NANOTECH 2022
(2ND EDITION)

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2ND GLOBAL VIRTUAL SUMMIT ON

NANOSCIENCE & NANOTECHNOLOGY

NOVEMBER 10 & 11, 2022

Theme : Innovatory Advancements: Micro to Nanotechnology and Real-World Applications

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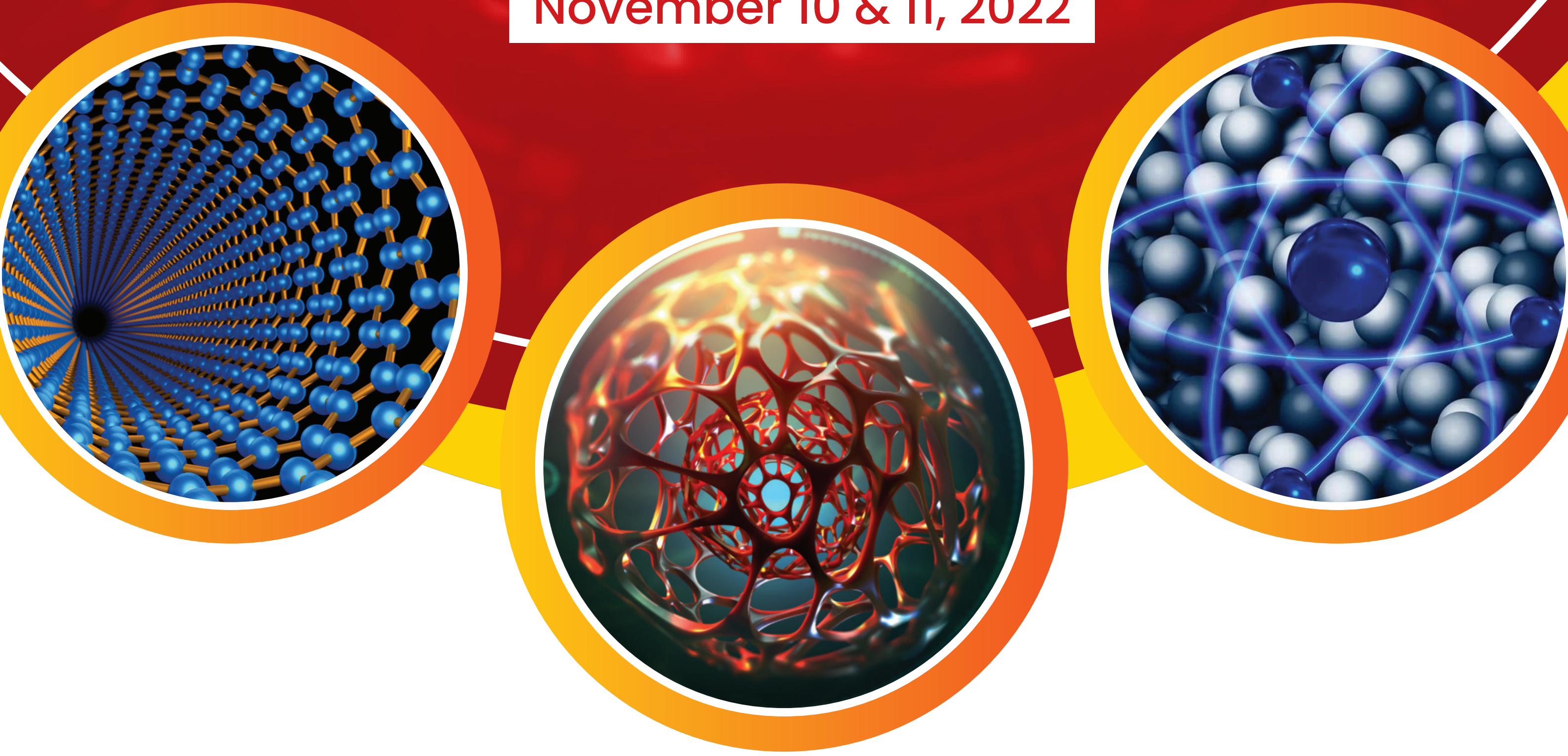
2nd Global Virtual Summit on Nanoscience & Nanotechnology

November 10 & 11, 2022



Theme: "Innovatory Advancements: Micro to Nanotechnology and Real-World Applications"

Keynote Forum

DAY 1

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Graphene Coatings: A Disruptive Approach for Mitigation of Corrosion

Raman Singh

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Corrosion and its mitigation costs dearly (any developed economy loses 3-4% of GDP due to corrosion, which translates to ~$250b to annual loss USA). In spite of traditional approaches of corrosion mitigation (e.g., use of corrosion resistance alloys such as stainless steels and coatings), loss of infrastructure due to corrosion continues to be a vexing problem. So, it is technologically as well as commercially attractive to explore disruptive approaches for durable corrosion resistance.

Graphene has triggered unprecedented research excitement for its exceptional characteristics. The most relevant properties of graphene as corrosion resistance barrier are its remarkable chemical inertness, impermeability and toughness, i.e., the requirements of an ideal surface barrier coating for corrosion resistance. However, the extent of corrosion resistance has been found to vary considerably in different studies. The author's group has demonstrated an ultra-thin graphene coating to improve corrosion resistance of copper by two orders of magnitude in an aggressive chloride solution (i.e., similar to sea-water). In contrast, other reports suggest the graphene coating to actually enhance corrosion rate of copper, particularly during extended exposures. Authors group has investigated the reasons for such contrast in corrosion resistance due to graphene coating as reported by different researchers. On the basis of the findings, author's group has succeeded in demonstration of durable corrosion resistance as result of development of suitable graphene coating. The presentation will also assess the challenges in developing corrosion resistant graphene coating on most common engineering alloys, such as mild steel, and presents results demonstrating circumvention of these challenges.

Biography

Professor Raman Singh's expertise includes: Alloy Nano/Microstructure-Corrosion Relationship, Stress Corrosion Cracking (SCC), Corrosion/SCC of Biomaterials, Corrosion Mitigation by Novel Material (e.g., Graphene), Advanced and Environmentally Friendly Coatings, High Temperature Corrosion. He has supervised 50 PhD students. He has published over 245 peer-reviewed international journal publications, 15 books/book chapters and over 100 reviewed conference publications. His professional responsibilities include Gust Professorships at ETH Zurich, and US Naval Research Lab, editor-in-chief of two journals, Fellow ASM International and Engineers Australia, over 40 keynote/plenary talks at international conferences (besides numerous invited talks), leadership (as chairperson) of a few international conferences.

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Highly Porous Metal Oxides as Optical Sensing Platforms

Noushin Nasiri

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Optical sensors are essential elements applied in video imaging, optical communications, biomedical imaging, security, night-vision, gas sensing, and motion detection, which possess the ability to transform light into electrical signals precisely. As the scale and diversity of application areas are growing, the need for innovative optical sensing technologies with higher performance in terms of speed, efficiency or wavelength range, as well as material flexibility and transparency is becoming more critical. Inspired by nanoscience and nanoengineering, numerous nanostructured materials have been recently developed exhibiting excellent photoelectronic properties. Amongst them, porous 3D nanostructured materials have attracted considerable research interest due to their large specific surface area. As the ultimate performance of nanostructured materials is strongly relied on the sizes, shapes, dimensionality, and morphologies, it is of great interest to synthesize porous nanostructured films with a controlled nanostructure and morphology. Here, we will discuss the latest advances in the fabrication of highly performing optical sensors made of highly porous metal oxide films. We will provide an overview of the fundamental mechanisms that have been successfully implemented for the self-assembly of hierarchical metal oxide nanostructures as high performing optical sensing platforms.

Biography

Dr Noushin Nasiri is the Head of the NanoTech Laboratory at the School of Engineering, Macquarie University. She is one of Australia's 2021-2022 Superstars of STEM, the recipient of 40 under 40 Most Influential Asian-Australians Award in 2021, and NSW 2019 Young Tall Poppy Science Award. Her research is focused on design and fabrication of nanostructured materials, functionalised coatings, miniaturized sensing technologies and wearable devices for health, energy and environmental applications. She serves on the editorial board of *Nanotechnology* and *Nanomanufacturing* journals and is an Associate Editor of Sensor Devices, Frontiers in Sensors. She is a passionate science communicator and three-times TEDx speaker who presented her research at TEDx Sydney Salon 2017, TEDx Macquarie University 2019 and TEDx Bligh Street 2020.

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Quantum mechanical and atomistic simulations for nanosized microelectronic devices

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As the sizes of microelectronic devices shrink to nanometers, the quantum mechanical and single atom effects become dominate. To judge whether a new device design is reasonable, first principles calculation with no dependence on parameters and with high reliability is necessary. In this talk, I will present our effort in doing atomistic and quantum mechanical simulations for nanometer devices, including their I-V curves. In particular, nonequilibrium self-consistent calculations will be used to describe the dielectric screening of the materials, and plane wave pseudopotential method will be used to describe the quantum transport. Unlike the conventional method using nonequilibrium Greens function to describe the quantum transport, scattering states will be calculated directly using plane wave basis set.

This allows the simulations of systems with tens of thousands of atoms. To speed up the calculation, we have also developed a charge patching method, with polarization charge density motifs. This allows fast calculations for large systems. Furthermore, ways of incorporating the electron-phonon coupling will be discussed in such device simulation. I will also discuss the effect of devices, and charge trapping to the performance of devices. Various ways of calculating the charger carrier trapping will also be discussed.

Biography

Dr. Wang has 30 years of experience in large scale electronic structure calculations. He has worked in O(N) electronic structure calculations in early 1990s. He invented the folded spectrum method which pushed the limit of nonselfconsistent electronic structure calculations from 100 atoms to thousands of atoms. He developed a linear combination of bulk bands (LCBB) method for million atom semiconductor heterostructrure electronic structure calculations. He also developed a parallel total energy plane wave pseudopotential program (PEtot), which has been changed into a commercial code PWmat. He invented a charge patching method, which enables the ab initio accuracy thousand atom calculations for nanosystems. He has developed a linear scaling three dimensional fragment method (LS3DF), which can be used to selfconsistently calculate systems with tens of thousands of atoms.

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Liquid crystal photoaligning and photopatterning by nanosize azodye layers: new trends

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Photoalignment and photopatterning has been proposed and studied for a long time [1]. Light is responsible for the delivery of energy as well as phase and polarization information to materials systems. It was shown that photoalignment liquid crystals by azodye nanolayers could provide high quality alignment of molecules in a liquid crystal (LC) cell. Over the past years, a lot of improvements and variations of the photoalignment and photopatterning technology has been made for photonics applications. In particular, the application of this technology to active optical elements in optical signal processing and communications is currently a hot topic in photonics research [2]. Sensors of external electric field, pressure and water and air velocity based on liquid crystal photonics devices can be very helpful for the indicators of the climate change.

