Webinar on the Frontiers of Advanced Energy Materials Research

先进能源材料研究前沿论坛

10月17日		
时间	**议程**	**嘉宾**
10月17日 08:30-08:35	Opening	Chair: Yinzhu Jiang Zhejiang University
10月17日 08:35-08:45	Opening Address	Prof. Tiejun Zhu Zhejiang University
10月17日 08:45-09:45	Advanced Electrode Materials for Metal-ion Batteries	Prof. Zaiping Guo University of Wollongong
10月17日 09:45-10:45	Constructing Aqueous Multi-Valence Metal Ion Batteries	Prof. Qingyu Yan Nanyang Technological University
10月17日 10:45-11:45	Half-Heusler Thermoelectric Materials	Prof. Tiejun Zhu Zhejiang University
10月17日 11:45-12:45	Lunch Break	
10月17日 12:45-13:45	Innovative ElectroMaterials	Prof. Jun Chen University of Wollongong
10月17日 13:45-14:45	Multiferroic Materials for energy harvesting and conversion	Prof. Zhenxiang Cheng University of Wollongong
10月17日 14:45-15:00	Break	
10月17日 15:00-16:00	Low-dimensional Nanoarchitectured Materials for Energy Storage: Recent advances and Future Perspectives	Prof. Hui Ying Yang Singapore University of Technology and Design

10月18日		
时间	议程	嘉宾
10月18日 09:00-10:00	Oxygen Electrocatalysis by Transition Metal Spinel Oxides	Prof. Zhichuan Xu Nanyang Technological Univeristy
10月18日 10:00-11:00	Solid electrolytes based on metal-organic frameworks for Li-metal batteries	Prof. Haobin Wu Zhejiang University
10月18日 11:00-12:00	Functional Materials for Gas-Involved Energy Reactions	Dr. Tianyi Ma The University of Newcastle
10月18日 12:00-13:00	Lunch Break	
10月18日 13:00-14:00	Advanced Sodium-based Rechargeable Batteries	Prof. Yinzhu Jiang Zhejiang University
10月18日 14:00-15:30	3 Minute Presentation Competition for Graduate Students	
10月18日 15:30-15:50	Closing Remarks and Prize Announcement	Prof. Yinzhu Jiang Zhejiang University

Prof. Zaiping Guo

Zaiping Guo received a PhD in Materials Engineering from the University of Wollongong in December 2003. She was an APD Fellow at University of Wollongong, where she continued as a group leader from 2007. She is a Distinguished Professor in the school of Mechanical, Materials, Mechatronic, and Biomedical Engineering, University of Wollongong. Her research focuses on the design and application of nanomaterials for energy storage and conversion, including rechargeable batteries, hydrogen storage, and fuel cells. She published more than 450 papers in peer-reviewed Journals, more than 200 papers were published in journals with IF > 10, and these publications have been cited >26,200 times with an h-index of 88. Her research achievements have been recognised through numerous awards, including an ARC Queen Elizabeth II Fellowship in 2010, an ARC Future Professorial Fellowship in 2015, and the Clarivate Analytics Highly Cited Researcher Award in 2018, 2019, and 2020.

Report title: Advanced Electrode Materials for Metal-ion Batteries.

Abstract: Energy storage is an important problem to realize low carbon society and there have been many challenges. Metal-ion batteries have attracted remarkable attention recently due to the high energy storage demands. The requirement of feasible electrode materials with high capacity and good cycling stability has promoted the exploration of various electrode materials for metal ion batteries. Materials engineering plays a key role in the field of battery research. In particular, engineering materials at the nanoscale offers unique properties resulting in high performance electrodes in various energy storage devices. Consequently, considerable efforts have been made in recent years to fulfil the future requirements of electrochemical energy storage devices. Various multi-functional hybrid nanostructured materials are currently being studied to improve energy and power densities of next generation batteries. In this talk, I will present some of our recent progress in the synthesis of different types of hybrid nanostructures to enhance the electrochemical energy storage properties of metal-ion batteries.

Prof. Qingyu Yan

Qingyu Yan is currently a professor in School of Materials Science and Engineering in Nanyang Technology University. He obtained his BS in Materials Science and Engineering, Nanjing University. He finished his PhD from Materials Science and Engineering Department of State University of New York at Stony Brook. After that, He joined the Materials Science and Engineering Department of Rensselaer Polytechnic Institute as a postdoctoral research associate. He joined School of Materials Science and Engineering of Nanyang Technological University as an assistant professor in early

2008 and became a Professor in 2018.

