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

能源、信息与材料国际会议（线上）

HAND BOOK

会议手册

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

能源、信息与材料国际会议　（线上）

ORGANIZATIONS

SPONSORS:

Xidian University

ORGANIZERS:

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.

“International Conference on Advanced Materials for Energy and Information Technology (Online)" will be held on August 29-30, 2020. Because of covid-19, an online conference will be provided as an international exchange platform. This conference is initiated by Yue Hao, Zhonglin Wang, Paul S. Weiss, and Lars Samuelson. AMEIT 2020 is sponsored by Xidian University, 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.

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Alphabetic order of last name

Agenda, August 29, 2020 (Beijing time)

Section	Time	Title	Speaker
A	9:20-9:30	Opening speech	Prof. Guangming Shi
	9:30-10:15	Harvesting Water Energy by Triboelectric nanogenerators–from Rain Droplet to Ocean Wave	Prof. Zhonglin Wang
	10:15-11:00	Reinventing Batteries Through Materials Design and New Tools	Prof. Yi Cui
	11:00-11:30	Tribotronics for Active Mechanosensation and Self-Powered Microsystems	Prof. Chi Zhang
Rest			
B	14:00-14:30	Recent Progress on Biodegradable Zinc-based Alloys for Cardiovascular Stents	Prof. Luning Wang
	14:30-15:15	Peptide and metabolite nanotechnology	Prof. Ehud Gazit
	15:15-16:00	Biomimetic Eye with Hemispherical Nanowire Array Retina	Prof. Zhiyong Fan
	16:00-16:30	The triboelectricity of the human body: energy harvesting, motion sensing and signal transmitting	Prof. Renyun Zhang
	16:30-17:00	Rational Design of Plasmonic Nanohybrids for Photocatalytic Synthesis	Prof. Jianming Zhang
	17:00-17:30	TENG based pressure sensor for continuous measurement of human arterial pulse wave	Prof. Jin Yang
Rest			
C	20:30-21:00	From nanotech to living sensors: biological spins as transducers of quantum information	Prof. Clarice D. Aiello
	21:00-21:45	Regulation of stem cell fate by naostructure mediated physical signals	Prof. Hong Liu
	21:45-22:30	Advanced Materials for Rechargeable Zinc-Air Battery	Prof. Zhongwei Chen

Agenda, August 30, 2020 (Beijing time)

Section	Time	Title	Speaker
D	9:30-10:15	2D Carbides and Nitrides (MXenes) for Energy Storage and Electronics	Prof. Yury Gogotsi
	10:15-11:00	Triboelectrification for Energy Harvesting, Delivery and Tribotronics	Prof. Sang-Woo Kim
	11:00-11:30	Simultaneous Energy Harvesting and Signal Sensing From a Single Triboelectric Nanogenerator for Intelligent Self-Powered Wireless Sensing Systems	Prof. Hua Yu
Rest			
E	14:00-14:30	Multimodal, multilayered soft electronics in advanced devices for cardiac surgery	Dr. Mengdi Han
	14:30-15:00	Enhancing the thermoelectric performance of chalcogenides via twin engineering and nanocompositing	Prof. Guang Han
	15:00-15:30	Semiconductor Nanowires for Optoelectronics Applications	Prof. Chennupati Jagadish
	15:30-16:15	Piezophotonic and piezo-phototronic effects from hybrid and layered structures for novel optoelectronic applications	Prof. Jianhua Hao
	16:15-17:00	A multifunctional electronic skin with advanced self-healing capabilities	Prof. Hossam Haick
	17:00-17:30	Hybridized and Coupled Nanogenerators	Prof. Ya Yang
Rest			
F	19:45-20:30	Polymer-based Nanomaterials for Energy Harvesting	Prof. Sohini Kar-Narayan
	20:30-21:00	Epitaxial Self-Assembly on Silicon: Nanopatterns with a Twist	Prof. Jillian M. Buriak
	21:00-21:45	One Dimensional Nanomaterials for Emerging Energy Storage	Prof. Liqiang Mai
	21:45-22:30	Microscale Light Emitting Diodes – From Neural Interfaces to Flexible Displays	Prof. John A. Rogers
	22:30-23:00	Piezoelectric nanotransducers	Prof. Christian Facolni

Time in different regions

	Beijing Time	London Time	New York Time
August 29, 2020	09:20-11:30	02:20-04:30	August 28 21:20-23:30
	14:00-17:30	07:00-10:30	02:00-05:30
	20:30-22:30	13:30-15:30	08:30-10:30
August 30, 2020	09:30-11:30	02:30-04:30	August 29 21:30-23:30
	14:00-17:30	07:00-10:30	02:00-05:30
	19:45-23:00	12:45-16:00	07:45-11:00

Speakers Abstracts

Zhonglin Wang

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Harvesting Water Energy by Triboelectric nanogenerators–from Rain Droplet to Ocean Wave

Abstract

Water covers more than 70% of earth's surface, but harvesting water related energy in our living environment has a rather low efficiency. The traditional electromagnetic generator (EMG) is most effective for high speed flowing water, and it is not effective for harvesting low-frequency, random direction and variable amplitude water wave energy. The triboelectric nanogenerator (TENG) invented by our group is a unique for harvesting such low-quality water energy. TENG is the applications of Maxwell's displacement current in energy and sensors. TENGs have three major application fields: micro/nano-power source, self-powered sensors and blue energy. In this presentation, we will present the applications of TENGs for harvesting water related energy, from tiny rain droplet to ocean wave. We will cover not only the fundamental science of triboelectric nanogenerators, but also will focus on the technology innovation and perspective future applications.

Biography

Prof. Zhonglin Wang is a pioneer and world leader in nanoscience and nanotechnology for his outstanding creativity and productivity. He has made innovative contributions to the synthesis, discovery, characterization and understanding of fundamental physical properties of oxide nanobelts and nanowires, as well as applications of nanowires in energy sciences, electronics, optoelectronics and biological science. His discovery and breakthroughs in developing nanogenerators establish the principle and technological road map for harvesting mechanical energy from environment and biological systems.

John A. Rogers

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Microscale Light Emitting Diodes – From Neural Interfaces to Flexible Displays

Abstract

Recent advances in materials science, optical engineering and manufacturing methods establish the foundations for technologies that embed large, addressable arrays of microscale inorganic light emitting diodes on unusual substrates, from plates of glass to sheets of rubber. The results create interesting opportunities for devices with applications that span consumer gadgetry and home entertainment equipment to neurotechnologies for neuroscience research and hardware for brain-machine interfaces. This talk summarizes the key ideas and the current development status, with sophisticated examples of digital micro-LED displays and cellular-scale optoelectronic interfaces to the deep brain.

Biography

John A. Rogers is the Louis Simpson and Kimberly Querrey Professor of Materials Science and Engineering, Biomedical Engineering and Medicine at Northwestern University, with affiliate appointments in Mechanical Engineering, Electrical and Computer Engineering and Chemistry, where he is also Director of the recently endowed Querrey/Simpson Institute for Bioelectronics. He has published more than 750 papers, 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 Smithsonian Award for American Ingenuity in the Physical Sciences (2013), the MRS Medal (2018) and most recently the Benjamin Franklin Medal from the Franklin Institute (2019). He is a member of the National Academy of Engineering, the National Academy of Sciences, the National Academy of Medicine, the National Academy of Inventors and the American Academy of Arts and Sciences.