We will demonstrate a physical model of photoalignment and photopatterning based on rotational diffusion in solid azodye nanolayers. We will also highlight the new applications of photoalignment and photopatterning in display and photonics such as: (i) fast high resolution LC display devices, such as field sequential color ferroelectric LCD; (ii) LC sensors; (iii) LC lenses; (iv) LC E-paper devices, including electrically and optically rewritable LC E-paper; (v) photo induced semiconductor quantum rods alignment for new LC display applications; (vi)100% polarizers based on photoalignment; (vii) LC smart windows based on photopatterned diffraction structures; (vii) LC antenna elements with a voltage controllable frequency.

Acknowledgements:

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2. V.G. Chigrinov, Liquid Crystal Photonics, Nova Science Publishers, 2015.

Biography

Professor Vladimir G. Chigrinov is Professor of Hong Kong University of Science and Technology since 1999. He is an Expert in Flat Panel Technology in Russia, recognized by the World Technology Evaluation Centre, 1994, and SID Fellow since 2008. He is an author of 6 books, 31 reviews and book chapters, about 322 journal papers, more than 677 Conference presentations, and 121 patents and patent applications including 38 US patents in the field of liquid crystals since 1974. He got Excellent Research Award of HKUST School of Engineering in 2012. He obtained Gold Medal and The Best Award in the Invention & Innovation Awards 2014 held at the Malaysia Technology Expo (MTE) 2014, which was hosted in Kuala Lumpur, Malaysia, on 20-22 Feb 2014. He is a Member of EU Academy of Sciences (EUAS) since July 2017. He got A Slottow Owaki Prize of SID in 2018 http://www.ee.ust.hk/ece.php/enews/detail/660. He is 2019 Distinguished Fellow of IETI (International Engineering and Technology Institute). http://www.ieti.net/news/detail.aspx?id=184 http://www.ieti.net/memberships/Fellows.aspx

Since 2018 he works as Professor in the School of Physics and Optoelectronics Engineering in Foshan University, Foshan, China. 2020-2024 Vice President of Fellow of Institute of Data Science and Artificial Intelligence (IDSAI) Since 2021 distinguished Fellow of Institute of Data Science and Artificial Intelligence.

Since March 2022 he is A Fellow of National Academy of Technology for his contributions to Information Electrical and Electronic Research : http://www.usnat.org/fellows.html.

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Rapid additive manufacturing anywhere anytime

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Rapid 3D printing on space/air/sea/land missions, where either gravitational force is missing or severe random disturbance may present continuously, is highly in demand. However, till today, there is no reliable technique for such working environments. The purpose of this study is to develop a technology for rapid 3D printing in solid state of polymeric materials to get rid of the problems in harsh working environment.

The basic concept is to cross-link by either UV-light or photo-induced-heat of polymeric materials in the solid state for rapid 3D printing. The uncross-linked parts can be removed by heating or cooling for melting, or washing away by solvent. Finally, the shape memory effect (SME) of the cross-linked polymers is applied to ensure high accuracy of the printed items.

We have successfully demonstrated this concept using a thermal gel and a UV cross-linkable vitrimer.

Keyword: Rapid 3D printing; solid state; cross-linking; thermal gel; vitrimer.

Biography

Dr Wei Min Huang has over 25 years of experience on various shape memory materials (alloy, polymer, composite and hybrid), he has published over 200 papers in journals, such as Accounts of Chemical Research, Advanced Drug Delivery Reviews, and Materials Today, and has been invited to review manuscripts from over 300 international journals (including Progress in Polymer Science, Nature Communications, Advanced Materials, and Advanced Functional Materials, etc), project proposals from American Chemical Society, Hong Kong Research Grants Council, etc, and book proposals from Springer, Elsevier and CRC. He has published two books (Thin film shape memory alloys – fundamentals and device applications, Polyurethane shape memory polymers) and is currently on the editorial board of over three dozen of journals.

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2D materials: from safety to immune applications

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Two dimensional materials such as graphene and MXenes are destined to leave an indelible mark in many application areas including biomedicine. In particular, due to a multitude of exceptional intrinsic properties, these materials offer new perspectives for the development of advanced tools for therapeutic delivery approaches, imaging, cancer theranostics, and tissue regeneration or engineering. For any biomedical applications, the immune system plays a fundamental role. Understanding whether and how immune cells respond to nanomaterials by immune activation or immunosuppression might allow taking advantage of both of those selected intrinsic immune properties. For example, immune activation could be useful to stimulate the immune system against malignant cells in cancer immunotherapy or as vaccine adjuvants. On the other hand, immunosuppression may find applications for overactive inflammation in allergic reactions, chronic inflammation, autoimmune disorders, and organ transplantation. Here we present our "Nanoimmunity-by-design concepts" as well as published and unpublished data on the immune-based applications of graphene, MXenes and other advanced 2D materials.

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Biography

Lucia Gemma Delogu, Ph.D., associate and full professor in Biochemistry and Pathology, is the head of the ImmuneNano-Lab at the Department of Biomedical Sciences of the University of Padua (Italy) www.delogulab.eu. After acquiring her experience as postdoctoral fellow at the University of Southern California (Los Angeles, USA) and at Sanford-Burnham Institute (San Diego, USA), she served for 5 years as Assistant Professor (non-tenure track) at the University of Sassari (Italy) and as Visiting Professor at the Technische Universität Dresden (TUD; Dresden, Germany). She introduced the "NanoImmunity-by-design" concept, for the design of nanomaterials based on their immunomodulatory characteristics. She pioneered the use of systems immunology approach by high-dimensional single-cell strategies in the context of nanomaterial applications. Her research focuses on the biological interactions of nanomaterials and nanoparticles, with a particular focus on their immunomodulation properties, biomedical applications and toxicological profile.

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Multicomponent High-Entropy Cantor alloys

Brian Cantor

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Brunel Centre for Advanced Solidification Technology, Brunel University

All human advances have depended on making new materials, and all materials are alloys, i.e. mixtures of several different starting materials or components. So the history of the human race has been the continued invention of new materials by discovering new alloys. Recently a new way of doing this, by manufacturing multicomponent high-entropy alloys, has shown that the total number of possible materials is enormous, even more than the number of atoms in the galaxy, so we have lots of wonderful new materials yet to find. And multicomponent phase space contains a surprisingly large number of extended solid solutions. The first group of these which was discovered are called Cantor alloys, an enormous composition range with a single-phase fcc structure, based loosely on the original equiatomic five-component Cantor alloy CrMnFeCoNi. This talk will discuss the previous history of alloying, the discovery of multicomponent alloys, the structure of multicomponent phase space, the fundamental thermodynamics of multicomponent solid solutions such as the Cantor alloys, the complexity of local atomic and nanoscale configurations in such materials, the effect of this on properties such as atomic diffusion, dislocation slip, and the resulting outstanding mechanical properties and potential applications, including at low and high temperatures, for corrosion and radiation resistance, and to enhance recycling and re-use.

Biography

Brian Cantor is an Emeritus Professor in the Department of Materials at the University of Oxford and a Research Professor in the Brunel Centre for Advanced Solidification Technology at Brunel University. He was previously Vice-Chancellor of the University of York and of Bradford University, Head of Mathematical and Physical Sciences at the University of Oxford, a research scientist and engineer at General Electric Research Labs in the USA, and worked briefly at Banaras Hindu University, Washington State, Northeastern, IISc Bangalore and the Kobe Institute. He founded and built up the World Technology Universities Network, the UK National Science Learning Centre, the Hull-York Medical School, and Oxford's Begbroke Science Park. He was a long-standing consultant for Alcan, NASA and Rolls-Royce, and editor of Progress in Materials Science. He invented the new field of multicomponent high-entropy alloys and discovered the so-called Cantor alloys.

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DNA and RNA medicines: Evolution of nanocarriers

Ernst Wagner
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It took fifty years from first RNA transfections to approved gene therapies as drugs. At least 19 gene therapies and 17 RNA therapies reached the medical market by Q1 2022, including mRNA vaccines. Targeted intracellular delivery remains the key requirement for such agents. For this purpose, chemical evolution approaches are pursued for refinements of synthetic nanocarriers. Natural evolution optimized viruses based on variation and selection of their gene and protein sequences. Our strategy focuses on such a bioinspired, sequence-defined process including (i) artificial amino acids (ii) precise assembly into sequences by solid phase-assisted synthesis (iii) screening for delivery and selection of top candidates, followed by further variation. The optimal sequence of nanocarriers depends on the DNA or RNA cargo, as will be outlined for pDNA, siRNA, mRNA, or Cas9/sgRNA delivery.

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Biography

Ernst Wagner is professor of Pharmaceutical Biotechnology and Center of Nanoscience at LMU Munich since 2001. From 1992-2001 he was Director Cancer Vaccines, Boehringer Ingelheim (first polymer-based gene therapy trial in 1994), 1987-1995 group leader at IMP Vienna and Vienna University Biocenter, 1985-1987 postdoc at ETH Zurich, in 1985 PhD in chemistry (TU Vienna). He is Academician of European Academy of Sciences, member of CRS College of Fellows, Board member of German Society for Gene Therapy. He has authored 490 publications, with 48 450 citations, h-index 110 (GS).

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Immune Transformation for Parkinson’s disease

Howard E. Gendelman

University of Nebraska Medical Center, Department of Pharmacology and Experimental Neuroscience

Our laboratories have developed the idea that transformation of CD4+ T cell effector to regulatory (Teff to Treg) can attenuate Parkinson’s disease progression by restoring immunological balance. We defined a pathway to restore this balance through the restoration of Treg numbers and function deploying the cytokine granulocyte-macrophage colony-stimulating factor (GM-CSF). These studies were conducted in PD preclinical models and two phase I clinical investigations. In all instances, disease associated signs and symptoms improved. However, despite the recorded efficacy, the cytokine’s short half-life, low bioavailability, and injection site reactions were limitations. In our recent works mRNA lipid nanoparticles were developed encoding an extended half-life albumin-GM-CSF fusion protein. These formulations were investigated in preclinical PD models. A single dose of the extended half-life nanoparticles generated measurable GM-CSF plasma cytokine resulting in increased Treg frequency and function, nigrostriatal neuroprotection, and in sustaining brain tissue immune homeostasis. Mechanistic evaluation of the novel neuropathological improvements performed in the disease-affected nigral brain region demonstrated a robust neuroprotective molecular signature. Such transforming immune regimens are being explored in disease-affected patient populations.

Biography

Dr. Howard E. Gendelman is co-founder of Exavir Therapeutics, and the Margaret R. Larson Professor of Internal Medicine and Infectious Diseases, Chairman of the Department of Pharmacology and Experimental Neuroscience, and Director of the Center for Neurodegenerative Disorders at the University of Nebraska Medical Center. Dr. Gendelman’s work focuses on how the neuroimmune system is involved in metabolic changes and cell damage throughout infectious, metabolic, and neurodegenerative disorders.