He is currently the Chair of the Electrochemical Society, Singapore Section. He is a fellow of Royal Society of Chemistry Since 2018. He is a highly cited researcher in Materials Science for 2018, 2019, 2020 indicated by Thomson Reuters. Yan has published more than 300 papers (with total citation of >26000 and h index of 84) on two research area: (1) thermoelectric materials; (2) electrochemical properties of materials for energy storage or conversion.

Report title: Constructing Aqueous Multi-Valence Metal Ion Batteries.

Abstract: Aqueous Al-ion batteries (AAIBs) are the subject of great interest due to the inherent safety and high theoretical capacity of aluminum. The high abundancy and easy accessibility of aluminum raw materials further make AAIBs appealing for grid-scale energy storage. However, the passivating oxide film formation and hydrogen side reactions at the aluminum anode, as well as limited availability of cathode lead to low discharge voltage and poor cycling stability. Here, we proposed a new AAIB system consisting of AlxMnO2 cathode, zinc substrate supported Zn-Al alloy anode and an Al(OTF)3 aqueous electrolyte. Through the in-situ electrochemical activation of MnO, the cathode was synthesized to incorporate a two-electron reaction, thus enabling its high theoretical capacity. The anode was realized by a simple deposition process of Al3+ onto Zn foil substrate. The featured alloy interface layer can effectively alleviate the passivation and suppress the dendrite growth, ensuring ultralong-term stable aluminum stripping/plating. The architected cell delivers a record-high discharge voltage plateau near 1.6 V and specific capacity of 460 mAh g-1 for over 80 cycles. This work provides new opportunities for the development of high-performance and low-cost AAIBs for practical applications.

Prof. Tiejun Zhu

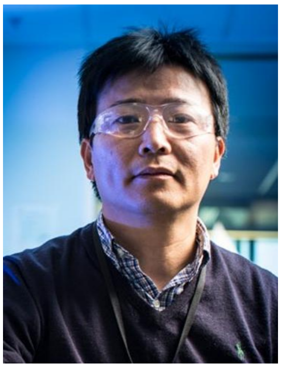
Tiejun Zhu is a Professor of Materials Science and Engineering at Zhejiang University. He obtained his Ph.D degree from Zhejiang University in 2001. He was a research fellow in Singapore-MIT Alliance from 2002 to 2004, and a visiting scientist in California Institute of Technology between 2011 and 2012. His current research is on the advanced fabrication, microstructure and transport mechanisms of high efficiency thermoelectric materials. He has published more than 250 papers. His publications have been cited more than 10000 times.

Report title: Half-Heusler Thermoelectric Materials.

Abstract: Half-Heusler (HH) compounds are important high temperature thermoelectric (TE) materials having attracted considerable attention in the recent years. High figure of merit zT values of 0.8~1.0 have been obtained in n-type ZrNiSn based HH compounds. However, developing high performance p-type HH

compounds with low cost is a big challenge. In this talk, we first show that a new p-type HH solid solutions with a high band degeneracy, Ti doped FeV0.6Nb0.4Sb, can achieve a high zT of 0.8. Further investigation shows that increasing Nb content in the Fe(V1-yNby)Sb solid solutions can achieve lower valence band effective mass and consequently higher carrier mobility. Moreover, the decrease in band effective mass can lead to the decrease in optimal carrier concentration, which is favorable for p-type Fe(V,Nb)1-xTixSb due to the limited solubility of Ti. In addition, FeNbSb has larger band gap Eg than that of FeVSb, and increasing Nb content in Fe(V1-yNby)1-xTixSb will prevent the degradation of the TE performance at high temperatures due to the bipolar conduction. Thus we obtain a high zT of 1.1 at 1100K for FeNb1-xTixSb without V substitution. More recently, we found that Hf doped FeNbSb exhibits a record high zT of 1.5 at 1200K due to simultaneously optimized electrical power factors and reduced lattice thermal conductivity. In view of abundantly available elements, good stability and high zT, FeNb1-xTixSb alloys can be great promising for high temperature power generation.