Yi Cui

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Reinventing Batteries Through Materials Design and New Tools

Abstract

The fast growth of portable power sources for transportation and grid-scale stationary storage presents great opportunities for battery development. The invention of lithium ion batteries has been recognized with Nobel Prize in 2019. How to increase energy density, reduce cost, speed up charging, extend life, enhance safety and reuse/recycle are critical challenges. Here I will present the 15year research in my lab to address many of challenges by understanding the materials and interfaces through new tools and providing guiding principles for design. The topics to be discussed include: 1) A breakthrough tool of cryogenic electron microscopy, leading to atomic scale resolution of fragile battery materials and interfaces. 2) Materials design to enable high capacity materials: Si and Li metal anodes and S cathodes. 3) Interfacial design with polymer and inorganic coating to enhance cycling efficiency of battery electrodes. 4) Materials design for safety enhancement. 6) Lithium extraction from sea water and for battery recycling. 7) New battery chemistry for grid scale storage.

Biography

Yi Cui is a Professor in the Department of Materials Science and Engineering at Stanford University. He received B.S. in Chemistry in 1998 at the University of Science and Technology of China (USTC), Ph.D in 2002 at Harvard University. After that, he went on to work as a Miller Postdoctoral Fellow at University of California, Berkeley. In 2005 he became an Assistant Professor in the Department of Materials Science and Engineering at Stanford University. In 2010 he was promoted with tenure.

He has published ~500 research papers and has an H-index of 201 (Google). In 2014, he was ranked NO.1 in Materials Science by Thomson Reuters as “The World’s Most Influential Scientific Minds”. He is a Fellow of Materials Research Society, Electrochemical Society and Royal Society of Chemistry. He is an Executive Editor of *Nano Letters*. He is a Co-Director of the Bay Area Photovoltaics Consortium, a Co-Director of Battery 500 Consortium and Co-Director of Stanford StorageX Initiative.

His selected awards include: MRS Medal (2020), Dan Maydan Prize in Nanoscience (2019), Nano Today Award (2019), Blavatnik National Laureate (2017), MRS Kavli Distinguished Lectureship in Nanoscience (2015), the Sloan Research Fellowship (2010), KAUST Investigator Award (2008), ONR Young Investigator Award (2008), Technology Review World Top Young Innovator Award (2004). He has founded four companies to commercialize technologies from his group: Amprius Inc., 4C Air Inc., EEnotech Inc. and EnerVenue Inc.

Yury Gogotsi

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2D Carbides and Nitrides (MXenes) for Energy Storage and Electronics

Abstract

2D carbides and nitrides, known as MXenes, are among the most recent, but quickly expanding 2D material families. The field is experiencing very fast growth with the number of papers on MXenes doubling every year with about 850 journal papers in 2019 and the same number in the first 6 months of 2020. Major breakthroughs have been achieved in the past 2-3 years, including the discovery of 2D M_5C_4 carbides with the twinned layers and CVD synthesis of $MoSi_2N_4$, representing a new family of 2D nitrides. Synthesis of dozens of predicted MXenes, demonstration of superconductivity in MXenes with specific surface terminations, stronger interactions with electromagnetic waves compared to metals, metallic conductivity combined with hydrophilicity and redox activity, led to numerous applications. MXenes are promising candidates for energy storage and related electrochemical applications, but applications in optoelectronics, plasmonics, electromagnetic interference shielding, electrocatalysis, medicine, sensors, or water purification are equally exciting. A new field calls “MXetronics” has emerged, because MXenes can find a broad use in electronics, replacing many of the currently used materials. At the same time, many more 2D carbides, nitrides and borides are to be discovered, some new material families (e.g., MeC_2) have already been theoretically predicted, but not yet experimentally realized. Solid solutions on M and X sites have been demonstrated, but effect of composition on their properties is still to be studied. MXenes show promise to become the largest known 2D family of materials with a major impact on many fields.

Biography

Yury Gogotsi is Distinguished University Professor and Charles T. and Ruth M. Bach Professor of Materials Science and Engineering at Drexel University. He also serves as Director of the A.J. Drexel Nanomaterials Institute. His research group works on 2D carbides, nanostructured carbons, and other nanomaterials for energy, water and biomedical applications. He is recognized as Highly Cited Researcher in Materials Science and Chemistry, and Citations Laureate by Thomson-Reuters/Clarivate Analytics. He has received numerous awards for his research including the ACS

Award in the Chemistry of Materials, Friendship Award from P.R.C., European Carbon Association Award, S. Somiya Award from IUMRS. He has been elected a Fellow of the American Association for Advancement of Science, Materials Research Society, American Ceramic Society, the Electrochemical Society, Royal Society of Chemistry, International Society of Electrochemistry, as well as the World Academy of Ceramics and the European Academy of Sciences. He holds honorary doctorates from the National Technical University of Ukraine, Frantsevich Institute for Problems of Materials Science, National Academy of Sciences, Ukraine, and Paul Sabatier University, Toulouse, France. He served on the MRS Board of Directors and is acting as Associate Editor of *ACS Nano*.

Hong Liu

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Regulation of stem cell fate by naostructure mediated physical signals

Abstract

Regulation of stem cell fate, especially controlling the omitted differentiation of stem cells, is the key for tissue regeneration in clinic. The conventional approaches for stem cell differentiation is building bio-microenvironment of the stem cells with some biomolecules as growth factors. However, the biomoelctules, including proteins, enzymes, and RNAs are , of expensive and easily to be degraded in vivo or out controlled to diffused into other tissues, which brings great difficulties for applications in tissue regeneration. Fortunately, some receptors with related to physical signals on the surface of extracellular matrix of stem cells provided a great opportunity about regulating the stem cell fate by physical signals. Compared with bio or chemical signals, physical signals can be applied quantificationally and periodically on the cells. However, the outside macroscopic physical fields can not be focused on the surface receptors of the cells. Recent years, great progress of functional nanomaterials, which can convert energy from outside physical field into another kind of energy, provided great possibility to applying localized physical signals on the cells, and realizing the stimulation the surface receptors locally and timely. Therefore, recent years, we proposed a new concept in bio-materials-physics interdisciplinary research, regulation of stem cell fate by nanostructure mediated physical signals, and took great progress in this area. In this talk, we will introduce the principal of regulation of stem cell fate by naostructure mediated physical signals, and recent progress in localized omitted differentiation of stem cells no the nanostructures and outside physical field irradiation. The important part of this talk are the evidences that electric signals produced on piezoelectric nanowires driven by ultrasonic irradiation can realize mesenchymal stem cell differentiation into neurons and glia cells without any chemical or bio growth factor. Most importantly, neural stem cells can be obtained by a transdifferentiation process through this method, which will have great important clinical applications in treatment of neurodegenerative diseases.

Biography

Dr. Hong Liu is a professor in Institute for Advanced Interdisciplinary Research (iAIR) and State Key Laboratory of Crystal Materials, Shandong University. He received his PhD degree in 2001 from Shandong University (China). He has filed 40+ patent applications and 300+ papers with total citation of over 20000 and H-index of 64. In 2009, he was awarded as Distinguished Young Scholar by National Natural Science Foundation of China. He was included in the Clarivate Analytics' Highly Cited Researchers 2018, and 2019 list. His current research is focused mainly on nanostructured energy materials, biosensors, biomaterials and tissue engineering, especially the interaction between stem cell and nanostrucutured biomaterials. He was awarded the first prize of Natural Science Award of Shandong Province and Chongqing City in 2020.