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Nano-theranostics and tumor chemical imaging enable precision oncology

Raoul Kopelman
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Nano-sized structures can have both therapeutic and diagnostic functions and can be utilised in-vivo provided they are bio-compatible, i.e., both non-toxic and bio-eliminable. The diagnostic function has been utilized for standard medical imaging, e.g., MRI and CT. Novel chemical imaging can map the tumor micro-environment (TME)'s "triad of chemical weapons of resistance to therapy": 1. Hypoxia (low O2) which resists radiotherapy; 2. Acidosis (low pH) which resists most chemotherapy drugs; 3. Hyperkalemia (High K+) which resists immunotherapy. Thus, chemical imaging of this triad, ahead of a cancer patient's treatment, can predict which treatment is least likely to fail, thereby replacing todays approach of trial-and-error. To avoid years of FDA approval for the method of chemical imaging, the latter has been applied to tumors in xenograft mice. An excellent correlation has been found between the tumor's O2 map (before treatment) and the follow-up radiotherapy efficacy. Technically, the O2 nano-contrast elements (nano-sensors) are embedded in a highly bio-compatible hydrogel nano-matrix, the imaging is done by tissue penetrating photoacoustic spectroscopy and the assessment of therapy by standard histology. Extensions of this approach to chemo- and immuno-therapy will be discussed.

~~Biography~~

~~Dr. Howard E. Gendelman is co-founder of Exavir Therapeutics, and the Margaret R. Larson Professor of Internal Medicine and Infectious Diseases, Chairman of the Department of Pharmacology and Experimental Neuroscience, and Director of the Center for Neurodegenerative Disorders at the University of Nebraska Medical Center. Dr. Gendelman's work focuses on how the neuroimmune system is involved in metabolic changes and cell damage throughout infectious, metabolic, and neurodegenerative disorders.~~

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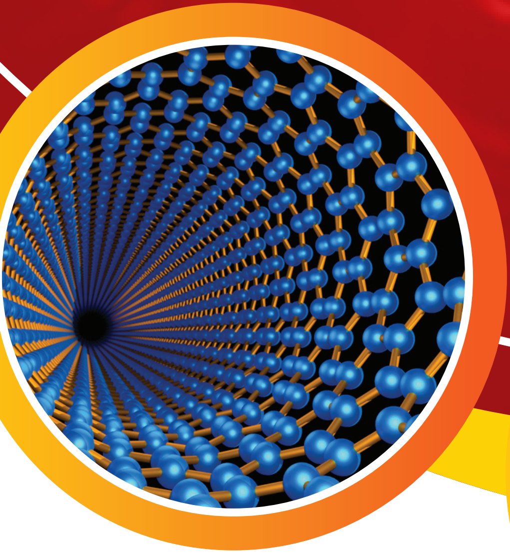

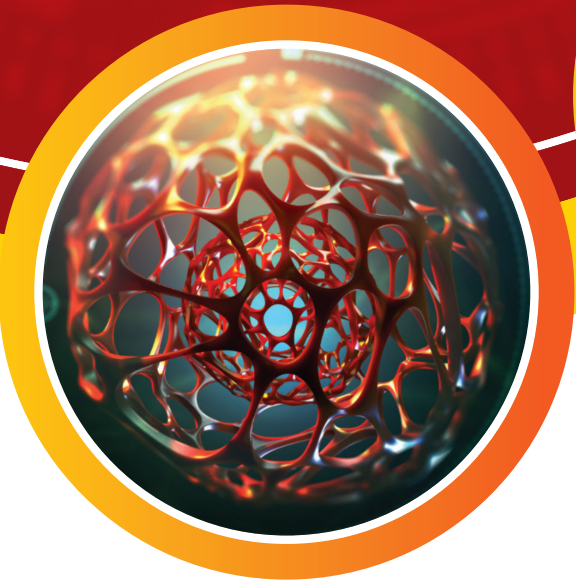

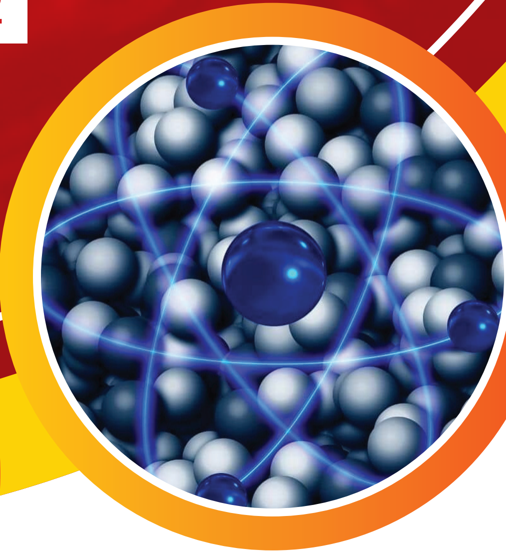

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Scientific Sessions

DAY 1

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Strain Engineering of ZrO$_2$@TiO$_2$ Core/shell Nanoparticle Photocatalysts

J. G. Swadener
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TiO2 photocatalysts can provide carbon capture utilisation and storage by converting atmospheric CO2 to green hydrogen, but the efficiency of current photocatalysts is still too low for economical usage. Anatase TiO2 is effective in transferring the charged particles produced by the photoelectric effect to reactants, because of its oxygen terminated surfaces. However, the anatase TiO2 bandgap is 3.2 eV, which requires photons with wavelengths of 375 nm or less to produce electron-hole pairs. Therefore, TiO2 is limited to using a small part of the solar spectrum.

Strain engineering has been used to design ZrO2@TiO2 core/shell structures with large strains in the TiO2 shell, which reduces its bandgap but maintains octahedral facets for charge separation and oxygen terminated surfaces for catalysis of reactants. Finite element analysis shows that shell thicknesses of 4-10 nm are effective in obtaining large strains in a large portion of the shell, with the largest strains occurring next to the ZrO2 surface. The c-axis strains for 4 nm and 10 nm shells are 1-6%. The strains reduce the bandgap in anatase TiO2 by 0.05-0.3 eV, which allows the use of light with wavelengths up to 414 nm. For the AM 1.5 standard spectrum, electron-hole pair creation in 4 nm and 10 nm thick TiO2 shells can be increased by a predicted 25% and 23%, respectively. The 10 nm thick shells provide a much larger volume of TiO2 and use proportionally less ZrO2. Surface plasmon resonators could also be added to further extend the usable spectrum and increase the production of electron-hole pairs many-fold.

Biography

Dr Greg Swadener is a member of the Mechanical, Biomedical and Design Engineering Department, Aston University conducting research in mechanics and materials and teaching FEA, CFD and numerical methods. He was previously a Scientist 3 with the Center for Integrated Nanotechnologies at Los Alamos National Laboratory. Prior to that, Dr Swadener received a PhD degree in Engineering Mechanics from the University of Texas at Austin and was a Research Assistant Professor at the University of Tennessee.

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Lead-free ceramics for dielectric energy storage capacitors

Dr. Zhilun Lu

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The global popularity of portable electronics and electric vehicles has spurred the development of energy storage devices toward higher power densities and energy densities. Dielectric capacitor, as a kind of important energy storage devices, has attracted tremendous attentions based on the advantages of high power density and fast charge-discharge rate, thus has a critical role to play in decarbonizing the 21st century economy. Finding less toxic, lead-free materials has been a major scientific and technological challenge.

Relaxor ferroelectric and antiferroelectric lead-free ceramics are promising candidates due to their relatively small remanent polarizations and high dielectric breakdown strengths. Novel tailored dopant strategies in BiFeO3-SrTiO3 (BF-ST) relaxor ferroelectrics have been proposed in our work: i) Nb-doping to increase resistivity by eliminating hole conduction and promoting electrical homogeneity and ii) alloying with a third perovskite endmember, BiMg2/3Nb1/3O3 (BMN), to reduce polar coupling without decreasing the average ionic polarizability. Using these strategies, ultrahigh energy density of 15.8 J cm-3 for BF-ST has been attained in multilayer ceramics. In addition, we combined theoretical calculations, in-situ synchrotron X-Ray diffraction and transmission electron microscopy data to give evidence to the underlying mechanisms that underpin optimization of energy storage density (6.5 J cm-3) in AgNbO3-based antiferroelectric ceramics from micro to macro scales. It is the first observation of a field induced ferrielectric phase and the first time to propose 4 principles for the design of high energy density in antiferroelectric ceramics. These two works both define clear engineering guidelines to design lead-free ceramics for high energy density capacitors to support sustainable development.

Biography

Dr Zhilun Lu is a Lecturer (Assistant Professor) at Edinburgh Napier University. He obtained his PhD from the University of Sheffield with the High-Quality PhD Thesis Prize and held post-doctoral research appointments at the Helmholtz-Zentrum Berlin and the Henry Royce Institute.

Dr Lu has published 60+ high impact journal papers (H index=23). One of his papers was selected as a Hot Article (as one of the top 10% of papers) in Energy & Environmental Science in 2020. And another paper was selected as a Highly Cited Article by Web of Science in 2021. He is a Professional Member (MIMMM) of the IOM3, a Member (MRSC) of the Royal Society of Chemistry and a Member of the American Chemical Society. He serves on the editorial boards of 5 prestigious materials journals. He is also a peer reviewer for numerous high-impact journals in physics, chemistry, and materials science including Nature Communications, Physical Review Letters, Chemistry of Materials, and Acta Materialia.

Dr Lu's research group focuses on the structure-composition-property relations of a broad spectrum of advanced functional materials, such as dielectric materials for energy storage capacitors, thermoelectric oxides, magnetic materials, microwave ceramics, and high entropy oxides.

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Effect of Fe doping on properties of nanosized ZnO and ZrO_2

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At present oxide semiconductors became one of the most intensively studied materials due to the high practical significance. The presented work contributes to the improvement of knowledge about magnetically doped nanoscopic semiconductor oxides. To increase the applicability of ZnO and ZrO2 nanoparticles the doping with TM is used. It should be noted that the magnetic properties of nanoscopic ZnO:Fe, ZrO2:Fe depend strongly on the method and conditions of sample preparation. Despite many publications published in this field, there are numerous discrepancies in the reported literature data. It is necessary to correlate magnetic studies with accurate structural investigations to determine the origin of the observed magnetic properties and to get to know the nature of magnetic interactions in these compounds.

In this work nanocrystals of ZnO and ZrO2 doped with Fe were obtained by two methods of chemical synthesis. It will be presented that nanoobjects with superparamagnetic properties are formed under certain conditions. It will be demonstrated that the solubility of Fe in nanoscopic oxides: ZnO and ZrO2, obtained by chemical synthesis methods, is limited. The very extensive characterization is required to understand the magnetic properties of nanoscopic semiconductive oxides. Going outside the classical characterization methods: the use of the micro-Raman method and the Mössbauer spectroscopy method, as well as the performance of dynamic magnetic measurements, allows to determine the origin of magnetic properties. An important element of the research is the application of the AC magnetic measurements, which allows distinguishing superparamagnetic behavior from the behavior of the spin-glass type.

