The Second International Conference on Advanced Materials for Energy and Information Technology (Online)

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School of Advanced Materials & Nanotechnology

Academy of Advanced Interdisciplinary Research

Conference introduction

Energy is the driving force for the development of human civilization, materials are the basis for social progress, and the information revolution is a new leap for nature transforming by mankind. Under the circumstances of increasingly severe global energy and environmental issues, with the strong government support and continuous breakthroughs in frontier basic research, global strategic emerging industries is growing rapidly, and a new round of technological and industrial revolution has been triggered by the technology integration of information, new energy, and novel materials.

The Second International Conference on "Advanced Materials for Energy and Information Technology (Online)" will be held on August 30-31, 2021. Because of covid-19, an online conference will be provided as an international exchange platform. This AMEIT2021 conference is chaired by Prof. Wei Huang at Northwestern Polytechnical University, Prof. Cewen Nan at Tsinghua University, Prof. Federico Rosei at University du Québec, and Prof. Patrice Simon at Université Paul Sabatier. AMEIT 2021 is sponsored by Xidian University and organized by School of Advanced Materials & Nanotechnology and Academy of Advanced Interdisciplinary Research.

This conference aims to provide a wide range of interdisciplinary academic exchange platform for scholars engaged in basic, application and development research in related fields, and promote researchers in fields of energy, information and materials to exchange and share the latest achievements of frontier research, and discuss the development trend and scientific issues of their respective fields, so as to achieve the purpose of mutual promotion and common improvement.

Xidian University

Directly under the Ministry of Education, Xidian University (XDU) is a national key university featuring electronic and information science. XDU has 17 colleges, more than 36,000 students, and around 2300 faculty. XDU has two campuses, covering an area of 270 hectares (2700000m²). The south campus is known as the new campus. North campus is located downtown and is 13 kilometers away from the south one. There are many world-renowned high-tech companies, such as Samsung, Micron Technology, etc. around the south campus and the location of the XDU south campus is named Electronic Valley by the Xi'an Municipal Government.

XDU is characterized by its electronic and information science disciplines. According to the latest report of ESI, the engineering and computer science disciplines are listed among top 1 ‰ in the world. In the Fourth National Assessment of First-level disciplines, 3 disciplines at Xidian University have been rated A. Electronic Science and Technology is rated A+, ranking #1 nationwide, Information and Communication Engineering A, and Computer Science and Technology A-. XDU also focuses on comprehensive development of disciplines like economics, management, humanities and sciences.

XDU has established cooperative relationships with 155 universities and institutions in more than 35 countries and regions. About 66 joint laboratories have been founded with multinational corporations, including Microsoft, IBM, Intel, SAP, etc. Since its establishment in 1931, XDU has cultivated more than 310,000 graduates.

School of Advanced Materials and Nanotechnology

School of Advanced Materials and Nanotechnology is a new research-based school established in 2013. The goal is to become a world-class school of materials, train national pillars of talent, and create international-leading core science and technology. We are committed to creating a first-class scientific research and teaching team in the fields of new materials, nanoenergy technology, information perception technology, etc., training first-class talents, and forming a first-class material discipline with distinctive features and obvious advantages.

At present, master's and doctorate's degree programs for materials science and engineering (first-level discipline), master's degree program for materials and chemical engineering, and undergraduate program for materials science and engineering, applied chemistry and nanomaterials and technology are provided. There are 74 full-time teachers, 1 recipient of the National Outstanding Teaching Award, 13 recipients of National Talent Project, and 5 recipients of Talent Project in Shaanxi Province.

A large-scale instrument testing platform of "Analysis and Testing Center" has been built. There are good conditions from the synthesis and preparation of advanced materials, structural characterization, performance testing to the research and development of micro-nano devices, which can provide a high-level scientific research platform for the cultivation of innovative talents.

西安电子科技大学 XIDIAN UNIVERSITY | 前沿交叉研究院 Academy of Advanced Interdisciplinary Research

Academy of Advanced Interdisciplinary Research

Academy of Advanced Interdisciplinary Research (AAIR) of Xidian University are founded in 2018, dedicating to promoting interdisciplinary research, strengthening disciplinary cross and fusion, and exploring frontier and interdisciplinary development, in response to world cutting-edge science and technology development and national major strategic needs. AAIR aims to attract and cultivate high-level scientific and technological talents, solve key and core scientific problems, produce influential scientific research results, and forming innovative operation mechanism and management mode. AAIR is also founded to further enhance Xidian's core competitiveness and international influence and promote its construction of a world-class university by building a "special zone for academic talents", so as to better serve the needs of the country, industries and make a unique, leading contribution to regional economic and social development.

AAIR has established several research centers, including: Quantum Information, XF-IJRC, Advanced Remote Sensing, Extreme Sensing, Space Solar Power Station System, Flexible Electronics, Smart Sensor, AI and Security, Advanced Optics and Perception, Piezotronics, AI-based Big Medical Imaging Data, Intelligence-Aided Teaching, etc, bringing together a high-level talent team consisting of academicians from Chinese Academy of Sciences and Chinese Academy of Engineering, internationally renowned scholars, national leading talents in innovation, and young scholars.

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Alphabetic order of last name

Registration Information

The is no fees to attend the conference. However, the Registration to the Conference is mandatory to attend the Virtual Sessions.

Please click the following Registration Link to complete your registration. Please double check your email address, since we will email you the link to the conference on August 29, 2021. Please check your spam folder as well.

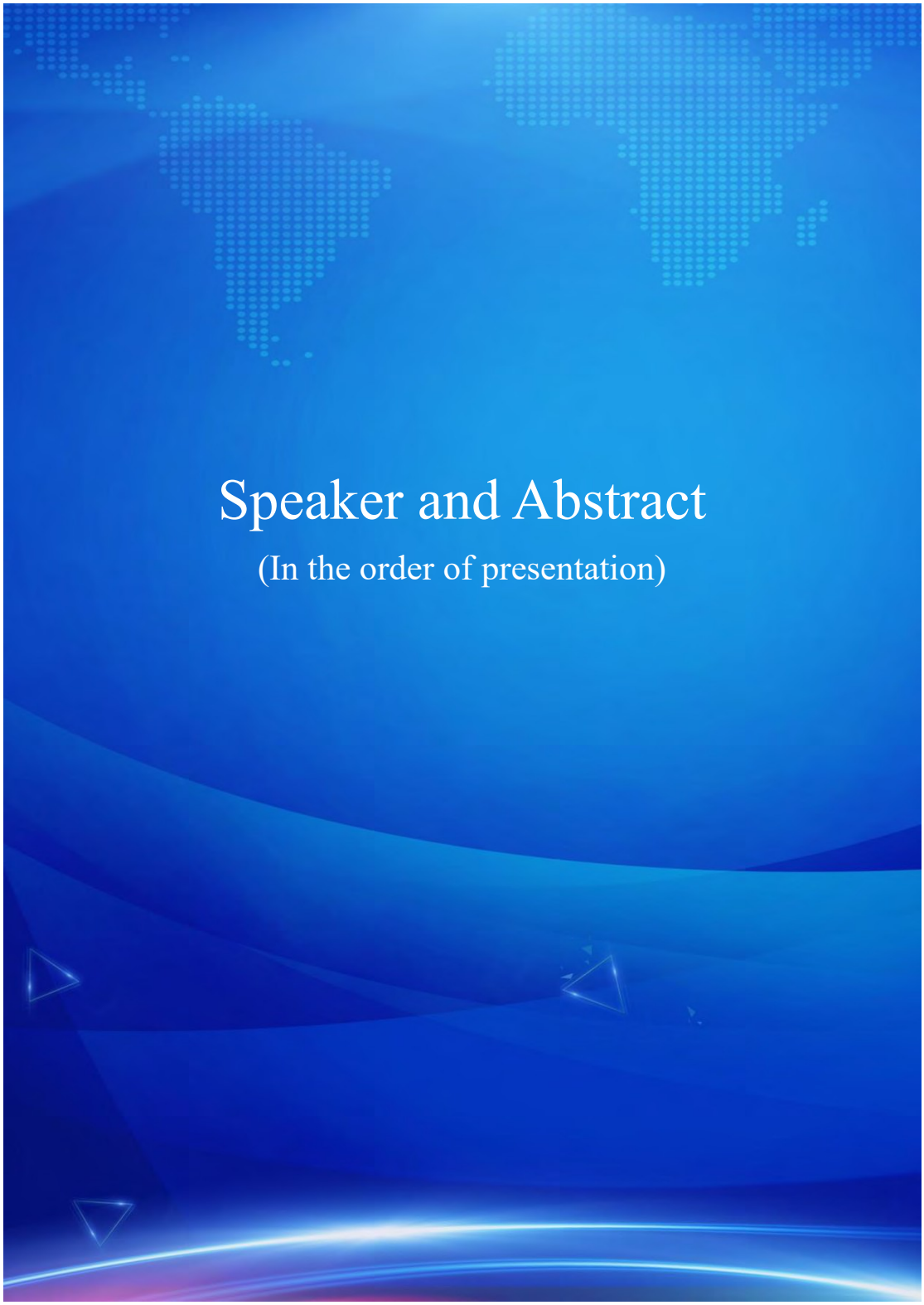
Registration Link: https://wj.qq.com/s2/8928207/b7e7/

