grown by pulsed laser deposition. Applied Physics Letters 110:8.

Biography

Daniel Li has completed his Undergraduate degree in Materials Science and Engineering at University of Illinois. He conducted research under John Rogers Research Group investigating novel biodegradable electronics. He has participated in a wide variety of both basic and clinical research regarding biomaterials in the context of orthopaedic applications, such as the use of hydrogels as a novel drug-eluting mechanism to combat osteomyelitis and tuberculosis infection. He has spent significant time overseas in the orthopaedics department at the 309th Hospital of the PLA in Beijing, China, working under the team of Dr Yuanzheng Ma. Currently, he is performing clinical outcomes research at Northwestern University regarding the evaluation of prosthetic joint infection.

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Dan Li et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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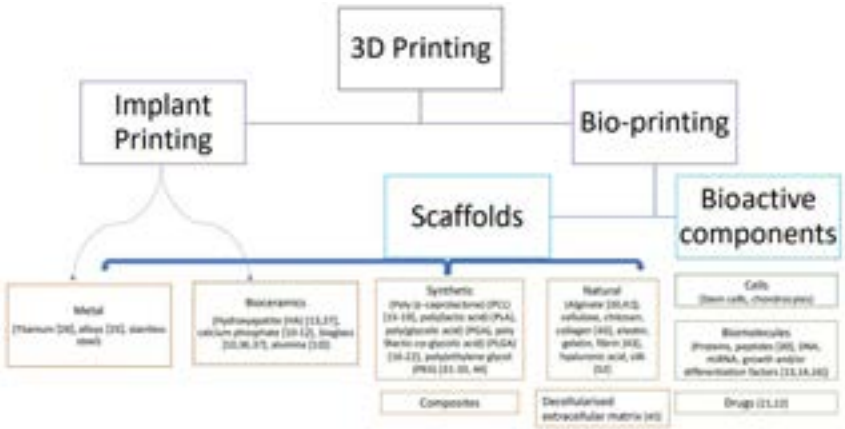
Advances in 3D printing in biomaterials for orthopaedic applications

Dan Li[1, 2], **Pravin Vence**[1], **Yaoyi Huang**[2], **Hong Shen**[2], **Yunlong Ma**[2] and **Yuanzheng Ma**[2]
[1]Northwestern University, USA
[2]309th Hospital of the PLA, China

3D printing aims to deliver intricate biomedical devices based upon advanced diagnostic imaging. With the current upsurge in public interest and increasing access to low-cost printers, efforts are underway to produce patient-specific anatomical models, customized implants, and individualized instrumentation. Examples include the development of disposable surgical saw guides and cutting blocks in total knee arthroplasty. These devices help minimize tissue loss and optimize the native biomechanics of the patient. This review explores the evolution of 3D printing technology in the context of biomaterials. It also aims to critiques the major challenges ahead in optimizing bioinks and biologic performance in bringing 3D bioprinting to clinical practice. Common materials include metals, bioceramics, synthetics, and natural polymers; each having specific mechanical properties, processing methodology and cell-material interaction. Biofunctional biomaterials are an emerging class of materials that display adaptability and activity at every phase of bone growth. These biomaterials have been shown to promote osteogenic differentiation, improve calcium phosphate (CaP) precipitation, and regulate osteoblast gene expression. When crafted to emulate the specific micro-environment of bone, polymer-surface modifications accelerate bony ingrowth. 3D printing holds promise as a scaffold for bone regeneration as precise control of the overall geometry and internal porous structure. The accompanying biomaterials may be successfully embedded within multi-cellular co-cultures and specific growth factors modulated to optimize growth and fixation. Bioceramics such as hydroxyapatite (HA), calcium phosphate, and bioglass, are osteogenic and promote cell proliferation, though they have been shown to lack appropriate mechanical strength. Composite scaffolds of HA and tricalcium phosphate and polycaprolactone (PCL)-HA with carbon backbones have been investigated to optimize biocompatibility and architecture to improve the porosity and mechanical strength of these constructs. Furthermore, microscale manipulation of biomaterials allow for integration of antimicrobial properties to combat infection.