Biography

Dr Izabela Kuryliszyn-Kudelska is head of Semimagnetic Semicondoctor Group in Institite of Physics, Polish Academy of Sciences in Warsaw. After graduating from Department of Physics Warsaw University, Dr Kuryliszyn-Kudelska earned her doctoral degree from the Institute of Physics, Polish Academy of Sciences. Her research interests involve experimental studies of magnetic, transport, magnetotransport, magnetooptical properties of II-VI, IV-VI and III-V semimagnetic (diluted magnetic) semiconductors. She is also engaged in experimental research of various magnetic nanoscopic materials: magnetically functionalized carbon nanotubes, graphene decorated with magnetic nanoparticles. Most recently her interest has focused on TM doped nanosized oxide semiconductors (ZnO, ZrO2).

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Theme: "Innovatory Advancements: Micro to Nanotechnology and Real-World Applications"

2nd Global Virtual Summit on
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November 10 & 11, 2022

Adhesion improvement of polymeric nanofibers on Nitinol for stent applications

Thomas Schneiders[1], Francis Ahrens[2] and Thomas Gries[1]

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Polymeric nanofibers have promising properties for stent coverings. High specific surface area, adjustable pore size, and scale of extra-cellular matrix are the most interesting. This can help decreasing in-stent thrombosis and restenosis rates for patients. Under current conditions textile covers mostly are attached by sewing, which is not feasible for nanofiber nonwovens. Furthermore, direct coating of nanofibers onto stents lowers manual labor and quality control efforts. But the integration and attachment of nanofibers onto stent materials lacks sufficient adhesion and has not been sufficiently re-searched until today. This study aims to find a method to evaluate the adhesion between a stent and nanofibers and develop methods for improving the adhesion to a sufficient level.

Nanofibers from thermoplastic polyurethane (TPU) were produced using the solution electrospinning method. Electrostatic forces are used to draw fibers with diameters on the nanometer scale from a polymer solution and produce nonwovens out of it in this technology. The nanofibers were directly spun on a cleaned and prepared Nitinol plates. The samples were tested in a 180° peel test according to DIN EN ISO 11339 and mean peel forces calculated from the stress-strain curves. The results for bare Nitinol plates were set as the baseline. Additionally, methods for adhesion and bonding improvement were tested. Heat treatment and solvent vapor treatment as a post-treatment, film coating with TPU, and argon plasma treatment as a pretreatment were used.

All methods were able to increase peel forces significantly. The untreated coated samples have a peel force/width of 99.8 ± 29.5 mN/cm and the highest measured peel force/width appears for the precoated sam-ples of 556.6 ± 211.7 mN/cm. Hence, the maximal increase of peel force/width in this study was around 5.5 times.

Biography

Thomas Schneiders is a project manager and PhD student at the Institut fuer Textiltechnik of RWTH Aachen University in Aachen, Germany. He has a Master's degree in Polymer and Textile Technology from the RWTH Aachen University as well and has 5 years of expertise in electrospinning and development of medical textiles and products. His research focus is in machinery, process and product development for electrospinning and the production of polymeric nanofibers. Especially for Tissue Engineering applications and stent coatings.

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Theme: "Innovatory Advancements: Micro to Nanotechnology and Real-World Applications"

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The Art of Polyvalency in Virus Detection and Inhibition

Weishan Huang[1,2]

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SARS-CoV-2, etiological pathogen of COVID-19, has resulted in a pandemic. There remains an urgent need of innovative technology of developing rapid diagnosis of active infections and affordable antiviral precise medicine for therapeutics. Most viruses have repetitive surface antigen units laid out on the virions following specific patterns, forming the viral capsid or envelop. To develop precise instant diagnosis of active SARS-CoV-2 infections and novel antiviral candidates against SARS-CoV-2 infection and transmission, we exploited the structural characteristics of the repetitive viral surface proteins and the geometrical distribution of these viral surface antigens. With DNA aptamers and engineered DNA nanostructure platforms, our preliminary data demonstrated that these DNA nanostructures containing polyvalent aptamers can enable specific and sensitive sensing of SARS-CoV-2 viruses and have sufficient antiviral activities against SARS-CoV-2 pseudoviral and live viral infections. Pattern-matching may be less critical for enveloped virus binding, likely due to the fluidity of the virus surface antigens on the envelop membrane. The art of polyvalency, regardless of the pattern-matching, is transferrable to the development of rapid diagnosis and potent inhibition of other enveloped viruses such as influenza and HIV.

Biography

Dr. Weishan Huang is an assistant professor of viral immunology at Louisiana State University in the USA. She received training in biology, biotechnology, pharmacology, and viral immunology. Her research focuses on principles and methods for T cell engineering for cell-based therapy, with major projects refining our understanding of regulatory and effector T cell biology during inflammation and cancers. Her team also work on viral genomics, host-virus interactions, and methods for potent and high-througput virus detection and inhibition. Her teaching interest is immunology and virology.

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Theme: "Innovatory Advancements: Micro to Nanotechnology and Real-World Applications"

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Nanoassembly of amyloid proteins at physiologically relevant concentrations

Yuri Lyubchenko and **Mohtadin Hashemi**

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The aggregation of amyloid beta (Aβ) is a self-assembly process that results in the production of fibrillar structures along with neurotoxic aggregates. However, in the vast majority studies in vitro the required Aβ concentrations is several orders higher of the physiological relevant concentrations of Aβ; no aggregation is observed at physiological low nanomolar range of Aβ. This suggests that the assembly of Aβ in aggregates in vivo utilizes pathways different from those used in experiments in vitro. We have discovered recently that surface plays a role of catalyst allowing the self-assembly of amyloid aggregates to occur at physiologically relevant concentrations. We proposed a model in which the monomers transiently immobilized on the surfaces work as nuclei for the next aggregation step. The model was verified by experimental time-dependent AFM measurements. AFM studies of aggregation of Aβ on supported phospholipid bilayer revealed a strong effect of the membrane composition on the surface aggregation catalysis. We combined AFM experimental studies with all-atom molecular dynamic (MD) simulations to characterize the on-surface self-assembly process of amyloid proteins. MD simulations show that the surface-protein interactions induce a conformational transition of the monomer facilitating binding of another molecule. A membrane-mediated aggregation catalysis explains a number of observations associated with the development of Alzheimer's disease. The affinity of Aβ monomers to the membrane surface is the major factor defining the aggregation process rather than Aβ concentration. Therefore, the development of potential preventions for the interaction of monomeric amyloids with membrane can help control the aggregation process.

Biography

Professor Yuri L. Lyubchenko received his PhD in Molecular Biophysics from the Moscow Institute Physics and Technology (Russia) and DSc degree in Molecular Biology from Institute of Molecular Genetics (Moscow, Russia). Currently, he is Professor of Pharmaceutical Sciences University of Nebraska Medical Center, Omaha, NE. His research spans a broad range of biomedical problems aimed at unraveling molecular mechanisms of such diseases as cancer, Alzheimer's and Parkinson's diseases. He has authored 289 research articles/book chapters. He was named UNMC distinguished scientist (2008). He is an Academic Editor for Nature-Scientific Reports, associate editor for New Journal of Science, Frontiers in Bioscience, Journal of Molecular Pharmaceutics and Precision Nanomedicine and serves as editorial member of a number of reputed journals. He also serves on NIH and NSF grant proposal review panels.

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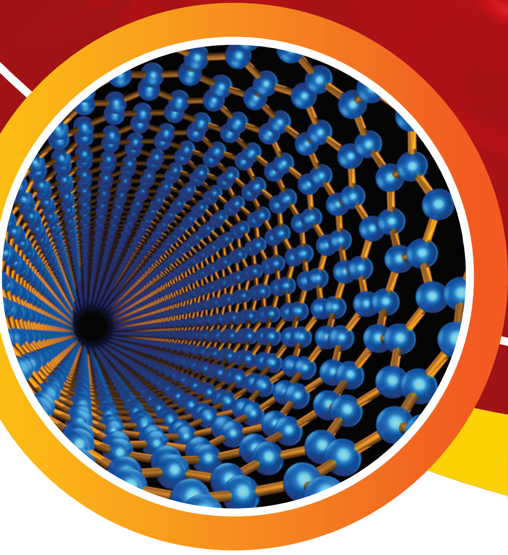

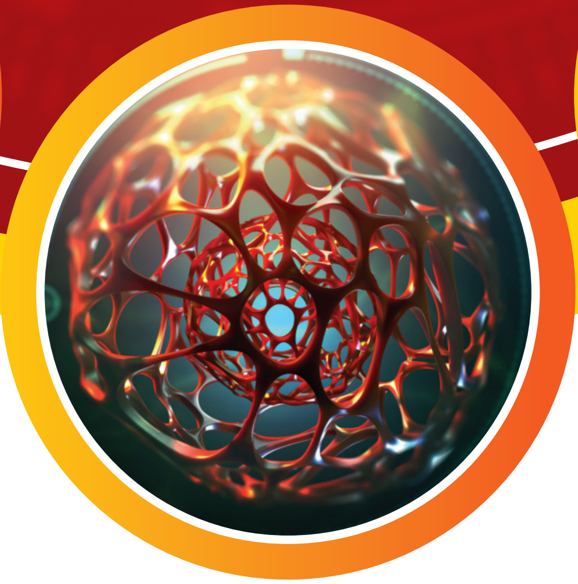

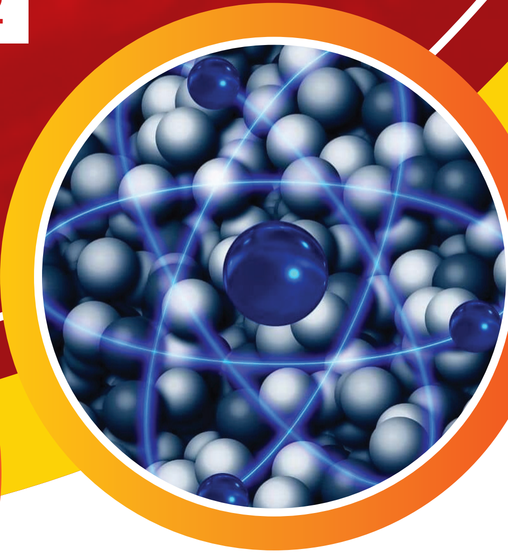

Theme: “Innovatory Advancements: Micro to Nanotechnology and Real-World Applications“

Keynote Forum

DAY 2

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Theme: "Innovatory Advancements: Micro to Nanotechnology and Real-World Applications"

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Biomimetic nanostructured scaffolds for regenerative medicine

Ilaria Cacciotti

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In the sector of the regenerative medicine/tissue engineering, the 'scaffold', a support for the cells adhesion, proliferation and, in the case of stem cells, differentiation towards specific cell phenotype, plays a pivotal role. It should act as a temporary matrix for cell proliferation, extracellular matrix (ECM) deposition, bone in-growth and neo-vascularization. In its design, several aspects have to be simultaneously satisfied, in terms of chemical composition, microstructure, mechanical and surface properties, strongly affecting the interaction with the cells/tissues. Actually, several efforts are dedicated to the development of biomimetic systems able to simulate the composition and/or the morphology of the tissue to be regenerated. For example, biomimetic scaffolds suitable for bone regeneration should be characterised by a nanostructure architecture and by the co-presence of an inorganic phase and an organic phase [Bianco et al., 2011a; Bianco et al., 2011b; D'Angelo et al., 2012]. As organic component, biopolymers such as polycaprolactone, polylactide, polyhydroxyalkanoates [Bianco et al., 2011a; Cacciotti et al., 2013; Cacciotti et al., 2014] have been proposed, whereas as inorganic component calcium phosphates (CaP) [Cacciotti, 2019] and bioglasses (BG) [Cacciotti, 2017]. Among the processing techniques, the additive manufacturing [Di Piazza et al., 2021] and electrospinning [Rahmati et al., 2021] allow to produce porous graded structures and custom made implants, and fibrous systems, comparable to the native extracellular matrix typical of different biological tissues, respectively. In order to provide specific functionalities, these structures can be loaded with proper antimicrobial and antioxidant agents, and their surfaces functionalised in order to improve the biological responsiveness [Cacciotti et al., 2018].