Prof. Jun Chen



Professor Chen is currently appointed as (1) Head of Postgraduate Studies | Intelligent Polymer Research Institute (IPRI); and (2) Associate Dean of Equity, Diversity & Inclusion | Australian Institute for Innovative Materials (AIIM), at The University of Wollongong (UOW). His research interests include: Sustainable Energy Devices/Systems, Electro-/Bio- Interfaces, Nano/Micro- Materials, 2D/3D Printing, and Design and Additive Fabrication of Smart Wearable Electronic Devices. Professor Chen has been identified in 2018 as Highly Cited Researchers by Web of Science - Clarivate Analytics.

Report title: Innovative ElectroMaterials.

Abstract: Since 2005, ARC Centre of Excellence for Electromaterials Science (ACES) at AIIM, funded by Australian Research Council (ARC), has been defining the cutting edge of electromaterials science with discoveries and technologies that will address some of today's most challenging global problems in clean energy, human health, and advanced manufacturing. We think of a smart device as a game-changing application, utilising the Innovative ElectroMaterials we develop in our laboratories to create new health and energy solutions that improve people's lives. Currently, ACES is focusing on the development of electromaterials-based 3D Architectures via additive fabrication for the following grand challenges:

· Contribute to the development of global sustainable energy supply.

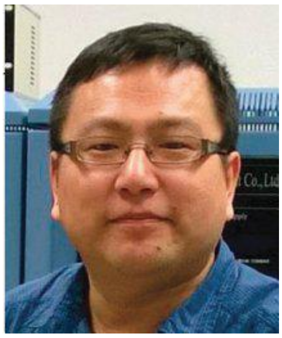
· Construct complex 3D structures with controlled element placement.

` To exquisitely manipulate fluid flow in 3D microfluidic platforms.

· To develop prosthetic limbs compatible with natural control.

· Understanding and controlling cell behaviour in 3D electromaterials structures under wired / wireless stimulation.

Prof. Zhenxiang Cheng



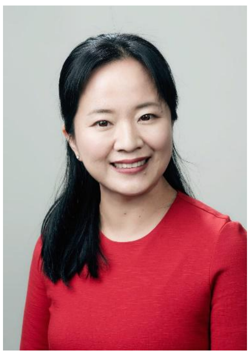
Zhenxiang Cheng is the Theme leader for Multiferroic Materials Program, and a Professor at Institution for Superconducting and Electronic Materials, Australian Institute for Innovative Materials, University of Wollongong, Australia. He received B.S. in Physics in 1995, a M.S. in Condensed Matter Physics in 1998 and a PhD in Material Science in 2001 from Shandong University, China. He was a JSPS (Japanese Society for Promotion of Science) fellow at National Institute for Material Science (NIMS) in Japan (2003-2005) and a Future Fellow from the Australia Research Council in 2009.

Cheng has published more than 400 SCI journal papers mainly in the field of applied physics, including Science, Nature Materials, Physics Report, Nature Communications, JACS and PRL. His research currently is mainly focusing on 1. Electronic polar materials and their applications 2. Multiferroic materials and the magnetoelectric coupling behaviour. 3.Nano ferroic materials for energy-related applications. 4. Magnetic and spintronic materials and the first principle calculation of electronic band structures.

Report title: Multiferroic Materials for energy harvesting and conversion.

Abstract: Multiferroic materials with the coexisting of both of spin and polarization degrees make them great application potentials in energy conversion and catalysis beyond applications based on their intrinsic ferroic property and magnetoelectric coupling. Feroelectric polarization accompanied with strong depolarization field can effectively accelerate the charge-hole separation therefore to improve the catalysis behaviour. The tunning of orbit degree of d electrons in multiferroic materials by understanding of the role of spin in the OER process can significantly improve the catalysis process. Some examples of multiferroic materials application in energy harvesting and conversation will be presented.

Prof. Hui Ying Yang



Dr. Yang Hui Ying is currently an associate professor at the Pillar of Engineering Product Development, Singapore University of Technology and Design, Singapore. She studies low dimensional nanomaterials for electrochemical energy storage and water treatment devices, which are centered on exploring the influence of function engineering and chemical doping on the materials synthesis and device performance. She has received a number of prestigious awards including the Outstanding Young

Manufacturing Engineer Award, IUMRS Young Researcher Award, IPS Nanotechnology Medal IES Prestigious Engineering Achievement Awards, Tan Kah Kee Young Inventor Award, L'Oreal Singapore for Women in Science National Fellowship, Lee Kuan Yew Fellowship, and Singapore Millennium Foundation Fellowship. She is elected to be the Fellow of Royal Chemistry Society in 2020. Her team is applying fundamental knowledge and new manufacturing methods in developing exceptional nanoscale materials and structures for efficient lithium storage and scalable water purification. Dr. Yang has published more than 260 manuscripts in top international journals with more than 12000 citations and a H-index at 61.