Recent Publications

1. Butler B A, Fitz D W, Lawton C D, Li D, Balderama E S and Stover M D (2018) Early diagnosis of septic arthritis in immunecompromised patients. Journal of Orthopaedic Science 23(3):542-545.
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Biography

Daniel Li has completed his Undergraduate degree in Materials Science and Engineering at University of Illinois. He conducted research under John Rogers Research Group investigating novel biodegradable electronics. He has participated in a wide variety of both basic and clinical research regarding biomaterials in the context of orthopedic applications, such as the use of hydrogels as a novel drug-eluting mechanism to combat osteomyelitis and tuberculosis infection. He has spent significant time overseas in the orthopedics department at the 309th Hospital of the PLA in Beijing, China, working under the team of Dr Yuanzheng Ma. Currently, he is performing clinical outcomes research at Northwestern University regarding the evaluation of prosthetic joint infection.

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Accepted Abstracts

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Al-MCM-41 reinforced epoxy-polybenzoxazine hybrid nanocomposites

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Polybenzoxazine (PBZ) is a highly cross-linked thermosetting resin that created a wide interest as a matrix material for the fabrication of composites. Combination of PBZ with epoxy polymer provides an excellent balance of material property and enhances the main features of the resultant polymer such as an easy thermal curing by ring opening polymerization without the need of hardeners or catalysts; a low shrinkage during curing; a high glass transition temperature with a high charring yield; a low coefficient of thermal expansion; a low moisture absorption and good chemical resistance. Hence, attempts were made in the present work that focuses on the development and fabrication of epoxy blended PBZ material and their subsequent characterization by surface analytical techniques in order to find their suitability as advanced composite materials. The composition consists of epoxy resin, benzoxazine resin and varying weight percentages (1, 3 and 5 wt%) of inorganic filler of F-Al-MCM-41. The synthesized monomer was confirmed by 1H NMR and FTIR. The final product was characterized by DMA, dielectric studies and SEM-EDAX. Thermal curing and stability of the final products were also investigated using TGA. Five wt% of epoxy-PBZ nanocomposites showed higher storage modulus and dielectric constant than the neat one indicating its possible use for capacitor applications. The interesting results obtained from the investigation are discussed with experimental evidences.

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Designing and application of biomaterials based cross-linked hybrid hydrogels

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Statement of Problem: Polymeric hydrogels are three dimensional (3D) interpenetrating (IPN) polymeric materials with high affinity and ability to hold water or molecular species within. Hybrid hydrogels can be considered as an advance material due to synergistic cocktail of organic and inorganic components. However, only an optimum concentration of the individual components can result in a stable, bio-compatible and cell sustaining hybrid hydrogel. Chitosan is a well-known biopolymer however, stiffness in the free standing dry films or high toughness in 3D structures results in brittle nature of the matrix. So, here we report the effect of secondary bio-polymers (Guar gum, PVA and glycerol) and inorganic nano-filler (Graphite) on the physico mechanical, physicochemical and bio-compatibility properties of the hybrid hydrogels.

Methodology & Theoretical Orientation: Longer chain length has the ability to increase the flexibility of the resulting hydrogel matrix in one hand, whereas, it also decreases the stability of 3D structure. So, along with co-polymeric mixture addition of graphite would certainly enhance the stability and intactness of the 3D structure. Additionally, dispersion of graphite also improves the cell adhesion and cell proliferation in the 3D hybrid hydrogel matrix. A set of hydrogels were designed with varying concentration of components over fixed and optimum concentration of graphite nanostructure. Optimum concentration of graphite was defined by the parameters such as cell adhesion, viability, proliferation of human embryonic kidney (HEK-293) cell line and A549, adeno carcinomic human alveolar basal epithelial cells, along with the swelling ability of the resulting hydrogels.

Findings: The ten times improvement in physico mechanical, chemical and swelling properties with higher cell adhesion efficiency of the hybrid materials projects their potential in the fields of advance materials for 3D cell culturing and tissue engineering.