Liqiang Mai

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One Dimensional Nanomaterials for Emerging Energy Storage

Abstract

One-dimensional nanomaterials can offer large surface area, facile strain relaxation upon cycling and efficient electron transport pathway to achieve high electrochemical performance. Hence, nanowires have attracted increasing interest in energy related fields. We designed the single nanowire electrochemical device for in situ probing the direct relationship between electrical transport, structure, and electrochemical properties of the single nanowire electrode to understand intrinsic reason of capacity fading. The results show that during the electrochemical reaction, conductivity of the nanowire electrode decreased, which limits the cycle life of the devices. We have developed a novel assembled nanoarchitecture was also presented, which consists of V_2O_3 nanoparticles embedded in amorphous carbon nanotubes that are then coassembled within a reduced graphene oxide network. The naturally integrated advantages of each subunit exhibit highly stable and ultrafast sodium-ion storage. In addition, we demonstrated a 3D nitrogen-doped graphene/titanium nitride nanowire (3DNG/TiN) composite as a freestanding electrode for Li–S batteries. The highly porous conductive graphene network provides efficient pathways for both electrons and ions and TiN nanowires attached on the graphene sheets have a strong chemical anchor effect on the polysulfides. As a result, the 3DNG/TiN cathode exhibits an initial capacity of 1510 mAh g^{-1} and the capacity remains at 1267 mAh g^{-1} after 100 cycles at 0.5 C. We also develop a bilayer-structured vanadium oxide ($Mg_{0.3}V_2O_5 \cdot 1.1H_2O$) with synergistic effect of Mg^{2+} ions and lattice water as the cathode material for magnesium-ion batteries (MIBs). The pre-intercalated Mg^{2+} ions provide high electronic conductivity and excellent structural stability and the lattice water enables fast Mg^{2+} ions mobility because of its charge shielding effect. As a result, the $Mg_{0.3}V_2O_5 \cdot 1.1H_2O$ exhibits excellent rate performance and an unprecedented cycling life with capacity retention of 80.0% after 10,000 cycles. Our work presented here can inspire new thought in constructing novel one-dimensional structures and accelerate the development of energy storage applications.

Biography

Liqiang Mai, Chair professor of Materials Science and Engineering at Wuhan University of Technology (WUT), Dean of School of Materials Science and Engineering at WUT, Fellow of the Royal Society of Chemistry. He received his Ph.D. from WUT in 2004 and carried out his postdoctoral research at Georgia Institute of Technology in 2006-2007. He worked as an advanced research scholar at Harvard University and University of California, Berkeley.

His current research interests focus on new nanomaterials for electrochemical energy storage and micro/nano energy devices. He has published over 380 papers in peer-reviewed journals such as *Nature, Nat. Nanotechnol., Nat. Commun., Adv. Mater., J. Am. Chem. Soc., Chem. Rev.*, etc. He has conducted more than 30 research projects as project principal such as National Basic Research Program of China, the National Science Fund for Distinguished Young Scholars, the Key Program of National Natural Science Foundation, etc. He is the winner of the Second Prize of National Natural Science Award, the First Prize of Natural Science Award by the Ministry of Education, Highly Cited Scientist of Clarivate in the world, Highly Cited Author of Royal Society of Chemistry in China, China Youth Science and Technology Award, and Guanghua Engineering Science and Technology Prize, the EEST2018 Research Excellence Award, etc. He is the associate editor of *J. Energy storage and the guest editor of Chem. Rev., Adv. Mater.*, and serves on the Editorial and Advisory Boards of *Joule (Cell press), Acc. Chem. Res., ACS Energy Lett., Adv. Electron. Mater., Nano Res. and Sci. China Mater.*

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Peptide and metabolite nanotechnology

Abstract

Our lab is extensively involved in the minimalistic, reductionist and non-biased quest towards the most fundamental molecular recognition and self-assembling modules in nature that possess unique physical properties including mechanical, optical, electronic and piezoelectric. For many years, our identification of -sheet-like arrangement of ultrashort dipeptides, most notably diphenylalanine (Phe-Phe) and its derivatives, had prompted the basic study and technological application of such short peptides. These peptides offer the combination of the materials properties of natural and synthetic polyamide with the ease and facile synthesis of dipeptide. We recently extended our studies in different directions. The first is the identification and utilization of minimalistic peptides that form helical structure. We realized that the Pro-Phe-Phe could form helical assemblies with notable mechanical properties. Inspired by nature, we replaced the proline with hydroxyproline to achieve Young's modulus comparable to titanium. One key direction is the use of co-assembly instead of self-assembly to achieve novel architectures and desired mechanical properties. Finally, in recent years, we become 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. Many of the properties 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.

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. He is also a member of Israel National Council for Research and Development (NCRD). Gazit is also the founding director of the BLAVATNIK CENTER for Drug Development. In 2015, he was knighted by the Italian Republic for his service to science and society. Gazit received his B.Sc. (*summa cum laude*) after completing his studies at the Special Program for Outstanding Students of Tel Aviv University (Currently the "Adi Lautman Program"), 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.

Sang-Woo Kim

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Triboelectrification for Energy Harvesting, Delivery and Tribotronics

Abstract

Energy harvesting systems based on triboelectric nanomaterials are in great demand, as they can provide routes for the development of self-powered devices which are highly flexible, stretchable, mechanically durable, and can be used in a wide range of applications. Our recent research interest mainly focuses on the fabrication of high-performance triboelectric nanogenerators (TENGs) based on various kinds of nanomaterials. Flexible TENGs exhibit good performances and are easy to integrate which make it the perfect candidate for many applications, and therefore crucial to develop. In this presentation, I firstly introduce the fundamentals and possible device applications of TENGs, including their basic operation modes. Then the different improvement parameters will be discussed. As main topics, I will present a couple of recent achievements regarding highly robust and efficient TENGs with multifunctional materials, etc. In addition, the presenter will reort transcutaneous ultrasound energy harvesting using capacitive triboelectric technology. A major challenge for implantable medical systems is the inclusion or reliable delivery of electrical power. Ultrasound was used to deliver mechanical energy through skin and liquids and demonstrated that a thin inplantable vibrating triboelectric nanogenerator is able to effectively harvest it. Finally The presenter is going to introduce a 2D materials-based tribotronics for possible future application toward tactile sensors, robots, security, human-machine interfaces, etc. The triboelectric charging behaviors of vaious 2D layered materials including graphene, MoS_2, $MoSe_2$, etc were investigated in order to decide the triboelectric position of each 2D material using the concept of a triboelectric nanogenerator, which provides new insights to utilize 2D materials in triboelectric devices, allowing thin and flexible device fabrication.

Biography

Dr. Sang-Woo Kim is an SKKU Distinguished Professor (SKKU Fellow) at Sungkyunkwan University (SKKU) and Director of the BK21 FOUR SKKU MSE Program. He received a Ph.D. in Electronic Science and Engineering from Kyoto University in 2004. His recent research interest is focused on piezoelectric/triboelectric nanoge nerators, self-powered sensors, and 2D materials including graphene, h-BN, and TMDs. Prof. Kim has published over 250 research papers including Science, Nature Journals, etc (h-index of 67) and presented more than 100 Plenary, Keynote, Invited talks in international/domestic conferences. Prof. Kim served as Chairman of the 4th NGPT (Nanogenerators and Piezotronics) conference at SKKU in 2018 and Director of SAMSUNG-SKKU Graphene/2D Research Center. He is currently serving as an Associate Editor of Nano Energy and an Executive Board Member of Advanced Electronic Materials. He received the Award for Excellent Basic Research 2019, the Research Award of the National Academy of Engineering of Korea (2018), IAAM Medal (2017), MCARE 2016 Award (ACerS-KIChE), The Republic of Korea President's Award for Scientific Excellence (2015), National Top 100 Research Award (2015), etc.