Acknowledgements

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Biography

Ilaria Cacciotti is Full Professor of Biomaterials & Tissue Engineering and Materials Science & Technology at University of Rome "Niccolò Cusano". She graduated in Medical Engineering at the University of Rome "Tor Vergata" (Master of Science Award 'Fondazione Raeli'), completed the Ph.D in Materials Engineering (Ph.D Thesis Award 'Marco Ramoni 2011, Ph.D Thesis AIMAT Award 2012) and obtained the II Level Master degrees in "Forensic Genetics" and in "Protection against CBRNe events". She is expert in the synthesis/processing/characterisation of biocompatible nanostructured materials, particularly for applications in the biomedical/environmental/agri-food sectors. She is member of the Editorial Board of several international journals, including Applied Science-MDPI, Applied Surface Science Advances- Elsevier, Frontiers in Biomaterials, Open Journal of Materials Science-Bentham Science. For her research activity, she received more than 20 awards, including the" L'ORÉAL-UNESCO Italy for Women and Science 2011" and "Young Researcher Award Elsevier" Materials Science and Engineering 2014".

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Theme: "Innovatory Advancements: Micro to Nanotechnology and Real-World Applications"

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The Fluid Architecture of Biological and Biomimetic Membranes

Reinhard Lipowsky

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Our body contains a large amount of biological membranes which enclose our cells and many intracellular organelles. These membranes, which have a thickness of only 4 to 5 nanometers, are fluid and create a flexible architecture that partitions space into many separate compartments.

Two particularly intriguing examples for this fluid architecture are the tree-like shapes of nerve cells and the nanotubular networks of the endoplasmic reticulum. The membranes provide robust barriers for the exchange of molecules between the different compartments, but can easily remodel their shape and topology. This remodeling is essential for important biological processes (cell division, vesicle trafficking, endo- and exocytosis) and can be studied in a systematic and quantitative manner using biomimetic model systems. In this talk, recent insights obtained from such synthetic biosystems are reviewed, integrating experimental observations and molecular dynamics simulations with the theory of membrane elasticity. [1-6]

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Biography

Reinhard Lipowsky has worked on a wide range of topics in chemical and biological physics, with a focus on synthetic biosystems. His main research areas are interfacial phase transitions and wetting phenomena, biomembranes and vesicles, as well as molecular motors and nanomachines. Recently, he focussed on the remodeling of membrane shape and topology in the context of bottom-up synthetic biology. He is one of the founding directors of the Max Planck Institute of Colloids and Interfaces, a fellow of the Max Planck School "Matter to Life", a member of the Berlin-Brandenburg Academy of Sciences, and holds honorary professorships at the University of Potsdam and at the Humboldt University in Berlin.

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Theme: “Innovatory Advancements: Micro to Nanotechnology and Real-World Applications“

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Development and application of micro/nano manufacturing

Jufan Zhang

Centre of Micro/Nano Manufacturing Technology, School of Mechanical and Materials Engineering, University College Dublin, Ireland

Micro and nano manufacturing is the key process to support the production of diversified products and components, including but not limited to optics, bio-implants, medical devices, sensors, and brings improved performance even new features to these products. However, it is still challenging in industries to achieve such a high machining accuracy on complex 3D components with low cost. The UCD Centre of Micro/Nano Manufacturing Technology has successfully applied the micro/nano manufacturing expertise in various industrial sectors. This talk introduces some representative research outputs and practice in development of new solutions.

Biography

Dr. Jufan Zhang received his PhD degree in 2009 from Harbin Institute of Technology, China. After working in the industry for years, he returned to academia and then hosted several major funding as the PI. He joined the Centre of Micro/Nano Manufacturing Technology, University College Dublin, Ireland in 2017, and now is working as the lecturer and assistant professor. His research interests mainly include the micro/nano manufacturing, micro/nano functional structures, innovative medical devices and bioimplants, optical imaging.

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Theme: "Innovatory Advancements: Micro to Nanotechnology and Real-World Applications"

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Hidden risks of nanotechnology in material conservation processes: How to identify them and prevent their toxicity

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Nanotechnology has advanced rapidly in recent times. Its scope covers various branches of applications where it has demonstrated, in most cases, its high effectiveness compared to conventional materials getting improved properties. Despite its progress, we are facing a new problem to solve: nanotoxicity. Over the years, the scientific community has perfected its methods for designing nanomaterials by different pathways to obtaining the most suitable according to particular needs. Today, commercially distributed nanomaterials offer their advantages to solve problems for their applications in the medical, pharmaceutical, construction, electronic, or metallurgy industry, among others. Although we have achieved highly effective hybrid and multifunctional materials, we must also consider how they may affect human beings, fauna, flora, and the ecosystem. Among them, we will focus on the nanomaterials used in conservation and restoration processes. External agents and environmental conditions, including- the effect of water, temperature, and heating-cooling cycles, as well as dispersed contaminants in the environment or biological colonization, may trigger its deterioration. Nowadays, corrective or protective treatments against decay processes caused by aggressive agents in construction materials, sculptures, archaeological, paleontological pieces, and pictorial works apply nanomaterials with consolidant, water-repellent, biocidal, or fire-retardant properties. However, it is essential to analyze its effectiveness and possible toxicity. This study explores the current state of nanotechnology in conservation, including state-of-the-art nanomaterials such as carbon or titanium nanotubes, nanocomposites, and multifunctional hybrid materials based on their morpho-structural, chemical, and granulometric properties and how they can reach the organism through the different access routes. At the same time, it proposes solutions to avoid risks of toxicity. This research is founded by the TOP HERITAGE project-(P2018/NMT-4372).

Biography

Geologist, expert in petrology and crystallography, Ph. D. in materials science and engineering, specialist in nanotoxicity and nano-prevention. Since 2001 (Carlos III University), she has delved into the study of nanomaterials, synthesis, characterization, and applications. Researching includes phase transformation processes from micro to nanoscale using polarized light, transmission and scanning electron microscopy, electron diffraction, EELS, HRTEM/HRSTEM, cathodoluminescense and X-ray diffraction. Since 2009, she is a member of the petrology applied to heritage group at the Institute of Geosciences (CSIC-UCM), applying nanotechnology to conservation of cultural heritage. Her scientific contribution includes articles in high-impact journals, participation as an invited speaker in international conferences, and member of international electron microscopy associations. She has published a book regarding multifunctional nanomaterials. Currently is invited editor in nanotoxicity in "Nanomaterials" journal. Nowadays, her objectives focus on divulging both the advantages of nanotechnology in the conservation of geomaterials and artworks and the possible risks of nanotoxicity.

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Theme: "Innovatory Advancements: Micro to Nanotechnology and Real-World Applications"

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II-VI based organic-inorganic hybrid nanostructures with unprecedented high degree of crystallinity and long-term stability, and unique properties

Yong Zhang
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Organic-inorganic hybrid materials can potentially offer enhanced even new properties compared to their inorganic and organic components. However, they often exhibit two drawbacks: structural disorder and lower stability. Hybrid halide perovskites are the good examples illustrating the pros and cons of the hybrids. Since the proposal of the semiconductor superlattice by Esaki and Tsu in 1970, it remains elusive to form a highly order superlattice with inorganic materials, because practically inevitable interdiffusion of different components. On the other hand, intuitively, forming a highly ordered hybrid structure is challenging, because it is not straightforward to force organic molecules taking the same conformation in the structure. Organic semiconductors typically are not as stable as inorganic. Despite impressive improvement in the stability of halide perovskite in recent years, the shelf life of their devices, even with applying the best encapsulation, remains in the order of a few thousand hours. A prototype hybrid structure that exhibits both high crystallinity and stability is of great interest to illustrate the design principles and directions of the effort to achieve the goals as well as reveal the realistic potential for improvement. A family of II-VI based organic-inorganic hybrid materials was discovered in early 2000. Some of them, □-ZnTe(en)0.5 (en = C2N2H8), have been shown to exhibit over 15-year shelf life under ambient conditions without any protection layer. They have also been shown to be the most ordered superlattices ever reported, among the pure inorganic or hybrid ones. Additionally, they offer several unique properties, such as, exceptionally strong band edge excitonic absorption, free of below bandgap defect emission, broad-range zero-thermal expansion.

Biography

Yong Zhang received his B.S. and M.S. from Xiamen University and Ph.D. from Dartmouth College in Physics. He joined National Renewable Energy Laboratory (NREL) in 1994 as a postdoc and was a Senior Scientist before he moved to University of North Carolina at Charlotte as Bissell Distinguished Professor with Electrical and Computer Engineering Department in 2009. He is an Adjunct Professor of Department of Physics and Optical Science. His research interests include electronic and optical properties of semiconductors and related nanostructures, organic-inorganic hybrid materials, impurity and defects in semiconductors, and novel materials and device architectures for energy, electronics, and related applications (e.g., photovoltaics, solid-state-lighting, electronic-photonic integrated circuits), using various optical spectroscopy techniques and large-scale first-principles and empirical electronic structure modeling methods. He is a Fellow of the American Physical Society.

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Theme: "Innovatory Advancements: Micro to Nanotechnology and Real-World Applications"

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Battery Electrodes: Nano vs Microstructuring

Nikhil A. Koratkar

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Battery electrodes comprise a current collector onto which a mix of active material particles, conductive carbon and binder additives are deposited. While this basic design has persisted for decades, the desired "size" of the active material particle is a matter of debate. Advances in nanotechnology have spurred interest in deploying nanoparticles as the active material. In this talk, I will compare nano with micro-particle electrodes, and discuss why the battery industry is unlikely to replace micro with nano-size particles. Given this, I will address the question as to whether there is a place for nanomaterials in battery design. I will show that the way forward lies in micro-particles constructed by the assembly of nanoscale building blocks and in micro-particles with engineered or natural nano-porosity. Such "multiscale particles" offer exciting possibilities to develop the next-generation of battery electrodes that are quintessentially both micro and nano with respect to their performance attributes.