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Modification of cotton fibers with magnetic core-shell mesoporous silica nano particles

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Fabric materials have a wide diversity in the nature which can highlight cotton as one of the most abundant consisted in 96% of cellulose. The functionalization of cotton avoids facile degradation and damage by the environment, moisture, microorganisms, etc., and allows obtaining a highly desired material with extensile applications such as medical, construction, textile, among others. Electrostatic assembly better known as layer-by-layer (LbL) technique is an alternative option of cotton modification that consists in depositing controllable nano layers by the adsorption of oppositely charged poly electrolytes on the surface for further immobilization of charged nanoparticles, besides, LbL technique is very attractive for cotton modification due to its simplicity and its easy incorporation in just one coating at ambient conditions. LbL has an environmental characteristic that the most common solvent employed is water and the concentration needed is relatively low. Nanostructured materials have been aimed of many investigations in the textile field because of their attracting characteristics such as high surface area and unique physicochemical properties compared to bulk materials. Recently, core-shell nanoparticles have been focused due to their synergistic affects using a combination of a core and a shell made by different precursors and which unique and useful functionalities are obtained depending on this interaction affording to expand the fields of applications according to the shape, size and smart characteristics given by these core-shell nanostructures. In the present study, we have pre-treated and modified cotton fibers using PDDA and PSS polymers in order to functionalize the surface with charged polyelectrolytes for further nanoparticles attaching by electrostatic interaction. Magnetite and magnetic core-shell mesoporous suspension were prepared for coating the cotton fibers to compare and characterize the resulting material as a novel, innovative and promising product for different fields of application.

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Journey from the forest of nanowires to the flatland of 2D materials

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Silicon whiskers were discovered in late 1950's and rediscovered in mid-90's. A single layer of graphite was discovered in 2004 (crowned with the 2010 Nobel prize) and followed by explosion of research on other 2D layered materials including MoS_2 and related transition metal dichalcogenides. Both breakthroughs led to exploration of fascinating properties of nanowires and atomically-thin layers, including quantum confinement, reduced density of structural defects, large active surface area and functional flexibility for electronics, photonics, sensors and energy applications. This seminar discusses our group research on fabrication, characterization and processing of semiconductor nanowires (NWs) into small-footprint chemical sensors, photodetectors and Li-ion batteries. The design of NW platforms spans from pick-n-place silicon and gallium nitride individual nanowire devices to vertically- and/or horizontally aligned periodic arrays towards wafer-scale device fabrication. From the forest of nanowires, the talk will proceed to the flatland of $MoTe_2$, $MoSe_2$ and other metal chalcogenide thin films, with the aim to benchmark their structural, optical and electrical properties and explore their potential application in beyond CMOS low-power, high-speed and flexible electronics and chem/bio-sensors.

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Anticorrosive performance of the scratched coating systems on carbon steel in marine environment by electrochemical technique

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In practice engineering, defects were inevitable for protective coating systems on steel surface. In this paper, a composite coating system, including primer, middle coat as well as top coat were used to protect the carbon steel against corrosion in marine environment. Among them, two environmental additives, glass fibers and thiourea were applied in middle coat to modify the coating system. The long-term corrosion durability and the self-healing ability of the scratched coating system were evaluated by multiple methods. Results of electrochemical technologies indicated that the coating system containing 0.5 wt.% fibers and 0.5 wt.% thiourea presented a good performance of corrosion protection and self-healing for carbon steel as immersing in 3.5% NaCl for 120 days. The evolution of localized corrosion factor with time obtained from current distribution showed that fibers combined with thiourea could effectively inhibit the occurrence of the local corrosion for the scratched coating systems and greatly delay the development of corrosion process. Surface characterization suggested that adequate of thiourea could be uniformly absorbed on fibers for a long time to play an important role in protecting the carbon steel. At last, the schematic models were established to demonstrate the action of fibers and thiourea on the exposed surface of the carbon steel and the scratched coating system in the whole deterioration process.