Jianhua Hao

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Piezophotonic and piezo-phototronic effects from hybrid and layered structures for novel optoelectronic applications

Abstract

Piezoelectric materials have shown great potential use for coupling with and control of photonic characteristics of various materials, leading to fertile areas of research in optoelectronics, energy devices and sensors. Piezophotonics and piezo-phototronic effects are coined by Prof. Z. L. Wang. Piezophotonics is the coupling between piezoelectric properties and photoexcitation, where strain-induced piezopotential modulates and controls the relevant optical process. Metal ions as activators may serve for demonstrating the piezophotonic effect since they are capable of responding to photoexcitation and subsequently emitting light. The progress in this field combined with the assembly and characterization of nanostructural materials based hybrid structures leads to exciting opportunities ranging from fundamental studies of piezoelectric semiconductors at nanoscale to improving conventional optoelectronic devices and conceiving novel optoelectronic applications. My group's works on the the luminescent materials with ability to be accessed and modulated remotely will offer opportunities for applications in the fields of magnetic optical sensing, piezophotonics, energy harvester, nondestructive environmental surveillance and novel light sources. Furthermore, III-VI layered materials in the two main categories of MX (e.g., InSe, InS, GaSe, and GaS) and M_2X_3 (e.g., In_2Se_3 and In_2S_3) are significant group of 2D semiconductors, which have gain renewed interests for optoelectronic applications in recent years thanks to their tunable bandgaps, efficient light absorption, and large carrier mobility. My group has demonstrated phototransistors based on centimeter-scale highly crystalline 2D III-VI InSe thin films. These characteristics in 2D III-VI semiconductors are attractive to make piezo-phototronics particularly helpful for understanding fundamental physics and developing novel optoelectronic devices based on 2D III-VI compound and heterostructure. The research was supported by the grant Research Grants Council of Hong Kong (GRF No. PolyU 153023/18P).

Biography

Jianhua Hao is a Professor in Hong Kong Polytechnic University (PolyU). He obtained his B.Sc., M.Sc., and Ph.D. degrees at Huazhong University of Science and Technology (HUST). After working at HUST, Penn State, University of Guelph and University of Hong Kong, he joined the faculty in PolyU. He has published 280+ SCI international journal papers. He received several International Awards and President's Award in PolyU. He serves as Associate Editor of InfoMat (Wiley) and Editorial Board Member of Adv. Opt. Mater. (Wiley). He is selected as 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). (Hao research group website: http://ap.polyu.edu.hk/apjhhao/)

Chennupati Jagadish

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Semiconductor Nanowires for Optoelectronics Applications

Abstract

Semiconductors have played an important role in the development of information and communications technology, solar cells, solid state lighting. Nanowires are considered as building blocks for the next generation electronics and optoelectronics. In this talk, I will introduce the importance of nanowires and their potential applications and discuss about how these nanowires can be synthesized and how the shape, size and composition of the nanowires influence their structural and optical properties. I will present results on axial and radial heterostructures and how one can engineer the optical properties to obtain high performance lasers, THz detectors, solar cells and to engineer neuronal networks. Future prospects of the semiconductor nanowires will be discussed.

Biography

Professor Jagadish is a Distinguished Professor and Head of Semiconductor Optoelectronics and Nanotechnology Group in the Research School of Physics and Engineering, Australian National University. He has served as *Vice-President and Secretary Physical Sciences of the Australian Academy of Science* during 2012-2016. He is currently serving as President of IEEE Photonics Society, Past President of Australian Materials Research Society. Prof. Jagadish is designated as Editor-in-Chief of Applied Physics Reviews from Jan 2020 and serves as an Editor of 3 book series and serves on editorial boards of 19 other journals. He has published more than 930 research papers (650 journal papers), holds 5 US patents, co-authored a book, co-edited 15 books and edited 12 conference proceedings and 17 special issues of Journals. He has won the 2000 IEEE Millennium Medal and received Distinguished Lecturer awards from IEEE NTC, IEEE LEOS and IEEE EDS. He is an Internal Member of US National Academy of Engineering and a Fellow of the Australian Academy of Science, Australian Academy of Technological Sciences and Engineering, The World Academy of Sciences, US National Academy of Inventors, Indian National Science Academy, Indian National Academy of Engineering, European Academy of Sciences, Indian Academy of Sciences, AP Akademi of Sciences, IEEE, APS, MRS, OSA, AVS, ECS, SPIE, AAAS, FEMA, APAM, IoP (UK), IET (UK), IoN (UK) and the AIP. He received many awards including IEEE Pioneer Award in Nanotechnology, IEEE Photonics Society Engineering Achievement Award, OSA

Nick Holonyak Jr Award, Welker Award, IUMRS Somiya Award, UNESCO medal for his contributions to the development of nanoscience and nanotechnologies, IEEE EDS Education Ward and Lyle medal from Australian Academy of Science for his contributions to Physics. He has received Australia's highest civilian honor, AC, Companion of the Order of Australia, as part of 2016 Australia day honors from the Governor General of Australia for his contributions to physics and engineering, in particular nanotechnology.

Zhiyong Fan

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Biomimetic Eye with Hemispherical Nanowire Array Retina

Abstract

Billions of years of natural evolution have created today's colorful biological world. Biomimetics have given us many inspiring ideas for solving scientific and engineering problems for more than 100 years. In this talk, the speaker will introduce design and implementation of a bioinspired artificial eye. The key component of the biomimetic eye is a hemispherical retina which is made of a high-density perovskite nanowire array grown by the vapor phase method. Ionic liquid is used as the front common electrode of the nanowire, and the liquid metal wire are used as the back contact electrode of the nanowire light sensor, mimicking the optic nerve fiber behind the retina. Device measurement shows that the electrochemical eye has high responsivity, reasonable response speed, lower detection limit and wider field of view, as well as basic imaging functions. In addition to the structure similar to the human eye, the nanowire density of the hemispherical artificial retina is higher than the density of the photoreceptor in the human retina, so it has the potential to achieve higher image resolution if individual photoreceptors are addressed.

Biography

Dr. Zhiyong Fan received Bachelor and Master degrees on Materials Science from Fudan University, China, then moved to University of California, Irvine for his PhD study. He worked as a postdoctoral fellow in the Department of Electrical Engineering and Computer Sciences at the UC, Berkeley, with a joint appointment at Lawrence Berkeley National Laboratory in 2007~2010. He then joined the Department of Electronic and Computer Engineering, Hong Kong University of Science and Technology (HKUST) in 2010 and now is a full professor. He is a Director of HKUST-ATAL Joint Innovation Laboratory, Associate Director of Material Characterization and Preparation Facility. He is a Fellow of the Royal Society of Chemistry, Senior Member of IEEE, and Founding Member of the Young Academy of Sciences of Hong Kong. His research interest is focused on functional nanomaterials and structures for electronic and optoelectronic devices. To date, he has published more than 180 peer reviewed papers with citations ~19,000, H index 69, and is a highly cited author of Clarivate Analytics in 2018.