Report title: Low-dimensional Nanoarchitectured Materials for Energy Storage: Recent advances and Future Perspectives

Abstract: Advanced two-dimensional (2D) materials have attracted significant interest due to their extraordinary physical and chemical properties over the past decade. Understanding and controlling the growth of novel 2D crystal materials is central for the performance of various applications, spanning from electronics to energy storage. Chemical vapor deposition (CVD) method is a key technology we used to develop exceptional nanomaterials and explore their applications in effective energy storage devices as well as scalable water purification. One of the greatest challenges besetting the development of battery technologies is fast charging, especially within flexible or compact designs. We discuss how the design of low dimensional nanostructure can correlate with the ion transportation efficiency, the activity of electrochemical reaction and energy storage based on chemical transformation. We have also studied the prospects of fast prototyping and scalability for 2D materials based devices.

Prof. Zhichuan Xu

Zhichuan is an associate professor in the School of Materials Science and Engineering, Nanyang Technological University. He received his PhD degree in Electroanalytical Chemistry and B.S. degree in Chemistry from Lanzhou University, China. His PhD training was received in Lanzhou University, Institute of Physics, CAS, and Brown University. Since 2007, he worked in State University of New York at Binghamton as a Research Associate and from 2009 he worked in Massachusetts Institute of Technology as a Postdoctoral Researcher. Dr. Xu has received several awards such as Chun-Tsung Endowment Outstanding Contribution Award - Excellent Scholar at 2018 and the Zhaowu Tian Prize for Energy Electrochemistry by International Society of Electrochemistry (ISE) in 2019. He was awarded Fellow of Royal Society of Chemistry (FRSC) on Nov. 2017. He served as the president of ECS Singapore Section. Dr. Xu is a Highly Cited Researcher by Clarivate Analytics, Web of Science (2018, 2019, and 2020).

Report title: Oxygen Electrocatalysis by Transition Metal Spinel Oxides.

Abstract: Exploring efficient and low-cost oxygen electrocatalysts for ORR and OER is critical for developing renewable energy technologies like fuel cells, metal-air batteries, and water electrolyzers. This presentation will present a systematic study on oxygen electrocatalysis (ORR and OER) of transition metal spinel oxides. Starting with a model system of Mn-Co spinel, the presentation will introduce the correlation of oxygen catalytic activities of these oxides and their intrinsic chemical properties. The catalytic activity was measured by rotating disk technique and the intrinsic chemical properties were probed by synchrotron X-ray absorption techniques. It was found that molecular orbital theory is able to well-explain their activities. The attention was further extended from cubic Mn-Co spinels to tetragonal Mn-Co spinels and it was found that the molecular theory is again dominant in determining the catalytic activities. This mechanistic principle is further applied to explain the ORR/OER activities of other spinels containing other transition metals (Fe, Ni, Zn, Li, etc.). The talk further gives insight on surface reconstruction on spinel oxides and how the bulk properties affect such reconstruction during OER.

Prof. Haobin Wu

Hao Bin Wu received his B.S. degree in chemistry from Fudan University in 2010, and Ph.D. degree in materials science and engineering from Nanyang Technological University under the supervision of Prof. Xiong Wen (David) Lou in 2015. After that he joined Prof. Yunfeng Lu's group at University of California, Los Angeles as a Postdoctoral Researcher. He joined Zhejiang University in July 2017. His research interests focus on nanostructured functional materials for electrochemical energy storage and conversion. Dr. Wu has co-authored over 110 peer-reviewed articles with a H-index of 72. He was named a Clarivate Analytics' Highly Cited Researcher from 2017 to 2019 in Chemistry and Materials Science.

Report title: Solid electrolytes based on metal-organic frameworks for Li-metal batteries.

Abstract: Solid electrolytes with high ionic conductivity and stability are the key to the development of future high-energy-density lithium metal batteries. We develop a new class of nanostructured solid electrolytes by constructing ionic channels in metal-organic frameworks (MOFs). By incorporating liquid electrolyte or ionic species into the pore channels of MOFs, especially with the assistance of open metal sites, the MOF scaffolds are transformed into ionic-channel analogs with lithium-ion conductivity and low activation energy. High ionic conductivity in the orders of 10-4-10-3 S/cm is achieved at room temperature with properly selected MOFs. Compared with liquid electrolyte, the electrochemical stability of the MOF-based electrolytes is improved and the flammability is significantly suppressed. Semi-solid lithium metal batteries are further demonstrated with the as-synthesized MOF-based electrolytes, exhibiting stable operation at ambient temperature.

