IWHTE

International Workshop of Young Scholars in Heat Transfer and Energy

April 26-28, 2019
Qingdao, China

Qingdao University of Science and Technology
Tsinghua University
Organization

Chairman
Bingyang Cao, Tsinghua University

Co-Chairman
Xiulin Ruan, Purdue University

Organization Committee
Guihua Tang, Xi’an Jiaotong University
Rong Chen, Chongqing University
Yong Shuai, Harbin Institute of Technology
Zepeng Wang, Qingdao University of Science and Technology
Yan He, Qingdao University of Science and Technology

Secretary General
Weigang Ma, Tsinghua University
# Agenda

## International Workshop of Young Scholars in Heat Transfer and Energy

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<td>Apr. 26</td>
<td>9:00-22:00</td>
<td>Registration</td>
<td>Hotel Lobby Huanghai Hotel</td>
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<td>18:00-20:30</td>
<td>Welcome Reception</td>
<td>Zhonghua Hall, 2nd floor</td>
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<td>Apr. 27</td>
<td>8:30-9:00</td>
<td>Opening Ceremony</td>
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<td>9:00-9:10</td>
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<td>9:10-9:50</td>
<td>Plenary Speaker: Yuri Kuzma-Kichta</td>
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<td>Moscow Power Engineering Institute, Russia</td>
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<td>9:50-10:30</td>
<td>Plenary Speaker: Chien-Yuh Yang</td>
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<td>‘Central’ University, Chinese Taipei</td>
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<td>10:30-10:40</td>
<td>Coffee Break</td>
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<td>10:40-11:20</td>
<td>Plenary Speaker: Masataka Mochizuki</td>
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<td>President of the Heat Pipes, Japan</td>
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<td>11:20-12:00</td>
<td>Plenary Speaker: Xiulin Ruan</td>
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<td>Purdue University, USA</td>
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<td>12:00-14:00</td>
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<td>14:00-14:10</td>
<td>Opening Ceremony of IWHTE</td>
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<td>Bingyang Cao, Chair of IWHTE, Tsinghua University</td>
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<td>Xing Zhang, Co-Chair of ISMNT 7, Tsinghua University</td>
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<td>14:10-14:40</td>
<td>Keynote Speaker: Baoxin Xu</td>
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<td>University of Virginia</td>
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<td>14:40-15:10</td>
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<td>City University of Hong Kong</td>
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<td>Invited Speaker: Wee-Liat Ong</td>
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<td>Apr. 27</td>
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<td>Keynote Speaker: Yong Shuai Harbin Institute of Technology</td>
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<td>16:15-16:35</td>
<td>Invited Speaker: Menglong Hao University of California, Berkeley</td>
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<td>16:55-17:15</td>
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<td>17:15-17:35</td>
<td>Invited Speaker: Xiaokun Gu Shanghai Jiao Tong University</td>
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<td>18:30-21:00</td>
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<td>Apr. 28</td>
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<td>Keynote Speaker: Shoji Mori Kyushu University</td>
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<td>Keynote Speaker: Paddy Chan The University of Hong Kong</td>
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<td>Invited Speaker: Hang Zhang Institute of Engineering Thermophysics, CAS</td>
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<td>Keynote Speaker: Bong Jae Lee KAIST</td>
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Session Chairs:
Liang Gong, China University of Petroleum
Mingjia Li, Xi’an Jiaotong University
Zheng Bo, Zhejiang University
Haidong Wang, Tsinghua University
Jun Shen, Technical Institute of Physics and Chemistry, CAS
Chengbin Zhang, Southeast University
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Bai Song  Peking University
Baoaning Huang  The Hong Kong University of Science and Technology
Baoxing Xu  University of Virginia
Bingyang Cao  Tsinghua University
Bong Jae Lee  KAIST
Chao Xu  North China Electric Power University
Chengbin Zhang  Southeast University
Cunliang Liu  Northwestern Polytechnical University
Cunlu Zhao  Xi’an Jiaotong University
Daili Feng  University of Science and Technology Beijing
Desong Fan  Nanjing University of Science and Technology
Dong Li  Northeast Petroleum University
Dongyan Xu  The Chinese University of Hong Kong
Haidong Wang  Tsinghua University
Hang Zhang  Institute of Engineering Thermophysics, CAS
Hongtao Xu  University of Shanghai for Science and Technology
Jianli Wang  Southeast University
Jianyong Chen  Guangdong University of Technology
Jie Chen  Tongji University
Jingzhi Zhang  Shandong University
Jun Li  Chongqing University
Jun Shen  Technical Institute of Physics and Chemistry, CAS
Ke Wang  Zhengzhou University
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<td>Zhonghao Rao</td>
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<td>Zuankai Wang</td>
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Participants Introduction

Prof. Bai Song

Institution: Peking University
Department: Energy and Resources Engineering
Position: Assistant Professor
Email: songbai@pku.edu.cn

Research areas
Heat Light; Energy; Nano; Bio

Short biography
Dr. Bai Song is an assistant professor in the College of Engineering at Peking University (PKU), Beijing, and a Co-PI at the Beijing Innovation Center for Engineering Science and Advanced Technology. He is also supported by the Thousand Young Talents program. Prior to PKU, he worked as a postdoctoral associate in the Mechanical Engineering Department at the Massachusetts Institute of Technology. He earned his PhD in 2015 in Mechanical Engineering at the University of Michigan, Ann Arbor, where he was honored with the ProQuest Distinguished Dissertation Award. He obtained his ME and BE at Tsinghua University, Beijing, and was a recipient of the Distinguished Master Thesis Award. He explores anything with an interesting thermal aspect, with a primary focus on the experimental, computational, and theoretical study of heat generation, transport, conversion, and storage, in diverse materials, devices and systems, and especially at small spatial and temporal scales. He further aims to leverage such knowledge to develop engineering solutions to real-world challenges in key areas including energy and environment, electronics and optoelectronics, quantum materials, and space exploration. He has published 3 papers in Nature and Science and 5 in their sister journals such as Nature Nanotechnology and Science Advances, on the fundamentals of nanoscale thermal radiation, phonon localization and second sound, and semiconductors and polymers of unusual high thermal conductivity.

Title of the talk
Extraordinary radiative heat transport at the nanoscale
**Short abstract**
Radiative heat transfer between objects separated by nanometer-sized gaps is of considerable interest for a variety of novel applications, including energy conversion, thermal logic, lithography, data storage, and scanning thermal microscopy. Although thermal radiation over macroscopic distances has been well understood for over a hundred years in terms of Planck’s law and the Stefan-Boltzmann law, radiative heat transfer at the nanoscale and the wave nature of thermal radiation remain largely unexplored. In this talk I will briefly review our recent study of some of the most fundamental questions in the field of nanoscale thermal radiation: 1) Can existing theories accurately describe radiative heat transfer in gaps as small as a few nanometers in size? 2) Can nanometer-thin films effectively interact with nanoscale radiation characterized by wavelengths in the micrometer range? 3) Can radiative thermal conductance in nanoscale gaps exceed those between blackbodies by a few orders of magnitude? To answer these questions, we built novel experimental platforms featuring nanometer-precise positioning mechanisms in conjunction with novel microdevices and scanning probes. Further, we performed state-of-the-art calculations and analysis to compare theoretical predictions with experimental observations. I will demonstrate that: 1) Current nanoscale radiation theories can adequately describe radiative heat transfer down to about 1 nm gaps. 2) Nanometer-thin films can enhance radiative heat transfer in nanometer gaps as effectively as bulk materials. 3) Radiative thermal conductance can exceed the blackbody limit by over 1000 times. These advances opened up many new opportunities in the emerging field of nanoscale thermal radiation. I will conclude with a brief discussion of ideas for further exploration.
Prof. Baoling Huang

Institution: The Hong Kong University of Science and Technology
Department: Mechanical and Aerospace Engineering
Position: Associate Professor
Email: mebhuang@ust.hk

Research areas
Microscale heat transfer; Thermoelectric devices and materials; Solar thermal conversion; Solid-state energy storage

Short biography
Prof Huang received his B.S. and M.S. degrees in Engineering Thermophysics from Tsinghua University, Beijing, China in 1999 and 2001. He worked in industry from 2001 to 2004. In 2008, he received his Ph.D. degree in Mechanical Engineering from the University of Michigan, Ann Arbor, USA. After graduation, he worked as a postdoctoral research fellow at the University of California, Berkeley and Lawrance Berkeley National Laboratory. He joined the Hong Kong University of Science and Technology in 2010. He has research experience in both theoretical modeling and experimental fabrications/measurements. His research interests are in the broad area of energy transport, conversion and storage.

Title of the talk
All-ceramic multilayer selective solar absorbers for concentrated solar power

Short abstract
Concentrated solar power (CSP) is a promising solar energy harvesting technology due to its efficient sunlight utilization, and high availability in energy storage. Selective solar absorbers, as the key components in CSP systems, are required to offer high stability and great selectivity at high temperatures. Selective solar absorbers based on multilayer metal/ceramic thin films are of low cost and excellent scalability. However, their thermal stability and spectral selectivity fall behind those state-of-the-art cermets and photonic absorbers. Here we propose an all-ceramic TiN/TiNO/ZrO2/SiO2 absorber with highly selective absorption, i.e., a high solar absorptance (91.2%) yet an ultralow thermal emittance (15.7% @ 1000 K), producing
an unprecedented solar-thermal conversion efficiency of 82.1% under 100-sun. Remarkably, the absorber is thermally stable up to 1000 K, boosting the operating temperature of conventional multilayer absorbers by ~300 K. The efficient and stable all-ceramic absorber can be readily produced in quantity via low-cost processes, rendering it an ideal candidate for high-temperature solar thermal technologies.
Research areas
Thermal transport of deformable materials; Multiscale mechanics in nanomanufacturing; Soft-hard integration

Short biography
Dr. Baoxing Xu is currently an assistant Professor in the Department of Mechanical and Aerospace Engineering at The University of Virginia. He received his PhD in Mechanics and Materials from Columbia University in 2012 and was a Beckman Postdoctoral Fellow at the University of Illinois at Urbana-Champaign from 2012 to 2014. Xu’s group research interests are focused on mechanics in extreme manufacturing of functional materials, structures and devices, bioinspired stretchable devices and structures, soft-hard material integrated systems, and thermal transport in extreme conditions.