August 30 (Beijing Time)

Section	Time	Title	Speaker	Chair
A	8:55-9:00	Opening speech	Guangming Shi	Rusen Yang
	9:00-9:45	Piezotronics and Piezo-phototronics of the Third Generation Semiconductors	Zhong Lin Wang	
	9:45-10:30	Bioelectricity from Viruses	Seung-Wuk Lee	
	10:30-11:15	Solar Fuel Production via Thermochemical Redox Cycles	Wojciech Lipiński	
	11:15-12:00	Atomically Precise Chemical, Physical, Electronic, and Spin Contacts and Interfaces	Paul S. Weiss	
Break				
B	14:00-14:45	Hybrid Perovskites: Emerging Light-Responsive Semiconductors	Tom Wu	Chi Zhang
	14:45-15:30	Thermal-assisted electrochemical fluoride-free synthesis and characterization of MXenes and pulsed laser deposition of 2D ultra films	Jianhua Hao	
	15:30-16:15	Tribotronics for Active Mechanosensation and Self-Powered Microsystems	Chi Zhang	
	16:15-17:00	Materials under the tip: Quantitative Imaging of Localized Functionalities at the Nanoscale	Jiangyu Li	
Break				
C	19:15-20:00	Six-Membered-Ring Inorganic Materials: Definition and Prospects	Hui-Ming Cheng	Haixia Zhang
	20:00-20:45	All Solid-State Batteries: from Interface Design to New Solid-State Electrolytes	Xueliang Sun	
	20:45-21:30	Phase Engineering of Nanomaterials (PEN)	Hua Zhang	
	21:30-22:15	Water Electrolysis for Hydrogen	Zhifeng Ren	
	22:15-23:00	Materials for ‘Epidermal’ VR/AR Technologies	John A. Rogers	

August 31 (Beijing Time)

Section	Time	Title	Speaker	Chair
D	9:15-9:45	Lead-Free Composite Piezo-Ultrasound Induced Energy Harvesting for Biomedical Applications	Qifa Zhou	Qifa Zhou Yadong Yin
	9:45-10:30	Recent progress of organic and perovskite PV at UCLA	Yang Yang	
	10:30-11:15	Plasmonic Nanostructures for Photothermal Conversion	Yadong Yin	
	11:15-12:00	Charge Transport and Structure in Polarizable Soft Materials	Erik Luijten	
Break				
E	14:00-14:45	Polymers for photovoltaic applications - challenges and chances for energy harvesting	Peter Müller-Buschbaum	Wojciech Lipiński
	14:45-15:30	Electron Transport through Dynamic Semiconductor Junctions	Qing Zhang	
	15:30-16:15	Multiscale Nanomaterials for Sensors and Energy Applications	Il-Doo Kim	
	16:15-17:00	Relaxed InGaN templates for all-nitride RGB nano/microLEDs	Lars Samuelson	
Break				
F	19:15-20:00	Metal-Organic Framework Glasses for Energy, Luminescence, and Membrane Technology	Yuanzheng Yue	Qing Zhang
	20:00-20:45	Peptide and Metabolite Assemblies as Novel Materials	Ehud Gazit	
	20:45-21:30	Piezoelectric materials and composites for in vivo biomechanical energy harvesting and utilization	Xudong Wang	
	21:30-22:15	New Materials for 3D Ferroelectric Microelectronics	Susan Trolier-McKinstry	
	22:15-23:00	Conductive Bacterial Nanowires: Fundamentals and Applications for Environment, Energy and Bioelectronics	Jun Yang	



Speaker and Abstract

(In the order of presentation)

Zhong Lin Wang

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Piezotronics and Piezo-phototronics of the Third Generation Semiconductors

Abstract

Piezoelectricity, a phenomenon known for centuries, is an effect that is about the production of electrical potential in a substance as the pressure on it changes. For wurtzite structures such as ZnO, GaN, InN and ZnS, due to the polarization of ions in a crystal that has non-central symmetry, a piezoelectric potential (piezopotential) is created in the crystal by applying a stress. The effect of piezopotential to the transport behavior of charge carriers is significant due to their multiple functionalities of piezoelectricity, semiconductor and photon excitation. By utilizing the advantages offered by these properties, a few new fields have been created. Electronics fabricated by using inner-crystal piezopotential as a "gate" voltage to tune/control the charge transport behavior is named piezotronics, with applications in strain/force/pressure triggered/controlled electronic devices, sensors and logic units. This effect was also extended to 2D materials such as MoS_2. The objective of this talk is to introduce the fundamentals of piezotronics and their application for robotics and human-machine interfacing.

Biography

Zhong Lin Wang is the Director of the Beijing Institute of Nanoenergy and Nanosystems, Director of the Institute of CUSPEA Technology (Wenzhou), and Hightower Chair at the Georgia Institute of Technology. Dr. Wang has received 2019 Albert Einstein World Award of Science, 2019 Diels-Planck lecture award, 2018 ENI award in Energy Frontiers (the "Nobel prize" for energy), 2015 Thomas Router Citation Laureate, 2011 MRS Medal from Materials Research Soci., et al. Dr. Wang was elected as a foreign member of the Chinese Academy of Sciences, member of European Academy of Sciences, and international fellow of Canadian Academy of Engineering. He is the founding and chief editor of an international journal Nano Energy, which now has an impact factor of 17.88. Dr. Wang pioneered the nanogenerators field for distributed energy, self-powered sensors, and large-scale blue energy. He coined the fields of piezotronics and piezophototronics for third-generation semiconductors. His Google scholar citation is over 290 000 with an *h* index of 261. Among 100 000 scientists across all fields worldwide, he is ranked #5 in the entire career scientific impact and #1 in 2019.

Seung-Wuk Lee

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Bioelectricity from Viruses

Abstract

The electrical properties of inorganic and organic materials have been well-established for several decades. However, our understanding of the electrical properties in biological materials is still elusive, although the first electrostatic force interactions were discovered from naturally originated biomaterials (i.e., ambers, wools, and straws). In my presentation, I will show our approach to produce virus-based electric energy generation. We exploit bacterial virus (M13 phage) as a programmable biomaterial to create precisely defined chemical and physical structures and characterize their mechanical force-induced piezoelectric and triboelectric properties. We genetically engineer one- to four-glutamate fused on the N-terminal of the major coat proteins of M13 phage and create a monolayer and multi-layer of the phage films. We then study their mechanical contact-induced electric potential generation. Upon contact with Ti/Pt coated atomic force microscopy tip, the phages can generate charges in a range of 2-4 $\mu C/m^2$. Using Kelvin probe force microscopy, we observe that more negatively charged phages can generate higher electric potential and diffuse the charges faster than that of less negatively charged phages. We also demonstrate that the phage electric nanogenerators can produce ~76 V of voltage and ~5.1 μA of current, enough to power 30 light-emitting diode devices upon an application of mechanical forces. Our electric characterization of viral particles can be useful to harvest ubiquitous mechanical vibrational energy from environment and can provide a novel modality to detect desired viruses in the future.

