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Abstract Book

2nd Edition of Materials Science and Nanoscience Webinar

April 16-17, 2021 | GMT 07:00 – 14:00

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KEYNOTE FORUM

DAY 1

2nd EDITION OF

MATERIALS SCIENCE AND NANOSCIENCE WEBINAR

APRIL

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GMT 07:00 – 14:00

V-Materials2021

Jinlian Hu
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Spider Silks and their Artificial Counterparts

Spiders make various types of silks which have diverse properties and form archetypes for artificial materials. Among them, exatraordinary toughness and smart behavior such as supercontraction and water collection are particularly attractive. Unlike silkworm, spiders cannot be farmed due to their cannibalistic nature, which limits the utilization of spider silks in their natural form for real world applications, artificial spider silks are hot theme in scientific research and commercial attempts. Through the effort of most talented scientists and engineers in the world, theer have been progresses in these areas. On one hand, chemical approach to make biomimic polymers has been attempted, good results have been achieved in terms of toughness and structural similarities. On the othe hands, by utilizing the repeating modules of spider silks with different gene sequence motifs, novel and high performance materials have been designed. There are so far a range of recombinant spider silk proteins, namely, spidrions, being genetically produced by a variety of host organisms. By reviewing the recent progress in different approaches to make artificial spider silks and their scientific foudnations, this talk will present key issues in making biomimetic fibrous materials for practical applications including textiles and apparel

Biography

Prof. Jinlian HU is a renowned fibers, textiles and biomaterials scientist. Her laboratory focuses on unearthing scientific principles and providing solutions to key problems in Healthcare of Wearable Materials in three major areas: Traditional Chinese medical therapies and their materials, energy materials and healthcare as well as spider silks and their relatives as biomaterials as well as personal protective integration. Professor Jinlian HU is a Fellow of the Royal Society of Chemistry, Hong Kong Institution of Textile and Apparel and the British Textile Institute. She published more about 400 papers, 13 books and hundreds of invited conference presentations.

Dao Hua ZHANG

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Antimonide-based materials and heterostructures for high performance photodetection

Antimonide based materials and heterostructures have been attracting tremendous interests due to their excellent performance for midwave infrared and terahertz wave photodetection. By selecting proper composition of antimony, the materials can be used for different wavelength spectra. We have fabricated Antimonide based heterostructures which show good detection performance with low dark current. By incorporating nanostructures with the antimonide based heterostructure, significant enhancement in detection performance in midinfrared range has been observed and a record high specifical room temperature detectivity is demonstrated. Based on surface plasmon in indium antimonide, we invented two terminal terahertz photodetectors which show superior detection performance.

Biography

Dao Hua Zhang received his MSc degree from Shandong University, and PhD degree from the University of New South Wales. He joined the School of Electrical and Electronics Engineering, Nanyang Technology, Singapore in 1991 and is currently a professor, Deputy Director of Centre of Excellence for Semiconductor Lighting and Displays, Program Director of Photonic NanoStructures and Applications. Professor Zhang's main research interests include semiconductor materials, devices and technology, photonic metamaterials and applications. He has published over 530 papers in international journals and 7 books/proceedings and filed 7 patents. He is Fellow of Institute of Physics, and Fellow of Institution of Engineering and Technology.

Mohamad Riduwan Ramli[1] Rafiza Ramli[3], Khairudin Mohamed[2], Zulkifli Ahmad[1]

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Thermal and Lithographic Performance of Silsesquioxane with Cycloaliphatic Epoxy-Siloxane Hybrid Spacer for Soft Lithography

Pattern replication and fidelity are crucial during soft lithography process. The flexibility and surface energy of the resist with that of the master mold are among the factors in determining such an effect. In this work, polysilsesquioxane bearing cycloaliphatic-epoxy spacer of different chain length at tethered positions is synthesized. Pattern replication using soft lithography is made using polymethylmethacrylate (PMMA) as master mold. The thermal and UV-cured lithographic performances are studied using differential scanning calorimetry (DSC) and thermal gravimetric analysis (TGA). It shows that chain length of spacer induces flexibility and thermal stability. Despite chain flexibility, increase in spacer length results in poor lithographic performance. This can be attributed to the behavior of spreading parameter with different surface energy between the PMMA mold and the polysiloxane resist surfaces.

Biography

Zulkifli Ahamd has completed his PhD from University of Reading, UK. He was an Academic Visitor at University of Birmingham (2016) and Swansea University (2018). He was a Programme Chairman of Polymer Engineering Section at School of Material and Mineral Resources, Universiti Sains Malaysia. He has published more than 150 papers ini ISI refereed journal with over 3000 citations. He was awarded Scientist Award from International Association of Advance Materia (IAAM), Sweden and Top Research Scientist Malaysia by Academy of Science Malaysia.

Alberto Vomiero

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Interfacial properties in composite nano-systems for energy harvesting

Composite nanostructures can be efficiently applied for Sunlight detection and conversion and, more in general, for energy harvesting and generation of solar fuels. In most of the applied systems, like photo-detectors, excitonic solar cells and (photo)-electrochemical cells to produce solar fuels, nanomaterials can play a critical role in boosting photoconversion efficiency by ameliorating the processes of charge photogeneration, exciton dissociation and charge transport. Critical role in such processes is played by the structure and quality of the interface, which needs to be properly assembled to obtain the desired functionality. Several strategies can be pursued to maximize energy harvesting and storage, including broadening of light absorbance to reduce solar light losses, fastening exciton dissociation and charge injection from the photoactive medium to the charge transporting materials, reducing charge recombination during charge transport and collection at the electrodes. In this lecture, a few examples of application of nanocomposites will be discussed, including all-oxide coaxial p-n junction nanowire photodetectors and solar cells, core-shell quantum dot fluorophores for high-efficiency luminescent solar concentrators, composite sulfides for hydrogen generation, and oriented carbon nanotube forest dispersed in polymer matrix as efficient low-temperature thermoelectric composite. Emphasis will be given to the role of interface engineering in improving the efficiency of energy conversion in different systems, spanning from electric power generation from Sunlight, to chemical fuel production, to conversion of heat lost through thermoelectric materials.

Biography

Alberto Vomiero is chair professor in Experimental Physics at the Department of Engineering Sciences and Mathematics, Luleå University of Technology, Sweden and chair professor in Industrial Engineering at the Department of Molecular Sciences and Nanosystems, Ca' Foscari University of Venice, Italy. His main interests are in the development of composite nanomaterials for energy and environmental applications, with emphasis on solar cells, luminescent solar concentrators and electrochemical systems for solar fuel production. He is a Fellow of several professional societies, associate editor of Nano Energy (Elsevier) and member of the Advisory Board of Small (Wiley).