Title of the talk
Thermal transport of mechanically deformed heterostructures and applications to sensor design

Short abstract
Heterostructures offer a unique platform for future energy efficient and multifunctional nanoelectronics and yet the inherent difference of material lattice structures between layer components or external loading conditions will render mechanical deformation. Understanding the fundamental thermal transport of these deformed heterostructures will be crucial for designing emerging heterostructures of relevance to applications in stretchable electronic and thermal devices with controllable heat-power dissipation and thermal management. In this talk, I will first present our understanding of thermal transports in heterostructures with structurally programmable layer components subjected to a mechanical loading. Then, I will talk designs of mechanical sensors by leveraging the unique response of thermal transport to mechanical loading and demonstrate the feasibility and reliability of their sensing functionalities.
**Prof. Bingyang Cao**

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<td>Engineering Mechanics</td>
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<td>Position</td>
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<td>Email</td>
<td><a href="mailto:caoby@tsinghua.edu.cn">caoby@tsinghua.edu.cn</a></td>
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**Research areas**

Nano-/Microscale heat transport; Thermal functional materials; Advanced thermal management technology

**Short biography**

Bingyang Cao is full professor and vice dean in the School of Aerospace Engineering, Tsinghua University. He got bachelor degree in 1998 and master degree in 2001 from Shandong University, and doctor degree of power engineering and engineering thermophysics in 2005 from Tsinghua University. He joined Tsinghua University in 2005 as a lecturer, was promoted to associate professor in 2008, and was exceptionally promoted to full professor in 2013. He was awarded the MOE New Century Talented Scientists Program (2011), the Excellent Youth Funding of NSFC (2013), the Zhonghua Wu Outstanding Young Scholar Award from China Engineering Thermophysics Society (2014), the Outstanding Young Scientists of NSFC (2018), the First Prize of Natural Science of MOE (2019), and the IAAM Medal from International Association of Advanced Materials (2019). He currently serves as chair of the Young Scientist Committee of the Heat and Mass Transfer Society of China, vice-chair of the Thermally Conductive Composite Committee of the Composite Society of China, executive committee member of the Asian Union of Thermal Science and Engineering, member of the Heat and Mass Transfer Society of China, member of the Combustion and Heat Transfer Committee of the Chinese Society of Astronautics, member of the Space Energy Committee of the Chinese Society of Astronautics, and member of the Union for Thermal Management Technology of China. His main research areas include micro-/nanoscale heat transport, thermally functional materials and advanced thermal management technologies. He has published more than 130 SCI-indexed journal papers. He is currently serving as Editor-in-Chief of ES Energy & Environment, editorial member of 6 international journals, including Journal of Physics: Condensed Matter (SCI), Scientific Reports (SCI), PloS One (SCI), Advances in Materials Research (SCI).
Research areas
Near-field thermophotovoltaic energy conversion system; Solar energy harvesting system using nanomaterials; Micro/nanoscale thermometry

Short biography
Dr. Bong Jae Lee is an Associate Professor in the Department of Mechanical Engineering at the Korea Advanced Institute of Science and Technology (KAIST). Prior to joining KAIST in 2011, Dr. Lee has worked in the Department of Mechanical Engineering and Materials Science at the University of Pittsburgh as an Assistant Professor for three years. He received his B.S. degree in Mechanical Engineering from Seoul National University in 2001 and his M.S. and Ph.D. degrees from the Georgia Institute of Technology in 2005 and 2007, respectively. Dr. Lee was the winner of the Georgia Tech Chapter of Sigma Xi Best Ph.D. Thesis Award in 2008 and was the recipient of the ASME - Hewlett Packard Best Paper Award (2nd place) in 2007. He also received Young Investigator Award from Thermal Engineering Division, KSME in 2014.

Title of the talk
Radiative properties of nanostructures

Short abstract
Tailoring thermal radiative properties using micro/nanostructured surfaces has drawn much attention due to potential applications in energy conversion devices, space thermal management, and infrared radiation detection. Thermal radiative properties can be spectrally and/or directionally controlled by exploiting electromagnetic resonance phenomena, such as surface plasmon, localized surface plasmon, and magnetic resonance. This presentation will address the fundamentals of electromagnetic resonance phenomena on sub-wavelength nanostructures and will provide some insights on the application of designed nanostructures in energy harvesting (e.g., photovoltaic and solar thermal devices). The second part of this presentation will outline the current research activities in Thermal Radiation Laboratory at KAIST.
Research areas
Thermal energy storage; Concentrating solar power; Concentrating PV/thermal; Fuel cells

Short biography
I got my Bachelor degree and Master degree in Xi’an Jiaotong University at 2002 and 2004, and got my PhD degree in Hong Kong University of Science and Technology at 2008. After the two years of post-doc period at University of Connecticut, USA, I joined Institute of Electrical Engineering of Chinese Academy of Sciences as an associate professor at 2010, and I joined North China Electric Power University as a full professor at 2013.

I have extensive research experiences in sustainable energy technologies and heat and mass transfer in micro-fluidics and electrochemical systems both numerically and experimentally. Currently, my research is focused on concentrated solar power (CSP) technology, thermal energy storage (TES), fuel cells, electronic cooling technology, etc. I have published more than 80 papers in prestigious peer-reviewed journals in the fields of new energy and electrochemistry systems. My publications have been widely cited for over 1600 times, nine of my papers have been indexed by ESI, and I have an SCI H-index of 31.

I have served as PI for several national projects, including the excellent young researcher funding of NSF, the national youth talent support program, a division of a national 973 project, and a young researcher funding of NSF.

In 2014 I have been awarded the Wuzhonghua excellent young scholar award. In the international community, I served as an associate editor for Science Bulletin in 2013-2017, and the editorial board member for Energies, Frontiers in Heat and Mass Transfer, etc.

Title of the talk
Solid-liquid phase change of molten salt and its utilization for high temperature heat storage

Short abstract
High temperature heat storage using latent heat is in urgent need for concentrating solar power, industrial energy saving, etc. This presentation will focus on the solid-liquid phase change of molten salt and its utilization for high temperature heat storage. The presentation will cover the following three aspects: the evolution of the mushy zone during the phase change of molten salt, the constrained melting process of molten salt inside an encapsulation, and the thermal performance of a storage system packed by PCM capsules.

Firstly, experimental study on the evolution of the mushy zone during the phase change of a high-temperature molten salt will be reported. The visual melting process was conducted in a container with one-side heating. Based on the obtained data, the temperature variation of the melting front was revealed, the moving rate of the melting front and the width of the mushy zone were calculated. Finally, two dimensionless formulas as functions of Stefan and Fourier numbers were developed to calculate the location of the melting front and the width of the mushy zone.

Secondly, the constrained melting process of molten salt inside a single spherical encapsulation will be analyzed. It is found the occurring natural convection significantly affect the melting front and accelerate the melting rate. Besides, the results show that the reported effective thermal conductivity equations can’t accurately calculate the natural convection during the melting process at very common conditions. Therefore, a new effective thermal conductivity correlation was developed to estimate the natural convection during the melting process with a relative error less than 8%.

Finally, the thermal performance of the packed-bed thermal energy storage (PBTES) system with PCM encapsulations will be reported. It is found phase change temperature of PCM and the cut-off temperature should be carefully chosen to take advantages of latent heat in practical applications. A cascaded PBTES system with PCM encapsulation is recommended for the phase change TES with large temperature differences.
Prof. Chengbin Zhang

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Position    | Associate professor  
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Research areas
micro/nano-scale fluid flow and heat transfer; Droplet dynamics; condensation and gas-liquid flow; Application of fractal in micro/nano-system

Short biography
Chengbin Zhang is Zhishan chair scholar and an associate professor at School of Energy and Environment, Southeast University, PR China. He graduated from East China Jiaotong University with a bachelor degree in Building Environment and Equipment Engineering in 2005 and Southeast University with a master's degree in Heating, Ventilating and Air Conditioning Engineering in 2008. He received his doctor degree in power engineering and engineering thermophysics in Southeast University in March, 2013 and continued to work in Southeast University as a lecturer. He became an associate professor at Southeast University in June 2016. His research covers a wide range of topics in micro/nano-scale fluid flow and heat transfer including droplet dynamics, condensation, gas-liquid multiphase flow, and the applications of fractal in micro/nano-system. He headed over in the project research of National Natural Science Foundation of China, Natural Science Foundation of Jiangsu Province, et al. He has published over 40 peer-reviewed papers in international journals, including Applied Physics Letters, AIChE Journal and International Journal of Heat and Mass Transfer, and his research paper has been cited by Web of Science over than 500 times. He also authorized over 10 inventive patents. He won the first prize in China’s Natural Science Award of Ministry of Education in 2011, the Outstanding Doctoral Thesis of Jiangsu Province in 2014, the Excellent Young Scholar of Jiangsu Province in 2017 and the Six-talent peak of Jiangsu Province in 2018 et al.
Prof. Cunliang Liu

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<th>Institution</th>
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<td>Department</td>
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**Research areas**
Heat transfer and cooling technology in aero-engine and gas turbine system

**Short biography**
Dr. Cunliang Liu received his Bachelor Degree in Thermal Engineering in 2005, his Ph.D in Aeronautical and Astronautical Propulsion Theory and Engineering in 2009, both from Northwestern Polytechnical University. He works on the state of the art technologies in the turbine film cooling and thermal analysis. Based on the self-developed transient heat transfer measurement technique with nonuniform initial temperature condition and turbulent heat diffusion models (turbulent Prandtl number distribution models), film cooling of diffuser shaped hole configurations and converging slot film hole configurations was studied to reveal the correlation rules and mechanism of their film cooling characteristics to the related aero-structure parameters. The effects and related mechanism of rib structure and cross-flow parameter in coolant channel, geometry deviation of hole structure and mainstream turbulence intensity on the film cooling characteristics were also revealed. He established a new analysis method for the unsteady convective heat transfer with the spatial distribution of the changing rate of unsteady flow temperature. And based on this method, the influence mechanism of unsteady flow temperature and wall thermal boundary conditions on the temporal behavior of turbine blade heat transfer coefficient has been revealed. At present, Dr. Cunliang Liu is author or coauthor of more than 65 papers in archival journals and conference proceedings. 9 patents have been authorized. And some research results have been applied in the design by aero-engine institute. He has been awarded the Humboldt Research Fellowship, the First Prize of Science and Technology Award of Shaanxi Higher Education and the Shaanxi Young Scholar Award, and been elected as the Member of the ASME Gas Turbine Heat Transfer Committee, and served as Session Chair of the ASME TURBO EXPOs.
Research areas
Electro-thermo-kinetic transport; Microfluidics and Nanofluidics; Blue Energy

Short biography
Dr. Cunlu Zhao is currently a Professor in the Department of Thermo-Fluid Science and Engineering of the School of Energy and Power Engineering at Xi’an Jiaotong University. He received his PhD in the School of Mechanical and Aerospace Engineering from Nanyang Technological University in 2012 and was a Postdoctoral Research Fellow at the University of Twente in the Netherlands from 2013 to 2016. Dr. Zhao’s research interests include microfluidics and nanofluidics, electrokinetic and thermokinetic transport phenomena, topology optimization of micro/nanoscale transport, thermal management and blue energy etc.