Christian Falconi

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Piezoelectric nanotransducers

Abstract

The properties of transducers are greatly affected by their dimensions due to both classic scaling laws and, at nanoscale, quantum effects. In the last years it has been demonstrated that nanoscale piezoelectric transducers can have crucial advantages in comparison with classic piezoelectric devices. Recently, we systematically analyzed the advantages of piezoelectric nanotransducers and both some of the most important open challenges and general strategies which may help to address them. As remarkable examples, nanoscale materials can withstand larger deformations, have higher piezoelectric coefficients, offer superior mechanical force-to-displacement sensitivities and operate at higher speed. Additionally, materials which are not piezoelectric in their bulk form can be piezoelectric as single layer. Besides, some devices can take advantage of mechanisms which only are possible at nanoscale; as an example, it has been proposed that 2D piezoelectric nanotransducers can be tuned by rewritable ghost floating gates "written" by tunneling triboelectrification. Moreover, at nanoscale there are more degrees of freedom for designing piezoelectric transducers and there can be more choices for the types of mechanical input, the positions of the contacts, the dimensionalities, and the shapes. After reviewing these and other advantages, we will discuss many issues that can complicate practical applications and some general methodologies to address them.

Biography

Christian Falconi (CF) received the M.Sc. and the Ph.D. degrees in Electronic Engineering from the University of Rome Tor Vergata in, respectively, 1998 and 2001. Since 2002 CF is Assistant Professor at the Department of Electronic Engineering, University of Rome Tor Vergata. Since 2013 CF is Adjunct Professor at the Sungkyunkwan University (SKKU, South Korea). Since 2017 CF is Adjunct Professor at the Beijing Institute of Nanoenergy and Nanosystems – Chinese Academy of Sciences (BINN – CAS, China). His research interests include electronic interfaces, sensors, micro-nanosystems and nanogenerators.

Jianming Zhang

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Rational Design of Plasmonic Nanohybrids for Photocatalytic Synthesis

Abstract

Recently, surface plasmon resonance (SPR) effects have been widely used to construct photocatalysts which are active in the visible spectral region. Such plasmonic photocatalysts usually comprise a semiconductor material transparent in the visible range (such as TiO_2) and plasmonic nano-objects (*e.g.* Au nanoparticles (Au NPs)). Specific SPRs, though, only partially cover the visible spectrum and feature weak light absorption. Here, we report our recent achievements to demonstrate novel strategies to construct Au NP-based nanohybrids for SPR photocatalytic clean energy generation and organic synthesis. We explore the unique role played by whispering gallery mode (WGM) resonances in the expression of the photocatalytic activity of plasmonic photocatalysts. Using numerical simulations, we demonstrate that, by solely exploiting a proper geometrical arrangement and WGM resonances in a TiO_2 sphere, the plasmonic absorption can be extended over the entire visible range and can be largely increased. Furthermore, the local electric field at the Au-TiO_2 interface is also considerably enhanced. These results are experimentally corroborated, by means of absorption spectroscopy and Raman measurements. In another work, to enhance the utilization of visible light, a core@multi-shell nanohybrid structure composed of a Ag core as scattering nanoresonator and oxide shell anchored with Au NPs on its surface was designed. Using numerical analysis and experimental verifications, we demonstrate that Ag nano-resonators induce an increase of the optical path as well as a near-field enhancement at the Au-TiO_2 interface. Consequently, the activity of the Au–TiO_2 plasmonic photocatalyst is significantly enhanced, leading to a high production rate for H_2 under visible light. We believe these designs could be adopted for future highly-active photocatalysts with applications in artificial photosynthesis.

Biography

Jianming Zhang is a Full Professor and deputy director of the Institute of Quantum and Sustainable Technology (IQST) at Jiangsu University. He received his Ph. D. on 2013 in Materials Science at L'Institut national de la recherche scientifique (INRS), and then spent three years as a postdoctoral research fellow at University of Quebec at Montreal (UQAM). In 2016 he joined the School of Chemistry and Chemical Engineering of Jiangsu University. His research is focused on the photon energy conversion for green synthesis and biomedicine, and the development of advanced fuel cell materials.

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Advanced Materials for Rechargeable Zinc-Air Battery

Abstract

Development of low cost, high energy, safe and long-life energy storage systems is critical for widespread commercialization of smart grid and electric vehicles. Rechargeable zinc-air battery has been considered as the most promising candidate as energy storage system for transportation, smart grids, and stationary power. They can display a considerably several times higher specific energy and volumetric energy density than that of the Li-ion battery. Besides, zinc-air batteries also demonstrate other desirable characteristics, such as abundant raw materials, environmental friendliness, safety, and low cost. The current zinc-air battery is typically composed of four main components: an air electrode, an alkaline electrolyte, a separator, and a zinc electrode. For the electrically rechargeable zinc-air battery, each main structural component faces its own challenges. In this presentation, we will present our recent work on advanced energy materials development for next generation rechargeable zinc-air batteries by focusing on the nanostructured bifunctional oxygen electro-catalysts and mechanical studies on their corresponding electrochemical behaviors during battery cycling. More specifically, we will discuss: 1) how the nanoengineered materials can enhance the catalytic activity and durability of oxygen electro-catalysts, 2) what is the structural evolution and actual species of oxygen electro-catalysts in the zinc-air batteries operation, 3) how the 3D air electrode architectures and mechanical understandings can advance the practical performance of the zinc-air batteries, as well as their extended applications include portable, flexible, and diversely shaped zinc-air batteries.

Biography

Dr. Zhongwei Chen is Canada Research Chair (CRC-Tier 1) Professor in Advanced Materials for Clean Energy at the University of Waterloo, Fellow of the Royal Society of Canada, Fellow of the Canadian Academy of Engineering, Director of Waterloo Center for Electrochemical Energy (WCEE), Associate Editor of ACS Applied Materials & Interfaces (ACS-AMI), and Vice President of International Academy of Electrochemical Energy Science (IAOEES). His research interests are in the development of advanced energy materials and electrodes for fuel cells, metal-air batteries, and lithium-ion batteries. He has published 3 book, 11 book chapters and more than 320 peer reviewed journal articles with over 26,000 citations with a H-index of 84 (GoogleScholar) He is also listed as inventor over 30 US/international patents, with several licensed to companies internationally. His research activities are currently supported by a large and highly integrated team, comprising over 30 research associate/postdoctoral fellows and 30 graduate students. In addition, Dr. Chen has already trained more than 80 others through his research program, totaling over 100 highly qualified personnel in all. He was the recipient of the 2016 E.W.R Steacie Memorial Fellowship, the member of the Royal Society of Canada’s College of New Scholars, Artists and Scientists in 2016, the fellow of the Canadian Academy of Engineering in 2017, the Rutherford memorial medal from The Royal Society of Canada in 2017, which followed upon several other prestigious honors, including the Ontario Early Researcher Award, an NSERC Discovery Supplement Award, the Distinguished Performance and Research Award. In 2018 and 2019, Dr. Chen was ranked as the Global Highly Cited Researchers by Clarivate Analytics. He was elected as Fellow of the Royal Society of Canada in 2019.

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), Fellow of the NANOSMAT Society, Member of Youth Innovation Promotion Association, CAS, and Youth Working Committee Member of Chinese Society of Micro-Nano Technology. 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 100 papers and attained 36 patents.