Dr. Tianyi Ma

Tianyi Ma received his PhD in 2013 from Nankai University, China. Then he worked as a postdoctoral research fellow from 2013 to 2014 in University of Adelaide, Australia. He was awarded Australian Research Council (ARC) Discovery Early Career Researcher Award (DECRA) in 2015, and continued independent research on the rational design of nanostructured materials and energy-related applications. He is currently a senior lecturer in University of Newcastle.

Report title: Functional Materials for Gas-Involved Energy Reactions.

Abstract: Various gas-involved, key and clean energy reactions, driven by (photo)electrocatalytic processes, including oxygen reduction reaction (ORR), oxygen evolution reaction (OER), hydrogen evolution reaction (HER), nitrogen reduction reaction (NRR), and carbon dioxide reduction reaction (CRR), have attracted tremendous research interest for the sake of clean, renewable, and efficient energy technologies. However, these heterogeneous reactions exhibit sluggish kinetics due to multistep electron transfer and only occur at triple-phase boundary regions. Therefore, much effort has been devoted to the development of cost-effective and high-performance photocatalysts and electrocatalysts to boost the activities as promising alternatives to noble metal benchmarks.

On top of the prolific achievements in materials science, the advances in interface chemistry are also very critical in consideration of the complex phenomena proceeded at triple-phase boundary regions, such as mass diffusion, electron transfer, and surface reaction. Therefore, insightful principles and effective strategies for a comprehensive optimization, ranging from active sites to electrochemical interface, are necessary to fully enhance the catalytic performance aiming at practical devices.

We have designed a series of efficient electrocatalysts and photocatalysts with multiscale principles in terms of electronic structure, surface chemistry, hierarchical morphology, and electrode interface. They have been applied in ORR, OER, HER, NRR, CRR, as well as the relevant practical applications in metal-air batteries, water splitting devices, fuel cells, etc. The synergy between nanostructure and chemical composition is systematically investigated by combining experimental evidence and theoretical simulation.

[1] Yan, J. Q., Ma, T. Y.,* et al. (2019) Single atom tungsten doped ultrathin α-Ni(OH)2 for enhanced electrocatalytic water oxidation. Nat. Commun., 10, 2149.

[2] Hao, L., Ma, T. Y.,* et al. (2019) Surface halogenation induced atomic site activation and local charge separation for superb CO2 photoreduction. Adv. Mater., 31, 1900546.

[3] Han, X. P., Ma, T. Y.,* et al. (2018) Metal–Air Batteries: From Static to Flow System. Adv. Energy Mater., 8, 1801396.

Prof. Yinzhu Jiang

Yinzhu Jiang is a full professor at School of Materials Science and Engineering in Zhejiang University, China. He received his Ph.D. degree in Department of Materials Science and Engineering from University of Science and Technology of China in 2007. He worked as a post-doctoral researcher in Heriot-Watt University, United Kingdom from 2007 to 2008 and an Alexander von Humboldt Fellow in Bielefeld University, Germany from 2008 to 2010. His research interests focus mainly on energy-related materials and electrochemistry, including rechargeable batteries, metal anodes and solid electrolytes.

Report title: Advanced sodium-based rechargeable batteries.

Abstract: The past decade has witnessed a rapidly growing interest towards sodium ion battery (SIB) for large-scale energy storage in view of the abundance and easy accessibility of sodium resources. Nevertheless, multiple challenges are yet to be addressed for a transition from laboratory to practical applications. In this context, the development of high-performance anode materials is vital. Anode materials featuring a combined conversion and alloying mechanisms upon sodium storage, are regarded as one of the most attractive alternatives due to their high theoretical capacities and relatively low working voltages. In this review, the current understanding of sodium-storage mechanisms in combined conversion-alloying anode materials is presented. The challenges faced by these materials in SIBs, and the corresponding improvement strategies are comprehensively discussed in correlation with the resulting electrochemical behavior. Finally, guidance and perspectives towards the development of advanced combined conversion-alloying materials for advanced sodium rechargeable batteries are provided.