Title of the talk
Electrokinetics-based micro- and nano-scale transport: some fundamentals and applications

Short abstract
Electrokinetics-based micro- and nanoscale transport nowadays plays important roles in various emerging technologies such as microfluidic lab-on-a-chips, soil remediation, fuel cells and salinity energy harvesting etc. In this talk, I will first discuss some fundamental aspects of electrokinetic transport related to non-Newtonian fluids, charge regulation and induced charge effects. Then, I will present some applications related to induced-charge electrokinetic transport, such as particle trapping/enrichment and ion selection. At last, I briefly present our current focus on the temperature-gradient-driven electrokinetic transport and electrokinetic energy conversion in nanocapillaries and their potential applications in energy harvesting and low-grade waste heat recovery.
Research areas
Heat and mass transfer phenomena at microscale interface; Thermophysical properties of energy materials; Energy system optimization

Short biography
She obtained her PhD degree from University of Science and Technology Beijing in 2015, majored in engineering thermophysics. She has been working in the field of micro/nano-assembled phase change materials (PCMs), including the design and synthesis of nanopore-based composite PCMs, the molecular simulation for predicting phase change thermal properties and revealing the underlying mechanism caused by nano-scale size effect and interface effect. She has presided over 5 government sponsored researches, supported by the National Natural Science Foundation of China, National key research and development program and Beijing Municipal Natural Science Foundation. She also served as a member of youth committee in heat and mass transfer of Chinese society of engineering thermophysics, and a member of youth committee in Beijing institute of thermal physics and energy engineering.

Title of the talk
Phase change in modified nanoporous materials: mechanism on highly improved energy storage performance

Short abstract
The mechanism of host--guest interaction driven phase change behavior is still unclear, although many pore-based composite phase change materials have been synthesized and tested. Here, we prepared stearic acid-metal organic framework MIL-101(Cr) composite phase change materials (PCMs). FTIR, PXRD, DSC, and 3-omega measurements were used to evaluate the constructional and phase change thermal properties of the obtained composites. With a pseudo-supercritical path
(PSCP)-based molecular dynamics method, the melting temperature and enthalpy in a complex restricted space were well predicted, and the radius of gyration, interaction energy, atom-atom radial distribution functions were further analyzed. The results showed that the surface modification highly improved the loading capacity for stearic acid (SA), from 30 wt% to 70 wt%, with a fusion enthalpy increasing from 46.3 J/g to 110.01 J/g, owing to the new formation of hydrogen bonding between modified surface and PCM. Thermal conductivity of the host–guest PCM was increased by 68.2%, which was higher than that of either the MIL-101(Cr)-NH₂ or the SA alone. It was important to study the underlying mechanism of modified surface on energy storage in confined nanopores. The discussion suggested a controllable design and preparation for high performance PCM composite.
Prof. Desong Fan

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Research areas
Thermal radiation; Thermal functional material; Electronics cooling

Short biography
Desong Fan, Doctor of Philosophy, Associate professor, and Master Supervisor.
Desong Fan earned his Ph.D. in thermal science from Nanjing University of Science and Technology (NJUST) in 2013. His research was awarded the Jiangsu Provincial Outstanding Doctoral Dissertation Award in 2014. He was a scholar with a Jiangsu Province"Six Talent Peak"(2016), an Excellent Young Scholars of Jiangsu Natural Science Foundation(2019). Currently, he is a director of thermal engineering Lab in NJUST. His research interests include the adaptive regulation of thermal radiation, space cooling paints, and electronics cooling. He also has experience in technology areas including sputtering, etching, spectra detection, and the rest processing tech. He presided over the National Natural Science Foundation of “smart thermal control film”(2014), the National Natural Science Foundation of “Multi-fields modulation of thermal radiative properties in thermochromic film”(2019), and other projects about 10 items. About 20 academic paper has published in international journal.
Prof. Dong Li

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Research areas
Solar energy utilization; Building energy saving; Optical properties of materials

Short biography
Dr. Dong Li is a full professor in the School of Architecture and Civil Engineering at Northeast Petroleum University (NEPU) in Daqing, China. And he is dean of Department of Building Environment and Thermal Energy Engineering at Northeast Petroleum University. He received the B.S. degree in Thermal Engineering in 2006 from Northeast Petroleum University and Ph.D. degree in Engineering Thermophysics in 2013 from Harbin Institute of Technology. In Apr. 2006, he joined the faculty of Northeast Petroleum University, China. From September 2014 to October 2015, he was a Visiting Scientist with the Material and Metallurgical Engineering, South Dakota School of Mines and Technology, Rapid City, South Dakota, USA. His current research interests are in the areas of solar energy utilization, building energy saving, and optical properties of materials. He has authored/co-authored about 120 journal papers and has 52 patented inventions in his current research. He also serves as a regular reviewer of many international journals on solar energy, building energy saving, and optical properties of materials. In addition, he serves on the Editorial Board of the Energy Conservation Technology, Journal of Applied Optics. Dr. Dong Li was a recipient of the 2018 Youth Top-notch Talent Support Program in NEPU, and the 2017 Youth Longjiang scholar.
Prof. Dongyan Xu

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Research areas
Micro/nanoscale heat transfer; Thermoelectrics; Boiling heat transfer; Thermal management; Microfluidics

Short biography
Prof. Dongyan Xu is currently an Associate Professor in the Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong. Prof. Xu received her Bachelor, Master, and Ph.D. degrees from Tsinghua University and Vanderbilt University. After that, she worked as a Postdoc in the University of California, Berkeley and Lawrence Berkeley National Laboratory for two years. She joined CUHK in 2010 as an Assistant Professor and was promoted to Associate Professor in 2016. Her current research interests include nanoscale heat transfer, thermoelectric materials and devices, thermal management, and boiling heat transfer.

Title of the talk
Advanced thermal energy harvesting devices for low-power electronic applications

Short abstract
With the recent advance of wireless sensor network and wearable electronics, there is a strong motivation to develop low-cost energy harvesting devices that can scavenge energy from the ambient environment and convert it to electricity. In this talk, I will present our recent research efforts on developing two types of thermal energy harvesting devices: (1) thermoelectric generators; (2) thermogalvanic cells. High power density micro-thermoelectric generators were developed by integrating pulsed electroplating with microfabrication processes. Through systematic optimization of materials properties, a record high power density of 13.6 mW cm\(^{-2}\) is achieved at a temperature difference of 34°C for flexible thermoelectric generators. The high power density can be attributed to the enhanced thermoelectric properties of the electroplated
materials, low parasitic contact electrical resistance, and high packing density of thermoelectric pillars. Compared to traditional thermoelectric devices, thermogalvanic cells can generate a much larger voltage, at a given temperature difference, due to the inherently high Seebeck coefficient of redox couples. However, the power output of flexible thermogalvanic cells is limited by the large internal resistance of the gel electrolyte, caused by the cell overpotential and resistance of charge and mass transfer. We tackled this issue by adding a trace amount of graphene into a gel electrolyte that is made of PVA and Fe(CN)$_6^{3-}$/Fe(CN)$_6^{4-}$ redox couple dissolved in water. Our preliminary study showed that only 1% graphene can effectively reduce the cell overpotential and the internal resistance. A single cell can achieve a maximum areal power density of 9.5 mW/m$^2$, which is comparable to the result reported in the literature.
Research areas
Nanoscale heat transfer; 2D materials; Thermal properties; Thermal functional devices

Short biography
Wang Haidong has achieved his PhD degree in Tsinghua University in 2011, after that he continued his research as a post-doc in Tsinghua until 2013. Then he worked as an assistant professor in Kyushu University in Japan for 4 years and came back to Tsinghua University as an associate professor in 2018. His current research interest is designing and fabrication of nanodevices, experimental characterization of thermal and electrical properties of low-dimensional nanomaterials.
Prof. Hang Zhang

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Research areas
Heat transfer at micro/nano scale; Energy transport and conversion; Optimization on devices and materials for energy applications

Short biography
Dr. Zhang is a Professor in Institute of Engineering Thermophysics, Chinese Academy of Sciences, which is located in Beijing, China. He earned his BS degree from Department of Physics at Nanjing University in 2007, and the PhD degree from Department of Physics at University of California, Riverside in 2012. In the years from 2013 to 2016, he was a postdoctoral scholar in Caltech. Dr. Zhang received Chinese Government Award For Outstanding Self-Financed Students Abroad in 2012 and the Wu Zhong-hua outstanding Young Scholar Award from Chinese Society of Engineering Thermophysics in 2017. Up to now, he has published more than 30 SCI papers on international journals (including Nature series journals, Advanced materials, PRX, Nano Letters etc.) and the total citation is higher than 2500 times (Google Scholar). His research interests focus on heat transfer at micro/nano scale; energy transport and conversion and optimization on devices and materials for energy applications.

Title of the talk
Measurement and tuning on the spectra of heat carriers

Short abstract
By performing the size-effect thermal conductivity measurements and calculating the heat flux suppression functions, we extracted spectral information and quantitative rules of thermal transport contributions from various phonons. According to the differences on physical properties and contributions to the thermal conduction of heat carriers in different spectral bands, the thermal transport properties of the whole spectrum were correspondingly tuned, which results in optimal performance on energy transport or conversion. The mechanisms behind the optimal configurations were revealed.
Prof. Hongtao Xu

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University of Shanghai for Science and Technology

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Institute of Engineering
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Research areas
Mechanism of heat and mass transfer; Solar energy utilization and energy saving and storage technology; Formation and prevention of combustion pollutants; Fire dynamics and building physics

Short biography
Hongtao Xu received his B.S. and M.S. from Xi'an Jiaotong University in 1999, 2002 and PhD from the Hong Kong Polytechnic University in 2005. After that, he worked in two consulting companies of Parson Brinckerhoff and AECOM for 6 years. In 2011, he joined University of Shanghai for Science and Technology. Now, he is active in many academic committee, such as Youth Working Committee of China Engineering Thermophysics Society, Boiler Technical Committee of China Boiler and Boiler Water Treatment Association et.al. He is also one drafter of the national standard of GB/T 36699-2018 Technical Conditions for Boiler Liquid and Gas Fuel Burners. Since 2013, he conducted one NSFC project, two Shanghai Fund projects and joined one National Key R&D Program. Now, he has published 32 SCI papers in international journals.
Professor Jianli Wang

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Research areas
Heat transfer at micro/nano scale; Thermal/electrical characterization; Design, install and support experimental system; Optimization design

Short biography
Dr. Wang is a associate Professor in Mechanical Engineering at Southeast University, which is located in Nanjing, Jiangsu Province of China. He earned his BS degree from the school of Energy and Power Engineering at Xi'an Jiaotong University in 2005, and the PhD degree from Power Engineering and Engineering Thermophysics at Tsinghua University in 2010. In the years from 2013 and 2014, he was a visiting scholar in school of material science in Caltech and in the school of mechanical engineering in Purdue University. At this period, his work was the ultrafast laser spectroscopy. Dr. Wang got National Excellent PhD Dissertation nomination in 2014. Up to now, he has published more than 20 papers in international journals and was funded by National Natural Science Foundation of China in 2014 and 2018. His research interests focus on heat transfer at micro/nanoscale; theoretical and experimental study of thermal contact resistance; designing, installing and supporting experimental system.