Biography

Nikhil Koratkar is the Clark and Crossan Chair Professor at the Rensselaer Polytechnic Institute (RPI) in the United States. His research has focused on the synthesis, characterization and application of advanced materials. Professor Koratkar is a winner of the NSF CAREER Award (2003), the Electrochemical Society's SES Young investigator Award (2009), ASME Gustus L. Larson Memorial Award (2015), IIT-Bombay Distinguished Alumnus Award (2019) and the RPI William H. Wiley 1866 Distinguished Faculty Award (2021). Koratkar is a Fellow of AAAS and of ASME. He has published over 230 archival journal papers (>29,000 citations, H-index = 81). In 2018 and 2021, Clarivate Analytics named him in their highly cited researchers list (top 1% by citations). Koratkar serves as an Editor of CARBON (Elsevier). He is a co-founder and serves on the advisory board of a start-up company (Alsym Energy) aimed at commercializing next-generation energy storage solutions.

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Theme: “Innovatory Advancements: Micro to Nanotechnology and Real-World Applications“

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A superficial tale: Semiconductor nanowires as a remarkable platform for nanoelectronics and sensing

Harry E. Ruda, Joe Salfi, David Lynall, David Gutstein, Selva Nair, Kris Burne, Alex Shik, Igor Savelyev, Marina Blumin, Jacky Lau, Carlos Fernandes, and Christina de Souza
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The first foray into semiconductor micron-scale ‘whiskers’ came from work by Wagner and Ellis in 1964, only to applied in the late 1990’s to realise nanowires with diameters of tens of nanometers. With the possibility of strong confinement in two dimensions, these structures present ideal vehicles for 1d physics and devices. However, surface related phenomena can provide a curse or opportunity in this quest - the latter is the focus of this presentation. Here, I focus on the opportunities in a few areas including ballistic conductance, random telegraph noise, and scattering from individual surface charges. Harnessing these phenomena can enable a host of new opportunities including making inroads in the quest to tame the elusive Majorana Fermion, in ultra-sensitive elevated temperature single charge electrometry and in single molecule level sensing.

Biography

Harry Ruda obtained his BSc from Imperial College in 1979 and PhD from MIT in 1982 for work on the optical and transport properties of II-VI based infrared detector materials. After as IBM postdoctoral fellow, he developed one of the first theories for electron transport in selectively doped 2DEG heterostructures. He then joined 3M corporation and led their II-VI blue laser program until joining the University of Toronto in 1989; he is currently a full professor, Stanley Meek Chair in Nanotechnology and Director of the Centre for Nanotechnology. He has about 300 journal publications with about 8,200 citations and h-index of 43. He serves on the editorial boards of numerous journals and is a Fellow of the Royal Society of Canada, Fellow of Institute of Physics, Fellow of the Institute of Nanotechnology, Fellow of the Institution of Engineering and Technology, and Fellow of the Canadian Academy of Engineering.

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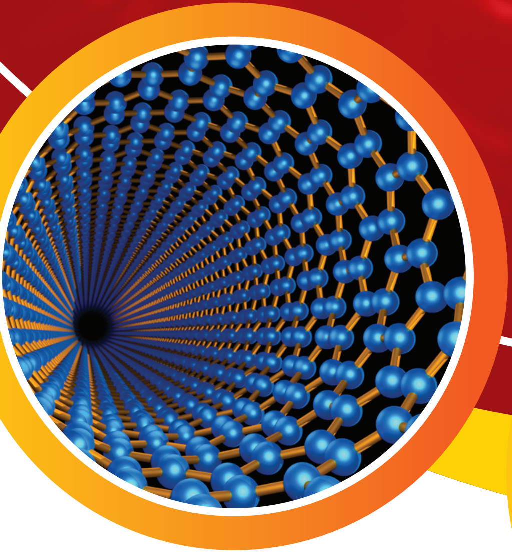

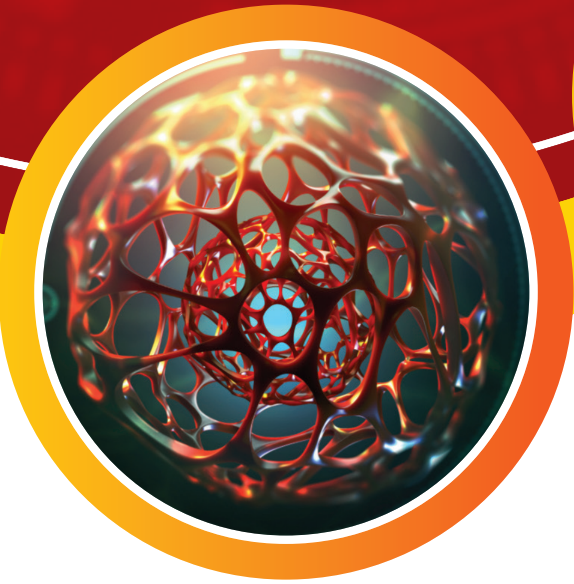

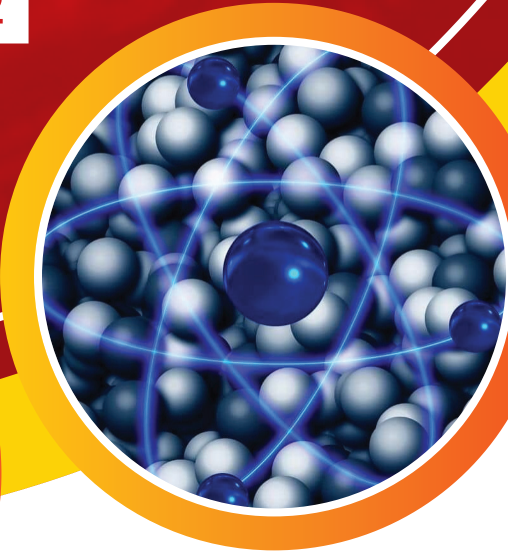

Theme: “Innovatory Advancements: Micro to Nanotechnology and Real-World Applications“

Scientific Sessions

DAY 2

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Theme: "Innovatory Advancements: Micro to Nanotechnology and Real-World Applications"

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Boosting the lipid-based nanosystems performance using ionic liquids

Ana Júlio[1,2], Rossana Roque[1], João Vieira[1,2], Címtia Almeida[1,2], Andreia Reis[3], João Guilherme Costa[1], Nuno Saraiva[1], Tânia Santos de Almeida[1,4], Catarina Rosado[1] e Catarina Pereira-Leite[1,5]

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The pharmaceutical and cosmetic industries are always looking for new, bioinspired, and sustainable materials for the development of innovative nanotechnology-based systems (1). Moreover, ionic liquids (ILs) are versatile compounds and their incorporation in topical formulations has been studied to enhance the overall properties of delivery systems (2, 3).

Thus, this work aimed to explore the opportunities offered by the combination of ILs with two different types of lipid-based nanosystems, namely transfersomes and solid lipid nanoparticles (SLNs). All formulations were prepared in the presence or in the absence of ILs and the produced nanoparticles were characterized in terms of hydrodynamic diameter, polydispersity index, and zeta potential. In the case of transfersomes, they were loaded with rutin and the association efficiency (AE), loading capacity, and rutin release were also evaluated.

The results showed that ILs improved the colloidal stability of the lipid-based nanoparticles and contributed to achieve nanoformulations with appropriate physicochemical properties towards a cutaneous application. Additionally, the properties of transfersomes were tuned by the incorporation of ILs in terms of the loading and release of rutin.

Overall, the work showed that it is possible to improve the stability of lipid-based nanoparticles by combining them with ILs, which open new perspectives for skin delivery. Further studies are ongoing to ascertain the biocompatibility and skin permeation of these systems.

Keywords: Solid Lipid Nanoparticles, Transfersomes, Ionic liquids, Skin delivery, Rutin.

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Biography

Ana Júlio is a PhD Student in Health Sciences at the Research Center for Biosciences and Health Technologies (CBIOS), from Lusófona's University in Lisbon, Portugal. She has already published sixteen articles in national and international peer-reviewed journals and one book chapter, and she is also author/co-author of several oral/poster communications in national and international meetings. She has also won three awards with her work and/or in collaborations. Her research interests are focused on the production of hybrid systems that combine controlled drug delivery systems and ionic liquids.

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Transparent conducting oxides for nanoscale electro-optic modulators and switches

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Electro-optic modulators are critical building blocks for many information processing systems which adhere to requirements given by both electrical and optical constraints. We present recently developed charge driven nanophotonic electro-optic devices enabling the next generation of electro-optic modulators featuring a significantly improved device performance regarding modulation efficiency (VπL < 1 Vcm), device footprint (< 1 mm2) and bandwidth (> 100 GHz). These novel high-performance nanophotonic electro-optic modulators and switches are based on transparent conducting oxides which provide the critical material properties for practical deployment in future electro-optic modulation applications. We present strategies and experimental validations of novel high-performance nanophotonic opto-electronic devices, involving heterogeneous integration of emerging materials into silicon photonic integrated circuits to exploit new functionality and device-scaling laws for efficient and ultrafast modulators. The optoelectronic implementations of neural networks are demonstrated which significantly extends the spectrum of information processing capabilities.

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Biography

Martin Thomaschewski received the MSc degree in Physics from the University of Kiel, Germany, in 2016, and the Ph.D. degree in Nanooptics from the University of Southern Denmark in the group of Sergey I. Bozhevolnyi in 2020. As a researcher in the field of active plasmonics and nanophotonics, his main focus lies on exploring strong light-matter interactions in nonlinear materials for optoelectronic devices. In his current position as postdoctoral researcher in the group of Prof. Volker Sorger (George Washington University, USA) he conducts research in active nanophotonics across a variety of electro-optic (EO) material platforms, including indium tin oxide (ITO), lithium niobate and transition metal dichalcogenide monolayers.