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Nanoparticles Joining in Stereolithographic Additive Manufacturing for Practical Components Fabrications

In stereolithographic additive manufacturing (STL-AM), 2-D cross sections were created through photo polymerization by UV laser drawing on spread resin paste including nanoparticles, and 3-D models were sterically printed by layer lamination. The lithography system has been developed to obtain bulky ceramic components with functional geometries. An automatic collimeter was newly equipped with the laser scanner to adjust beam diameter. Fine or coarse beams could realize high resolution or wide area drawings, respectively. As the row material of the 3-D printing, nanometer sized metal and ceramic particles were dispersed in to acrylic liquid resins at about 60 % in volume fraction. These materials were mixed and deformed to obtained thixotropic slurry. The resin paste was spread on a glass substrate at 50 μm in layer thickness by a mechanically moved knife edge. An ultraviolet laser beam of 355 nm in wavelength was adjusted at 50 μm in variable diameter and scanned on the spread resin surface. Irradiation power was changed automatically for enough solidification depth for layer bonding. The composite precursors including nanoparticles were dewaxed and sintered in the air atmosphere. In recent investigations, ultraviolet laser lithographic additive manufacturing (UVL-AM) was newly developed as a direct forming process of fine metal or ceramic components. As an additive manufacturing technique, 2-D cross sections were created through dewaxing and sintering by UV laser drawing, and 3-D components were sterically printed by layer laminations with interlayer joining. Though the computer aided smart manufacturing, design and evaluation (Smart MADE), practical materials components were fabricated to modulate energy and material transfers in potential fields between human societies and natural environments environments as active contributions to Sustainable Development to Goals (SDGs).

Biography

Soshu Kirihara is a doctor of engineering and a professor of Joining and Welding Research Institute (JWRI), Osaka University, Japan. In his main investigation "Materials Tectonics" for environmental improvements of "Geotechnology", multi-dimensional structures were successfully fabricated to modulate energy and materials flows effectively. Ceramic and metal components were fabricated directly by smart additive manufacturing, design and evaluation (Smart MADE) using high power ultraviolet laser lithography. Original stereolithography systems were developed, and new start-up company "SK-Fine" was established through academic-industrial collaboration.

Navpreet Kaur[1], Mandeep Singh[1], Abderrahim Moumen[1], Giorgio Duina[1], Gayan Chathuranga Kumarage Wadumesthree[1], Dario Zappa[1], Vardan Galstyan[1], Nicola Poli and Elisabetta Comini[1,*]

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Metal oxide nanostructures for chemical sensing application

Bay by day, the demand for portable, low cost, and efficient chemical/gas-sensing devices is increasing due to worldwide industrial growth for various purposes such as environmental monitoring and health care. To fulfill this demand, nanostructured metal oxides can be used as active materials for chemical/gas sensors due to their high crystallinity, remarkable physical/chemical properties, ease of synthesis, and low cost. In particular, (1D) one-dimensional metal oxides nanostructures, such as nanowires, exhibit a fast response, selectivity, and stability due to their high surface-to-volume ratio, well-defined crystal orientations, controlled unidirectional electrical properties, and self-heating phenomenon. Furthermore the functionalization of metal oxide nanomaterials and the fabrication of heterojunctions are other effective strategies to enhance their response and tune the selectivity to a specific gas. In this case, the formation of a p-n, p-p, or n-n interfaces is a significant factor to improve the reaction between the sensing structure and gaseous compounds. Herein, we report on the novel preparation and characterization of different nanostructures and hetrostructures morphologies such as SnO_2, CuO, NiO, WO_3, Bi_2O_3 and ZnO NWs, TiO_2 nanotubes and NiO/ZnO, NiO/WO_3, branched 1D-1D nano-heterostructures and NiO/SnO_2, SiO_2/SnO_2, CuO/ZnO Core-shell, TiO_2/GO and ZnO/GO composites and SAM functionalized ZnO NWs. The prepared materials have been analyzed using scanning electron microscopy (SEM), transmission electron microscopy (TEM), x-ray diffraction (XRD), UV-Vis and Raman spectroscopy. Finally, chemical gas sensors have been fabricated based on the prepared materials and tested towards a wide range of reducing and oxidizing gases.

Biography

Elisabetta Comini received her master degree in physics at the University of Pisa and her Ph.D. degree in material science at the University of Brescia. In 2001 she has been appointed assistant professor of physics of matter at Brescia University. In 2016 she became full professor. EC has been organizer of several symposia in the sensing field for MRS and E-MRS. EC has a high productivity confirmed by the numerous publications on international journals (more than 360) and the high number of invited presentations at conferences. EC is a researcher specialist in the growth of metal oxides, particularly nanowires, thin films and the measurement of their electronic, functional and structural properties. EC is the director of SENSOR laboratory (Brescia University, http://sensor.unibs.it) and is a co-founder of NASYS.

Giuliana Impellizzeri

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Innovative nanocomposites made of polymers and semiconductors for applications in photocatalysis

The immobilization of inorganic nanomaterials on polymeric matrices has been drawing a lot of attention in the recent years due to the extraordinary properties characterizing the as-obtained materials. The hybrid materials, indeed, combine the properties of the polymers such as flexibility, low-cost, mechanical stability, high durability, ease of availability, with the properties of the inorganic counterpart. In particular, if the inorganic fillers are nanostructured photocatalysts, the materials will be able to utilize the energy delivered by light to catalyze chemical reactions. Additionally, since the anchoring of the nanomaterials to the polymers, the dispersion of the materials in the environment is prevented, thus overcoming one of the main limits that impedes the application of nanostructured photocatalysts on a large scale. In this keynote, I will present several typologies of hybrid photocatalytic nanomaterials, made of polymers (thermoplastic ones) and semiconductors (TiO_2 and ZnO in the forms of nanoparticles, nanotubes, and nanolayers). Several methods to realize hybrid inorganic-organic materials will be illustrated, and all of them are easily up-scalable from laboratory to process scale. The described materials were deeply characterized and their remarkable photocatalytic abilities were evaluated by the degradation of several organic water pollutants such as dyes, phenol, pesticides, drugs, and personal care products. The antibacterial performance was also evaluated for selected samples. The relevance of the obtained results will be discussed, opening the route for the application of these multifunctional hybrid materials in photocatalysis, and especially for wastewater remediation.

Biography

Giuliana Impellizzeri has obtained her PhD in Physics from the University of Catania, Italy. She is Senior Scientist at the CNR-IMM. She has published more than 150 papers in international referred journals, holding a H-index of 32 (source: Google Scholar). She is Editor of Materials Science in Semiconductor Processing journal (Elsevier), and Associated Editor of Frontiers in Chemistry, Catalysis and Photocatalysis (Frontiers). She is project evaluator for the European Commission and for the Italian Minister of Education.