Renyun Zhang

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The triboelectricity of the human body: energy harvesting, motion sensing and signal transmitting

Abstract

Human skin has a very positive charge affinity due to its surface biological composition. Such a high positive charge affinity leads to electron transfer between the skin and other materials when the physical contact-separation process is happening. Utilizing such unique properties, we have constructed different types of triboelectric nanogenerators (TENGs) for harvesting energy from body motions with maximum output power density above 30 W/m^2. Moreover, the charge transfer process during the contact-separation can be used to sense and identify different body motions that can have great applications in healthcare and security areas.

Biography

Renyun Zhang is an associate professor at Mid Sweden University. He received his Ph.D. in 2007 in Biomedical Engineering at Southeast University, and then spent three years as a postdoctoral research fellow at Mid Sweden University. His research focuses on the energy harvesting technology and transparent thin films.

Jin Yang

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TENG based pressure sensor for continuous measurement of human arterial pulse wave

Abstract

Real-time heath monitoring and assessment is becoming more and more critical and indispensable, which largely contributes to the advancement of the field of wearable electronics for biomedical applications. Pulse wave carries comprehensive information regarding human cardiovascular system, which is highly correlated to various physiological diseases related to heart. To measure the subtle changes in the pulse wave, various novel materials and nanotechnologies are applied to develop wearable sensors over the past decades, including piezoelectric materials, metal nanowires, and conductive fibers. However, the above mentioned wearable sensors are incapable of measuring the distinguishable arterial pulse wave owing to the insufficient sensitivity. In this work, we developed a TENG based pressure sensor for capturing subtle mechanical change of the blood pressure in the vessel and expressing it in electrical signals as human pulse waveform. Our TENG based pressure sensor holds a low pressure detection limit of 5 Pa and a small scale of 10×10×1 cubic millimeters for ease in carrying. It is capable of continuous measurement of human pulse wave. In addition, based on the TENG based pressure sensor, a low power consumption sensor system was further developed, including a TENG based pressure sensor for human pulse signal extraction, a management circuit for signal processing and a wireless transmission component to communicate the measured cardiovascular parameters to personal mobile phone. This work paved a simple, cost-effective and user-friendly approach for low power consumption measuring human pulse wave, which would be a competitive alternative to current complex cardiovascular monitoring systems and could be immediately and extensively adopted in a variety of applications, and ultimately improving our way of living.

Biography

Jin Yang received the BE, ME and PhD degrees in instrumentation science and technology from Chongqing University in 2002, 2004, and 2007, respectively. Currently, he is a professor with the College of Optoelectronic Engineering, Chongqing University. His current research interests focus on sensor and actuator, measurement and instrumentation, nanogenerator, self-powered sensor and systems.

Hua Yu

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Simultaneous Energy Harvesting and Signal Sensing From a Single Triboelectric Nanogenerator for Intelligent Self-Powered Wireless Sensing Systems

Abstract

The puzzle of sustainable power and reliable signal sensing poses a tough challenge for electronic systems in the era of the Internet of Things. Fortunately, triboelectric nanogenerator (TENG), as a promising electro-mechanical conversion method, has been widely used to solve these two problems as reported. In existing reports, TENG is used either as an energy harvester or a self-powered sensor, yet it cannot undertake both demands at the same time in a single system. In this work, by proposing a method of decoupling/extracting signals and energy, energy harvesting and signal sensing in a single device were both achieved by extracting the energy and capturing signal simultaneously from a rotating triboelectric nanogenerator (R-TENG), through which a real self-powered sensing system is realized. Firstly, we proposed a R-TENG device adopting PCB manufacturing process, which can obtain energy and sense signals from external rotation. Then, we designed a decoupled signal processing unit and a reserved power management unit that supplies for the signal processing unit and an additional wireless transmission module with a microcontroller. Finally, we set up a validation system that uses wind-driven R-TENG to collect wind energy while detecting wind speed information. The collected energy powers the entire system and the measured wind speed information is successfully transmitted to the receiving end wirelessly. This method of decoupling/extracting signals and energy expands the application of TENG that it can be used as energy harvester and sensor simultaneously in a self-powered system.

Biography

Hua Yu is a Full Professor and dean of electronic science and technology department in Chongqing University. He received his B.Sc in electrical engineering from Harbin Engineering University, Harbin, China, and the M.S., and Ph. D. degrees in Electrical Engineering from Huazhong University of Science and Technology, Wuhan, China, respectively. In 2007, he joined the research group of Nanoscale Science & Engineering in State University of New York, Albany, USA, working as a post doctor.

From 2009 to now, he has served as professor and dean of electronic science and technology department in Chongqing University. He has also been a vice dean of Micro-Nano Device and System Key Lab. During 2016, he has been researching as a visiting scholar for one year in Georgia Institute of Technology, Atlanta, USA. His research is focused on the self-powered sensors, Internet of Things, Smart Data, MEMS (Micro-Electro-Mechanical System), Intelligent Manufacturing, Electronic device and Integrated Circuit design.

Ya Yang

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Hybridized and Coupled Nanogenerators

Abstract

A hybridized electromagnetic-triboelectric nanogenerator is to utilize electromagnetic and triboelectric nanogenerators to simultaneously scavenge mechanical energy from one mechanical motion. As compared with the individual energy harvesting unit, the hybridized nanogenerator has much larger output power, higher conversion efficiency so that it can be used to solve the power source issue of some devices with larger power consumption. The hybridized nanogenerators have the potential applications in self-powered sensors, wearable devices, and networks. Rapid advancements in various energy harvesters impose the challenge on integrating them into one device structure with synergetic effects for full use of the available energies from our environments. We report a multi-effects coupled nanogenerator based on ferroelectric barium titanate, promoting the ability to simultaneously scavenging thermal, solar, and mechanical energies. By integration of a pyroelectric nanogenerator, a photovoltaic cell and a triboelectric-piezoelectric nanogenerator in one structure with only two electrodes, multi-effects interact with each other to alter the electric output, and a complementary power source with peak current of ~ 1.5 μA, platform voltage of ~ 6 V and peak voltage of ~ 7 V is successfully achieved. Compared with traditional hybridized nanogenerators with stacked architectures, the one-structure-based multi-effects coupled nanogenerator is smaller, simpler and less costly, showing prospective in practical applications and represents a new trend of all-in-one multiple energy scavenging.

Biography

Professor Ya Yang has developed coupled nanoenergy materials and devices for next generation energy conversion and storage. He has published over 180 SCI papers including Science Advances, Energy & Environmental Science, Advanced Materials, Nano Letters, ACS Nano, and so on. He has applied over 40 patents and finished over 50 invited talks, where the published papers have been cited by over 10000 times with a H-index of 60. His research interests include the hybridized and coupled nanogenerators, self-powered sensors, and ferroelectric materials-based devices. He is an editorial board member of iScience, Nano-Micro Letters, Scientific Reports、Nanomaterials and Energies. His research results have been reported by various academic journals and medias including Nature Photonics 、 ScienceDaily 、 Phys.org 、 Nanotechweb.org.