Biography

Professor Lee earned his B.S and M.S. from Korea University (Seoul) and his Ph.D. from the University of Texas at Austin (2003). After a postdoctoral fellowship at Lawrence Berkeley National Lab, he joined a faculty position at UC Berkeley in 2006, was promoted to Associate Professor (2011) with tenure, a full professor (2015). He is also a Faculty Scientist, LBNL Physical Bioscience Division. The Lee group uses chemical and biological approaches to create precisely defined nanomaterials, to investigate complex phenomena at their interfaces, and to develop novel, biomimetic, functional materials. Among other awards, Professor Lee is R&D 100 Award (2013 & 2015) and an NSF CAREER awardee. He is a fellow at American Institute for Medical and Biological Engineering. Dr. Lee's on going research was chosen as one of 12 highlight researches chosen by the President Obama's National Science Foundation Report for the US Congress entitled "Manufacturing Goes Viral" (2014) and chosen as one of top five Future Nanomanufacturings by *Scientific American* (2013).

Wojciech Lipiński

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Solar Fuel Production via Thermochemical Redox Cycles

Abstract

High-flux solar irradiation obtained with optical concentrators is an excellent source of clean process heat for high-temperature physical and chemical processing. The area of solar thermochemistry aims at direct thermochemical production of chemical fuels and advanced thermochemical processing of materials. Cheap and efficient solar production of synthesis gas (syngas), the precursor to synthetic drop-in hydrocarbon fuels such as petrol, diesel and kerosene, is an intriguing approach to transform today's fossil-based to tomorrow's renewable-based transportation sector. In the most ambitious scenario, synthesis gas is obtained from sunlight, water and recycled carbon dioxide. Solar-driven thermochemical redox cycles have been demonstrated as a promising approach to water and carbon dioxide splitting. While direct on-sun high-temperature reduction of metal oxides has been carried out with numerous metal oxides, the process conditions become less challenging when solar-driven carbothermal reduction is employed. We have investigated ceria-based and ceria-doped mixed metal oxide partial methane oxidation coupled to redox cycling for enhanced syngas production, materials stability and system scalability. Intriguing interplay effects were found to improve structural and catalytic properties in ceria-containing compositions.

Biography

Wojciech Lipiński obtained his Master of Science degree in environmental engineering from Warsaw University of Technology (2000), doctorate in mechanical and process engineering from ETH Zurich (2004), and habilitation in energy technology from ETH Zurich (2009). He has published over 170 articles in refereed journals and conference proceedings. He is serving on editorial boards of Journal of Quantitative Spectroscopy and Radiative Transfer, Computational Thermal Sciences, and Solar Energy. Dr Lipiński's contributions to research and education have been recognised with several honours and awards including the the Elsevier/JQSRT Raymond Viskanta Award in Radiative Transfer (2013), the Future Fellowship by the Australian Research Council (2014), and the Yellot Award by the American Society of Mechanical Engineers (2020). He is Fellow of the American Society of Mechanical Engineers (2021).

Paul S. Weiss

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Atomically Precise Chemical, Physical, Electronic, and Spin Contacts and Interfaces

Abstract

Two seemingly conflicting trends in nanoscience and nanotechnology are our increasing ability to reach the limits of atomically precise structures and our growing understanding of the importance of heterogeneity in the structure and function of molecules and nanoscale assemblies. By having developed the "eyes" to see, to record spectra, and to measure function at the nanoscale, we have been able to fabricate structures with precision as well as to understand the important and intrinsic heterogeneity of function found in these assemblies. The physical, electronic, mechanical, and chemical connections that materials make to one another and to the outside world are critical. Just as the properties and applications of conventional semiconductor devices depend on these contacts, so do nanomaterials, many nanoscale measurements, and devices of the future. We discuss the important roles that these contacts can play in preserving key transport and other properties. Initial nanoscale connections and measurements guide the path to future opportunities and challenges ahead. Band alignment and minimally disruptive connections are both targets and can be characterized in both experiment and theory. Chiral assemblies can control the spin properties and thus transport at interfaces. I discuss our initial forays into these areas in a number of materials systems.

Biography

Paul S. Weiss holds a UC Presidential Chair and is a distinguished professor of chemistry & biochemistry, bioengineering, and materials science & engineering at UCLA, where he was previously director of the California NanoSystems Institute. He studies the ultimate limits of miniaturization, developing and applying new tools and methods for atomic-resolution and spectroscopic imaging and patterning of chemical functionality. He and his group apply these advances in other areas including neuroscience, microbiome studies, tissue engineering, and high-throughput gene editing. He led, coauthored, and published the technology roadmaps for the BRAIN Initiative and the U.S. Microbiome Initiative. He has won a number of awards in science, engineering, teaching, publishing, and communications. He is a fellow of the American Academy of Arts and Sciences, AAAS, ACS, AIMBE, APS, AVS, Canadian Academy of Engineering, IEEE, MRS, and an honorary fellow of the Chinese Chemical Society and Chemical Research Society of India. He is the founding and current editor-in-chief of *ACS Nano*.

Tom Wu

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Hybrid Perovskites: Emerging Light-Responsive Semiconductors

Abstract

As an emerging class of light-responsive semiconductors, hybrid organo-metal perovskites seamlessly marry the characteristics of organic and inorganic materials. Perovskites have been on the radar screen of material scientists for over a century, before the reign of silicon, but only a decade ago they started receiving a strong wave of renewed interests thanks to their extraordinary photovoltaic performance. The hybrid nature of organo-metal perovskites leads to a unique combination of physical properties such as superior visible light absorption, decent charge transport, defect tolerance, solution processing, and even ferroelectric-like polarization. In this talk, I will share our view on the opportunities and challenges of hybrid perovskites and their heterostructures. One challenge confronting perovskites is their modest charge mobility, which is often two or three orders of magnitude lower than common semiconductors like polycrystalline silicon. I will review various strategies towards enhancing the device performance of hybrid perovskites via coupling with low-dimensional materials. We found that combining 3D hybrid perovskites with 1D carbon nanotubes or 2D two-dimensional metal dichalcogenides significantly enhances charge transport and device performance. I will also discuss perovskite-based opto-iontronics, such as nonvolatile photo-memories, which is a new research thrust leveraging on the highly correlated electrons, ions, and photons in hybrid organo-metal halide perovskites.

Biography

Dr. Tom Wu received his B.S. degree from Zhejiang University and Ph.D. degree from the University of Maryland, College Park. Before joining University of New South Wales (UNSW) in Sydney as a full professor, he worked as postdoc in Argonne National Laboratory in Chicago, assistant professor in Nanyang Technological University (NTU) Singapore, and associate professor in King Abdullah University of Science and Technology (KAUST). Dr. Wu has authored over 300 peer-reviewed papers with over 21,000 citations and a H-index of 81 (Google Scholar) in the areas of oxide thin films, nanomaterials, and hybrid perovskites, with a focus on their electronic, magnetic, and optical functionalities. He is among the 2019 and 2020 Clarivate Analytics List of Highly Cited Researchers. He also serves as an Associate Editor for ACS Applied Materials & Interfaces.

Jianhua Hao

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Thermal-assisted electrochemical fluoride-free synthesis and characterization of MXenes

Abstract

2D transition metal carbides and nitrides known as MXenes have become an important family of nanomaterials, which exhibit versatile properties leading to numerous promising applications. Unfortunately, MXenes are commonly synthesized by selective chemical etching of A elements such as Al from the layered MAX materials using hazardous hydrofluoric acid reagent. Therefore, it is of significance to explore a HF-free route for MXenes synthesis. We have developed electrochemical etching (E-etching) method. Taking advantage of the highly controllable and selective thermal-assisted E-etching process, we have prepared and characterized the MXene nanosheets with specific structures and surface groups. As a much safer and milder method than the conventional HF-etching, the E-etching method with diluted HCl is developed to prepare MXene (Ti_2CT_x), whose structural and surface properties changed with various Eetching conditions. This method has been successfully extended to produce novel MXenes (e.g., V_2CT_x and Cr_2CT_x), showing promises for MXene preparation. Our research paves a non-toxic and HF free route to prepare various MXenes and demonstrates sustainable energy and biochemical sensing applications of the materials. This work is fully supported by the grant from Research Grants Council of Hong Kong GRF (15301020).