Alessia Sambri[1], Emiliano Di Gennaro[2], Dennis, M. Scuderi[3], V. Christensen[4], Thomas S. Jespersen[4], and Fabio Miletto Granozio[1]

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Freestanding oxide heterostructure membranes hosting a 2-dimensional electron gas

Two-dimensional electron gases (2DEGs) at oxide interfaces, as LaAlO3/SrTiO3 (LAO/STO) and its several variants, show multiple functional properties of major physical interest, including a high low-temperature mobility, superconductivity, a large Rashba spin-orbit coupling, an exceptionally large spin-to-charge conversion efficiency and a yet controversial magnetic ground state. Such properties are tunable under external control parameters, as electric field effect. In a number of experiments briefly described in the talk, we will first show the capability of tailoring unexpected samples properties by pushing growth control of our crystalline interfaces to the highest level. We will then focus on the control of strain relaxation, selecting the conditions in which an epitaxially strained state is retained much above the expected critical thickness. In this regime, strain relaxation is highly disruptive and surprisingly causes the formation of freestanding LAO/STO membranes, which preserve the metallic properties of macroscopic LAO/STO samples[1]. Such membranes can be manipulated, contacted and employed as elements of microscopic circuits on a generic surface. Methods allowing to successfully predetermine the shape and position of membranes will also be shown[2].

[1]A. Sambri et al., Adv. Funct. Mat. (2020), 1909964 DOI 10.1002/adfm.201909964

[2] R. T. Dahm et al., ACS Appl. Mater. Interfaces (2021), 12341DOI: 10.1021/acsami.0c21612

Biography

Fabio Miletto Granozio has completed his PhD in Naples, Università “Federico II”, and had his postdoctoral experiences both in Naples and in Grenoble, France (at CEA). He is presently a Research Director at the CNR-SPIN Institute. He has been coordinating in years 2014-2018 a very EU Project coordinating several hundreds of participants, the COST Action “TO-BE”, *Towards oxide-based electronics*. He has published over 100 papers and gave over 40 invited talks.

Tokeer Ahmad

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Smart Nanostructures for Multifunctional Properties and Applications

Nanomaterials are among the most challenging areas of current scientific and technological research because of the variety of interesting changes in their properties at nano-dimension. Functional nanmaterials find the possibility for their applications in water splitting processes for hydrogen generation as a renewable source of green energy. Fe_3O_4 nanocubes were prepared in one pot process for the electrochemical water splitting and supercapacitor applications. As-synthesized Fe_3O_4 nanocubes with high specific surface area of 268 m^2g^{-1}, are ferromagnetic at room temperature and affects the electro-catalytic activity of the electrode materials. Similarly, the catalytic activity of ultrafine RuO_2 was examined against the Horseradish peroxidase enzyme (HRP) and applied as sensor for the detection of H_2O_2 in the solution. Besides that, the stimulating bifunctional electro-catalytic performance of RuO_2 nanoparticles was studied under different atmospheric conditions. The studies of Yttrium Ferrite nanoparticles by citrate precursor route reveal the formation of monophasic orthorhombic $YFeO_3$ nanoparticles with fairly uniform distribution of nearly spherical particles, high specific surface area of ~338 m^2/g and visible band gap of 2.5 eV. Photocatalytic generation of hydrogen by using $YFeO_3$ nanoparticles has also been studied under the visible light irradiations which showed a significant H_2 evolution reaction rate up to 131.6 µmol $h^{-1}g^{-1}$. The chemistry of some oxide based multiferroics of general structure AMO_3 (A= Y, Gd & Bi and M = Fe, Mn & Cr) nanoparticles will also be discussed.

Biography

Prof. Tokeer Ahmad did his masters (chemistry) from IIT Roorkee and Ph.D. from IIT Delhi. Presently, he is full Professor at Jamia Millia Islamia, New Delhi. Prof. Tokeer Ahmad has supervised 9 PhD's, 9 projects, published 116 research papers and one book with research citation of 3430, h-index of 35 and i10-index of 73. Prof. Ahmad is active reviewer of 91 journals, delivered 84 Invited talks and presented 120 conference papers. Prof. Ahmad has received DST-DFG award, ISCAS Medal, Inspired Teacher's President Award, Distinguished Scientist Award and elected as Member of National Academy of Sciences India. Recently, Prof. Ahmad has been figured in World Top 2% Scientists by Stanford University, USA.

Katerina Dohnalova

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Theoretical prospects towards enhanced optical properties in silicon nanoparticles

The indirect bandgap of bulk crystalline silicon is the major issue for implementing this abundant and non-toxic material also for lighting, displays or thin film photovoltaic applications, where efficient light absorption and emission are required. Some improvement is achieved by quantum confinement in small 1-5 nm silicon nanocrystals (Si-NCs). Similar to direct bandgap materials, quantum confinement in Si-NCs leads to size-tunable bandgap and sensitivity to the surface chemistry and environment. On top of that, in originally indirect bandgap materials, also the radiative rate is size-dependent. For Si-NCs, this is observable down to the smallest of sizes and appears to vary strongly with different ligands. The covalent surface chemistry of Si-NCs enhances the role of ligands beyond a mere protective layer and solubility agent. Upon deeper inspection, using density functional theory (DFT), we uncovered the strong effects of surface chemistry on the k-space projected density of states and radiative rates, caused by mutually interdependent effects: (i) orbital displacement, (ii) direct contribution from surface elements into the density of states close to the bandgap, (iii) charge transfer and (iv) ligand/matrix induced strain. We demonstrate on multiple examples that the k-space projection of the density of states is an essential tool for investigations of the electronic and optical properties in the nanocrystalline materials with an originally indirect bandgap, especially for Si-NCs with notoriously complex surface chemistry.

Biography

Katerina Dohnalova completed her PhD *en-cotutelle* from Universite Louis Pasteur, France and Charles University, Czech Republic and postdoctoral studies from Czech Academy of Sciences, Czech Republic and University of Amsterdam, The Netherlands. Currently, she is group leader and senior lecturer at the University of Amsterdam and co-founder of a “green nanotechnology” start-up Spectris-dot BV. She has published more than 50 papers in reputable journals and 2 book chapters. Besides her scientific career, she is an active board member of the diversity & inclusion council and a group promoting women’s rights, proud mother and a professional artist.