Title of the talk
Application of time-domain thermoreflectance technique in determining the energy transport in nanostructures

Short abstract
Time-domain thermoreflectance (TDTR) technique has been demonstrated as an effective tool in determining the energy transport in nanostructures. Using this technique, we present our studies of the ultrafast carrier dynamics in semiconductors and the thermal transport property in graphene-sandwiched multilayer nanofilms. On a picosecond time scale, the ultrafast reflectivity measured from a semiconductor film is comprised of damped oscillatory and non-oscillatory components, which are
induced by coherent phonons and relaxation of photo-excited carriers, respectively. The latter can be further interpreted by three distinct processes, including the free carrier absorption, band filling and electron-hole combination. Based on this fact, a model is proposed to account for the combined effect of the intraband and interband transition, which can be used to explain the rich phenomenon on ultrafast reflectivity. On the other hand, when the thermal equilibrium between the carrier and phonon is achieved, the TDTR has been proved to be a reliable technique to characterize the thermal performance of the multilayered nanostructure. To extract the thermal conductivity of each layer and the thermal boundary resistances in the Al/W/G/W/SiO₂/Si multilayer structure, a serial samples, including W/SiO₂/Si, Al/W/SiO₂/Si, and Al/(W/G)ₙ=1,3/W/SiO₂/Si, are fabricated. The thermal conductances of Al/W, W/G/W, and W/SiO₂ interfaces are found to be about 315, 32.4, and 13.4 MWm⁻²K⁻¹, respectively. Understanding the energy transfer mechanisms and thermal properties of the multilayered nanostructures that comprised microelectronic devices establishes the foundation for reliable product design.
Prof. Jianyong Chen

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Research areas
Heat transfer enhancement; System optimization; Energy saving in the thermal system

Short biography
Dr. Jianyong Chen got his Ph.D at Royal Institute of Technology-KTH, Stockholm, Sweden in 2015. After that, he has been working as a lecturer and researcher at Guangdong University of Technology, Guangdong, China. His research interests include energy saving in thermal systems, heat transfer enhancement technologies, etc. He got grants from National Natural Science Foundation of China (NSFC) and Science and Technology Program of Guangzhou. His recent research is more focusing on applying vapor-liquid separation to the condensation and evaporation in different heat exchangers, such as fin-and-tube, tube-and-shell, plate heat exchanger, for performance improvements.
Prof. Jie Chen

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Position  Professor
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Research areas
Nanoscale thermal transport; Thermoelectric materials; Thermal interface materials; Phononics

Short biography
Jie Chen is a full professor of Physics at Tongji University. He obtained his Ph.D. degree in Physics from National University of Singapore in 2012. He then worked as an ETH Fellow with Professor Petros Koumoutsakos at ETH Zurich from 2013 to 2015. He has been a faculty member at Tongji University since 2015. His research focuses on nanoscale thermal transport, thermoelectric materials, thermal interface materials, and phononics. He has published over 40 papers in international peer-reviewed journals, and his current H-index is 20.

Title of the talk
Coherent phonon transport and phonon localization in carbon based nanomaterials

Short abstract
Coherent transport of phonons offers unprecedented opportunities for improving materials’ thermoelectric properties. Unlike the widespread demonstrations of coherent transport of electrons and photons, unambiguous observation of coherence of phonons is extremely challenging because of the short coherence length of phonons. In this talk, I will discuss the coherent phonon transport and phonon localization in two types of carbon based nanomaterials. One is the single-layer graphene with periodic arrangement of holes, in which the localization is induced by the random perturbation of the hole positions. The other is the carbon schwarzite structure (host cage) with negative Gaussian curvature, which is an ideal system to study the phonon mode hybridization induced by the interaction between the host cage and guest atom. The phonon localization behaviour is well captured by the phonon wave packet simulation and further characterized by the spectral phonon localization length. The impacts of phonon localization on the material’s thermal conductivity are also discussed. Our work provides effective guidance for engineering thermal transport based on a new path via phonon localization.
Prof. Jingzhi Zhang

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Research areas
Heat transfer enhancement; Two phase flow in mini/micro channels; Boiling and Condensation; Microfluidic; Numerical simulation

Short biography
Jingzhi Zhang is an Assistant Professor in the School of Energy and Power Engineering in Shandong University. His research interests include numerical simulation, multiphase flow, phase-change heat transfer enhancement techniques, supercritical fluids, and compact heat exchangers. He has published 20 papers as a senior author in peer-reviewed journals and conference proceedings, including 5 papers in top international journals recently.

Title of the talk
Experimental and numerical studies of Taylor and annular flows in mini/micro channels

Short abstract
Gas-liquid Taylor flow and condensing annular flow in mini/micro channels were investigated experimentally and numerically. A novel experimental setup based on multi-vision system is built to obtain the top and from views of flow patterns in smooth tubes simultaneously. Using the three-dimensional reconstruction technology, characteristics of void fraction are discussed. Detailed flow pattern characteristics including gas-liquid interface, velocity vectors, streamlines will be discussed based on numerical results. Condensing annular flow are also covered to show detailed condensing process in mini/micro round, flatten channels and in microfin tubes. Local heat transfer coefficients, liquid film thickness, and streamlines will be discussed in detail. Effects of mass flux and vapour quality on condensing heat transfer coefficients and frictional pressure drops are also presented.
Prof. Jun Li

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Research areas
Biomass energy conversion; PEM Fuel cells

Short biography
Prof. Li has worked for 12 years in the field of bioelectrochemical system, mainly focusing on construction and mass transfer regulation of highly efficient catalyst layers and biofilm, transport and conversion properties of multi-element, multi-phase reactant and charged ion in porous media, and system improvement and ion transfer regulation between anode and cathode.

He is responsible for 4 projects supported by National Natural Science Foundation of China, and has published 3 chapters in 3 books, 80 SCI indexed papers, including 20 papers in the IF>6.0 journals, 38 papers in 10% TOP journals. All publications has been cited over 1500 times by SCI excluding self-citation. His H-index was 20. He has already authorized 9 patents and was a recipient of China National Funds for distinguished Young Scientists and the 2010 program for New Century Excellent Talents in Ministry of Education of China.
Prof. Jun Shen

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Research areas
Heat transfer enhancement; Magnetic refrigeration; Adiabatic demagnetization refrigeration

Short biography
Professor Jun Shen, from Technical Institute of Physics and Chemistry, CAS, is an expert in the field of refrigeration and cryogenic technology. She was selected as the committee member of the cryogenics division of Chinese Association of Refrigeration. Over 150 SCI journal papers have been published with 922 citations from the core database of Web of Science. And 47 patents including 18 invention patents and 3 international patents have been issued. She has delivered more than 13 keynote/invited talks in various major international academic conferences. The research was supported by 4 projects (including Excellent Youth Scientists Funding) from the National Natural Science Foundation of China, and other projects as the National Key R&D Program of China and Distinguished Young Scientist of the Chinese Academy of Sciences (CAS) etc. She received the National Program for Support of Top-notch Young Professionals, the prestigious Leading Scientist of Hundred Sciences and Technology Talents Program of Beijing City, Lu Jia-Xi Young Talents Award from CAS, Wu Zhong-hua Outstanding Young Scholar Award, the 14th Chinese Young Women Scientist Award, and the Science and Technology Award of the Beijing City (Second Prize, 1st winner).
Prof. Ke Wang

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Research areas
Intensity heat transfer and energy saving; Development of high performance heat transfer equipment; Structure integrity and reliability analysis

Short biography
Dr. Ke Wang, Associate Professor, Commissioner of Youth Committee of Heat and Mass Transfer Society of China, Commissioner of High Temperature Strengt Committee of Mechanical Engineering Material Society of China, elected Deputy General Secretary of Henan Mechanics Committee. He did his degree in Chemical Engineering in Zhengzhou University, In 2000, he went on to study master programme at Northumbria University in UK. He finished his PhD in Chemical Engineering in 2010 at Zhengzhou University, and then became a Research Assistant-professor at Hong Kong University of Science and Technology. He has been employed at Zhengzhou University since 2012. Currently He takes charge of two NSFC funding project-“Flow resistance reduction and heat transfer enhancement in graded flow heat transfer equipment”, “Study on dynamics characteristics coupling with heat transfer and heat transfer enhancement mechanism for complicated crossflow”. He has published over 70 papers/articles in national/international journals.
Prof. Liang Gong

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Research areas
Microelectronic equipment cooling and thermal management; Micro-nano system thermal management and multi-field coupling; Geothermal and solar energy development and utilization; Reservoir numerical simulation

Short biography
Liang Gong, Ph.D., Specially-appointed Professor, Vice Dean of Institute of New Energy, Vice Director of Department of Energy & Power Engineering, the Committee Member of the Youth Committee for Heat & Mass Transfer of China, the Committee Member of the University Research Association for Engineering Thermophysics of China and the Committee Member of American Society of Thermal and Fluids Engineers. He received the Ph.D. degree from Xi’an Jiaotong University in 2011. He was with Georgia Institute of Technology as visiting scholar from 2008 to 2010. Currently, he is with China University of Petroleum (East China). His research interests mainly focus on numerical study on fluid flow and thermal management in microsystem, flow drag reduction and lossless transportation, geothermal and solar energy development and utilization and reservoir numerical simulation. As a principle investigator, he has been responsible for 18 projects supported by the National Natural Science Foundation of China (NSFC), the National Natural Science Foundation of Shandong Province, the Ministry of Education of China, the Qingdao City Government et al. He is the author/co-author of more than 70 journal and conference papers, was the editor of Open Physics and guest editor of Journal of Natural Gas Science and Engineering, and is a peer reviewer of Scientific Reports, Energy, International Journal of Heat & Mass Transfer, Applied Thermal Engineering, Energy Conversion & Management, et al. He also holds 8 Chinese patent.
Research areas
Nanoscale heat transfer; Ultrafast spectroscopy; Laser processing

Short biography
Liang Guo received his Bachelor degree in mechanical engineering, Tsinghua University in 2009. He conducted graduate research on nanoscale heat transfer in mechanical engineering, Purdue University. His projects include heat transfer across metal-dielectric interfaces and phonon dynamics in thermoelectric materials. He obtained his PhD degree in 2014. Then, from 2014 to 2017, he did postdoctoral research in chemistry, University of California, Berkeley. The project is to apply femtosecond two-dimensional electronic spectroscopy (2DES) to study energy transfer in two-dimensional semiconductors. He joined mechanical and energy engineering of South University of Science and Technology, China in 2018. He has obtained 1 funding from National Natural Science Foundation and support from Overseas High-Caliber Personnel program (level C), Shenzhen.