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The role of CNTs on the characteristics of mechanically alloyed and spark plasma sintered CNT-Fe nanocomposites

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Metal composites reinforced by carbon nanotube (CNT) often show improved mechanical properties along with various interesting properties associated with the interfaces between CNTs and metal matrix. For example; ion irradiation experiments on CNT-aluminum composite demonstrate that the CNT-metal interfaces can act as efficient defect recombination sites and as a result reduce void generation and radiation hardening. Most of the metal matrices studied so far are non-ferrous metals, e.g., Al, Cu, Ni etc., and there are only few studies on CNT-ferrous alloy. A recent research paper concerning the fabrication of 304LSS–CNT composites using mechanical alloying combined with hot pressing and melting has also been found. Recently, we fabricated and investigated a 304 stainless steel and carbon nanotube (304SS-CNT) composite with an aim to study its microstructures and high-temperature tensile properties. 304SS powders were mixed with carbon nanotubes using ball milling and consolidated using the spark plasma sintering technique. Tensile specimens made from the consolidated samples of 304SS-CNT were tested in a temperature range from 299 K to 773 K. The yield strength and the work hardening of the 304SS-CNT samples were found to be higher than those of a sample fabricated from 304SS without carbon nanotubes for all tested temperatures. 304SS-CNT samples have a microstructure significantly different from the 304SS sample, e.g., reduced grain size and many small cuboidal particles. Composition analysis using energy-dispersive spectroscopy revealed that the cuboidal particles are chromium carbides and the chromium content is reduced in the 304SS-CNT matrix. In this study, we extended our previous work to CNT-Fe matrix composites. We will present the role of CNTs on the formation of micro structures and mechanical properties of pure Fe and ferrous alloys.

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Compatibilization and reinforcement effect of thermally reduced graphene: Elemental sulphur composites on high density polyethylene (HDPE)

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In this study, structure and properties of various hybrid composites of high-density polyethylene (HDPE) containing thermally reduced graphene (TRG) and elemental sulphur were investigated. Samples of HDPE-TRGS hybrid composites were fabricated by twin-screw extruder and injection molding machine in accordance with the standard test specimens. Mechanical properties and morphology of HDPE and HDPE-TRGS hybrid composites were examined by universal testing machine (UTM), TEM and SEM. Furthermore, AT- FTIR, XRD and Raman spectroscopy, examinations were performed to establish the structure-properties relationships. The mechanical properties significantly improved, when the proper amounts of TRGS materials were added to HDPE. The tensile strength of the hybrid composites was increased with insignificant loss of elongation. These improvements in properties are mainly due to the compatibilizing effect of TRGS and polymerization of octasulfur rings. TEM and SEM studies show that the graphene and sulfur were dispersed in HDPE matrix uniformly and make the composite more compactable. Elemental mapping and EDAX spectra showed that sulfur is present in the composite and distributed uniformly.

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Strong hydrogels fabricated by 3D printing with oppositely charged polymers

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Hydrogels are commonly used to prepare bioinks, as they are soft and hydrophilic as well as possess similarities to biological tissues. Natural hydrogels, such as alginate, gelatin, collagen and chitosan, which show good biocompatibility with nontoxic degradation products, have received great attention in the field of biomedical engineering. However, these natural hydrogels have limitations for their broad applications because they are weak by nature. Therefore, many studies focus on improving mechanical properties of hydrogels. 3D printing is a layer-by-layer printing process, where there are often layer defects or weak interface adhesion in 3D printed layered structures with hydrogels. As a new approach, alternate printing of two kinds of hydrogels maybe possible to overcome the drawbacks of printing one hydrogel alone. Furthermore, alternate printing of two oppositely charged ionic hydrogels is expected to result in a strong interface adhesion between layers, but it has not been found in the literature. In this study, we report a new strategy and approach for fabrication of strong hydrogel constructs with strong interfacial bonding by utilizing the ionic interaction between two oppositely charged hydrogels. Six natural ionic polymers are chosen as the representatives of anionic and cationic hydrogels, respectively. Specific properties such as rheological properties of the prepared hydrogels, shape fidelity of a printed structure, structure integrity of a printed construct in the cell culture medium are investigated. These properties help us to find the best concentration of each hydrogel and the best combinations for bioprinting. The interfacial adhesion properties between the printed hydrogel layers are also examined. Additionally, the biocompatibility of the best pair of bioink is also investigated.