Pasquale Sacco [1,2], Eleonora Marsich [3], Ivan Donati [1]

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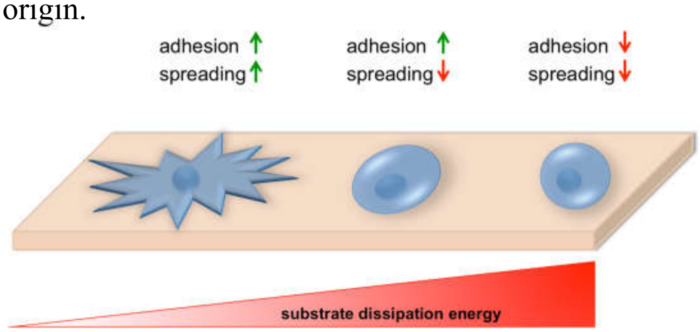
Substrate Dissipation Energy Regulates Cell Adhesion and Spreading

Recent evidences have led to hypothesize that dissipation of energy through viscoelastic extracellular matrix (ECM) could play a cardinal role in directing cell-fate decisions, but whether and how it correlates with specific cell response has remained unclear up to date. In this talk I will introduce substrate dissipation energy as novel cell-fate controller.[1] Specifically, I will illustrate recent findings about viscoelastic and plastic chitosan-based substrates endowed with different dissipative energies capable of modulating cell behavior in terms of adhesion and spreading. While keeping constant stress relaxation and systematically decoupling overall stiffness from linear elongation, we have introduced an energy dissipation term (J/mol), that is the molar energy required to deviate from linear stress-strain regime and enter into plastic region. Strikingly, we have unveiled an inverse relationship between substrate energy dissipation and cell response, with high adhesion/high spreading and low adhesion/no spreading detected for substrates at low and high dissipation energy, respectively. We concluded that cells decide how to react depending on the effective energy they can earmark for their functions. Of note, I will show how combinations of facing 5-consecutive sugars (pentads) composing substrates are essential in damping shear stress, thus behaving as cell traction forces dampers. Collectively, in this talk I will illustrate how the crosstalk between cells and ECM can be considered as energetic in origin.



[1] Sacco P, Baj G, Asaro F, Marsich E, Donati I. Substrate Dissipation Energy Regulates Cell Adhesion and Spreading. Advanced Functional Materials 2001977, 2020.

Biography

I am a Senior PostDoctoral Fellow at AREA Science Park & University of Trieste. I was Visiting at NTNU (Trondheim, Norway). Since 2014, I have published more than 30 Full Research Papers and Review Articles in leading peer-reviewed international journals at the edge of biomaterials fabrication, characterization and translation in Biomedical sector, including Advanced Functional Materials, ACS Applied Materials & Interfaces and Biomacromolecules. I was grantee of European Cooperation in Science & Technology (COST). The overall results of my research have been recognized by national and international awards, as well as the "Julia Polak European Doctorate Awards", awarded by the European Society for Biomaterials council and the medal "Leonardo da Vinci", awarded by the Italy Ministry of Education, Universities and Research. I serve as invited Guest Editor for the Special Issue "Polymers toward Mechanobiology" in Polymers journal (MDPI). Furthermore, I serve as Referee for more than 20 international journals.

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Jingrun Ran and Shizhang Qiao

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Future Aesthetics and Design Education: how to integrate new values with responsibility

The global energy crisis and environmental problems drive the aggressive search for a clean and renewable energy source to replace fossil fuels. The production of clean and carbon-free hydrogen energy from inexhaustible solar energy through photocatalytic water splitting is a 'dream technology' to address the worldwide energy shortage, environmental contamination and the greenhouse effect. The core challenge of this advanced technology lies in the development of low-cost and environmentally benign photocatalysts with sufficiently high activity and stability to produce hydrogen at a cost comparable to the conventional fossil fuels. Recently, emerging two-dimensional (2D) materials such as MXene, phosphorene, 2D metal-organic framework (MOF) and ReS2 have attracted tremendous attention due to their outstanding characteristics of ultrathin thickness, large surface area, high-aspect ratio and abundant active sites. Therefore, the rational design and synthesis of 2D materials based photocatalysts to achieve efficient and stable light-induced H2 production is highly promising. Furthermore, both advanced characterizations (e.g., aberration-corrected atomic-resolution transmission electron microscopy, synchrotron-based X-ray absorption spectroscopy and femtosecond fluorescence spectroscopy) and density functional theory based theoretical computations are adopted to investigate the atomic-level structure/composition-performance relation in photocatalysts. Finally, a general principle to develop high-performance photocatalysts for efficient solar-to-hydrogen energy conversion is concluded.

Biography

Dr. Jingrun Ran received his PhD degree in Chemical Engineering from the University of Adelaide. Now he is working as an ARC DECRA Fellow in Prof. Shi-Zhang Qiao's group, focusing on the atomic-level design and synthesis of photocatalysts for producing energy fuels and value-added chemicals using renewable solar energy. Dr. Jingrun Ran has been recognized as a Clarivate Highly Cited Researcher in 2020. He has published 41 papers in refereed journals, including *Nat. Commun.*, *Adv. Mater., Angew. Chem. Int. Ed., Energy Environ. Sci., Adv. Energy Mater., Chem. Soc. Rev., Sci. Adv.* (over 10647 citations, h-index: 29 based on Google Scholar).

Lea Sirota

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Metamaterials with programmed properties for waveguiding inspired by quantum mechanics

I demonstrate how acoustic, mechanical and electric transmission-line metamaterials that are based on embedded active feedback mechanism can realize unique waveguding inspired by quantum-mechanical phenomena. With the embedded feedback design, the couplings between the metamaterial unit cells and the consequent dynamical properties are determined in a real-time closed loop operation, and can be reprogrammed at will by the user. In particular, a controller can create structural couplings that are impossible to create with fixed elements, either passive or active. I present two examples. The first is a realization of unidirectional, topologically-protected waveguiding, along the boundary of a mechanical metamaterial constrained to out-of-plane vibration. The controller achieves this by creating non-reciprocal couplings that violate Newton's third law. The second is emulation of quantum tunneling in an effectively continuous acoustic metamaterial. The controller mimics the tunneling in real-time by creating effectively negative constitutive parameters of a specific form, resulting in negative refraction of waves unimpeded in the normal direction. In a concluding note I discuss the outlook for feedback-based materials in advanced waveguiding applications.

Biography

Lea Sirota is an assistant professor at the School of Mechanical Engineering, Tel-Aviv University. Her research area includes feedback-based acoustic/mechanical metamaterials with real-time re-programmable properties, adaptive acoustic silencing and cloaking, active imitation of artificial acoustic environment, and more. Lea completed postdoctoral appointments at the Department of Mechanical Engineering, Massachusetts Institute of Technology, and at the School of Physics and Astronomy, Tel-Aviv University. Her PhD is from the Faculty of Mechanical Engineering, Technion – Israel Institute of Technology.

Siu Hong Dexter Wong[1]

[1]Department of Biomedical Engineering, The Hong Kong Polytechnic University, Hong Kong, China.