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Near Infrared-II Quantum Dots for Application in Optoelectronics

Jianying Ouyang*, Neil Graddage, Jianping Lu, Ye Tao, Jianfu Ding, Patrick Malenfant
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This presentation will cover the synthesis of near infrared 1000-1700 nm (NIR-II) colloidal quantum dots (QDs) with reactivity elevated by secondary phosphine and colloidal stability enhanced by trialkylphosphine, including lead chalcogenides (PbSe and PbSeS) and silver chalcogenides (Ag2Se and Ag2Te) QDs. The synthesized high quality QDs showed great performance in optoelectronics such as photovoltaics and photodetectors. For example, small-sized (≤ 3.7 nm) PbSe QDs were synthesized with the addition of organic phosphines [ACS Appl. Mater. Interfaces 2011, 3, 553]. The greatly increased particle yield ensured small-sized PbSe QDs were obtained in high yield and high quality. As a result, Schottky-type solar cells using our PbSe QDs as the active material achieved a high power conversion efficiency (PCE) of 2.82%. By adding secondary phosphine (diphenylphosphine DPP), homogeneously alloyed PbSeS QDs were synthesized and the corresponding PCE was as high as 3.44% [ACS Appl. Mater. Interfaces 2011, 3, 1511]. Recently, by employing secondary phosphine (DPP) to elevate the precursor reactivity, we achieved accurate size control of the Ag2Se QDs with a distinct excitonic absorption peak. As a result, by incorporation of a suitable hole-transporting layer between the active layer and Ag anode, the resulting photodiode showed a responsivity of 4.17 mA/W at 1200 nm (NIR-II region) [ACS Appl. Nano Mater. 2020, 3, 12209]. Ag2Te QDs achieved a focused size distribution and enhanced colloidal stability by adding extra trialkylphosphine and/or DPP [ACS Appl. Nano Mater. 2021, 4, 13587]. The corresponding photodiode demonstrated responsivity up to 1400 nm. These results demonstrate that Ag-based QDs offer a low-toxicity route for low-cost fabrication of NIR-II photodetectors.

Biography

Dr. Jianying Ouyang is a senior research officer at National Research Council of Canada (NRC). She received her PhD in polymer chemistry from National University of Singapore in 2003. Upon graduation, Dr. Ouyang did her postdoctoral research on C60/polymer composites at City University of New York from 2003 to 2004. In 2005, Dr. Ouyang joined NRC as a visiting fellow and conducted research in synthesis and characterization of colloidal quantum dots (QDs). In 2008, Dr. Ouyang was hired by NRC as an assistant research officer, and continued QDs research for applications including bio-imaging, photovoltaics, and photodetectors. From 2014, Dr. Ouyang also dedicated in purification and enrichment of semiconducting single-walled carbon nanotubes (SWCNTs) used in printable electronics including thin film transistors (TFT), gas sensors, and near infrared photodetectors. Dr. Ouyang has published >50 papers in peer-reviewed scientific journals including *ACS Nano* and *Angewandte Chemie.*

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Understanding Molecular Mechanism of GPCR signal transduction in nanodiscs

Meng Zhang[1], **Miao Gui**[1], **Philipp Aschauer**[1], **Mahmoud Nasr**[2], **Alan Brown**[1] and **Gerhard Wagner**[1]

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G-protein coupled receptors (GPCRs) are the largest superfamily of transmembrane proteins and the targets of over 30% of currently marketed pharmaceuticals. Activation of GPCRs by their ligands leads to different downstream signaling processes by engaging different signal transducers such as G-proteins and β-arrestins. "Biased" ligands that can preferentially activate one pathway are of particular interest for drug development due to their selectivity and potential for fewer adverse side effects. A detailed understanding of GPCR signaling mechanisms through different pathways is required for the rational design of pathway-selective drugs. Our lab uses CryoEM and NMR for GPCR mechanistic studies in nanodiscs. Our structures on the neurotensin receptor 1 (NTSR1)/Gαi1β1γ1 complex in nanodisc reveal an extended network of protein/protein interactions as compared to structures obtained in detergents. The findings show that the lipid membrane modulates the structure and dynamics of complex formation and provide a molecular explanation for the stronger interaction between GPCRs and G-proteins in lipid bilayers. We propose an allosteric mechanism for GDP release, providing new insights into the activation of G-proteins for downstream signaling. The C-terminus tail of GPCRs important for β-arrestin signaling is invisible in CryoEM structures due to its dynamic nature. Our solution NMR studies on a segmentally C-terminus labeled GPCR, the cannabinoid receptor 2 (CB2), deciphered its unique phosphorylation barcodes in response to the five non-visual GRKs respectively. The phosphorylation sites are observed to serve as driving forces for binding β- arrestin but not G protein, demonstrating the key role of phosphorylation for selectivity towards β-arrestin over G-protein. Our findings provide guidance for design and development of selective drugs without unwanted side effects.

Biography

Meng Zhang is a Research Associate in Prof. Gerhard Wagner's lab at Harvard Medical School. She earned her Bachelor of Science at Nankai University in Tianjin, China, in 2011, and her PhD in Chemistry from the University of Michigan in 2016, working with Prof. Ayyalusamy Ramamoorthy on structural and dynamics studies of amphipathic membrane proteins using Nuclear Magnetic Resonance (NMR) technology. Fascinated by the powerful roles membrane proteins play in human life, after completing her PhD, she joined Prof. Wagner's lab because Prof. Wagner is an excellent leading scientist in both membrane protein studies and NMR technology development. Here, she reported the first complex structure of activated G protein coupled receptor (GPCR)-G protein in membrane, which provides insights into the molecular mechanism of intercellular signal transduction. Meng's research interest focuses on the structure and functionality of membrane proteins for drug development to treat difficult diseases..

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Impact of Nanotechnology on Data Storage by Magnetic Recording

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Nanotechnology developments have enabled rapid progress in various leading-edge technologies. A characteristic example is the remarkable decrease of the distance between the magnetic media on the hard disk and the read/write transducer of the magnetic head in magnetic storage devices. Among various challenges for reducing the magnetic spacing has been the excessive thinning of the protective overcoat of the hard disk and magnetic head, consisting of amorphous carbon (a-C). However, the remarkable decrease in a-C film thickness to a few nanometers raises a concern about its quality and protective capability. In general, a-C films with higher sp3 atomic hybridization demonstrate higher density and better nanomechanical and corrosion properties. Conversely to traditional deposition methods that use neutral carbon atoms as film-forming precursors, filtered cathodic vacuum arc (FCVA) uses energetic C+ ions, which is advantageous for depositing ultrathin, smooth films with superior nanoscale properties. This presentation will elucidate the role of important FCVA process parameters in ultrathin film growth and present new approaches for reducing the a-C film thickness without jeopardizing its structure and properties. FCVA-deposited a-C films possess a multi-layered structure consisting of surface and interface layers of relatively low sp3 contents and intermediate bulk layer of much higher sp3 content, a result of the inherent deposition mechanisms. When the a-C film thickness is reduced to only 2–3 nm, the effects of the ultrathin (1–2 nm) surface and interface layers become increasingly more pronounced, resulting in the decrease of the overall sp3 content and, consequently, the depletion of the film's protective capability. Methods for overcoming this undesirable effect having direct implications in future magnetic recording will also be discussed.

Biography

Kyriakos Komvopoulos is Distinguished Professor in the Department of Mechanical Engineering at the University of California, Berkeley. He is also the founder and director of the Surface Sciences and Engineering Laboratory and the Computational Surface Mechanics Laboratory, and holds the positions of Faculty Scientist, Materials Sciences Division, Lawrence Berkeley National Laboratory, Principal Investigator, Center for Information Technology in the Interest of Society, and Principal Investigator, The Berkeley Stem Cell Center. He is internationally known for pioneering research in surface nanosciences and nanoengineering, with important implications in several emerging technologies, including communications, microelectronics, information storage, and biotechnology. Current research is on theoretical/numerical nano/micro-scale contact mechanics, tribology, mechanics of ultrathin films, characterization of single/multi-layer ultrathin films deposited by sputtering and filtered cathodic arc, plasma-assisted surface modification of biopolymers for enhanced biocompatibility and cell activity, mechanotransduction effects at single-cell and tissue levels, scaffolds for tissue engineering, and flexible/stretchable bioelectronics.

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PdSe2: a Pentagonal Layered Material Bridging the Gap Between 2D and 3D Materials

Liangbo Liang*, **Kai Xiao**, **Alexander Puretzky**, **An-Ping Li**, **David Geohegan**, and **Bobby Sumpter**
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PdSe2 is a new layered material with an in-plane pentagonal network and stronger-than-vdW interlayer coupling. It offers great trade-off between carrier mobility, band gap, and air stability for nanoelectronics. Because of its unique atomic structure and strong interlayer coupling, it behaves like 2.5D material and many of its properties are different from those of commonly known 2D materials, such as graphene and MoS2. Here I will highlight how first-principles modeling/simulation guided experiments to explore its structural, electronic, and vibrational properties. Because of strong interlayer coupling, its electronic band gap varies significantly from 1.3 eV (monolayer) to 0.06 eV (bulk), based on calculations and measurements. For 2D graphene and MoS2 that have weak interlayer interactions, the layers are quasi-rigid in low-frequency interlayer vibrations whose Raman signals are weak; however, in PdSe2 the layers are no longer quasi-rigid, according to our Raman scattering calculations and measurements, and thus the interlayer Raman modes can show strong intensities. Finally, our calculations found that the pentagonal structure and strong interlayer coupling lead to low diffusion energy barriers for defects, and hence both intralayer and interlayer hopping of defects can occur relatively easily in PdSe2 compared to MoS2, as observed by scanning tunneling microscope (STM). Interestingly, the high mobility of defects and strong interlayer coupling in PdSe2 also contribute to phase transition to multiple different structures: including 2D Pd2Se3, 3D Pd17Se15, and 1D pentagonal PdSe2 nanoribbons, as corroborated by our DFT calculations. Our works demonstrated that PdSe2 constitutes a novel layered material featuring great transistor performance, strong interlayer coupling, versatile phase transition, etc.

Biography

Dr. Liangbo Liang is a theoretical/computational research staff member in the Center for Nanophase Materials Sciences (CNMS) at Oak Ridge National Laboratory (ORNL). Prior to that, He was a Wigner Fellow at ORNL from 2015 to 2018. He received his Ph.D. degree in Physics from Rensselaer Polytechnic Institute (RPI) in 2014. His current research generally lies in condensed matter theory and computational physics, focusing on developing and applying large-scale theoretical/computational methods on supercomputers to understand and engineer diverse materials from first principles. He is particularly interested in integration of accurate theoretical/computational approaches with various experimental techniques for the understanding of nanomaterials and quantum materials, including modeling of scanning tunneling microscopy/spectroscopy (STM/S), Raman scattering, photoluminescence spectroscopy. Methods including DFT and many-body GW approach are used to study electronic, magnetic, optical, vibrational, and Raman scattering properties of diverse materials.