Biography

Jianhua Hao is currently Chair Professor of Materials Physics and Devices in the Hong Kong Polytechnic University (PolyU). Jianhua Hao has published more than 300 SCI papers, including the recently published high-impact journal papers as corresponding author in *Nature Materials, Nature Commun., Adv. Mater., JACS, Angew. Chem. Int. Ed., Chem. Soc. Rev., Adv. Energy Mater., Nano Energy, ACS Nano, Adv. Funct. Mater., and Nano Lett.*. Prof. Hao has received "Natural Science Award by the Ministry of Education", “TechConnect Global Innovation Award”, “Special Merit Award and Gold Medal of Geneva”, and President’s Award in PolyU. He serves as an Associate Editor of *InfoMat* (Wiley). He is selected as Hong Kong RGC Senior Research Fellow, Chang Jiang Scholar Chair Professor. He is elected as Fellow of the Optical Society (OSA Fellow), Fellow of Royal Society of Chemistry (FRSC), and Fellow of Institute of Physics (FInstP).

Chi Zhang

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Tribotronics for Active Mechanosensation and Self-Powered Microsystems

Abstract

Tribotronics has attracted great attentions as a new research field about the control and tuning of semiconductor transport by triboelectricity. Here, the tribotronics is firstly reviewed for active mechanosensation and human-machine interfacing. As the fundamental component, contact electrification field-effect transistor is analyzed, in which the triboelectric potential could be used to control the electrical transport in semiconductors. On the basis, several tribotronic functional devices have been developed including tribotronic smart skin, tactile sensing array and tuning diode, which has demonstrated triboelectricity-controlled electronics and established the active mechanosensation for external environment. In addition, the triboelectric power management strategy is also reviewed, in which the triboelectricity can be managed by electronics in reverse action. With the implantation of triboelectric power management module, the harvested triboelectricity by various kinds of human kinetic and environmental mechanical energy could be effectively managed as a power source for self-powered microsystems. By the research prospects for interactions between triboelectricity and semiconductor, tribotronics is expected for significant impacts and potential applications in MEMS/NEMS, flexible electronics, robotics, wireless sensor network, and Internet of Things.

Biography

Prof. Chi Zhang received his Ph.D. degree from Tsinghua University in 2009. After graduation, he worked in Tsinghua University as a postdoc research fellow and NSK Ltd., Japan as a visiting scholar. He now is the principal investigator of Tribotronics Group in Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Sciences (CAS). Prof. Chi Zhang's research interests are triboelectric nanogenerator, tribotronics, self-powered MEMS/NEMS, and applications in sensor networks, human-computer interaction and new energy technology. He has been awarded by National Natural Science Foundation of China for Excellent Young Scientist Award, and also granted by Beijing Municipal Science & Technology Commission, Beijing Natural Science Foundation, China Postdoctoral Science Foundation, and CAS. He has published over 130 papers and attained 40 patents.

Jiangyu Li

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Materials under the tip: Quantitative Imaging of Localized Functionalities at the Nanoscale

Abstract

In the last two decades, nanostructured materials have revolutionized information technology, energy systems, and medicines. With the advances in microscopy and analytical tools, we can now image compositions, phases, and structures with atomic and sub-atomic resolution. The length scales upon which physical properties can be quantitatively measured, however, largely lag behind, making it difficult to directly connect compositions, structures and properties of nanostructured materials and systems. In this talk, I will briefly review our efforts using scanning probe microscopy to address this challenge in the past a few years, with particular emphasis on mechanistic understanding regarding competing microscopic mechanisms and data analytic approaches with machine learning and artificial intelligence. Cases studies on resistive switching in ferroelectrics, polar order in organic-inorganic solar cells, and low-dimensional heat conduction in nanostructured thermoelectrics will be given, and future challenges and opportunities will be highlighted.

Biography

Jiangyu Li joins Southern University of Science and Technology in 2020, and serves as the Chair in the Department of Materials and Science and Engineering. Prior that, he was a Research Scientist at Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, and a Professor in the Department of Mechanical Engineering, University of Washington. He obtained his B.E. degree in 1994 from the Department of Materials Science and Engineering, Tsinghua University, and Ph.D. degree in 1998 from the Department of Mechanical Engineering, University of Colorado-Boulder. Li works in the general field of mechanics and physics of materials, focusing on advanced scanning probe microscopy and its applications in functional materials. He has published over 200 journal articles, and has been recognized by Sia Nemat-Nasser Medal from ASEM, Young Investigator Award from ICCES, and Microscopy Today Innovation Award from Microscopy Society of America. He currently serves as Associate Editor for Journal of Applied Physics and Science Bulletin.

Hui-Ming Cheng

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Six-Membered-Ring Inorganic Materials: Definition and Prospects

Abstract

The six-membered ring (SMR) is a common structure unit for numerous material systems. Such materials include, but are not limited to, two-dimensional materials (graphene, h-BN, and transition metal dichalcogenides), and three-dimensional beryllium and magnesium, MgB2, and Bi2Se3. Although many of these materials have already become “stars” in materials science and condensed-matter physics, little attention has been paid to the roles of the SMR unit across a wide range of compositions and structures. In this presentation, we analyze these materials with respect to their very basic SMR structural unit, which has been found to play a deterministic role in the occurrence of many intriguing properties and phenomena. As a result, we have defined this group of materials as six-membered-ring inorganic materials, which opens a new perspective on materials research and development. SMR materials deserve wide attention and in-depth investigation from materials design, new physical discoveries to target-wizard applications. It is expected that SMR materials will find niche applications in next-generation information technology, renewable energy, space, and other important fields.

Biography

Prof. Hui-Ming Cheng is a Professor and the founding director of the Advanced Carbon Research Division of Shenyang National Laboratory for Materials Science, IMR CAS since 2001, and the Institute of Technology for Carbon Neutrality, Shenzhen Institute of Advanced Technology, CAS, since 2021. He is a member of Chinese Academy of Sciences and a fellow of TWAS. His research activities focus on carbon nanotubes, graphene, other 2D materials, energy storage materials, photocatalytic materials, and bulk carbon materials. He has published over 750 papers with a WoS h-index of 139, and is a Highly Cited Researcher in both chemistry and materials science fields. He has given over 190 plenary/keynote/invited lectures at various conferences, and won two State Natural Science Award of China in 2006 and 2017, Charles E. Pettinos Award from American Carbon Society, Felcht Award from SGL, Germany, and ACS Nano Lecture Award. He now is the founding Editor-in-Chief of Energy Storage Materials and Associate Editor of Science China Materials.

Xueliang (Andy) Sun

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All Solid-State Batteries: from Interface Design to New Solid-State Electrolytes

Abstract

In this talk, I will talk about two types of solid-state electrolytes including sulfide-based electrolyte (focusing on interface) and halide-based electrolytes (focusing on synthesis). In the first part of this talk, I will demonstrate to apply ALD/MLD for interface design between sulfide-based electrolyte and cathode material. Compared with polymer-based and oxide-based electrolytes, sulfide-based electrolyte generally exhibits the highest ionic conductivity (10^{-3} ~ 10^{-2} S/cm) and favorable mechanical property. However, the serious interfacial challenge, bad air stability, narrow electrochemical windows of sulfide-based electrolyte significantly impede development of sulfide-based ASSLBs. Atomic layer deposition (ALD) and molecular layer deposition (MLD) are unique coating techniques that can realize excellent coverage and conformal deposition with precisely controllable at the nanoscale level due to its self-limiting nature, which are ideal for addressing the challenges of interface in SSLBs. In the second part of this talk, I will talk about halide-based electrolyte for ASSLBs. Compared with sulfide-based electrolyte, both experimental and theoretical results recently demonstrate that halide-based electrolytes have more advantages including high RT ionic conductivity (>10^{-3} S cm^{-1}, theoretically possible 10^{-2} S cm^{-1}), wide electrochemically stable window (possible up to 6 V), high air-stability, good stability toward oxide cathode materials, and even salable water synthesis strategy.