Developing nanomaterials to harness molecular dynamics for biomedical engineering

Biophysical microenvironment plays critical roles in regulating cellular behaviours. Developing tunable dynamic nanomaterials is highly instrumental to investigate the mechanism underlying the relationship between cell responses and the dynamic cues. In particular, cell adhesion is controlled by the dynamic interaction between cell surface receptors, such as integrin, and adhesive motifs, such as Arg-Gly-Asp (RGD). Thus, nanomaterials possessing the ability of dynamic control of ligand presentation on the material surfaces can offer benefits in regulation of cell-implant interactions, which are important for tissue engineering, immunoregulation or fundamental mechanotransduction study *in vitro* and *in vivo*. We have demonstrated functional nanomaterials with stimuli-responsive functions or precisely-controlled nanogeometry for nanoscopic ligand presentation to regulate integrin-mediated adhesion and specialization of stem cells, macrophages and cancer cells. We believe that our nanoplatforms are not only desirable for studying the effect of microenvironment mechanical cues on cellular behaviour but also shed novel insights into the design of biomedical devices.

Biography

Wong, Siu Hong Dexter has completed his PhD and postdoctoral studies from the Chinese University of Hong Kong, Hong Kong, China. He currently works in the Hong Kong Polytechnic University as research assistant professor. He has published more than 25 international peer-reviewed papers and has been serving as an editorial board member of repute. Dexter has been extensively working on novel stimuli-responsive platforms and nanocomposite hydrogel to study and regulate cellular mechanotransduction for tissue engineering, and immune and cancer responses. He is also interested in novel nanoprobe for biomarker detection.

Corrente Giuseppina Anna

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Organic Mixed Valence Compounds for Electrochromic and Electrofluorochromic Applications

Organic mixed-valence compounds (MVs) consist of two or more chemically identical but differently charged redox centres connected by a π-conjugated bridging unit.[1] The bridge as well as the nature of the substituents determine their electrooptical properties, influencing the electronic coupling between the redox and bridge localized states. Arylamines are the most used redox centers in organic MV systems due to the stability of the radical cation forms and to the high extinction coefficient of the intervalence charge transfer transition (IVCT) in the near infrared region (NIR).[2] These systems are crucial materials in electrochromic (EC) and electrochrofluorochromic (EFC) devices, allowing the modulation of both coloration and emission, respectively, by small and reversible electrical stimuli. Therefore, they have attracted a great deal of interest due to their potential application as chemical sensors, biochemical labels, optical memories and displays.[3] Herein, we provide an overview on organic MVs with a different number of arylamino redox centres, bridged by properly functionalized fluorene and dibenzofulvene backbones.[5-6] We highlight the importance of the structure-properties relationships that results in a fine-tuning of the electrochromic and electrofluorochromic response. The developed devices exhibit different colorations as transmissive-to-black electrochromic switching behavior with high transmittance changes (close to 100%) and fast response time, as well as high quantum yield and high contrast ratio (I_{off}/I_{on}) in EFC device application. Additionally, electrochromic device shows an intense absorption in the near-infrared region, which is an important characteristic for tunable shading in dimmable windows.

Biography

Dr Corrente obtained her graduate degree in Chemistry at the University of Calabria in 2012. In 2014, at the same University she took her University II Level Master in “Servizi di Prototipazione e Ricerca per le Nuove Tecnologie e i nuovi materiali (SPRINT)” with the title of “Technical expert in the use of complex instrumentation for the study and analysis of new technologies and new materials.” She earned her Ph.D. in “Ingegneria dei materiali e delle strutture e nanotecnologie” at the University of Salento (Italy) in 2018, working on energy conversion and energy saving by multifunctional dibenzofulvene-based organic materials

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DAY 2

2nd EDITION OF

MATERIALS SCIENCE,
AND NANOSCIENCE WEBINAR

APRIL

16-17, 2021

GMT 07:00 – 14:00

Alberto Bianco
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Design and application s of multifunctional low-dimension nanomaterials

Graphene and other related two-dimensional materials are considered unique systems for many applications in different fields, including the biomedical sectors. They are offering the possibility to explore a wide range of reactions for their chemical functionalization and for the design of complex multifunctional systems that allow further their exploitation in therapy, imaging and diagnosis. In this presentation, I will illustrate the chemical strategies to functionalize graphene-based nanomaterials with appropriate functional groups and therapeutic molecules in view of their biomedical applications. I will describe few examples of their use in cancer therapy and imaging. I will also present appropriate strategies to enhance the biodegradability and tune the toxic effects of these nanomaterials.

Biography

Dr. Alberto Bianco received his PhD in 1996 from the University of Padova. As a visiting scientist, he worked at the University of Lausanne, the University of Tübingen (as an Alexander von Humboldt fellow), the University of Padova and Kyoto University. He is currently Research Director at the CNRS in Strasbourg. His research interests focus on the design of multifunctional carbon-based nanomaterials for therapy, diagnostics and imaging. He is fellow of the European Academy of Science and Academia Europaea, and in 2019 he has been awarded with the CNRS Silver Medal. Since 2011 he is Editor of the journal CARBON.

Jos Haverkort

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Light emission from hexagonal SiGe:

It has been a holy grail for several decades to demonstrate direct bandgap light emission in silicon. Both silicon and germanium are known to be indirect bandgap semiconductors. However, by transforming Si and Ge to the hexagonal crystal phase, the L-minimum is folded towards the Γ-point, yielding a direct bandgap arrangement.

Here we report light emission[1] from hexagonal crystal phase SiGe. Extrapolations between Hex-Si and Hex-Ge predict that Hex-SiGe will be a direct bandgap semiconductor at Ge-compositions above 65%. We measured the photoluminescence spectra of Hex-Ge as a function of excitation power and temperature. Importantly, the spectra can be interpreted as being exclusively due to band-to-band recombination. We subsequently investigated the photoluminescence spectra of Hex-SiGe as a function of the composition. We observe a broad tunability of the direct bandgap between 1.8 µm at 0.65% Ge and 3.5 µm at 100% Ge, measured at 4K. Importantly, we observe a subnanosecond recombination lifetime in Hex-SiGe, which can be explained by a breaking of the translational symmetry due to alloying. Moreover, we observe a temperature independent photoluminescence efficiency in the full temperature window between 4K and 300K, which demonstrates that the recombination mechanism in Hex-SiGe is purely radiative. For serving as a Si-compatible light emitter, the radiative efficiency at room temperature is most important. We observe a very high radiative recombination efficiency which is comparable to a III/V semiconductor.

Reference:

1. Nature, 580, 205 (2020)

Biography

Jos Haverkort obtained his PhD at Leiden University in 1987and is currently an Associate Professor at Eindhoven University of Technology in the Netherlands. He has been focusing on the optical properties of III/V semiconductors, which recently turned into the study of hexagonal GaP nanowires (NWs), orange emitting hexagonal InGaP NW-shells, green emitting hexagonal AlInP NWs and presently hexagonal SiGe NWs. Hexagonal SiGe is a direct bandgap semiconductor which efficiently emits light between 1.8 and 3.5 micron. This new semiconductor is very promising for chip to chip an eventually intra-chip optical communication as well as for infrared optical sensors.