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A new interfacial bio-sensing approach for detecting aberrant protein phosphorylation in cancer

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Protein phosphorylation is one of the most prominent post-translational mechanisms for protein regulation, which is frequently impaired in cancer. Through the covalent addition of phosphate groups to certain amino-acids, the interactions of former residues with nearby amino-acids are drastically altered, resulting in major changes of protein conformation that impacts its biological function. Herein, we report that these conformational changes can also disturb the protein's ability to interact with and adsorb onto bare gold surfaces. Based on the direct interaction of proteins with the gold interface, we further developed an extremely simple method for aberrant phosphorylation detection that circumvents the current need for phospho-specific antibodies. The novel interfacial bio-sensing method, which only requires 50 ng of purified protein, was applied to EGFR phosphorylation analysis in several lung cancer cell lines and enabled monitoring their cell sensitivity to tyrosine kinase inhibitors (TKI) a drug frequently used in the clinic for lung cancer treatment.

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Thermal investigation of phase change materials based on LLDPE, paraffin wax and expanded graphite

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Paraffin waxes which are saturated hydrocarbon mixtures, generally entailing of a mixture of different alkanes are frequently used as phase change materials (PCMs) due to their numerous advantages such as high latent heat of fusion, negligible super-cooling, low vapor pressure in the melt and chemical inertness. Paraffin waxes, blended with appropriate polymers to avoid the leaching of paraffin during heating, seem to be the best way for preparation of smart PCMs for different applications such as thermal storage of solar energy, thermal protection of electronic devices, thermal protection of food and medical goods, passive storage in bio climatic buildings and thermal comfort in vehicles. Due to the relatively low thermal conductivity of linear low density polyethylene (LLPDE) and also paraffin wax (approximately 0.2 W/mK) it is necessary to improve the thermal conductivity of the PCMs by adding conductive fillers. Nowadays, expanded graphite (EG) is commonly used to improve mechanical, electrical conductivity, thermal conductivity and other thermophysical properties. In this contribution thermal properties of the PCMs based on LLDPE, paraffin wax RT42 (melting point around 42°C) and expanded graphite were characterized by unique devices, namely PCGT and DICO devices, which allows an investigation of thermal properties of large sized samples in comparison with common differential scanning calorimetry (DSC). Storage and release of thermal energy of the PCMs have been performed by means of PCGT device. It was confirmed that all prepared PCMs were able to store and release thermal energy. Also reproducibility of storage and release heat of the PCMs by repeating of heating and cooling process has been demonstrated. The best results in view of time needed for storage and release energy were achieved with PCMs containing 15 wt% of EG. Thermal conductivity and diffusivity of the PCMs have been measured by DICO device. Increase of the EG content in the PCMs led to the increase of thermal conductivity and also thermal diffusivity for all investigated PCMs.

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Competitive crystallization in Al-Sm involving metastable large-unit-cell intermetallic phases: chemical partitioning and crystal genes

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Amorphous alloys of Al-Sm exhibit competitive devitrification behavior upon reheating, involving competition between multiple metastable phases. These include large-unit-cell phases with cubic, hexagonal and tetragonal symmetry, along with more conventional stable and metastable compounds. Phase selection during crystallization is strongly path dependent, owing to effects of non-crystalline ordering and the role of diffusion and chemical partitioning in the morphological dynamics. In this work, devitrification kinetics is investigated and quantified using high energy X-ray diffraction, thermal analysis and electron microscopy. Measurements are related to system thermodynamics in the highly driven regime highlighting principles of selection. Growth mechanisms are investigated in detail, with particular attention to chemical partitioning associated with the initial crystallization front. Implications with respect to other Al-RE (rare-earth) systems are also discussed.