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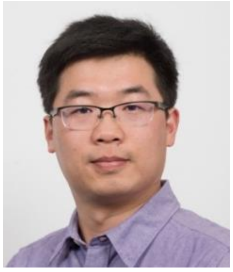

Enhancing the thermoelectric performance of chalcogenides via twin engineering and nanocompositing

Abstract

Thermoelectric materials realize direct inter-conversion between thermal and electrical energy, thus providing opportunities to harvest useful electricity from waste heat. Defect engineering and nanocompositing have proven effective to optimize the thermal and electrical properties of a diversity of thermoelectrics. However, it is challenging to introduce high-density twin boundaries into complex thermoelectric materials and to construct nanostructured composites with uniformly distributed low-dimensional carbon materials. Herein, we synthesized orthorhombic@cubic core-shell Cu_5FeS_4 icosahedral nanoparticles that contain high-density twin boundaries in the form of fivefold twins. Spark plasma sintering consolidates the nanoparticles into nanostructured pellets, which retain high-density twin boundaries and tuned fraction of secondary Fe-deficient cubic Cu_5FeS_4 phase. As a result, thermal and electrical transport properties are synergistically optimized, leading to an enhanced zT of ~0.62 at 710 K, which is about 51% higher than that of single-phase Cu_5FeS_4. Additionally, we synthesized a series of SnSe/reduced graphene oxide (rGO) nanocomposites *in situ via* a facile single-step bottom-up solution method, where rGO nanosheets are incorporated intimately into the SnSe matrix. Nanocomposites significantly reduces the lattice thermal conductivity of the material, leading to a low lattice thermal conductivity of 0.36 W m^{-1} K^{-1} at 773 K to yield a maximum zT of 0.91 at 823 K, representing a ~47% increase compared to SnSe. Our study provides a new pathway to improve thermoelectric performance of metal chalcogenides by way of engineering twin boundaries and chalcogenide/rGO composite architectures at the nanoscale.

Biography

Dr Guang Han received his PhD in Materials Engineering from The University of Queensland (UQ), Australia in 2014, and was awarded UQ Dean's Award for Outstanding Research Higher Degree Theses. After his PhD, he moved to School of Chemistry at the University of Glasgow, UK as a Postdoctoral Research Associate. In early 2017, he joined College of Materials Science and Engineering at Chongqing University as a "One Hundred Talents Plan" Professor. His research interests are focused on the development of advanced inorganic nanostructures for thermoelectric energy conversion and electrochemical energy storage, by understanding the fundamental relationships among synthesis, structure and property of nanomaterials.

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Polymer-based Nanomaterials for Energy Harvesting

Abstract

Harvesting energy from ambient mechanical sources in our environment (e.g. underground tunnel vibrations, machinery, walking, etc.) has generated tremendous interest as it offers a fundamental energy solution for 'small power' applications, including but not limited to wireless sensors. In this context, piezoelectric and/or triboelectric materials offer the simplest means of directly converting mechanical vibrations, from sources such as moving parts of machines, fluid flow and even body movements, into electrical power for microscale device applications. In particular, nanoscale energy harvesters, or nanogenerators, are capable of converting low-level ambient vibrations into electrical energy, thus paving the way for the realisation of the next generation of self-powered devices. Polymer-based nanogenerators are attractive as they are inherently flexible and robust making them less prone to mechanical failure which is a key requirement for vibrational energy harvesters. They are also lightweight, easy and cheap to fabricate, lead free and biocompatible, but their energy harvesting performance is often found lacking in comparison to more commonly studied inorganic materials. My group thus develops scalable nanofabrication techniques for flexible and low-cost polymer-based nanogenerators with improved energy conversion efficiency, by using facile template-assisted nanowire growth techniques. In this talk, I will discuss our recent advances in incorporating polymer nanowires into scalable piezoelectric and triboelectric nanogenerators. In particular, I will focus on the role of crystallinity in determining energy harvesting properties of these nanowires. I will also introduce advanced scanning probe microscopy methods that we use for the characterization of these polymeric nanomaterials and the extraction of relevant materials properties for nanogenerator design.

Biography

Dr Sohini Kar-Narayan is an Associate Professor in Device & Energy Materials at the Department of Materials Science & Metallurgy at the University of Cambridge. She received a BSc (Honours) in Physics in 2001 from the University of Calcutta, India, followed by MS (2004) and PhD (2009) in Physics from the Indian Institute of Science, Bangalore. Following a postdoctoral appointment at the Department of Materials Science in Cambridge, she was awarded a prestigious Royal Society Dorothy Hodgkin Fellowship in 2012. Dr Kar-Narayan is interested in functional nanomaterials for applications in energy, sensing and bio-medicine. This research is primarily funded through a European Research Council Starting Grant that was awarded to her in 2015. She was the recipient of a World Economic Forum Young Scientist Award in 2015, and is a Fellow of Clare Hall College, Cambridge.

Hossam Haick

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A multifunctional electronic skin with advanced self-healing capabilities

Abstract

Integrating self-healing capabilities into soft electronic devices and sensors is important for increasing their reliability, longevity, and sustainability. Although some advances in self-healing soft electronics have been made, many challenges have been hindering their integration in digital electronics and their use in real-world conditions. We designed an electronic skin (e-skin) with high sensing performance toward temperature, pressure, and pH levels - both at ambient and/or in underwater conditions. The e-skin is empowered with a novel self-repair capability that consists of an intrinsic mechanism for efficient self-healing of small-scale damages as well as an extrinsic mechanism for damage mapping and on-demand self-healing of big-scale damages in designated locations. The overall design is based on a multilayered structure that integrates a neuron-like nanostructured network for self-monitoring and damage detection and an array of electrical heaters for selective self-repair. This system has significantly enhanced self-healing capabilities; for example, it can decrease the healing time of micro-scratches from 24 hr to 30 sec. This electronic platform layers down the foundation for the development of a new sub-category of self-healing devices in which electronic circuit design is used for self-monitoring, healing and restoring proper device function. The new platform would be highly useful for developing chemical and physical sensors for skin-attached/wearable applications that collect information about the human body under harsh conditions (e.g., continuous movements and exposure to sweat or rain).

Biography

Hossam Haick is a Full Professor in the Technion – Israel Institute of Technology and head of five major European consortia. Highly multi-disciplinary in nature, the research of Prof. Haick focuses on novel solid-state and flexible devices/sensors as well as electronic sensory nanoarrays non-invasive diagnosis of diseases via volatile biomarkers. Prof. Haick's comprehensive approach comprises materials and device development, system integration, testing in lab and clinical environments and exploitation of project results/hardware. Prof. Haick has received more than 72 prizes and recognitions, including the Knight of the Order of Academic Palms (conferred by the French Government), the Humboldt Senior Research Award, the "Michael Bruno" Prize, the Changjiang Award, etc.

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Epitaxial Self-Assembly on Silicon: Nanopatterns with a Twist

Abstract

Information storage relies upon nanopatterned and nanostructured interfaces. Typically, the various approaches to nanopatterning of surfaces, including silicon, are broken into two major classes: top-down methods such as photolithography, e-beam lithography and scanning force microscopy variants, and bottom-up synthetic techniques, including self-assembly. Since lithography is the single most expensive step in computer chip manufacturing, the use of self-assembled block copolymers (BCPs) templates on surfaces is being seriously considered by the semiconductor industry to pattern sub-20 nm features on a semiconductor surface; the Industry Technology Roadmap for Semiconductors (ITRS) terms this approach 'directed self-assembly', or DSA. Here, we will describe the remarkable versatility of using BCPs, polymers that contain sufficient chemical information to form highly ordered templates over large areas. Recently, the experimental observation of what are termed static distortion waves (SDWs) [also referred to as mass distortion waves (MDWs)] that are local chiral twisting of lattices, has become a topic of extreme interest in the area of 2D-based materials - perfect timing as the discovery of SDWs/MDWs in block copolymer-based self-assembled structures that are at least an order of magnitude larger in scale serve as an easily studied and tailored model for these motifs on 2D materials.