Steven J. Eppell

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Why Bother With Nano In Biomaterials?

A brief history of how modern nanoscience and nanotechnology got started will provide some perspective for answering the question why we bother with nano in biomaterials. Then three vignettes will be used to show how the nanoscale can play an integral role in the design, synthesis, and measurement of a novel biomaterial. From these stories emerge three conclusions. Designing biomaterials to interact with cells in desired ways requires nanoscale thinking. Biomimetic material synthesis often follows bottom up self-assembly which requires nanoscale thinking. Finally, measurement of biomaterials to ensure that the desired design parameters have been met often requires techniques with nanoscale resolution. To drive forward next generation biomaterials will likely require invention of new measurement techniques to provide the needed data. In short, achieving biocompatibility of 21st century biomaterials will, in large part, be an exercise in applying nanoscience in creative ways to develop nanotechnologies useful to the biomaterials engineer

Biography

Steven Eppell completed his PhD in physics and now is Associate Professor of Biomedical Engineering and directs the Nanoscale Orthopedic Biomaterials Laboratory at Case Western Reserve University, USA. He has published 58 peer reviewed papers, 2 book chapters, and holds 3 patents. He holds a particular interest in understanding, designing, and synthesizing clinically useful materials systems at the nanoscale.

Benoît Lessard

Department of Chemical and Biological Engineering, University of Ottawa, Ottawa, Ontario K1N 6N5, Canada.

The rise of Silicon Phthalocyanines as n-type organic semiconductors for thin film transistors and organic photovoltaics

Phthalocyanines (MPc) are conjugated macrocycles that chelate a metal or metalloid inclusion and have been used as commercial dyes for decades. MPcs have also found application in organic electronics due to their chemical stability and favourable optoelectronic properties. Silicon phthalocyanines (SiPc) are a class of MPc that have recently attracted interest from our group and several others. Due to the oxidation state of the silicon, we observe two axial bonds that are perpendicular to the aromatic macrocycle serving as handles to impart solubility and tune surface and bulk properties without having a significant effect on the optical and electrochemical properties, a significant advantage over divalent MPc such as copper (CuPc) or zinc (ZnPc) MPcs. Interestingly, these SiPc derivatives are all inherently n-type semiconductors: they favour the transport of electrons over holes which is uncommon for MPcs. The following presentation will focus on the engineering of SiPc based electronic devices. The choice of axial groups and its effect on surface morphology and molecular stacking on the device performance leading to several emerging structure property relationships and a roadmap to high performance

Biography

Prof. Benoit H. Lessard is a Tier 2 Canada Research Chair and Associate Professor in the Department of Chemical & Biological Engineering at University of Ottawa. Recipient of 2018 Ontario Early Researcher Award, 2015 Charles Polanyi Prize in Chemistry and 2018 J. Mater. Chem. C Emerging Researcher. Since 2008, Prof. Lessard has published 91 peer reviewed journal articles, 14 patent applications, 1 book chapter and presented his work over 90 times at international and national conferences. Prof. Lessard is co-founder of Ekidna Sensing inc, which is a spinoff company based on cannabinoid sensors. Prior to joining uOttawa, Prof. Lessard was NSERC Banting Fellow at the University of Toronto on organic electronics and obtained his PhD (2012) from McGill University in Polymer reaction engineering.

Xiaojia Wang
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Study of Thermal and Magnetic Transport in Functional Materials Enabled by Ultrafast Optical Metrology

Transport phenomena play an important role in designing and engineering materials with tailored functionalities. This is especially true for materials with reduced dimensions. Thermal conductivity and interfacial thermal conductance, as basic transport properties of materials and interfaces, can provide a wealth of information on the fundamental scattering processes of charge and thermal carriers with structural defects, boundaries, and interface imperfection. In this talk, I will share our group's activities on advancing the state-of-the-art ultrafast optical metrology to study the thermal and magnetic properties of functionalized materials spanning a wide range of applications. This will include: (1) creating the ultralow thermal conductivity using single crystals of correlated perovskite oxides; (2) revealing the 3D anisotropic thermal transport in black phosphorus, as the next-generation of "wonder materials" for the semiconductor industry; (3) engineering interfacial thermal transport across the solid-solid interface between sapphire and polystyrene, and across the solid-liquid interface between functionalized nanoparticles and water; (4) developing low-damping and high-thermal stability materials with perpendicular magnetic anisotropy for spintronic applications. Last but not least, I will highlight our recent work on manipulating spin precession using optically launched acoustic strains at ultra-high frequencies (~60 GHz). The structure-property relationships of functional materials revealed by the ultrafast pump-probe technique open up opportunities of tailoring material properties by structural engineering at the atomic and molecular levels. Ultimately, such an understanding can be leveraged to guide the design and optimization of materials, as promising building blocks for high-performance electronic devices, thermal management, solid-state energy conversion, spintronics, and data storage.

Biography

Xiaojia Wang is currently an associate professor in the Department of Mechanical Engineering at the University of Minnesota, Twin Cities. Prior to this, she was a postdoctoral research associate in the Department of Materials Science and Engineering at the University of Illinois at Urbana-Champaign. She received her Ph.D. in Mechanical Engineering from the Georgia Institute of Technology in 2011, and her M.S. in 2007 and B.S. in 2004 from Xi'an Jiaotong University, China, all in Mechanical Engineering. For details, please visit her research group website: https://mnttl.umn.edu/publications.

Ruksana Baby[1], Kavita Mathur[2], and Emiel

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Non-destructive Quantification of Skin-Fabric Contact Area Using the X-ray Micro-Computed Tomography System

Skin health and comfort is significantly influenced by the textiles next to skin while excessive and repetitive friction between the two surfaces imposes the risk of skin redness, irritation, blisters and pressure ulcers. According to the adhesion-friction theory, contact area is a critical factor which influence the adhesion between the two surfaces, and therefore friction. Hence authors have developed a novel non-destructive method to experimentally quantify contact area (fiber area at skin-textile interface) using the X-ray micro-computed tomographic (XRM-CT) three dimensional (3D) image analysis. While most studies available in literature were found interested in the surface profiles of the textiles for contact area analysis, the authors of this study investigated both the surface profiles and the inner construction to understand their effects on skin friction under different physical, mechanical and micro-climatic conditions. Ring-spun 100% cotton made plain and satin woven fabrics with varying thread densities were investigated in this study. The 3D images (pixel size 1.13 µm) were analyzed to calculate the amount of fibers (%) using two components, the total fiber area in a slice and the total area of the slice, and then plotted against distance to compare among fabrics. The 3D images and the fiber area % analysis were in good agreement to comprehend and compare the contact area among fabrics. Yarn and fabric properties such as yarn diameter, crimp%, packing factor, fabric thickness, volumetric density and cover factor were also demonstrated using the 3D images and found more reliable since the entire analysis process was non-destructive.