Biography

Dr. Andy (Xueliang) Sun is a Full Professor and senior Canada Research Chair (Tier I) at the University of Western Ontario, Canada. Dr. Sun is a Fellow of Royal Society of Canada and Fellow of the Canadian Academy of Engineering. Dr. Sun's research is focused on advanced materials for energy conversion and storage including Li batteries and fuel cells. Dr. Sun is an author and co-author of over 550 refereed-journals with H-index of 100 and citations of over 38,000 times. Dr. Sun is a **highly cited researcher**. Dr. Sun received various awards such as Award for Research Excellence in Materials Chemistry Winner from Canada Chemistry Society (2018), Award of Merit of the Federation of Chinese Canadian Professionals (2018), and Western Hellmuth Prizes (2019). Dr. Sun is a Vice Chairman of the International Academy of Electrochemical Energy Science (IAOEES). He also serves as an Editor-in-Chief of "Electrochemical Energy Review" under Spring-Nature.

Hua Zhang

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Phase Engineering of Nanomaterials (PEN)

Abstract

In this talk, I will summarize the recent research on phase engineering of nanomaterials (PEN) in my group, particularly focusing on the rational design and synthesis of novel nanomaterials with unconventional phases for various promising applications. For example, by using wet-chemical methods, for the first time, we have successfully prepared novel Au nanostructures (*e.g.*, the hexagonal-close packed (*hcp*) 2H-Au nanosheets, 4H-Au nanoribbons, and crystal-phase heterostructured 4H/*fcc* and *fcc*/2H/*fcc* heterophase Au nanorods), epitaxially grown metal nanostructures on the aforementioned unconventional Au nanostructures and 2H-Pd nanoparticles, and amorphous/crystalline heterophase Pd and PdCu nanosheets. In addition, by using gas-solid reactions, metastable 1T'-phase group VI transition metal dichalcogenides (TMDs), *e.g.*, WS_2, WSe_2, MoS_2, $MoSe_2$, $WS_{2x}Se_{2(1-x)}$ and $MoS_{2x}Se_{2(1-x)}$, have been prepared. Moreover, the phase transformation of TMDs during our developed electrochemical Li-intercalation process has also be observed. Impressively, the lithiation-induced amorphization of $Pd_3P_2S_8$ has been achieved. Importantly, the concepts of phase engineering of nanomaterials (PEN), crystal-phase heterostructures, and heterophase nanomaterials are proposed.

Biography

Hua Zhang is the Herman Hu Chair Professor of Nanomaterials in Department of Chemistry, City University of Hong Kong. He received his PhD in 1998 in Peking University. In 2006-2009, he worked as assistant/associate/full professor in Nanyang Technological University. His current research interests focus on phase engineering of nanomaterials (PEN), 2D nanomaterials, nanomaterials with unconventional phases and amorphous phase, and epitaxial growth of heterostructures for applications in catalysis, clean energy, and (opto-)electronic devices. He was elected as a Foreign Fellow of the European Academy of Sciences (EurASc), Academician of the Asia Pacific Academy of Materials and Fellow of the Royal Society of Chemistry. His numerous awards and honors include "Highly Cited Researchers" in Chemistry and Materials Science in 2015-2020 and in Materials Science in 2014, one of 19 “Hottest Researchers of Today” in the world in 2015 and one of 17 “Hottest Researchers of Today” and No. 1 in Materials and More in the world in 2014 (Clarivate Analytics/Thomson Reuters. He has published more than 520 papers with, the citations >90,000 and H-index=148 (Web of Science), and the citations >104,000 and H-index=157 (Google Scholar).

Zhifeng Ren

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Water Electrolysis for Hydrogen

Abstract

Hydrogen gas (H_2) has a very high energy density and is also very environmentally friendly when it is used a fuel because the byproduct is the purest water, but the current way to commercially produce H_2 using fossil fuels mainly from gas reforming and coal gasification is not sustainable due to the release of a vast amount of CO_2 to the atmosphere. Water electrolysis using the over supplied grid power during the off peak hours is not only clean but also economical if high performance catalysts for both the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) can be made in large scale at a low price. In this talk I will present our effort on discovering viable highly efficient catalysts for water splitting, especially seawater splitting due to the abundance supply of seawater than the fresh water.

Biography

Zhifeng Ren is an M. D. Anderson Chair Professor of Department of Physics and the Director of the Texas Center for Superconductivity at the University of Houston (TcSUH). He received his BS in 1984 from Xihua University, MS in 1987 from Huazhong University of Science and Technology, and PhD in 1990 from the Institute of Physics, Chinese Academy of Sciences. His research focuses on thermoelectrics with high ZT, boron arsenide single crystals for high thermal conductivity, enhanced oil recovery, water splitting for H_2 generation, heated filters for catching and killing SARS-CoV-2 causing COVID-19 pandemic, carbon nanotubes, solar absorbers, flexible transparent conductors, superconductors, *etc*.

John A. Rogers

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Materials for 'Epidermal' VR/AR Technologies

Abstract

Advanced, immersive systems for virtual and augmented reality (VR/AR) promise to transform the way that we interact with computer-generated environments and, by extension, with one another. Although audio-visual aspects of VR/AR hardware are increasingly well developed, a frontier, underexplored opportunity for materials science and engineering is in the development of interfaces that add spatio-temporally controlled physical sensations to the VR/AR experience, with the skin as the input interface. This talk introduces a collection of foundational ideas in materials science and electrical engineering that enable a unique, new class of technology for this purpose – thin, soft, lightweight sheets that embed wirelessly controlled arrays of millimeter-scale mechanical actuators, capable of gently laminating onto the skin at nearly any region of the body. These systems qualitatively expand the VR/AR interface through complex patterns of physical sensory inputs, time-coordinated with visual and auditory cues.

Biography

John A. Rogers is the Simpson/Querrey Professor of Materials Science and Engineering, Biomedical Engineering and Medicine at Northwestern University, where he is also Director of the Institute for Bioelectronics. He has published more than 750 papers. he is a co-inventor on more than 100 patents and he has co-founded several successful technology companies. His research has been recognized by many awards, including a MacArthur Fellowship (2009), the Lemelson-MIT Prize (2011), the MRS Medal (2018) and the Benjamin Franklin Medal (2019). He is a member of the National Academy of Engineering, the National Academy of Sciences, the National Academy of Medicine, and the American Academy of Arts and Sciences.

Qifa Zhou

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Lead-Free Composite Piezo-Ultrasound Induced Energy Harvesting for Biomedical Applications

Abstract

Acoustic-induced energy transfer (AET) represents an emerging technology that can be integrated into implantable medical systems for wirelessly powering and signal communication. However, most devices are made of toxic lead-based piezoelectric materials. Thus, it is vital to develop lead-free alternatives with satisfactory performance. This study presents the development of a new Fe_2O_3-added (K,Na)(Nb,Sb)O_3-(Bi,Na)ZrO_3 (F-KNN) lead-free ceramic-based piezo-composite (e.g., $k_{33} \approx 0.65$, $g_{33} \approx 40.1$ V·m/N×10^{-3}) and its application on bio-implantable devices. Compared to the traditional piezo-ultrasound systems with the limited portability, we developed a novel design and implementation of an ultrasound-induced energy transfer strategy for 3D twining wireless-powering implants, which shows transmission capability with high power, and flexible directivity. This new ultrasonic system exploits a focused ring piezo-transducer as the external acoustic source and a F-KNN-based lead-free linear piezo-array as the harvester. Under the FDA regulation, the ultrasoud-induced stable powering (~ 21.3 mW·cm^{-2}) was demonstrated ex vivo under 12-mm porcine tissue. The 3D twining design also ensures the device achieving stable energy harvesting without operational difficulties, a unique advantage to facilitate its future clinical applications.

Biography

Qifa Zhou received his Ph.D. degree from the Department of Electronic Engineering at Xi'an Jiaotong University. He is currently a professor of Biomedical Engineering and Ophthalmology at the University of Southern California. Dr. Zhou is a fellow of the Institute of Electrical and Electronics Engineers (IEEE), the International Society for Optics and Photonics (SPIE), and the American Institute for Medical and Biological Engineering (AIMBE). He has published more than 290 peer-reviewed articles in journals including Nature Medicine, Nature Biomedical Engineering, Nature Communication and Science Advances. His research focuses on the development of piezoelectric composites and piezoelectric single crystal for high-frequency ultrasonic elastography, stimulation on ocular tissue, intravascular and photoacoustic/OCT imaging as well as energy harvesting on biomedical applications.

