Department of Mechanical Engineering
香港城市大學
City University of Hong Kong

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MNE Newsletter

We hope everyone had a wonderful summer.

In this issue, we introduce two young faculty members, Prof. ZHAO Shijun and Prof. LI Weihong, who are both leading scholars in their respective fields. We also share some research highlights, exciting news and achievements of our staff and students.

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1.1 Prof. ZHAO Shijun

Associate Professor

Education:
Ph.D. in Engineering, Peking University, China
Bachelor in Physics, Peking University, China

Experience:
Postdoctoral Research Associate, Oak Ridge National Laboratory, USA
Postdoctoral Research Associate, Peking University, China

Prof. Zhao received his Bachelor's degree in Physics and his Ph.D. degree in Nuclear Engineering, both from Peking University. After graduation, Prof. Zhao conducted his postdoctoral research at the College of Engineering at Peking University. Prior to joining the City University of Hong Kong, he was a postdoctoral research associate at Oak Ridge National Laboratory. Prof. Zhao's current research group works on computational materials properties. Specifically, his group aims to understand defect thermodynamics, defect production, defect migration, and defect evolution in different materials under condition of deformation or irradiation. The defects considered include point defects, impurities, dislocations, stacking faults, grain boundaries, surfaces, etc. For this purpose, different simulation techniques at different scales are concurrently or sequentially used.

Prof. Zhao's research interests are computational materials science, and in particular, the influence of defects on materials' properties. Both intrinsic defects, such as grain boundaries, interfaces and dislocations as well as those produced by ion beams are considered. For this purpose, various computational methods, spanning from density functional theory, molecular dynamics and kinetic Monte Carlo simulations are used.

1.2 Prof. LI Weihong

Assistant Professor

Education:
2013 - 2018 Ph.D., Department of Energy and Power Engineering, Tsinghua University, China
2009 - 2013 B.S., Department of Thermal Engineering, Tsinghua University, China

Experience:
2021 - Present Assistant Professor, City University of Hong Kong
2019 - 2021 Research Assistant Professor, Hong Kong University of Science and Technology
2018 - 2019 Postdoc, School of Engineering, University of Glasgow

Prof. Li Weihong earned his bachelor's and PhD degrees from the esteemed Department of Energy and Power Engineering at Tsinghua University in 2013 and 2018. Presently, he holds the position of Assistant Professor in the Department of Mechanical Engineering at City University of Hong Kong (CityU). Before coming to CityU, Prof. Li served as a Research Assistant Professor in the Department of Mechanical and Aerospace Engineering at The Hong Kong University of Science and Technology (HKUST). Concurrently, he held the prestigious role of a Junior Fellow at the HKUST Jockey Club Institute for Advanced Study. Earlier, he contributed significantly as a Research Associate at the School of Engineering, University of Glasgow, UK.

Prof. Li's achievements have earned him a series of notable accolades, including the Young Engineer Turbo Expo Participation Award from ASME and the IGTI Student Scholarship from ASME, and he has been honored twice with the National Scholarship of Tsinghua University. Prof. Li has been actively engaged in editorial roles, serving as a Young Editorial Board Member for Energy Storage and Saving since 2022, and as a Guest Editor for Frontier of Energy from 2021 to 2023.

Prof. Li has published over 50 journal papers and 20 conference papers, with some featured in prestigious journals such as Science Advances, Advanced Science, Advanced Functional Materials, Cell Reports Physical Sciences, Energy Conversion and Management, International Journal of Heat and Mass Transfer, Aerospace Science and Technology, and Applied Thermal Engineering, among others.

2.1 Liquid metal droplets bouncing higher on thicker water layer

The problem

Liquid metal (LM) has gained increasing attention for its potential utility in a wide range of applications, such as flexible electronics, soft robots, and chip cooling devices, owing to its low melting temperature, good flexibility, and high electrical and thermal conductivity. However, in ambient conditions, LM is susceptible to coverage of a thin oxide layer, resulting in unwanted adhesion with underlying substrates that undercuts its originally high mobility.