Title of the talk
Excitation, detection and modulation of energy carriers by ultrafast laser

Short abstract
Transport properties of energy carriers, such as electrons, holes, phonons and excitons, determine thermal conductivities of materials, thermoelectric efficiency, photovoltaic efficiency and many other key figures of merits in energy-related applications. However, it is difficult to study behaviors of these energy carriers in macroscale. Ultrafast laser provides a series of methods to reveal microscopic energy carrier dynamics in both time and energy domains with high resolution. In this talk, I will present my work on utilization of ultrafast laser to study electron, phonon and exciton dynamics in ultrafast temporal regime. Besides excitation and detection, ultrafast laser is also capable of modulating population or phase of energy carriers, so that creating a platform for studying irregular thermodynamic states.
Dr. Lili Yang

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Research areas
Solar energy utilization; Thermal radiation; Solar energy capture

Short biography
Yang is Assistant Professor of engineering thermophysics of Nanjing University of Aeronautics and Astronautics of China, with established research in micro/nano scale thermal radiation and solar energy utilization. She holds a PhD in engineering thermophysics, awarded by Nanjing University of Science and Technology of China. She has undertaken some research on solar energy capture and absorption on microstructural surfaces, including enhanced absorption mechanism, full spectrum capture method and microstructural preparation. She chaired a Natural Science Foundation project and participated in several major and key projects of the Natural Science Foundation.
Prof. Liwu Fan

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Research areas
Thermal energy storage; Boiling and condensation; Thermophysical properties

Short biography
Dr. Liwu FAN is a Professor, supported by the "100 Talents Program" since March 2016, in the Department of Energy Engineering at Zhejiang University, Hangzhou, China. He is the Deputy Director of the Institute of Thermal Science and Power Systems, and is also affiliated with the State Key Laboratory of Clean Energy Utilization at Zhejiang University.

Dr. FAN got his Ph.D. degree in Mechanical Engineering from Auburn University on August 2011. Upon graduation, he spent two years from October 2011 to September 2009 to work as a postdoctoral fellow in the State Key Laboratory of Clean Energy Utilization at Zhejiang University. He then joined the faculty in the Department of Energy Engineering at Zhejiang University and got promoted to Associate Professor on December 2013. With the financial support by the China Scholarship Council, he went to the Department of Nuclear Science and Engineering at Massachusetts Institute of Technology to work as a visiting scholar for one year from September 2014 to September 2015.

Dr. FAN's research interests have mainly been focused on phase change heat transfer and its enhancement using materials and interfaces at the micro-/nanoscale, with emphasis on solid-liquid phase change for latent heat storage, liquid-vapor phase change for highly-efficient thermal management, as well as multiscale heat and mass transfer through porous media for energy-efficient buildings and heat exchangers. He has been the Principle Investigator of more than 10 research grants supported by the National Natural Science Foundation of China (NSFC), the Natural Science Foundation of Zhejiang Province, the National R&D Program, and so on. The accumulated funding is more than 5.0 million RMB.
Title of the talk
Atomistic understanding of the effects of hydrogen bonds on the melting process and heat conduction of erythritol as a latent heat storage material

Short abstract
To elucidate the microscale mechanisms of hydrogen bonds (HBs) on the melting process and heat conduction of erythritol as a latent heat storage material, it is studied using molecular dynamics (MD) simulation accompanied with experimental verifications. In order to find a better description of erythritol molecules, four force fields are tested for the prediction of density and heat capacity of erythritol at various temperature points of interest. As compared to the measured values, the applicability of GROMOS force field is verified and this force field is adopted in the following simulations. The microscopic melting process of erythritol is simulated using interface/NPT method. The predicted melting point is about 394 K, coinciding with the measured value (~392 K). It is demonstrated that the HBs energy change associated with structural changes can be a primary contribution to the latent heat of fusion. Upon melting, the strong inter-molecular HBs in solid erythritol break off and form weaker intra and inter-molecular HBs in the liquid phase. In addition, non-equilibrium MD simulation is performed to study the microscopic heat conduction between erythritol molecules and the dependence of the vdW and Coulomb heat fluxes on the interatomic distance $r$ are examined. The results demonstrate the better heat transfer capability of HBs interactions than the Coulomb or vdW interactions. In the solid phase, the greater the HBs number, the greater the amount of heat transfer through HBs.
## Dr. Menglong Hao

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### Research areas
Nonlinear thermal transport; Thermal insulation materials; Battery thermal management

### Short biography
Menglong Hao is currently a postdoctoral scholar at University of California, Berkeley working with Prof. Chris Dames. He received his Ph.D. in Mechanical Engineering from Purdue University in 2016. His B.S. and M.S. are from Southeast University, China, and Ulm University, Germany, respectively. He has broad research interest in heat transfer and energy conversion. His recent projects include thermal switch for battery thermal management and thermally insulating aerogels with the results published in Nature Energy and Science.

### Title of the talk
Thermal switches and their application in battery thermal management

### Short abstract
Thermal devices with nonlinear heat transfer characteristics, such as thermal switches and thermal diodes, have gathered much attention recently with potential applications in thermal management and energy scavenging. This talk will briefly review the various thermal switching mechanisms and then focus on a new type of thermal switch based on shape memory alloy wires. A high switch ratio of more than 2000:1 has been achieved with this concept in ideal vacuum conditions. Further, this thermal switch is used to regulate the temperature of lithium ion batteries. Because of the batteries’ poor performance in cold and hot environments, the temperature stability provided by such a thermal switch immensely improves their ability to endure extreme temperatures and charge cycles.
Research areas
High-efficiency energy utilization theories, energy conservation and emission reduction technologies; Biomass carbon sequestration; Energy storage

Short biography
Dr. Ming-Jia Li is the associate professor in School of Energy & Power Engineering, Xi’an Jiaotong University. She was granted bachelor degree from University of Liverpool, U.K and master degree from University of Nottingham, U.K. She obtained the doctoral degree from Xi’an Jiaotong University with the joint program cooperated by Columbia University, U.S., followed by the Postdoc fellow in Columbia University, U.S. She mainly focuses on theory and technology of high energy efficiency utilization and biomass carbon sequestration. She was awarded international and national awards such as Young Scientist Award of Asian Union of Thermal Science and Engineering, National Innovative Talents Support Plan of China Postdoctoral Foundation, Thousands Talent Plan in Shanxi Province etc. She published 54 SCI papers in a variety of international journals with h-index of 18. Among them, 8 papers are selected in Essential Science Indicators (1% top) including 2 Hot papers (0.1% top) and 6 Research Front papers. She gave presentations for more than 11 times in international conferences and universities, 2 invited talks in international conferences. She served as 3 session chairs in international conferences. She also has 7 patents of invention and 3 software copyrights. She is on the Editorial Board in Journal of Energy & Environment and invited as the guest editor of Journal of Energy. Moreover, she serves as reviewers of about 20 international journals and the secretary general to co-found the 1st International Conference on Supercritical CO2 Power System successfully.

As a PI, she totally hosted 22 research programs, Eg. National Natural Science Foundation of China, National Key Research and Development Program subtopics, National Innovative Talents Support Plan of China Postdoctoral Foundation, and International Cooperation Program etc.
Research areas
Organic transistors; Flexible temperature sensors; Thermal conductivity measurements

Short biography
Paddy K. L. Chan obtained the bachelor degree in mechanical engineering from The University of Hong Kong in 2002, and PhD degree in mechanical engineering from University of Michigan in 2007. He is also holding a master degree in electrical engineering and computer science from University of Michigan. He is currently an associate professor of The University of Hong Kong and leading the Laboratory of Nanoscale Energy Conversion Devices and Physics. Before joining HKU in 2011, he worked in Hong Kong Polytechnic University as an assistant professor from 2007 to 2011.

Title of the talk
Organic temperature sensor based on metal/organic hybrid thin film and the corresponding thermal conductivity study

Short abstract
The properties of the interface between the metal/organic semiconductors is closely related to the interactions between the materials and the band alignment. In the current work, we embedded silver nanoparticles into pentacene thin film to form a thermistor which can be used for temperature sensing purposes. By examining the thermal boundary conductance of the interface and the overall thermal conductivity of the film, we simulated the thermal response of the 2D temperature sensor array under different layout configuration. By integrating the thermistor with the active matrix organic transistor array, we fabricated a large area 16 × 16 temperature sensor which can be directly used for temperature mapping of objects with various shape. We applied anodization growth to deposit the aluminium oxide (AlOₓ) dielectric insulator, and thus the 10 bits temperature array can be powered under 5V. Furthermore, by
carefully controlling the concentration of the silver nanoparticles and varying the combinations of the metal and organic semiconductors, we can modify the sensitivity of different temperature sensors. If the petancene thin film is separately embedded with Ag and Al nanoparticles, the sensitivity of the thermistor changes from 0.05 K$^{-1}$ to 0.08 K$^{-1}$. The proposed low voltage flexible thermal sensor array is suitable for novel portable electronic devices and potentially scale up for electronic skin applications.
Prof. Rong Chen

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Research areas
Solar energy utilization by photochemistry; Optofluidics; Fuel cell; Microscale transport and interfacial phenomena; Heat/mass transport in porous media

Short biography
Professor Rong Chen received BSc and MSc degrees in Power Engineering and Engineering Thermophysics from Chongqing University in 2000 and 2003, and Ph.D. degree from Department of Mechanical Engineering of the Hong Kong University of Science and Technology in 2007. Then he spent three years working in the same Department. He is currently a full professor in School of Energy and Power Engineering, Chongqing University. He has published more than 100 peer reviewed papers in journals. He has been awarded the National Natural Science Fund for Outstanding Young Scholar, Science and Technology Innovation Leader of National Special Support Program for High Level Talents, Youth Science and Technology Innovation Leader of Innovative Talents Promotion Plan, Young Scholars of Chang Jiang Scholars Program and Program for New Century Excellent Talents in University. In 2013, he was awarded the Second-class Prize of National Natural Science of China (The 3rd receiver).
Prof. Shengchun Liu

Institution: Tianjin University of Commerce
Department: School of mechanical engineering
Position: Vice dean
Email: liushch@tjcu.edu.cn

Research areas
Heat and mass transfer; Phase change mechanism; Refrigeration and air-conditioning systems; System efficiency optimizations

Short biography
Dr. Shengchun Liu is a professor in Tianjin University of commerce (TJUC) and a member of the Heat and Mass Transfer Society of China. He has more than 15 years of research experience in cooling and refrigeration systems, especially with alternative refrigerant to hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs). He holds a PhD in Mechanical Engineering from Tianjin University. At TJUC, his research focuses on heat and mass transfer, phase change mechanism, refrigeration and air-conditioning systems, system efficiency optimizations, and natural refrigerant as substitutes to HFCs. He is a consultant for the phase-out of HCFCs in China and he is actively involved in the phase-down of HFCs in China. He was previously a visiting scholar at the West Virginia University in United States, Laboratoire de Mécanique et Technologie de l'ENS in Paris, France and University of Tokyo in Japan. He has received awards from United Nations Development Programme, United Nations Environment Programme, World Bank, United Nations Industrial Development Organization and Foreign Economic Cooperation Office of China’s Ministry of Environment Protection.
Research areas
Boiling; CHF enhancement; Two phase flow; Thin liquid film thickness measurement

Short biography
Shoji Mori is a full professor of Mechanical Engineering at Kyushu University. He received his Ph.D. degree in Engineering from Kyushu University in 2003. He joined the Department of Chemical Engineering at Yokohama National University as an assistant professor in 2004, and he became an associate professor in 2007. He has been a faculty member at Kyushu University from 2019. From 2009 to 2011, he worked cryo-preservation and thermal therapies at Bioheat and Mass Transfer Laboratory, Department of Mechanical Engineering, University of Minnesota, Minneapolis, as a visiting professor (Prof. John C. Bischof). His research interests are currently focusing on novel thermal systems using porous materials.