Biography

Dr. Kavita Mathur areas of expertise include yarn and fabric formation and structure, technical textile design, smart textiles, composites, and physical/mechanical properties of fibers and fibrous assemblies. Specific research areas include the impact of textiles on health, sleep, performance and comfort, digital color communications, material innovation, smart textiles and fiber composites. She has over a decade of industry experience with a broad portfolio in Medical, Industrial, Composites, Government, Defense and Consumer Industries. She has published several articles, in refereed journals and proceedings. She is co-inventor of three published patents applications.

Dawen Li

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Rapid Photonic Annealing for High-Performance Perovskite Solar Cells

Hybrid perovskite solar cells (PVSCs) have attracted extensive attention due to rapid progress in power-conversion efficiency (champion efficiency ~25.1%) and device fabrication from solution processes, which is fully compatible with low-cost roll-to-roll (R2R) printing. However, large-scale R2R manufacturing is currently limited by their lengthy annealing times from traditional hotplate heating. Thus, developing an alternative annealing technique is essential to realize mass-production of high-performance PVSCs through high-speed printing. In this seminar presentation, I will talk about rapid photonic annealing to make high-performance perovskite solar cells. We demonstrated that infrared lamp, rapid thermal processing (RTP), UV-LEDs can be employed to anneal perovskite active layer and achieve high-performance solar cells in a much short time (tens of seconds) as compared to hotplate annealing with comparable or better performance. These novel technology developments, particularly layer-specific UV-LED annealing, will pave the way to realize large-scale manufacturing of high-performance fully flexible perovskite solar panels through cost-effective R2R printing.

Biography

Dr. Dawen Li is an Associate Professor in the Department of Electrical and Computer Engineering at the University of Alabama. Dr. Li received his Ph.D. in Electrical Engineering and Computer Science from the University of Michigan, Ann Arbor, in 2006. During his Ph.D. study, Dr. Li had intern experience at Bell Labs, Lucent Technologies in 2004. From 2006 to 2008 he was a post-doctoral research fellow at the University of Michigan, Ann Arbor. Dr. Li joined the University of Alabama in 2008. He is a recipient of NSF CAREER award. Dr. Li's current research focuses on organic electronics and perovskite-based photovoltaics

Kevin N. Wood[1]

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Dendrites and Pits vs Needles and Canyons: The Quest to Create Uniform Lithium Electro-Deposition and Dissolution

Commercial adoption of lithium metal anodes within battery devices would change the energy storage landscape. Unfortunately, lithium electro-deposition and dissolution occurs in a heterogeneous manner. This nonideal behavior leads to capacity loss, power density depletion, and safety concerns. Shockingly, very little is even known about this heterogeneity and what fundamental parameters can be tuned to control or prevent dendrite growth. Therefore, this talk focuses on our laboratory's quest to create homogeneous lithium electro-deposition and dissolution. This talk includes 3 parts: 1) interpreting the specific voltage and current 'fingerprints' of lithium metal anodes that indicate the presence of 'dendrites' and 'pits', 2) an in-depth look at why non-uniform dissolution/deposition (dendrites and pits) degrade the performance of batteries using lithium metal anodes and 3) results on our newly invented Rapid Oxidation and Reduction (ROAR) treatment for Li metal anodes that could help make Li metal anodes a commercial reality.

Biography

Kevin N. Wood is an assistant professor at San Diego State University. He obtained his Ph.D. in Materials Science from the Colorado School of Mines and was a postdoctoral researcher at both the National Renewable Energy Laboratory and the University of Michigan. He is the director of the Interface Design Laboratory which focuses on designing/developing novel characterization methods for operando/in-situ analysis. In the last 5 years Dr. Wood has published 20 peer reviewed journal articles on the topic of Battery Materials and Technology

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Characterization and Modeling of Thermal Protective and Thermo-physiological Comfort Performance of Polymeric Textile Materials

In 2017, National Fire Protection Association (NFPA) reported a death toll of 64 firefighters and injuries to 58,835 firefighters in more than 1 million fire incidents across the USA. According to the U.S. Department of Labor statistics, 1,566 workers also died from injuries in the oil-and-gas drilling industry and related fields from 2008 through 2017. The majority of these fatalities and burn injuries results from an inadequate protection and comfort provided by firefighters' and oilfield-workers' fire protective polymeric textile materials used in their workwear. Hence, both the thermal protective and thermo-physiological comfort performance of fabrics used in workwear significantly contribute to limit firefighters' and oilfield-workers' skin burns and heat stress. Considering this, various test methods that have been standardized by ASTM (American Society for Testing Materials) or ISO (International Organization for Standardization) were used to measure the protective and comfort performance of the fabrics under different thermal exposures and ambient environment. But, these tests are fabric destructive in nature, time consuming, and/or expensive to carry out on a regular basis. As a result, our previous studies have focused on characterizing and developing empirical models to predict the protective and comfort performance based on physical properties of the fabrics. However, there are still some technical knowledge gaps in the existing literature related to this. This keynote presentation critically reviewed the literature on characterization and modeling of thermal protective and thermo-physiological comfort performance of fire protective textile fabric materials. The key issues in this field has been presented for the future research.

Biography

Dr. Sumit Mandal is an Assistant Professor of Textile Science in the Department of Design, Housing and Merchandising (DHM) at Oklahoma State University (OSU), USA. He did his Postdoc from Empa - Swiss Federal Laboratories for Materials Science, Switzerland; PhD from University of Alberta, Canada; Post Graduate Certificate from Nottingham Trent University, United Kingdom; Masters from The Hong Kong Polytechnic University, Hong Kong; and Bachelors from Calcutta University, India. His research primarily focuses on thermal protective textiles for the safety of high-risk sector workers. He has disseminated 1 book, 8 book chapters, more than 60 journal papers and conference presentations.

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APRIL

16-17, 2021

GMT 07:00 – 14:00

V-Materials2021

Ferda Mindivan

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Graphene Derivatives in Biomaterials

Natural and synthetic polymers are widely explored for many biomedical applications. They have modifiable physical and chemical properties for the arrangement of bioactivities, biodegradability and biocompatibility. However due to the low mechanical properties, they have limited applications when subject to loads. The use of graphene and graphene derivatives at composite biomaterial studies are to overcome of disadvantaged properties. The extraordinary physical, chemical and electronic properties of graphene derivatives such as graphene oxide (GO), reduced graphene oxide (rGO) and graphene quantum dots (GQDs) has led to a wide range of applications. Graphene derivatives have been considered for various biomaterials such as hip and knee joints, internal membranes, nerve or muscle fibers and artificial kidney or heart. The present study aims to supply an overview of the current state of the graphene filler or reinforced biocomposite materials for this exciting field of science.