Prof. Steven WANG

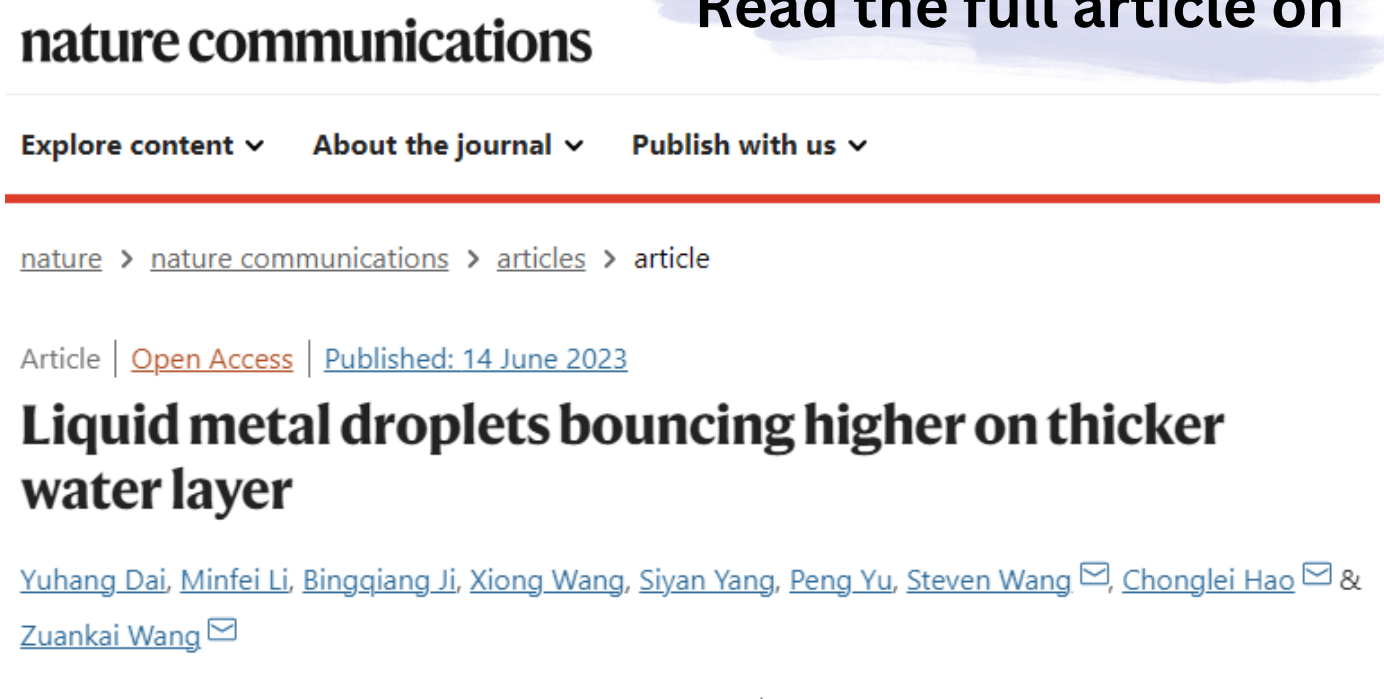
The solution

Prof. WANG and his team discovered that after covering the solid substrate surface with a thin water layer, the LM droplet bounces off the solid surface, i.e., the mobility of the LM droplet is significantly enhanced, compared to the effect of a bare solid surface. They highlighted that the mobility of LM droplets can be significantly enhanced by increasing the underlying water layer thickness, which provides a method for modulating LM mobility in practical situations.

New insights

Prof. WANG and his team discovered an unusual phenomenon characterised by the complete rebound of LM droplets from the water layer with negligible adhesion. More counterintuitively, the restitution coefficient, defined as the ratio between the droplet velocities after and before impact, increases with water layer thickness. The team found that the complete rebound of LM droplets originates from the trapping of a thinly low-viscosity water lubrication film that prevents droplet-solid contact with low viscous dissipation, and the restitution coefficient is modulated by the negative capillary pressure in the lubrication film as a result of the spontaneous spreading of water on the LM droplet. This phenomenon is not only fundamentally interesting, but also has many practical applications, such as heat dissipation, simple flexible circuit fabrication and enhanced jumping and mobility in 3D-printed robots.

Read the full article on



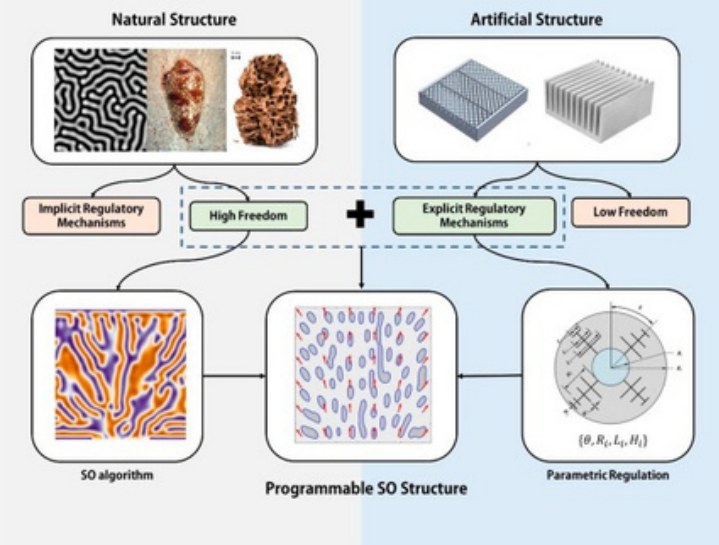
2.2 Termite nest-inspired self-organization approach for heat sink design

Ultrahigh heat transfer performance with low pumping pressure

Prof. LI Weihong

The problem:

Heat sinks are critical components in energy conversion and storage systems. While advanced design methods like topology optimization and biomimicry show promise, they are either not yet fully developed or fail to meet industrial design objectives. A comprehensive design framework is urgently required to create ultrahigh-performance heat sinks.