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Designing anisotropic metamaterials with wave propagation isolation properties

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The advancement of additive manufacturing has led to a new paradigm in the design of materials. New artificial materials arose, not through chemically modified material units but rather through appropriately coined inner material architectures. The wording metamaterials has been employed to designate the potential of creating static and dynamic behaviors which are typically not encountered in common engineering materials. Up to now a considerable amount of works have been dedicated to a class of metamaterials named auxetics, because of their property of laterally expand when stretched. In the current work, we present a systematic approach to create two-dimensional orthotropic metamaterials with a non auxetic material behavior that exhibit wave propagation isolation features. To that scope, we employ polygonal-shaped unit cell material architectures that lead to highly anisotropic material designs in a systematic manner. We compute the anisotropic metamaterial's wave propagation characteristics for all propagating material directions. Thereupon, we identify a material direction of vanishing longitudinal and shear phase velocities. We observe that the vanishing phase velocity direction coincides with the material direction with the weakest normal mechanical modulus. We discuss on the role of Poisson's ratio and shear stiffness obtained by wave propagation features, deriving overall conclusions on the underlying structural mechanisms.

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Enhancement of thermoelectric properties in mechanically alloyed $Bi_{0.4}Sb_{1.6}Te_3$ bulk nanocomposite containing $Ti_{50}Cu_{28}Ni_{15}Sn_7$ amorphous particles

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During mechanical alloying of Bi, Sb and Te elemental powder mixture, the $Bi_{0.4}Sb_{1.6}Te_3$ compound phase can be obtained after 2 hours of mechanical alloying treatment. The as-milled $Bi_{0.4}Sb_{1.6}Te_3$ powders were further mixing with $Ti_{50}Cu_{28}Ni_{15}Sn_7$ amorphous particles to form $Ti_{50}Cu_{28}Ni_{15}Sn_7/Bi_{0.4}Sb_{1.6}Te_3$ composite powders after 30 minutes ball milling. The $Ti_{50}Cu_{28}Ni_{15}Sn_7/Bi_{0.4}Sb_{1.6}Te_3$ composite powders were consolidated into bulk samples with a diameter of 20 mm and thickness of 10mm by using vacuum hot pressing. The nano-/microstructured structure were observed for $Ti_{50}Cu_{28}Ni_{15}Sn_7/Bi_{0.4}Sb_{1.6}Te_3$ bulk samples. TEM bright-field image shows that the $Ti_{50}Cu_{28}Ni_{15}Sn_7$ amorphous phase with particle size of about 50 nm were homogeneously distributed along the grain boundary of $Bi_{0.4}Sb_{1.6}Te_3$ matrix with grain size around 0.5~2.0 μm. The thermoelectric properties of $Ti_{50}Cu_{28}Ni_{15}Sn_7/Bi_{0.4}Sb_{1.6}Te_3$ samples were measured. The results indicated, either use high purity (99.999%) or low purity (99.5%) Sb and Te as starting materials, the values of figure of merit (ZT) for the $Ti_{50}Cu_{28}Ni_{15}Sn_7/Bi_{0.4}Sb_{1.6}Te_3$ bulk composite samples were found to increase with temperature in the range from 298 K to 580 K. It is the first time that such specific behavior has been observed. For 3 wt.% amorphous $Ti_{50}Cu_{28}Ni_{15}Sn_7/Bi_{0.4}Sb_{1.6}Te_3$ specimen use high purity Sb and Te powders as starting materials, the maximum ZT value is only 0.9 at 473 K but is expected to reach 1.18 when the ZT curve is extended from 473K to 580K. For 1.75 wt. % amorphous $Ti_{50}Cu_{28}Ni_{15}Sn_7/Bi_{0.4}Sb_{1.6}Te_3$ specimen fabricated from low purity Sb and Te powders, the maximum ZT value is 1.08 at 580 K, which is the highest ZT values among the existing typical low temperature thermoelectric materials has been measured at 580 K.

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Effect of voltage on micro arc oxidation of 6061-Al alloy

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The ceramic film on 6061-Al alloy was prepared by micro arc oxidation (MAO). Effect of voltage on the microstructure and corrosion resistance of MAO coatings were studied by scanning electron microscopy (SEM), X-ray diffraction (XRD), electrochemistry impedance spectroscopy (EIS) and a coating thickness tester. The results showed that the surface morphology of MAO coating on 6061 aluminum alloys is porous volcano-like microstructures. The ceramic coatings are mainly composed with the phase of γ-Al_2O_3 and slight α-Al_2O_3. Mullite phase ($3Al_2O_3$•$2SiO_2$) appeases when the value of voltage is 500V. With the voltage increasing, the coating thickness and the size of discharge channels increased. The micro cracks will appear at 500V. However, the number of discharge channels and corrosion resistance increased at first and then decreased with the increasing of voltage. Accordingly, when the value of voltage is 450V, the corrosion resistance of the coating showed enhanced properties.