Yang Yang

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Recent progress of organic and perovskite PV at UCLA

Abstract

In this presentation, I will firstly introduce the basic principle of photovoltaic (PV) materials and devices. Once the fundamental aspects have been laid out, I will follow with a detail discussion of organic photovoltaics (OPV) and perovskite (PVSK) PV technologies. I will summarize our work beginning in 2008 on the design and synthesis of near-infrared polymer donors/non-fullerene acceptors. Especially, we highlight our work on the first report on the near-infrared acceptor Y1, which pioneered the future development and usage of acceptors belonging to the Y1 family (or series). Being solution-processed at relatively low temperatures, it is inevitable that crystallographic defects are formed in abundance during fabrication. Such defects may cause undesirable energy losses by non-radiative recombination to limit the performance of PSCs. More importantly, it has become apparent that defect activity is fundamentally responsible for the operational instability issues hindering the commercialization readiness of PSCs. Here, the strategies and the in-depth mechanisms of preventing the formation of specific detrimental defects accumulated at grain boundaries or the surface will be reported, including by designing various passivation molecules with certain functional groups, such as carbonyl groups, amine groups, or sulfonic groups. I will also discuss our discovery on reconfiguring the band-edge states of photovoltaic perovskites by conjugated organic cations and the surface reconstruction behavior during post-treatments in perovskite process.

Biography

Dr. Yang received his Ph.D. in Physics and Applied Physics from the University of Massachusetts. Dr. Yang has more than 430 refereed papers; more than 30 issued patents, and more than 200 plenary, keynote, and invited talks. He has accumulated of more than 120,000 citations and his ***H-Index*** **is ~160** as May of 2021. His major research interests are in the solar energy and highly efficient electronic devices. Currently he is the Carol and Lawrence E. Tannas Jr. Endowed Chair Professor at UCLA. He has received the following honors/awards: invited to join the Advanced Materials Hall of Fame (2021); Highly Cited Researcher in three major fields: Materials Science, Chemistry, and Physics, Thomson Reuters (now Clarivate Analytics); 2019 Sustainable Energy Award. UK Royal Society of Chemistry; Highly Cited Researcher in both Materials Science and Chemistry Categories (2013-2016, & 2020).

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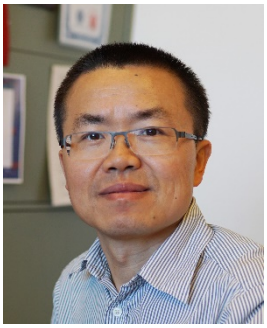

Plasmonic Nanostructures for Photothermal Conversion

Abstract

The plasmonic photothermal effect involves nonradiative conversion of light to heat by plasmonic nanostructures. It has attracted significant attention due to their widespread potential applications in developing energy conversion devices, therapeutic agents, and sensors and actuators. Here we report our recent progress on the design and preparation of plasmonic nanostructures for photothermal conversion. We first introduce the general principle of plasmonic photothermal conversion and then discuss the strategies for improving efficiency, which has been the focus of this field. We then discuss a number of typical application types, such as solar energy harvesting, steam generation, photothermal actuation, and color printing, to elucidate how to tailor the nanomaterials to meet the requirements of these specific applications. In addition to the photothermal effect, other unique physical and chemical properties can be coupled to further explore the application scenarios of plasmonic photothermal materials.

Biography

Prof. Yadong Yin received his B.S. in 1996 and M.S. in 1998 in Chemistry from the University of Science and Technology of China, and then received a Ph.D. in 2002 from the University of Washington, Seattle, by working with Prof. Younan Xia. In 2003 he became a postdoctoral fellow at the University of California, Berkeley, under the supervision of Prof. A. Paul Alivisatos, and then a staff scientist at Lawrence Berkeley National Laboratory in 2005. He joined the Department of Chemistry, University of California, Riverside in 2006, and became a Full Professor in 2014. His recent recognitions include Cottrell Scholar Award (2009), DuPont Young Professor Grant (2010), 3M Nontenured Faculty Grant (2010), NSF CAREER award (2010), NML Researcher Award (2016), and MRS Fellow (2020). Being recognized as one of the world's most highly cited researchers by Clarivate Analytics from 2014 to 2020, he is currently an associate editor of the Journal of Materials Chemistry C. Also, he serves on the editorial board of a number of journals, such as Advanced Functional Materials, Science China Materials, Research, Nano Letters, and Chemical Reviews.

Erik Luijten

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Charge Transport and Structure in Polarizable Soft Materials

Abstract

Soft materials in confined geometries, from colloidal systems to polyelectrolyte brushes, exhibit static and dynamic properties that are controlled by electrostatic interactions. Interestingly, the structure of these systems depends not only on parameters like temperature and pressure, but also can be controlled by manipulating the spatial variation in permittivity. Examples include the grafting of polymers onto metallic vs. insulating substrates and variation of the solvent in colloidal suspensions. Incorporation of the dielectric effects in theoretical and computational predictions is often intractable due to their many-body nature. I will demonstrate how this limitation can be overcome, leading to discoveries that range from the control over ionic transport in nanochannels to pattern formation in dipolar thin films. As a next step in complexity, I will then discuss the consequences of charge regulation, where the variation in polarization charges is augmented by configuration-dependent ionization states of colloids, nanoparticles, and polymers. *In toto*, these phenomena offer underexplored avenues for the design of functional materials.

Biography

Erik Luijten received degrees from Utrecht University and Delft University of Technology. Following faculty appointments in the Department of Materials Science and Engineering at the University of Illinois at Urbana-Champaign, he joined Northwestern University, with appointments in Materials Science and Engineering and Applied Mathematics. Since 2016, he serves as chair of the Department of Materials Science and Engineering. Professor Luijten's research interests encompass a wide range of topics, with an emphasis on collective behavior in complex fluids and soft condensed-matter systems. These topics are generally studied via large-scale computer simulations and innovative algorithms. Professor Luijten received the IAPWS Helmholtz Award, an NSF CAREER Award, and a Xerox Award for Faculty Research. He is a Fellow of the American Physical Society.

Peter Müller-Buschbaum

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Polymers for photovoltaic applications - challenges and chances for energy harvesting

Abstract

Next generation solar cells based on polymers are an interesting alternative to conventional silicon based solar cells as they feature new possibilities introduced by using a different class of materials. Instead of expensive ultra-high vacuum technologies, fabrication can be done in ambient conditions at room temperature, using wet chemical processing, and thereby enabling usage of fabrication methods such as roll-to-roll printing or spray coating. Consequently, the production of polymer solar cells has the potential to become very cheap and easy. Moreover, the use of polymers allows for flexible solar cells and lightweight devices, which will be usable in a very different fashion as compared to the immobile silicon solar panels. This includes mobile and off-grid photovoltaic applications. It is also worth to mention that polymer solar cells can operate under diffuse light conditions or even in-door. In addition, the energy payback times of polymer solar cells are significantly shorter as compared to the today's silicon solar cells. However, despite all these significant advantages of polymer solar cells, still fundamental knowledge is limited and needs to be improved to overcome existing challenges. For example, it is challenging to detect the complex morphologies, which are necessary to have high efficiency polymer solar cells. The combination of advanced x-ray and neutron scattering techniques (for example GISAXS, GISANS and GIWAXS) will be presented for overcoming these challenges. Other challenges are related to the device fabrication based on printing or spraying as well stability of the solar cells. Selected examples will be shown to illustrate these challenges and possibilities to overcome them and bring polymer solar cells into large-scale application.

Biography

Peter Müller-Buschbaum is full professor heading the Chair of Functional Materials at the Technical University of Munich in the Department of Physics, scientific director of the Munich neutron source FRM-II and scientific director of the Heinz Maier Leibnitz Zentrum MLZ. He is the German representative at the European Polymer Federation, Associate Editor of ACS Applied Materials & Interfaces and heading Bavarian key laboratory TUM.solar and the Network for Renewable Energies (NRG) of the Munich School of Engineering (MSE).