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Low-energy electron irradiation assisted observation of nanometer-sized Laves phases at alloy surfaces for high-precision statistical characterization

Hengfei Gu[1,2], Chengze Liu[1,3], Jieli Shen[4], Fusen Yuan[1,3], Fuzhou Han[1,3], Yingdong Zhang [1,3], Muhammad Ali[1,3], Wenbin Guo[1,3], Jie Ren[1,3], Lifeng Zhang[5], Songquan Wu[6] and **Geping Li[1,3]***

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Under electron beam irradiation, knock-on atomic displacement is commonly thought to occur only when the incident electron energy is above the incident-energy threshold of the material in question. However, we found that when exposed to a high flux of electrons with a low energy of 30 keV that is far below the theoretically predicted incident-energy threshold of Zr, surface Zr metallic atoms can be knocked off into vacuum.[1] We proposed a model of scattering of a single atom nucleus by multiple electrons within the lifetime of the resulting phonon to interpret this surprising physical phenomenon. Depending on the binding enegies of atoms within different phases, selective sputtering was found to occur under low-energy electron irradiation, giving rise to the exposure of the Laves-phase nanoparticles at the surface of a zirconium alloy (Zircaloy-4), which is comprised of micrometer-sized α-Zr grains and nanometer-sized Zr(Fe,Cr)2 Laves phases. Based on this finding, we developed a methodology for statistical characterization of Laves phases directly at a surface of or any exposed cross-section cut from a zirconium alloy with high precision and efficiency.[2] The presented way to irradiate may be extended to other materials aiming for applications in fields of nanotechnology, surface technology, and others.

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[2] H. Gu, J. Shen, F. Yuan, F. Han, C. Liu, Y. Zhang, M. Ali, W. Guo, J. Ren, L. Zhang, Applied Nanoscience 2021, 11, 1549.

Biography

Dr. Gu has obtained his Master degree in Materials Science and Engineering from the Institute of Metal Research, Chinese Academy of Sciences. His advisor is Prof. Geping Li. After graduation, he worked at the same institute as a research assistant for two years. Currently, he has completed his Ph.D. program in Chemistry at Rutgers University, USA, under supervision of co-PIs including Prof. G. Charles Dismukes, Prof. Leonard Feldman and Prof. Eric Garfunkel. His research areas cover deformation behaviors of alloys and nanoparticles, electron-atom scattering, electrochemical and photoelectrochemical catalysis, and interface chemistry and physics in metal oxide semiconductor devices. He has published 5 first-author papers and more than 35 co-author papers in reputed journals.

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Single Cell and Extracellular Vesicle Profiling

Jina Ko

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Due to an inherent biological heterogeneity across individuals and within a disease, it is extremely challenging to identify robust biomarkers that can accurately represent molecular status of the body for disease diagnostics. To solve this intractable problem, we have developed microfluidic platforms and molecular tools that enable high throughput, multiplexed profiling of biomarkers (e.g. cells, extracellular vesicles; EV). We achieved high throughput profiling by combining sequencing with parallelization of microchip technologies and droplet microfluidics. We overcame the variability of any individual biomarker between individual patients, by developing tools that can measure multiple markers and we applied machine learning to identify signatures that persist across this variability. To resolve cell and EV heterogeneity, we have recently developed an ultra-fast cycling method for single cell analysis and an ultra-high sensitive microfluidics that can achieve single particle detection sensitivity, enabling individual EV measurements.

Biography

Jina Ko is an Assistant Professor in the Departments of Pathology and Laboratory Medicine and Bioengineering at University of Pennsylvania. She focuses on developing single molecule detection from single extracellular vesicles (EV) and multiplexed molecular profiling to better diagnose diseases and monitor treatment efficacy. Jina graduated from Rice University with a B.S. in Bioengineering and a B.A. in French Studies in 2013 and she earned her Ph.D. in Bioengineering at the University of Pennsylvania in 2018. During her Ph.D., she developed machine learning-based microchip diagnostics that can detect blood-based biomarkers to diagnose pancreatic cancer and traumatic brain injury. For her postdoctoral training, she worked at Massachusetts General Hospital and the Wyss Institute at Harvard University as a Schmidt Science Fellow and a NIH K99/R00 award recipient. Jina developed new methods to profile single cells and single EV with high throughput and multiplexing.

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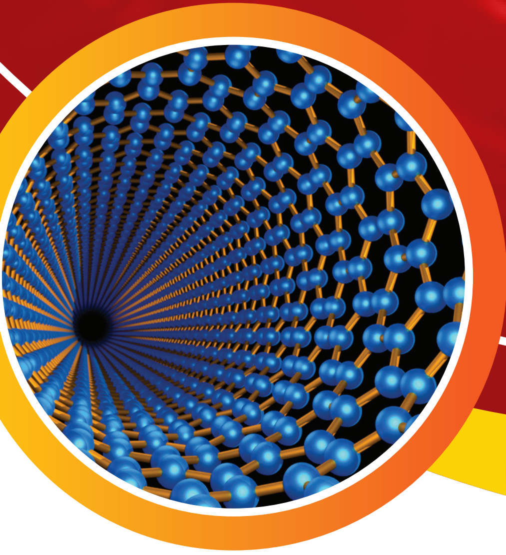

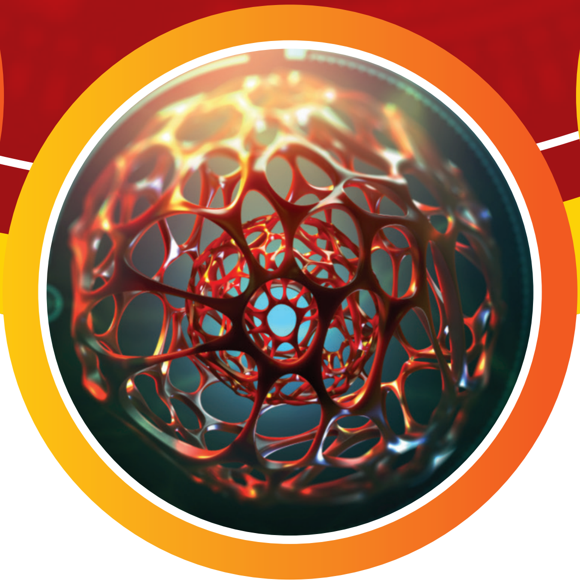

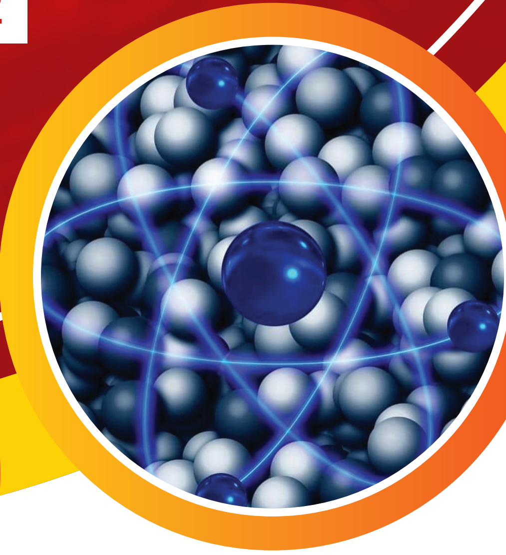

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Poster Presentation

DAY 2

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Pull-out of pristine and functionalized carbon nanotubes from cement: a molecular dynamic study

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Carbon nanotubes (CNTs) are widely used to reinforce cement-based composites. The improvement of the mechanical properties of the resulting materials depends on the strength of the interface formed between the CNTs and the cement matrix. The experimental characterization of the interfacial properties of these composites is still limited. In this poster, pull-out simulations of pristine and carboxyl-functionalized CNTs from a tobermorite crystal were carried out to study the interfacial shear strength (ISS) of these composites from an atomic perspective (figure 1). The effects of CNT diameter and degree of functionalization on the pull-out process were analyzed according to ISS and non-bonded energy results. The influence of H-bonding and electrostatic interactions between the CNT and the matrix were also studied. Both kinds of interactions increased ISS values. The results show that functionalized CNTs could perform better as reinforcing agents.

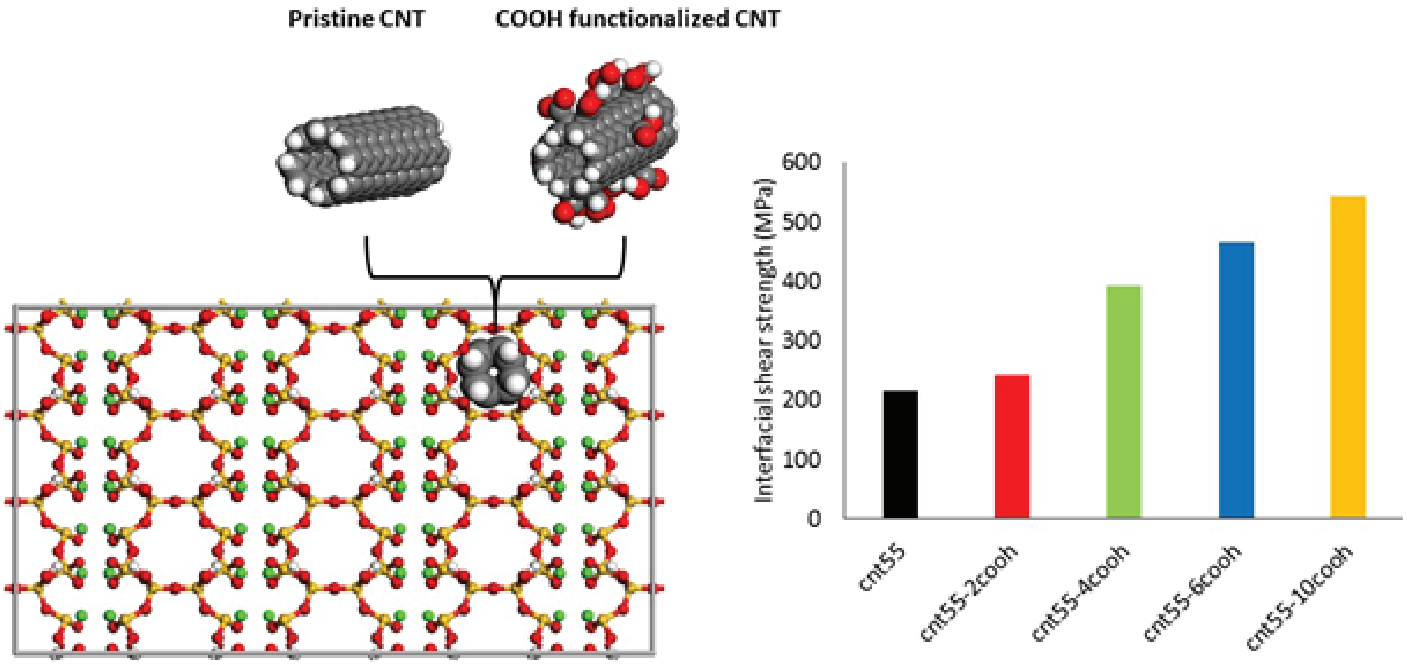

Figure 1. *Models (left) and results (right) of pull-out simulations of CNTs from a tobermorite matrix.*

Biography

Isabel Lado-Touriño holds a PhD in Chemistry and currently works as an Associate Professor at the Universidad Europea de Madrid´s Industrial Engineering Department. Her research interests include molecular simulations of organic and inorganic nanomaterials using molecular mechanics, molecular dynamics and density functional theory methods.

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