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Comparative photoluminescence study of $GdBO_3$: Eu phosphor in bulk and nano phase for its implication in solid state lightening

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Rare-earth borates are excellent candidates for solid state lightening application due to its robust nature and brilliant optical properties. $GdBO_3$: Eu^{3+} is one of the finest phosphors existing amongst borate phosphors for primary red color. In this work we investigate the nature of structure-composition-optical relationships in both nano and bulk forms of $GdBO_3$:Eu^{3+}. Nanophosphors have unique physical and chemical properties as compared to their bulk counterpart and so their emission efficiencies vary which can finely be tuned and considerably improved. $GdBO_3$ exists in both monoclinic and triclinic phase. $GdBO_3$ containing 1 at.% Eu^{3+} were prepared in nano-crystalline, monoclinic and triclinic forms by hydrothermal and polyol route. Techniques like XRD, FTIR, TEM, luminescence and lifetime measurements were used to characterize the samples. SAED pattern illustrate phase formation while presence of nano rods with 200 nm length and width less than 10 nm are confirmed from TEM images. Boron was found in both trigonal and tetrahedral coordination in nanorods and triclinic phase, whereas only BO_4 structural unit exists in monoclinic $GdBO_3$. Based on bond angle and bond length values obtained from Rietveld refinement of the XRD patterns it is inferred that local environment around Eu^{3+} in the triclinic form is more distorted compared to monoclinic form. This explains increase in the relative intensity of electric dipole allowed transition of Eu^{3+} in triclinic form compared to monoclinic form. Red to orange ratio of Eu^{3+} in triclinic and nanorods is found to be higher than the monoclinic phase. From the results it is inferred that the nanorods have improved red color characteristics compared to the other two forms. By size tuning we improvised optical parameters of the phosphor to develop materials with optimum luminescence characteristics.

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Energy efficient CuO-ZnO heterojunction nanocomposite: Study of band gap tuning, energy band alignment and photo-induced charge transfer mechanisms

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Oxide-semiconductor based heterojunction nanocomposites (HNCs) have garnered enormous research interest worldwide and exhibited progressively advanced features such as effective separation of photo generated electron hole pairs for their auspicious adoption in photovoltaic, photocatalytic and optoelectronic applications. Great emphasis has been paid to fulfill the objectives of HNCs by synthesizing nanocrystalline narrow band gap p-type copper oxide with wide band gap n-type zinc oxide using sol-gel technique. The structural, optical and electronic properties of developed HNCs were studied using X-ray diffraction, micro-Raman spectroscopy, high resolution transmission electron microscopy (HRTEM), photo-luminescence spectroscopy and X-ray photoelectron spectroscopy (XPS) and ultraviolet photoelectron spectroscopy (UPS) techniques. Results revealed that Cu doping concentration upto 5% remains within the solubility limit of ZnO however, the higher Cu-doping concentration leads to formation of ZnO-CuO HNCs. Cu-doping decreases ZnO band gap by introducing impurity energy levels and exhibits absorption in visible region of electromagnetic radiation. The crucial information of local electronic structures has been understood in terms of the hybridized electronic states and variation of valence band maxima with respect to Fermi level with increasing the Cu-doping in ZnO-CuO HNCs. The enhanced photocatalytic activities and efficient charge transfer mechanism in ZnO/CuO HNCs are rationalized and studied in terms of band gap tuning, energy band alignment and charge migration at ZnO/CuO heterojunction interfaces. Detailed results will be presented.