Title of the talk
Critical heat flux enhancement of large heated surface by the use of a honeycomb porous plate in a saturated pool boiling of water

Short abstract
A honeycomb-structured ceramic porous plate (HPP) is used for the CHF enhancement in a saturated pool boiling. HPP is commercially available as a filter for purifying exhaust gases from combustion engines. This honeycomb porous plate has considerably smaller micro-pores on the order of 0.1 micrometer, as compared with those for sintered metal powders, and is simply attached to the test surface without any treatment, such as spraying or sintering. Moreover, the CHF has been enhanced experimentally up to approximately three times that of a plain surface (approximately 320 W/cm²) with a heated surface of 50 mm in diameter. In this presentation, I will show the CHF enhancement mechanism using HPP as well as several further CHF enhancement techniques.
Research areas
Micro-/nano-scale fluid dynamics; Transport phenomena; Phase change heat transfer; Surface science and engineering.

Short biography
Dr. Shuhuai Yao, Ph.D. of Mechanical Engineering, Stanford University, is now an Associate Professor in the Department of Mechanical and Aerospace at the Hong Kong University of Science and Technology. Her research focuses on understanding the fundamentals of micro-/nano-scale fluid dynamics, transport phenomena, phase change heat transfer, surface science and engineering, and integrating theory and experiments to develop innovative technologies for instrumentation. Prof. Yao has more than 100 scientific publications in peer-reviewed journals and international conferences, 5 US patents, and 4 patents pending. Total citation >2900 with H-index of 23.

Title of the talk
Tuning water and ice nucleation on biomimetic biphilic surfaces

Short abstract
The phase change phenomena of water plays a key role in a wide range of industrial and civilian applications involving heat transfer processes, such as power generation, thermal management, heating systems, ventilating, and air conditioning (HVAC), water harvesting and desalination. Over the past decade, various artificial surfaces have been developed to regulate the phase change process. In this work, we leverage novel nanoengineering strategies to develop biomimetic biphilic surfaces that allow for efficient and effective phase changes. We report the bio-inspired surface design and engineering, the interfacial phase change phenomena (vapor condensation and freezing) as well as the theoretical modelling of phase change heat transfer on the
biphilic nanostructured surfaces. We show the patterned biphilic topography with high wetting contrast allows for a seamless integration of filmwise and dropwise condensation modes. The biphilic structures tune the nucleation rates of water and ice in the sequential condensation-to-freezing process, enabling the suppression of ice formation while sustaining rapid water condensation. Our experimental and theoretical investigation of condensate freezing dynamics further unravels the correlation between the onset of droplet freezing and its characteristic radius, offering a new insight for controlling the multiphase transitions among vapor, water, and ice in supercooled conditions.
Prof. Tingting Miao

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Research areas
Thermophysical properties; Thermoelectric properties; Thermal and electrical transport

Short biography
Tingting Miao is an associate professor in the College of Mechanical and Transportation Engineering at China University of Petroleum-Beijing. She received her Ph.D. degree from School of Aerospace of Tsinghua University in 2013, majored in power engineering and engineering thermophysics. She worked at University of California, San Diego as a visiting scholar in 2017 for one year. She has been working in the field of thermoelectric properties measurement and physical mechanisms study of micro/nanoscale thermoelectric materials. She developed the ac heating - dc detecting T type method for characterization of the thermoelectric properties of the nanoscale materials. Based on this method, the thermoelectric performance of an ultra-long double walled carbon nanotubes, an individual single crystal Bi$_2$S$_3$ nanowire and the graphene fibers were characterized. The related results were published on Applied Physics Letters, Nanoscale and Journal of Applied Physics etc. She has presided 4 government sponsored researches, which were supported by the National Natural Science Foundation of China General Projects and Youth Fund, China Postdoctoral Science Foundation, Science Foundation of China University of Petroleum-Beijing. She is a member of the Young Scientist Committee of the Heat and Mass Transfer Society of China.

Title of the talk
Study on the thermoelectric properties of individual micro/nanowire by applying T-type method
Short abstract
A comprehensive method to evaluate the thermoelectric performance of one-dimensional nanostructures, called T-type method, has been first developed. The Seebeck coefficient is determined by ac heating-dc detecting T-type mode. The thermal conductivity is determined by dc heating-dc detecting T-type mode, and the electrical conductivity can be determined by standard four-probe method in the T type frame. By applying the developed T-type method, the thermoelectric properties, including Seebeck coefficient, thermal conductivity and electrical conductivity, of an ultralong double-walled carbon nanotube (DWCNT) bundle and an individual free-standing single crystal Bi$_2$S$_3$ nanowire have been first characterized separately. The determined figure of merit of the DWCNT bundle achieves $10^{-3}$ which is significantly larger than that reported for carbon nanotube samples. The bundle consists of thousands of nanotubes aligned along the long axis with low levels of impurities, and the thermal conductivity is significantly reduced compared to that of individual double-walled nanotube, while the electrical conductivity is superior to most of the carbon nanotubes samples. From the measurement results of the Bi$_2$S$_3$ nanowire, the determined figure of merit is far less than the reported values of nanostructured bulk Bi$_2$S$_3$ samples, and the mechanism is that the Seebeck coefficient is nearly zero in the temperature range of 300 - 420 K and changes its sign at 320 K.
Research areas
Nanoscale heat transfer; Hybrid materials; phononics; Molecular dynamics; Frequency domain thermoreflectance

Short biography
Wee-Liat graduated with a BEng in Mechanical Engineering from the National University of Singapore (NUS) and was the valedictorian of his class as well as the recipient of the IES gold medal and Lee Kuan Yew gold medal in 2002. He joined the Institute of Microelectronics, Singapore and worked in the fields of bioMEMS and microfluidics. In 2015 he received his PhD in Mechanical Engineering at Carnegie Mellon University under Prof. Jonathan Malen and Prof. Alan McGaughey, where he studied nanoscale heat transfer focusing on organic-inorganic nanostructured materials using both experimental and simulation techniques. He, then, joined the Department of Chemistry, Columbia University as a post-doctoral fellow to study thermal transport behaviour in novel hybrid materials. Currently, he is a professor at the Zhejiang University-University of Illinois at Urbana Champaign Joint Institute in China that is setup to explore a new model for research and teaching collaboration. He has given several invited talks and published in leading peer-reviewed journals including Nature materials, Nano letters, ACSnano, and Journal of the American Chemical Society.

Title of the talk
Organic-inorganic superstructured materials with phase-dependent thermal transport

Short abstract
Superstructured hybrid materials self-assemble from solutions and are scalable replacements for single crystal semiconductors for many technologies. Although their electrical, electronics, and optoelectronics properties have been investigated, thermal properties of these materials remain relatively unchartered. This inhibits technological
adoption where thermal management is requisite to prevent performance and lifetime degradation. In this talk, I will focus on thermal transport in two novel hybrid material systems - the superatom crystals (SACs) and hybrid perovskites. SACs are periodic self-assemblies of superatoms which are clusters of atoms that behave as a unit with emergent properties distinct from their elemental atoms. The hybrid perovskite family, on the other hand, is a leading candidate for next-generation solar cells. Its solar conversion efficiency, due to its favorable but complex transport properties, rivals that of incumbent solar technology. In my presentation, I will discuss the mechanisms of thermal transport in these three-dimensional hybrid superstructured materials. I have used the frequency domain thermoreflectance technique to characterize their thermal conductivity behaviour. Room-temperature thermal conductivity measurements depict a dependence on their group velocities while temperature dependent measurements suggest the possibility of tuning the dynamic disorder in these materials to modulate their thermal transport. An in-depth understanding of the heat transfer process will allow us to achieve longer lifetime and better thermal stability for devices built using these materials.
Prof. Weigang Ma

Institution               Tsinghua University
Department               Department of Engineering Mechanics
Position                 Associate Professor
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Research areas
Nanoscale thermal transport; Nano/Microscale thermophysical properties; Nano/Microscale thermoelectrics

Short biography
Dr. Weigang Ma is an associate professor in the Department of Engineering Mechanics at Tsinghua University, and the Editorial Board Member of Journal of Thermal Science. He obtained his BE and PhD in 2006 and 2012, respectively, and then worked as a postdoctoral research associate, at Tsinghua University. He joined Tsinghua University in 2013 as a Lecturer and was promoted to Associate Professor in 2014. His current interests include Nanoscale thermal transport, Nano/Microscale thermophysical properties and Nano/Microscale thermoelectrics. Dr. Ma’s research has led to more than 50 SCI-indexed journal papers, published on International Journal of Heat & Mass Transfer, Nano Research, Nanoscale, Carbon, etc. He has delivered 5 keynote/invited talks in various major international academic conferences. He served as a Guest Editor of Applied Thermal Engineering and an Associate Editor of 16th International Heat Transfer Conference.

Title of the talk
Study of the thermal transport across the interface with high temporal resolution

Short abstract
Interface thermal transport of dissimilar materials plays a critical role in reliability of micro/nano devices, such as Cu/Si interface in integrated circuits with three dimensional Si vias and graphene/metal interface in envisioned graphene based devices. In this talk, we used femtosecond pump-probe spectroscopy to study the thermal transport and thermal stress propagation in Pt film/glass substrate system, and to study ultrafast carrier dynamics across monolayer graphene/Cu substrate interface.
For Pt film/glass substrate sample, four modes based on the pump and probe light incident directions are developed to study thermal transport. The measured reflectance signals in four measurement modes are different in whole change trend and local oscillation. We developed a superposition model considering thermal transport and thermal stress to depict experimental data in four modes. Theoretical prediction matches well with the experimental data. Thermal conductivity of Pt film and glass substrate is extracted from the experimental data based on Fourier thermal conduction model. For graphene/Cu sample, the pump beam excites graphene and the sublayer Cu. The probe beam measures the total reflectivity of graphene/Cu sample. The measured time scale is in 10 ps which enable us to study ultrafast carrier dynamics within graphene and across graphene/Cu interface.
Prof. Xiaokun Gu

Institution
Shanghai Jiao Tong University

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School of Mechanical Engineering

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Associate Professor

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Xiaokun.gu@sjtu.edu.cn

Research areas
Phonon transport, Atomic simulation, Thermal properties in extreme conditions

Short biography
Dr. Xiaokun Gu is currently a tenure-track Associate Professor in School of Mechanical Engineering at Shanghai Jiao Tong University. He received his PhD in Mechanical Engineering from University of Colorado at Boulder in 2016. Gu’s research interests are to understand phonon transport in novel materials and to develop efficient atomic simulations methods.