Biography

Assistant Prof. Dr. Ferda Mindivan, born in 1983, graduated from Ataturk University, Erzurum, Turkey, Department of Chemistry, in 2005. After receiving her PhD degree from the same university in the field of Physical Chemistry in 2013, she is continuing her Professional career as assistant professor in the Bioengineering Department, Bilecik Seyh Edebali University, Bilecik, Turkey. Her main research interests are biomaterials and their structural, thermal, mechanical and tribological characterizations.

Raktim Sarma

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Hybrid Polaritonic Metasurfaces: From Nonlinear Optics to Optoelectronics

Metasurfaces, which are two-dimensional equivalent of metamaterials, offer a unique and efficient platform to study and control light-matter interactions in the sub-wavelength limit. When combined with semiconductor heterostructures, the metasurfaces can be coupled to fundamental excitations such as intersubband transitions in quantum wells. Such hybrid devices can provide opportunities for both fundamental studies of light-matter interactions as well as for new ultrathin optical devices such as voltage tunable optical modulators and nonlinear frequency generators. In the first part of this talk, I will present a low dissipation optical modulator using a hybrid plasmonic metasurface where the tuning mechanism relies on field induced tunneling of electrons in semiconductor heterostructures. In the second part of the talk, I will concentrate on hybrid dielectric metasurfaces coupled to intersubband transitions for high efficiency second harmonic generation. I will finally conclude by presenting fundamental studies of strong-light matter interaction between Mie modes in dielectric resonators and intersubband transitions in semiconductor quantum wells.

Biography

Raktim Sarma is a Senior Member of Technical Staff at Sandia National Laboratories. He received his PhD in Applied Physics from Yale University in 2017. During his PhD, his work on optical gyroscopes was recognized by *Photonics.com* as one of the top ten research stories of 2015 and was highlighted by media outlets as “World’s Smallest Gyroscope”. Dr. Sarma joined Sandia National Laboratories in 2016 and has been working there in the areas of low-loss, tunable, nonlinear, ultrathin metasurfaces and advanced optical devices to support Sandia’s nanophotonics strategy. To date, Dr. Sarma has authored over 85 publications and conference papers.

Achraf Harrati[1], Ahmed Manni[1], Fahd Oudrhiri Hassani[2], Abdeslam El Bouari[1], Iz-Eddine El Amrani El Hassani[3], Chaouki Sadik[1]

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Potentiality of new dark clay-rich materials for porous ceramic applications in Ouled Sidi Ali Ben Youssef Area (Coastal Meseta, Morocco)

Potential use of raw clayey deposits from El Jadida, Morocco, in the manufacture of traditional ceramic products has been evaluated through careful sampling and an in-depth characterization of the outcropping features in the area. We collected six representative clay-rich materials (C1-C6) for subsequent analyses including physico-chemical, mineralogical, and thermal analyses. Our results revealed that those ferruginous clays were found suitable for dark ceramic bodies. The further mineralogical examination confirmed low to medium contents of clay minerals but subordinated by quartz, calcite, dolomite, and plagioclase as the main non-clay minerals. Ternary diagram plots indicated that the studied clays were suitable for structural clay products and clay roofing tiles. C5 sample exhibited the best physico-chemical and mineralogical properties due to its illitic nature (64%), low quartz content (28%), high plasticity index (32), and lower loss on ignition (10.84%). Therefore, the C5 clayey sample was selected as a potential candidate to be mixed with expanded perlite (EP) for the production of insulating ceramics. The developed specimens at 1100 °C were ascertained through their bulk density, water absorption, shrinkage, bending strength, thermal conductivity, structural and mineralogical properties.

Biography

Kevin N. Wood is an assistant professor at San Diego State University. He obtained his Ph.D. in Materials Science from the Colorado School of Mines and was a postdoctoral researcher at both the National Renewable Energy Laboratory and the University of Michigan. He is the director of the Interface Design Laboratory which focuses on designing/developing novel characterization methods for operando/in-situ analysis. In the last 5 years Dr. Wood has published 20 peer reviewed journal articles on the topic of Battery Materials and Technology

Zaynab Aouzal[1], Mimouna Bouabdallaoui[1], Abdelqader El Guerraf[1], Sana Ben Jadi[2], Abdelhadi El Jaouhari[2], Mohamed Bazzaoui[2], Rongguang Wang[3], El Arbi Bazzaoui[1]

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[3] Department of Mechanical Systems Engineering, Faculty of Engineering, Hiroshima Institute of Technology, 2-1-1 Miyake, Saeki-ku, Hiroshima 731-5193, Japan.

Surface-Enhanced Raman Scattering for conducting polymers in situ investigation: Application to poly(5-amino-1,4-naphtoquinone)

Electropolymerization of 5-amino-1,4-naphthoquinone on electrochemically roughened gold elec-trode has been performed by anodic oxidation of the monomer in CH_3CN + 0.1 M $LiClO_4$ electro-lytic medium. The cyclic voltammograms recorded during the first stages of electropolymerizetion clearly demonstrate the competition between the oxidation reactions of the monomer and the working electrode. Thanks to the surface asperities of the roughened electrode and to gold particles embedded within the inner layers of the polymer, the Raman analyses with red laser line led to the observation of surface-enhanced Raman scattering effect. The in-situ SERS spectra of poly(5-amino-1,4-naphthoquinone) obtained during the gradual variation of the electrode potential between the reduced and the oxidized states in both directions in CH_3CN + $LiClO_4$ medium confirmed the electroactivity and electrochemical stability of the polymer during the doping-undoping process, as well as the reversibility of the transition between the oxidized (C=O) and reduced ($C\text{-}O^{-}\cdots Li^{+}$) forms of the quinone groups. Moreover, SERS analyses were also carried out using metal colloids. In this case, despite the very low polymer concentration (traces) and the mild experimental conditions (weak laser power) used in these experiments, a large amplification of the Raman signal took place. Thanks to the suspension of silver or gold particles, the polymer displays a SERS effect, which greatly improves the signal-to-noise ratio of the Raman spectra, thus allowing to perform a much better vibrational analysis and to determine the orientation and the fixation mode of the polymer on the metal surface.

Biography

Zaynab has completed her PhD in 2019 from Mohammed first University faculty of science, Oujda, Morocco. She has her expertise in conducting polymers and their electrosynthesis. Her focus is based on the use of conjugated polymers as coating for application in corrosion protection. She has published 10 papers indexed international journals and 2 moroccan patents.