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Ultrasound in wet biological materials subjected to drying

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The aim of this article is to present the effect of external action of air-borne ultrasound (US) upon biological wet materials subjected to drying. The study allows determining the drying effectiveness of such products like fruits and vegetables by convective drying with ultrasound enhancement. The vibration and heating effects induced by power ultrasound are considered. The mathematical model of drying is developed and validated experimentally using the data obtained from the experimental tests carried out on the hybrid dryer equipped with ultrasonic generator. The obtained results proved that the vibration effect induced by ultrasound has a great impact on the acceleration of mass transfer without significant elevation of product temperature and thus on the drying efficiency with respect to energy utilization and the quality of dried products like fruits and vegetables.

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Confined nanoscale geometries to enhance sensitivity of plasmonic immunoassays

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Sensitive transduction of bio-molecular binding events on chip carries profound implications to the outcome of a range of biological sensors. This includes biosensors that address both research as well as diagnostic questions of clinical relevance, e.g., profiling of biomarkers, protein expression analysis, drug or toxicity screening and drug-efficacy monitoring. Nanostructured biosensors constitute a promising advance in this direction owing to their ability in catering to better sensitivity, response times and miniaturization. Plasmonic sensors are particularly interesting among nano-biosensors as they exploit light matter interactions in the nanoscale to transduce bio-recognition events with high sensitivity and miniaturized measurement footprints. Examples of plasmonic sensors include localized surface plasmon resonance spectroscopy (LSPR), surface enhanced Raman spectroscopy (SERS) and metal-enhanced fluorescence (MEF). The performance of the plasmonic sensors critically relies on ability to engineer nanoscale geometric attributes at length scales that typically overlap with the size of small proteins. Such geometries invariably introduce constraints on the molecular binding response, thus altering the interaction outcomes, viz. density and kinetics of adsorption, molecular orientations, in a manner that would impact the resulting optical response. A careful engineering of the nanoscale geometries can simultaneously take advantage of EM field enhancements together with molecular interaction within nanoscale geometries. To this end, this project aims at an engineered nanoscale interface with geometry tailored to simultaneously favor molecular adsorption and plasmonic enhancements for application to plasmonic sensors based on surface-enhanced Raman and fluorescence spectroscopies.

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Advanced protection and evaluation techniques against corrosion

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Corrosion is an unavoidable scenario, which leads to widespread of losses and dangers if not properly protected. Every country faces heavy economic losses due to corrosion everyday irrespective of the level of development of the country and their geographical location. With more industrial advances in the world together with atmospheric changes, there are more challenges to overcome in corrosion protection strategy development. Proof of durability for long term protection under harsh environment is necessary. Need for novel advanced corrosion protection strategies such as smart coatings with self-healing capabilities became inevitable with more environmental regulations being adopted such as the ban of chromate conversion coating. Another major demand from end users from various industrial sectors is the requirement for multifunctional properties to supply the same coating system such as esthetic necessities, fire retardant properties, etc. without compromising corrosion protection attributes. This becomes even more challenging as productivity has also become one strong demand. Thus, to provide productive coating systems with outstanding corrosion protection properties to prove long lasting protection even under harsh environmental and service conditions together with multifunctional properties is the key to success in this area. On the other hand, it is very important to use proper corrosion characterization techniques and methods to evaluate the performance of these coatings. These challenges and a review on current advanced coating systems will be presented in this talk. Recent developments in advanced zinc rich coatings and sol-gel coatings will also be discussed. Some insight into advanced corrosion and electrochemical characterization techniques to evaluate these coatings will also be presented.

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Tunable light-emitting carbon-dot/polymer flexible films prepared through one-pot synthesis

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Development of efficient, inexpensive and environmental-friendly light emitters, particularly devices that produce white light have drawn intense interest due to diverse applications in the lighting industry, photonics, solar energy and others. We present a simple strategy for the fabrication of flexible transparent films exhibiting tunable light emission through one-pot synthesis of polymer matrices with embedded carbon dots assembled in situ. Importantly, different luminescence colors were produced simply by preparing C-dot/polymer films using carbon precursors that yielded C-dots exhibiting distinct fluorescence emission profiles. Furthermore, mixtures of C-dot precursors could also be employed for fabricating films exhibiting different colors. In particular, we successfully produced films emitting white light with attractive properties (i.e., warm white light with a high color rendering index)–a highly sought after goal in optical technologies.

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