Title of the talk
Role of four-phonon scatterings and temperature dependent interatomic force constants in the thermal conductivity of graphene

Short abstract
Understanding the mechanisms of thermal conduction in solids is a long-lasting research topic. Peierls-Boltzmann transport equation (PBTE) based studies have been successfully applied to predict the thermal conductivity of many solids, but most previous works only considered three-phonon scatterings and relied on interatomic force constants (IFCs) extracted at 0 K. In this talk, I will present our study on the roles of four-phonon scatterings and the temperature dependent IFCs on phonon transport in graphene through our PBTE calculations. We demonstrate that the strength of four-phonon scatterings would be severely overestimated by using the IFCs extracted at 0 K compared with those corresponding to a finite temperature, and four-phonon scatterings are found significantly reduce the thermal conductivity of graphene even at room temperature. In order to reproduce the prediction from molecular dynamics simulations, phonon frequency broadening has to be taken into account when determining the phonon scattering rates. Our study elucidates the phonon transport properties of graphene at finite temperatures, and could be extended to other crystalline materials.
Prof. Xiulin Ruan

Institution: Purdue University
Department: Mechanical Engineering
Position: Professor
Email: ruan@purdue.edu

Research areas
Nanoscale heat conduction; nanoscale thermal radiation; thermoelectrics

Short biography
Dr. Xiulin Ruan is a professor in the School of Mechanical Engineering and Birck Nanotechnology Center at Purdue University. He received his B.S. and M.S. from the Department of Engineering Mechanics at Tsinghua University, in 2000 and 2002 respectively. He then received an M.S. in electrical engineering in 2006 and Ph.D. in mechanical engineering in 2007 from the University of Michigan at Ann Arbor, before joining Purdue. His research and teaching interests are in multiscale multiphysics simulations and experiments of phonon, photon, and electron transport and interactions, and he has published over a hundred journal articles on these topics. He received the NSF CAREER Award (2012), Air Force Summer Faculty Fellowship (2010, 2011, and 2013), ASME Heat Transfer Division Best Paper Award (2015), Purdue University Faculty Scholar Award (2017), and other awards. He currently serves as an associate editor for ASME Journal of Heat Transfer and an Editorial Board member for Scientific Reports.

Title of the talk
A multi-temperature model (MTM) for non-equilibrium thermal transport regime beyond the two-temperature model (TTM)

Short abstract
Conventionally, the two-temperature model has been widely used for electron-phonon coupled non-equilibrium thermal transport. However, we show that in many emerging applications including thermal transport across interfaces and laser-matter interactions, different phonon branches can be driven into strong thermal non-equilibrium. Therefore, assuming an equilibrium lattice can lead to misleading results. Here, we present a multi-temperature model to systematically capture the non-equilibrium among different phonon branches, and demonstrate its advantages over the conventional two-temperature model for bulk materials and across interfaces.
Prof. Yanan Yue

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Wuhan University

Department  
School of Power and Mechanical Engineering

Position  
Professor

Email  
yyue@whu.edu.cn

Research areas
Laser spectroscopy-based characterization techniques; Thermophysical property of nanostructured materials; Nanoscale thermal probing based on near-field optics

Short biography
Prof. Yue obtained his Bachelor's degree in 2007 from Wuhan University majoring Thermal Energy and Power Engineering, and his Ph.D. in Mechanical Engineering at Iowa State University, US in 2011. After graduation he worked in DOE-Energy Assessment Centre at University of Wisconsin for a year, and then he joined Wuhan University as an associate professor. Currently he is a professor in School of Power and Mechanical Engineering at Wuhan University. He has published more than 50 papers in highly visible journals among thermophysical area with citation more than 900 times. He has won a few academic awards including the Research Excellence Award of Iowa State University, Presentation Award of 39th Annual Conference of Thermal Analysis Society, Best Paper Award of Hubei Society of Mechanical Engineers and the Outstanding Reviewer Award of IOP Publishing Group (Institute of Physics, UK).

Title of the talk
Conduction-driven micro/nanoscale heat convection characterization based on novel Raman spectroscopy and hot-wire method.

Short abstract
The heat exchange between gas molecules and solid surface could be more significant at micro/nanoscale rather than bulk conditions, while is not given much attentions in the past years. In this work, I would like to report two techniques we developed in the past that can be used to quantitatively describe micro/nanoscale heat convection effect. The first one based on Raman spectroscopy and steady-state joule heating method is
designed for parallel measurement of thermal conductivity and heat convection coefficient simultaneously. In the measurement, steady-state joule heating is applied to a conductive wire, and Raman spectrum is used for mapping the temperature profile along the wire when a steady state is reached. Combined with heat conduction Poisson's equation, the heat convection coefficient and thermal conductivity can be derived simultaneously at a single measurement. To validate this method, a carbon nanotube fibre is tested with measurement results in accordance with reported values in the literatures. The second technique is developed based on a modified steady-state hot-wire method which provides higher precision to study the temperature-dependent rare-gas convection effect. In this technique, instead of using a temperature-dependent thermal conductivity material, we choose the Pt wire which features the constant thermal conductivity within a small temperature range below 100 °C. The constant thermal conductivity will ensure the stable heat conduction dissipation while the heat convection evaluation is of higher accuracy. In the measurement, we studied the temperature dependent heat convection coefficient under different gas pressures ranging from free-molecule regime to transition regime. The ballistic thermal transport between the gas molecule and micro-scale solid surface is observed and quantitatively studied. Overall, both techniques are heat conduction driven thermal characterizations for heat convection evaluation which provides the scope for future study of nanoscale heat convection (ballistic heat transfer) in thermal management of nanoelectronics.
Prof. Yinshi Li

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Department: Key Laboratory of Thermo-Fluid Science and Engineering of MOE
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Research areas
Fuel Cell; Flow Battery; Solar Energy; Micro/Nanoscale Heat and Mass Transport

Short biography
Dr. Yinshi Li is currently a full Professor in School of Energy and Power Engineering at Xi’an Jiaotong University. He received his PhD in Mechanical Engineering from the Hong Kong University of Science and Technology in 2011. He has made much contributions in the areas of Fuel Cells, Renewable Energy Storage, Solar Energy, Micro/Nanoscale Heat and Mass Transport, and published more than 50 international peer-reviewed papers in various prestigious journals, such as Angew. Chem. Int. Edit, J. Mater. Chem. A, ChemSusChem, J. Electrochem. Soc., J. Power Sources, Appl. Energ., Int. J. Heat Mass Tran. In recent years, he received many awards, including the National Science and Technology Progress Award (Innovation Team), Thousand Talent Program for Young Outstanding Scientists, New Century Excellent Talents in University Award, Young Talent Support Plan of XJTU, Excellent Editorial Membership in Chinese Science Bulletin (2014, 2016) and Science China Technological Sciences (2018), Top 100 of the Create the Future Design Contest in 2018 launched by NASA Tech Briefs to help stimulate and reward engineering innovation. Currently, he serves as several members of editorial board, such as Scientific Reports, Journal of Thermal Science, Science China Technological Sciences, and hold the Membership in Royal Society of Chemistry.
Prof. Yong Shuai

Institution: Harbin Institute of Technology
Department: School of Energy Science and Engineering
Position: Professor, Dean
Email: shuaiyong@hit.edu.cn

Research areas
Solar Energy Utilization; Micro/Nanoscale Energy Conversion and Transfer; Measurement Techniques for Thermal Radiation Properties

Short biography
Dr. Shuai Yong is a full professor in the School of Energy Science and Engineering at Harbin Institute of Technology in Harbin, China. He received the B.S. degree in 2001 and Ph.D. degree in 2006, from Harbin Institute of Technology, both in Engineering Thermophysics. In Oct. 2004, he joined the faculty of Harbin Institute of Technology, China. From April 2011 to April 2012, he was a Visiting Scientist with the Mechanical Engineering at Georgia Institute of Technology, Atlanta, USA. His current research interests are in the areas of solar energy utilization, micro/nanoscale energy conversion and transfer, and measurement techniques for thermal radiation properties. He has authored/co-authored about 90 journal papers and has 19 patented inventions in solar energy utilization and thermal radiation measurement. Dr. Shuai was a recipient the 2013 Program for New Century Excellent Talents in Ministry of Education of China, the 2015 Outstanding Youth Science Foundation of NSFC, and the 2016 Youth Yangtze River scholar.

Title of the talk
Introduction to solar-driven high-temperature thermochemical energy conversion into fuels

Short abstract
Solar thermochemical technique is used concentrated solar radiation as high temperature heat source to drive chemical reaction. During the process, the solar energy is converted into fuels with the assistance of thermochemical reaction, which is largely employed in hydrogen production and greenhouse gas emission reduction.
fields. The photo-heat conversion characteristics are studied during the solar thermal dissociation process of ferrite particle. A novel solar thermochemical reactor is proposed for solar syngas production. Clean energy storage efficiency via solar to chemical energy conversion is strongly based on this reactor and the mechanisms and kinetics of species involved. The economic feasibility of solar-to-fuel energy conversion efficiency is strongly based on a better control of reactor operating conditions with respect to the chemical reactions involved.
Dr. Yuan Dong

**Institution**  
University of Missouri

**Department**  
Mechanical and Aerospace Engineering

**Position**  
Research Scientist

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**Research areas**
Nanoscale thermal transport; molecular dynamics; graphene; density functional theory

**Short biography**
Yuan Dong is a Research Scientist in Mechanical and Aerospace Engineering Department at the University of Missouri. He received a bachelor’s degree in Engineering Mechanics and Aerospace Engineering in 2008, and doctorate in Power Engineering and Engineering Thermophysics in 2014, both from Tsinghua University, Beijing, respectively. His current research interests include the heat and mass transport phenomena in low dimensional materials, novel interfaces and intelligent materials, which are investigated through large scale atomistic simulation tools. He has published over 20 papers in international peer-reviewed journals, and his current H-index is 11.