Qing Zhang

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Electron Transport through Dynamic Semiconductor Junctions

Abstract

In this talk, we discuss electron transport through dynamic semiconductor junctions formed with a pair of semiconducting or/and metallic electrodes which possess distinct chemical potentials. When the two electrodes are brought in contact, electrons could diffuse from the high into the low chemical potential electrode. Once the two electrodes are being separated, the diffused electrons are then discharged to the external circuit and flow back to the high chemical potential electrode, converting the mechanical power to electrical power. In addition, a direct current is generated in the direction of the built-in electric field in the dynamic p-n junction across the contacted surfaces if one electrode is slid on the other, flowing from the p-semiconductor through the external circuit to the n-semiconductor. The generated currents and voltages are studied through sliding speeds, accelerations, contacting forces, operation temperatures and the geometries of the top electrode. The direct current generation can be attributed to electron-hole pairs generated at the two sliding surfaces, which are then swept out the dynamic junction by the built-in electric field. (Acknowledg-ements: This project is financially supported by MOE AcRF Tier1 (2018-T1-005-001), MOE AcRF Tier2 (2018-T2-2-005) and A*STAR AME IRG Grant SERC A1983c0027, Singapore.)

Biography

Qing Zhang is a professor at Centre of Micro-/Nano-electronics, School of Electrical and Electronic Engineering, Nanyang Technological University (NTU), Singapore. His research interests cover nanomaterials and nano/micro-electronic devices, carbon/silicon based thin films, etc. His attention focuses on carbon nanotube and nanostructure-based devices and fundamentals, etc. He and his group members have studied functionalized carbon nanotubes for several types of sensors, logic circuits and Li-ion batteries, etc. He has published more than 260 peer-review scientific papers in the fields of electronic materials, physics and devices for data processing, sensing and energy storage and harvesting.

Il-Doo Kim

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Multiscale Nanomaterials for Sensors and Energy Applications

Abstract

Electrospun nanofibers, as the forefront of advanced fibrous materials, hold extraordinary potential applications ranging from environmental, energy to biology owing to their integrated advantages of fine diameter, extremely high aspect ratio, and ease of scalable synthesis from various materials. In invited talk, I summarize recent progress and a collection of advances, particularly focused on the synthesis, characterization, and utilization of electrospun polymeric membranes, highly porous metal oxide, and conducting carbon nanofibers. For multiscale integration of hetrostructured materials, tight anchoring of catalyst materials on porous supports is important. Several case studies will be discussed. I will end my presentation by suggesting possible future research direction and potential suitability of 3D nanofibers and 1D high density yarn for applications in outstanding colorimetric sensors, exhaled breath gas analyzing sensors for early stage disease diagnosis as well as energy storage applications. In particular, as a new power generation system, I will introduce our recent study on transpiration driven power generator, which is operated by water and/or vapors. Lastly, I highlight that rational design and robust synthesis of hierarchically assembled nanomaterials, particularly on 1D functional fiber supports can facilitate commercialization for broad applications including membrane filtering, sensors, bio/tissue engineering, and energy materials.

Biography

Prof. Il-Doo Kim received his Ph.D. degree (2002) from KAIST. From 2003 to 2005, he was a postdoctoral fellow with Prof. Harry L. Tuller at MIT. He is a chair professor at KAIST (Department of Materials Science and Engineering). The Il-Doo Kim group' research work is focused on novel synthesis of inorganic nanomaterials optimized for application in ultra-sensitive chemical sensors (exhaled breath gas analysis for disease diagnosis), highly efficient energy storage devices (Li-ion batteries), and water-driven energy harvesting system. Prof. Kim has published over 324 articles, 5 book chapters, and holds 230 international patents. Moreover, a number of patents related with nanofiber synthesis and applications have been successfully licensed to 9 companies. Prof. Kim is an Associate Editor of the ACS Nano, a member of Young Korea Academy Science and Technology (YKAST). He is a director of Membrane Innovation Center at KAIST.

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Relaxed InGaN templates for all-nitride RGB nano/microLEDs

Abstract

The large lattice mis-match between red-emitting active layers, with at least 35% indium in the QWs, and the GaN substrate still limits the efficiencies to very low values, typically <5%. We propose to use seeding techniques originally developed for nanowire growth, to seed the formation of ternary InGaN pyramids which later are converted to thin c-facet platelets of InGaN. The top-facet of each such template is on the scale of 300nm to 1.5µm, thus better described as template for nanoLEDs. These can either be used as single nanoLED for a pixel or as an array of such nanoLEDs, constituting a complete microLED pixel.

Biography

Lars Samuelson got his PhD in Physics in 1977 followed by a post-doc at IBM San José Research Centre. In 1986 he became full Professor in Semiconductor Physics at Chalmers/Göteborg University. In 1988 he returned to a Professorship in Semiconductor Electronics at the Physics Department at Lund University, at the time when he initiated the interdisciplinary research center the Nanometer Structure Consortium, later named NanoLund, today engaging more than 300 scientists. He has recently taken on a 50% position as a Distinguished Professor at Southern University of Science and Technology (SUSTech), in Shenzhen, China, acting as Director of a Research Center on Nanoscience & Nanotechnology. He became a Fellow of the Inst. of Physics (FInstP) in 2004, of the American Physical Society (APS, Materials Physics) in 2009, and in 2020 he became Fellow International of the Japanese Society for Applied Physics (JSAP). He became a Member of the Royal Swedish Academy of Sciences (Physics class) in 2006 and of the Royal Swedish Academy of Engineering Sciences in 2007. In 2008 he was appointed “Einstein Professor” by the Chinese Academy of Sciences. In 2013 he was awarded the IUVSTA Prize for Science for the Triennium 2010-2013 and in 2014, the Fred Kavli Distinguished Lectureship in Nanoscience. Lars Samuelson is the Founder and Chief Scientist of four start-up companies engaged in commercialization of the nanowire and nanomaterials technologies, in QuNano AB, GLO AB, Sol Voltaics AB and Hexagem AB. Samuelson is the author of well over 700 articles (h-index 86, Web-of-Science, listed in the top 1% highly cited researchers by Web-of-Science), and has given >300 plenary/invited talks at international conferences and workshops.

Yuanzheng Yue

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Metal-Organic Framework Glasses for Energy, Luminescence, and Membrane Technology

Abstract

Metal-organic frameworks (MOFs) are a rapidly expanding family of crystalline materials with great potential for applications in advanced technologies. In 2015, we discovered that some of MOFs can be melt-quenched to glass state. Since then, the research activities on MOF glasses have been rapidly developing and numerous breakthroughs have been made concerning their microstructure and physical properties, as well as the mechanisms of MOF melting and glass formation. Recently, we found that MOF glasses are an excellent class of functional materials for Li-ion batteries, photonic devices and gas-separation membranes. Furthermore, we have succeeded in producing large size glasses from some MOFs and this is a crucial step towards the future applications of MOF glasses. In my talk, I will first review the current understanding of the structure, dynamics and properties of these glasses. Then I will demonstrate some interesting electrochemical behavior of the first MOF glass anode that we developed for Li-ion batteries. I also show both the photonic functions and the gas-separation capability of MOF glasses. Finally, I will give my view about the future of MOF glass research and development.

Biography

Yuanzheng Yue is a Professor of Chemistry at Aalborg University (AAU), Denmark. In 1995, he received his Ph.D. degree in Materials Science at Technical University of Berlin. In 1998, he established the first inorganic glass research laboratory of Denmark. His research activities focus on glass science and technology, metal-organic framework glasses, metallic glasses, and amorphous materials for thermal insulation and energy storage. He has published over 320 peer-refereed papers in journals including Nature and Science. He has delivered 110 invited talks at international conferences. He is a council member of the International Commission on Glass (ICG), the founding chair of the ICG Technical Committee for Glass Fibers. He holds Knight's Cross of the Order of the Dannebrog in Denmark. He is Fellow of Royal Society of Chemistry and Fellow of the European Academy of Sciences.