Biography

Prof. Jillian M. Buriak holds the Canada Research Chair of Nanomaterials for Energy in the Department of Chemistry at the University of Alberta. She graduated with an A.B. from Harvard University in 1990, and a Ph.D. in 1995 from the Université de Strasbourg in France, and was an NSERC post-doctoral fellow at The Scripps Research Institute in La Jolla, California from 1995-1997. She started her independent career at Purdue University as an Assistant Professor of Chemistry in 1997 and was promoted to Associate Professor with tenure in 2001. In 2003, she moved to the University of Alberta and NINT in Canada as a Professor of Chemistry and Canada Research Chair. Recent awards include the *ACS Nano* Lectureship (North America, February 2020), the Rio Tinto Alcan Award from the Canadian Society for Chemistry (2018), the XingDa Lectureship from Peking University (2018), and the Arthur K. Doolittle Award from the Polymer Materials Science & Engineering Division of the American Chemical Society (2015). She is a Fellow of the Royal Society of Chemistry (UK), the Royal Society of Canada, and the American Association for the Advancement of Science. Buriak was on the Board of Reviewing Editors for *Science* from 2004-2009, was an Associate Editor for *ACS Nano* from 2009-2013, and from 2014-2020 was the Editor-in-Chief of the ACS journal *Chemistry of Materials.* In July of 2020, she rejoined *ACS Nano* as an Associate Editor.

Clarice D. Aiello

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From nanotech to living sensors: biological spins as transducers of quantum information

Abstract

Experiments suggest that nontrivial quantum mechanical effects involving spin might underlie biosensing phenomena as varied as magnetic field detection for animal navigation, metabolic regulation in cells and optimal electron transport in chiral biomolecules. If this is correct, organisms might behave, for a short time, as “living quantum sensors” and might be studied and controlled using quantum sensing techniques developed for technological sensors. I will outline our approach towards performing coherent quantum measurements and control on proteins, cells and organisms in order to understand how they interact with their environment, how physiology is regulated by such interactions, and how nanomaterials can be tailored to mimic the room-temperature behavior of some biological molecules. Can coherent spin physics be established – or refuted! – to account for physiologically relevant biosensing phenomena, and be manipulated to technological and therapeutic advantage?

Biography

Prof. Clarice D. Aiello is a quantum engineer interested in how quantum physics informs biology at the nanoscale. She is an expert on nanosensors harnessing room-temperature quantum effects in noisy environments. Aiello received her Ph.D. from MIT in Electrical Engineering and held postdoctoral appointments in Bioengineering at Stanford, and in Chemistry at Berkeley. She joined UCLA in 2019, where she leads the Quantum Biology Tech (QuBiT) Lab. She has been actively fostering community in the field of Quantum Biology as chair of the APS March Meeting invited symposium on “Quantum Biology: beyond photosynthesis” (20), and as co-chair and main organizer of Moore Foundation-sponsored workshop on “Spins in biology" at UCLA (19). She was recognized by: MIT's School of Engineering's Award for Extraordinary Teaching and Mentoring; the Life Sciences Research Foundation Postdoctoral Fellowship (Moore Foundation Fellow); the Faculty for the Future Fellowship from the Schlumberger Foundation; the Fulbright Science and Technology Award; UNESCO's Fellowship Programme in Support of Priority Areas; and the Bourse d'Excellence Eiffel from the French Ministry of Foreign Affairs. Clarice has already delivered a total of 52 scientific presentations nationally and internationally (05–to date; countries: US, Australia, Austria, Brazil, Canada, England, France, Germany, Israel, Japan, The Netherlands, Norway, South Africa, Spain, Slovakia). She was a keynote speaker at the following venues: MindshareLA (20); HRL Laboratories (20); NSF Nanoscale Science and Engineering Grantees Conference (19); The Australian and New Zealand Conferences on Optics and Photonics (ANZCOP/SPIE) (19); and the IEEE MIT Undergraduate Research Technology Conference (19).

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Recent Progress on Biodegradable Zinc-based Alloys for Cardiovascular Stents

Abstract

Following the footsteps of biodegradable Mg-based and Fe-based alloys, biodegradable Zn-based alloy becomes a newcomer in the family of biodegradable metals and alloys. The combined superior mechanical properties, appropriate degradation rates, excellent biocompatibility of biodegradable Zn-based alloys have brought worldwide research interest on the design, development and clinical translation of Zn-based alloys. The current talk will summarize opportunities and challenges in the development of biodegradable Zn-based alloys for cardiovascular stents.

Biography

Dr. Lu-Ning WANG received his BEng from University of Science and Technology Beijing (USTB) in 2002, an MSc degree from Tsinghua University in 2005, and a PhD degree in materials engineering from University of Alberta in 2011. After postdoctoral training in the same institute, he received prestigious NSERC Visiting fellowship and joined University of Calgary in 2012. He has been a full professor and the PI of the Laboratory of Advanced Healthcare Materials in USTB since 2013. He was appointed as the dean of the School of Materials Science and Engineering in 2017. His research interests and scientific areas are: biomaterials, surface modification, metallic implants, hybrid materials fabrication and characterization. He is a member of TMS and NACE. He is also serving in the editorial board of *International Journal of Nanomedicine, Journal of Materials Science & Technology* and *Rare Metals*.

Mengdi Han

Northwestern University

Multimodal, multilayered soft electronics in advanced devices for cardiac surgery

Abstract

Many minimally invasive surgeries rely on catheters equipped with elements for sensing and/or actuation to deliver, through small incisions, diagnostic measurements and therapeutic interventions for a range of diseases and conditions. The rigid physical properties of these devices and their relatively primitive modes of operation impede their conformal contact with soft tissue surfaces, limit the scope of their uses, lengthen the times for the surgeries and increase the required levels of surgical skill. We report materials, two and three dimensional (2D and 3D) device designs and fabrication approaches for integrating advanced electronic functionality with such types of surgical tools, with a specific focus on balloon catheter systems. Here, multimodal, multiplexed soft electronic systems in multilayered configurations support capabilities that range from high-density spatiotemporal mapping of temperature, pressure and electrophysiological parameters, to options in programmable high-density actuation of thermal inputs and/or electrical stimulation, radio frequency (RF) ablation and irreversible electroporation (IRE). The resulting advanced classes of medical instruments enable soft contacts to curved tissue surfaces, with ability to address broad requirements in minimally invasive surgeries. Demonstrations with endocardial balloon catheter devices in plastic heart models and on Langendorff-perfused animal and human hearts, together with numerical multi-physics modeling of their operation, highlight some of the essential features of the technology.

Biography

Mengdi Han received his B.S. degree in 2012 from Huazhong University of Science and Technology and his Ph.D. degree in 2017 from Peking University, both in Electrical Engineering. He was a visiting scholar at Department of Materials Science and Engineering, University of Illinois Urbana-Champaign from 2015 to 2017. Starting from 2017.9, he works as a postdoctoral fellow at Querrey Simpson

Institute for Bioelectronics, Northwestern University. He published more than 60 SCI-indexed papers, including 15 first author papers published in Nature Electronics, Nature Biomedical Engineering, Proceedings of the National Academy of Sciences, Nano Letters, ACS Nano, etc. His research interests include bioelectronics, soft electronics, advanced manufacturing, and energy harvesting. His recent work focuses on advancing soft materials, mechanical designs, electrical engineering concepts, and integration strategies to yield ‘instrumented’ minimally invasive surgical tools with sensors and actuators in multiplexed array format, capable of performing customizable diagnostic and therapeutic functions.