**Title of the talk**
Multiscale modeling of heat transfer in low-dimensional materials

**Short abstract**
The heat transfer in low-dimensional materials is very important and intriguing phenomena containing the following non-trivial effects: The strong boundary scattering induced thermal conductivity reduction and the low-dimensional effect induced thermal conductivity enhancement. Understanding the underlying mechanism and building reliable models for such heat transfer are critical for the applications in advanced chip cooling, high efficient thermal electrics as well as other energy related nanomaterials. Here we present our work in recent years which targeted on the multiscale modelling of nanoscale heat transfer. The first principles calculation is on the electron scale. The molecular dynamics simulation is on the atomic and molecular scale. The phonon gas model based on the thermomass theory is on the mesoscopic scale. Bridge these scales we have developed a series of fundamental understanding and engineering applicable models, which enhance our capability to harness the energy flow in nanoscale.
**Prof. Zheng Bo**

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**Research areas**
Mass & heat transfer; Nanoscale transport; Electrical double-layer; Two-dimensional nanomaterials; Energy storage and conversion

**Short biography**
Dr. Zheng Bo is a professor of College of Energy Engineering at Zhejiang University and State Key Laboratory of Clean Energy Utilization, deputy director of the Commission on Education and Science of Zhejiang Electric Power Society, and the Editorial Board Member of *Nano-Micro Letters, Scientific Reports*, and *ES Energy & Environment*. He received his B.E. degree and Ph.D. degree (in Engineering Thermophysics) in 2003 and 2008, respectively, from Zhejiang University. During 2009-2011, he was a postdoctoral research associate in Mechanical Engineering at University of Wisconsin, Milwaukee. After that he joined Zhejiang University as an Associate Professor in 2011, and was promoted to Professor in 2015. Dr. Bo’s research has led to 1 book (Springer Publisher) and more than 60 SCI-indexed journal papers, published on *Chemical Society Reviews, Energy & Environmental Science, Advanced Materials, International Journal of Heat & Mass Transfer, Nano Energy*, etc. His papers have been cited for over 2,000 times (ISI Web of Knowledge), including 6 highly cited paper (ISI Web of Knowledge). He was appointed by the Ministry of Science and Technology as the Chair of the 2nd BRICS Young Scientists Forum in 2017. He served as the reviewer for more than 60 international journals, including *Nature Communications* and *Energy & Environmental Science*, and the reviewer for NSF/DOE projects (USA) and NSFC projects (China). He is the Excellent Young Scholar of National Science Foundation of China and Young Changjiang Scholars.
Prof. Zhihao Chen

Institution: Tianjin University
Department: School of Mechanical Engineering
Position: Associate Professor
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Research areas
Boiling; Microlayer evaporation; Marangoni Condensation

Short biography
Zhihao Chen was graduated from Yokohama National University (YNU) and obtained his PhD Degree in 2011. Then, he worked in the same group of Yokohama National University as an Assistant Professor. After that, he came back to Tianjin University and been an Associate Professor from 2015.
His research interests focused on the phase change heat transfer, including boiling and condensation, especially for the microscopic mechanisms of boiling and condensation heat transfer.
His recent achievement includes the high speed measurement of microlayer during nucleate boiling by using laser interferometric method, the new technique for enhancing the critical heat flux by utilizing the different-mode-interacting boiling, the discovery of spontaneous drop movement induced by surface tension gradient during Marangoni condensation.

Title of the talk
High speed measurement on microlayer structure by laser interferometry during nucleate pool boiling

Short abstract
During nucleate pool boiling, it was previously confirmed that a microlayer existed on the heat transfer surface beneath a boiling bubble which forms with the rapid expansion of the boiling bubble. The studies on the structure and evaporation of microlayer were very important for elucidating the mechanism of boiling heat transfer. By using laser extinction method, the linear distribution of microlayer thickness was previously confirmed. However, the microlayer structure was still not well-known in the entire nucleate boiling region, from isolated bubble region to the CHF point, with
significantly different heat flux of boiling. In this study, high speed laser interferometric method was adopted in order to easily observe the 2-dimensional microlayer structure during the nucleate boiling of water. Based on the experimental studies, the major results were obtained as follows. 1, the linear distribution of microlayer thickness was confirmed in the inner region of microlayer, which is in good accordance with the previous results. 2, for the relative low heat flux in the isolated bubble region, the special bended-shape of microlayer was observed near the outer periphery. 3, the microlayer can be observed in the entire nucleate boiling region, even for the CHF condition. 4, the thickness gradient of microlayer in the linear distribution region is constant, independent with the heat flux of boiling.
Prof. Zhijun Zhang

Institution: Northeastern University
Department: School of Mechanical Engineering and Automation
Position: Associate Professor
Email: zhjzhang@mail.neu.edu.cn

Research areas
Multi-scale Modelling and Simulation; Transport Process in Food Engineering; Vacuum science and Space Technology

Short biography
He received the BS degree in Vacuum technology and equipment, the MS and PhD degrees in Fluid Machinery and Engineering in 2002, 2005 and 2009 respectively. He is now a vice professor at Mechanical Engineering Department in Northeastern University, China.
Prof. Zhonghao Rao

Institution: China University of Mining and Technology
Department: School of Electrical and Power Engineering
Position: Professor
Email: raozhonghao@cumt.edu.cn

Research areas
Battery thermal management; Thermal energy storage; Heat and mass transfer enhancement

Short biography
Professor Rao is a full professor in the School of Electrical and Power Engineering at China University of Mining and Technology. He obtained his PhD degree in Chemical Process Equipment from South China University of Technology in 2013. He worked as JSPS fellow and senior research scholar at Hokkaido University and Texas A&M University in 2015 and 2018, respectively. His main research interests include battery thermal management, energy storage safety, phase change heat transfer and novel heat pipe. He has published 111 SCI indexed papers in peer-reviewed journals, has been authorized 13 patents of invention and has been serving as the editorial board member for several journals. Prof. Rao has been awarded Second-Prize of the Science and Technology Award of Guangdong Province (Rank 2) and Second-Prize of Technological Invention Award of Guangdong Province (Rank 6). He is a member of the Youth working Committee of Heat and Mass transfer, the Chinese Society of Engineering Thermal Physics, and also a member of the Youth working committee of Thermodynamics and Energy Utilization.
Prof. Zuankai Wang

Institution  
City University of Hong Kong

Department  
Mechanical Engineering

Position  
Professor

Email  
zuanwang@cityu.edu.hk

Research areas
Micro/nanoscale thermal transport; phase change; fluid dynamics, wetting

Short biography
Dr. Zuankai Wang is currently a Professor in the Department of Mechanical Engineering at the City University of Hong Kong, and one of the founding members of Young Academy of Science of Hong Kong. He earned his B.S. degree in Mechanical Engineering from Jilin University in 2000 and Master degree in Microelectronics from Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences, in 2003, and Ph. D. degree in Mechanical Engineering at Rensselaer Polytechnic Institute in 2008. After one year postdoc training in Biomedical Engineering at Columbia University, he joined in the City University of Hong Kong in September 2009 as an assistant professor. His work has been included in the Guinness Book of World Records, and highlighted in Nature, Nature Physics and many other media coverages. Prof. Wang has received many awards including the 35th World Cultural Council Special Recognition Award (2018), President’s Lectureship at City University of Hong Kong (2018, the first Professor to deliver this lecture), Outstanding Research Award (Senior, 2017) and President’s Award at the City University of Hong Kong (2017, 2016), Changjiang Chair Professor by Ministry of Education of China (2016). Outstanding Youth Award conferred by the International Society of Bionic Engineering (2016), OSA Young Scientist Award (2016). The Ph.D. students he supervised have won a number of prestigious awards including Young 1000 Talent Plan (2017, two PHD graduates), MRS Graduate Student Gold Award (2016 Fall Meeting), Hiwin Doctoral Dissertation Award (2016), Hong Kong Young Scientist Award (2015), and MRS Graduate Student Silver Award (2015 Spring Meeting).

Title of the talk
Engineering nature-inspired surfaces to rectify fluid and thermal transport.
Short abstract
In particular, I will discuss our recent progress in the exploration of various nature-inspired topological structures for various engineering implementations. I will show that the rational design and control of topological effect, which is generally overlooked in the conventional design, will be able to fundamentally change the solid/liquid interfaces, extend the boundaries of conventional engineering, and spur innovations for various implementations such as thermal management, electricity and power generation, liquid diode-like transport (1-6).

References:
Conference rooms map
Tips

Wechat Group
You could scan through the Wechat software to join the Wachat group of “ISMNT7”, where you could meet each other among the attendees.

Transportation Guide:

Huanghai Hotel (黄海饭店)
Address: 75 Yan'an 1st Rd, Shinan District, Qingdao City, Shandong Province, China
(山东省青岛市市南区延安一路75号)
Phone number: +86 532 82870215

1. From airport
Public transportation
Airport shuttle bus shift to bus:
(1) Airport Line 2 (No.702) shift to Bus No. 302
  1 hour 9 min, 21.0 RMB yuan, walk for 215 meters
(2) Airport Line 2 (No.702) shift to Bus No. 604
  1 hour 9 min, 21.0 RMB yuan, walk for 273 meters
(3) Airport Line 2 (No.702) shift to Metro Line 3
  1 hour 9 min, 22.0 RMB yuan, walk for 606 meters
(4) Bus No. 305/Special line No. 305 shift to Bus No. 302
  1 hour 9 min, 3.0 RMB yuan, walk for 543 meters
(5) Airport Line 2 (No.702) shift to Bus No. 214
  1 hour 9 min, 21.0 RMB yuan, walk for 504 meters

Taxi
33 kilometers, 45 min, 92 RMB yuan

2. From Qingdao Railway Station
Public transportation
(1) Metro Line 3
  20 min, 2 RMB yuan, walk for 616 meters
(2) Bus No. 202, 321, 304/ Special line No. 304
  27 min, 1 RMB yuan, walk for 664 meters
3. From Qingdao Railway North Station
(1) Bus No. 636 shift to No. 302
   1 hour 22 min, 2 RMB yuan, walk for 488 meters
(2) Metro Line 3
   56 min, 5 RMB yuan, walk for 517 meters

**Taxi**
3.6 kilometers, 15 min, 12 RMB yuan

**Open website in Huanghai Hotel:**

**Domestic delegates:**
Select “CMCC huanghai hotel” through Wlan to get access to the Internet after certification.

**Foreign delegates:**
Please ask helps from conference volunteers.

**Weather:**
Website: http://www.tianqi.com/qingdao/15/

<table>
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<tr>
<th>04月26日 星期五</th>
<th>04月27日 星期六</th>
<th>04月28日 星期日</th>
<th>04月29日 星期一</th>
<th>04月30日 星期二</th>
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<tr>
<td>晴 11~17℃</td>
<td>多云 9~16℃</td>
<td>小雨到大雨 11~14℃</td>
<td>阴 12~17℃</td>
<td>多云 12~18℃</td>
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<td>优东南风 3级</td>
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<td>优西北风 4级</td>
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April 26, Friday, Sunny, 11~17℃.  
April 27, Saturday, Cloudy, 9~16℃.  
April 28, Sunday, Light to moderate rain, 11~14℃.  
April 29, Monday, Overcast, 12~17℃.  
April 30, Tuseday, Cloudy, 12~18℃.