Ehud Gazit

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Peptide and Metabolite Assemblies as Novel Materials

Abstract

We use a minimalistic, reductionist and non-biased approach in order to identify the most fundamental molecular recognition and self-assembling modules in nature. Such structures possess unique physical properties including mechanical, optical, electronic and piezoelectric ones. We established the ability of very short peptides, as short as dipeptide and tripeptide, to form ordered assemblies with piezoelectric properties comparable to inorganic materials such as lithium niobate. These peptide assemblies and especially those related to the diphenylalanine dipeptide, are being studied by numerous groups around the world. In recent years, we became more and more interested in metabolites, both as the basis for disease but also as building blocks for materials with mechanical, optical and electronic properties. Such metabolites could include amino acids, nucleobases and vitamins. Many of the properties, including piezoelectricity, that are found in short peptides could be observed also in metabolite assemblies. Intriguingly, natural systems also use metabolite to form optically-active assemblies such as *tapetum lucidum* retro-reflectors. We will also discuss our attempts to make functional bio-piezoelectric devices based on the peptide and metabolites.

Biography

Ehud Gazit FRSC FNASc OSSI is a Professor and Endowed Chair at the School of Molecular Cell Biology and Biotechnology, Faculty of Life Sciences and the Department of Materials Science and Engineering, Faculty of Engineering and a member of the Executive Council of Tel Aviv University. Gazit received his B.Sc. (*summa cum laude*) after completing his studies at the Special Program for Outstanding Students of Tel Aviv University and his Ph.D. (with highest distinction) as a Clore Fellow at the Department of Membrane Research and Biophysics, Weizmann Institute of Science in 1997. For his Ph.D. work, he received the John F. Kennedy Award. He has been a faculty member at Tel Aviv University since 2000, after completing his postdoctoral studies as a European Molecular Biology Organization (EMBO) and Human Frontiers Science Program (HFSP) fellow at Massachusetts Institute of Technology (MIT), Cambridge MA, USA where he also had held a visiting appointment (2002–2011). He also had a visiting appointment at St John's College, Cambridge University, Senior Visiting Professor appointment at Fudan University, China and a Guest Professor appointment at Umeå University, Sweden.

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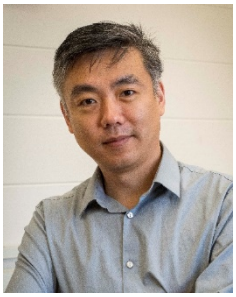

Piezoelectric materials and composites for in vivo biomechanical energy harvesting and utilization

Abstract

Nanogenerator (NG) has been considered as a promising solution to biomechanical energy harvesting inside human body. So far, many technology innovations have advanced the NG technology toward a broad range of biomedical applications. Fundamentally, materials design and engineering draw the boundary where this technology may advance. In this talk, I introduce our most recent development of piezoelectric materials and composites that are particularly designed for implantable NG applications. First, I present our wafer-scale approach to creating piezoelectric biomaterial thin films based on γ glycine crystals. The self-assembled sandwich film structure enabled both strong piezoelectricity and largely improved flexibility. Then, new ferroelectric composites are presented as a new material used in 3D printing for directly manufacturing of piezoelectric architectures with tunable piezoelectric and mechanical properties. Toward the end, novel applications of implantable piezoelectric materials are introduced, which enable the closed-loop electrostimulations for many biomedical therapeutics.

Biography

Prof. Xudong Wang is the Grainger Institute for Engineering Professor in the department of Materials Science and Engineering at University of Wisconsin – Madison, and the Energy & Sustainability thrust Leader at the Grainger Institute for Engineering. Dr. Wang received his PhD degree in Materials Science and Engineering from Georgia Tech in 2005. His current research interests include developing advanced nanomaterials and nanodevices for mechanical energy harvesting from human activities for biomedical applications; and understanding the coupling effect between piezoelectric polarization and semiconductor functionalities. He has won number of prestigious national and international awards, including PECASE, NSF CAREER Award, DARPA Young Faculty Award, etc. He has published more than 170 papers on peer-reviewed journals, including Science, Nature, Nature Energy, etc. His current h-index is 75.

Susan Trolier-McKinstry

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New Materials for 3D Ferroelectric Microelectronics

Abstract

In the last decade, there have been major changes in the families of ferroelectric materials available for integration with CMOS electronics. These new materials, including $Hf_{1-x}Zr_xO_2$, $Al_{1-x}Sc_xN$, $Al_{1-x}B_xN$ and $Zn_{1-x}Mg_xO$, offer the possibility of new functionalities. This talk will discuss the possibility of exploiting the 3rd dimension in microelectronics for functions beyond interconnects, enabling 3D ***non-von Neumann*** *computer architectures exploiting ferroelectrics for local memory, logic in memory, digital/analog computation, and neuromorphic functionality*. This approach circumvents the end of Moore's law in 2D scaling, while simultaneously overcoming the "von Neumann bottleneck" in moving instructions and data between separate logic and memory circuits. Computing accounts for 5 – 15% of worldwide energy consumption. In the U.S., data centers alone are projected to consume approximately 73 billion kWh in 2020. While recent efficiency gains in hardware have partially mitigated the rising energy consumption of computing, major gains are achievable in a paradigm shift to 3D computing systems, especially those that closely couple memory and logic. The talk will cover the relevant materials, their deposition conditions, and what is known about the wake-up, fatigue, and retention processes

Biography

Susan Trolier-McKinstry is an Evan Pugh University Professor and Steward S. Flaschen Professor of Ceramic Science and Engineering, and Professor of Electrical Engineering. Her main research interests include thin films for dielectric and piezoelectric applications. She directs both the Center for Dielectrics and Piezoelectrics and the Center for Three-Dimensional Ferroelectric Microelectronics. She is a member of the National Academy of Engineering, a fellow of the American Ceramic Society, IEEE, and the Materials Research Society, and an academician of the World Academy of Ceramics. She currently serves as an associate editor for *Applied Physics Letters*. She was 2017 President of the Materials Research Society; previously she served as president of the IEEE Ultrasonics, Ferroelectrics and Frequency Control Society, as well as Keramos.

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Conductive Bacterial Nanowires: Fundamentals and Applications for Environment, Energy and Bioelectronics

Abstract

Electron transfer is fundamental to the metabolism of biological systems. Microorganisms extract electrons by oxidizing a wide range of electron sources and transport them to electron receptors. Extracellular electron transfer takes place in dissimilatory metal-reducing bacteria (DMRB) when electron acceptors are not soluble and not accessible to intracellular enzymes. Various mechanisms of extracellular electron transfer have been reported for DMRB. Recent reports suggested that extracellular electron transfer may be facilitated by pilus-like appendages also called bacterial nanowires, because they are conductive. However, there is no evidence presented to verify electron transport along the length direction of bacterial nanowires. The mechanism of electron transport in such conductive bacterial nanowires is still not clear. Here we apply multiple nanotechnological tools to study electrical and other physical properties of such conductive bacterial nanowires. We also demonstrated the potential applications of such bacteria for energy and environmental applications. Our data establish bacterial nanowires as a viable strategy of extracellular electron transport. This function of bacterial nanowires implies many applications in environment, energy and bioelectronics.

Biography

Jun Yang is Professor in Mechanical & Materials Engineering and Biomedical Engineering, and Director of WIN 4.0 (Western's Industry 4.0 Network) at Western University (The University of Western Ontario). He is Fellow of the Canadian Academy of Engineering (FCAE). His research interests include Industrial Internet, Intelligent Manufacturing, Internet of Things, Additive Manufacturing/3D Printing, Printed Electronics, Metamaterials, MEMS, Flexible/wearable Electronics, Sensors and Actuators, Biophysics and Surface Science. He has published ~180 papers in high quality journals. He holds 28 granted/pending patents. Three of his inventions have been licensed to industries for mass production. He has given ~ 100 plenary/keynote/invited talks on conferences, symposiums and workshops. Dr. Yang was a recipient of 2009 Early Researcher Award, 2012 University's Faculty Scholar Award, 2012 and 2014 Western Innovation Funds Award, Second place, 3rd China Innovation and Entrepreneurship Competition, 2015 Xerox UAC Award, 2016 NSERC Discovery Accelerator Award and 2017, 2018, 2019 Western's Vanguard Awards and 2019 Engineering Award for Excellence in Research at Western, Significant Achievement Award, UNIDO (United Nations Industrial Development Organization) Global Science and Technology Innovation Center, 2020.