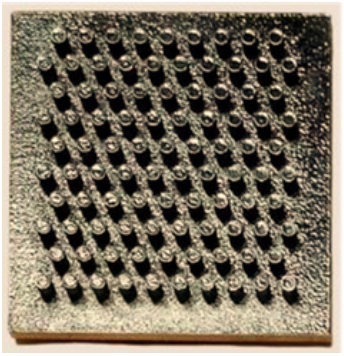
The solution:

The team of Prof. Li began by examining natural entities that shared objectives similar to heat sink design, aiming to understand the self-organisation principles guiding their evolution. Taking inspiration from termite nests, formulated a set of partial differential equations encompassing both a diffusion term and an anti-diffusion term. By integrating several control fields into these equations, they ensured that the resulting geometries were adaptable to heat sink applications.

When contrasted with standard regular pin-fin arrays, the optimized heat sinks exhibit a surprising performance enhancement. They display a significant 60% increase in the Nusselt number and a sharp 40% reduction in friction factor. These improvements can be attributed to enhanced velocity uniformity, an expanded contact area and reduced form drag. By melding this innovative self-organisation strategy with additive manufacturing techniques, their work offers a potent blueprint for the next generation of heat sink designs.

Termite nests

Regular pin-fin arrays



Optimized pin-fin arrays

Read the full article on

Energy Conversion and Management

Volume 286, 15 June 2023, 116996

A bioinspired programmable Self-Organization approach for designing additively manufactured heat sinks

Bocheng Yu [a], Zijie Lu [a], Binyan Wang [a], Xinxing Wang [a], Jian Lou [a], Li Yang [a], Weihong Li [b]

2.3 Anaerobic-aerobic treatment of high-strength and recalcitrant textile dyeing effluents

Prof. LEE Duu-Jong

The problem

Inadequate treatment of industrial effluents that contains hazardous pollutants is a pressing global concern for human health, the ecosystem and long-term social and economic development. Hence, eco-friendly treatment of complex textile and dyeing wastewaters is a pressing environmental concern. Textile industries are responsible for one of the major environmental pollution problems in the world, because textile wastewater contains dyes mixed with various contaminants. Therefore, environmental legislation commonly obligates textile factories to treat these effluents before discharge into the receiving watercourses. Such high-strength and recalcitrant effluents have a low BOD/COD ratio (<0.1)n and hence are generally regarded as non-biodegradable.

The Solution

An approach adopting different treatment paths and integrated anaerobic–aerobic processes for high-strength and recalcitrant textile dyeing wastewater was examined. The study demonstrated that over 97% of suspended solids (SS) and more than 70% of chemical oxygen demand (COD) were removed by polyaluminum chloride pre-coagulation of the suede fabric dyeing stream. Up to 58% of COD and 83% of SS were removed through hydrolysis pretreatment of other low-strength streams. COD removal of up to 99% from a feed of 20,862 mg COD/L was achieved by integrated anaerobic–aerobic treatment of the high-strength stream. in addition to achieving high COD removal of 97%, the anaerobic granular sludge process demonstrated multi-faceted attributes, including high feed loading, smaller footprint, little sludge production and good stability. The integrated anaerobic–aerobic treatment offers a robust and viable option for highly contaminated and recalcitrant textile dyeing wastewater. The high COD presents a potential urban energy source to be recovered via the novel process.

Read the full article on

ELSEVIER

Bioresource Technology

Volume 379, July 2023, 129060

Anaerobic-aerobic treatment of high-strength and recalcitrant textile dyeing effluents

Hai-Yong Yao [a b], Hui Guo [a b], Feng Shen [b], Ting Li [b], De-Yang Show [c], Ming Ling [b], Yue-Gen Yan [d], Kuan-Yeow Show [a b d], Duu-Jong Lee [e f]

Show more

3.1 Introducing the powerful nanogenerator with ultrahigh power

A fascinating range of student and staff research projects that have direct applications to daily life was showcased at the STEM Carnival cum Student Project Exhibition 2023 held by the College of Engineering Bright Future Engineering Talent Hub at City University of Hong Kong (CityU) from 5 to 7 July.

This year, Professor Steven Wang, from the MNE department, Mr. ZHANG Zhi, MNE PhD Student, and Mr. Lo Wai Kin, MNE PhD student, introduced the powerful nanogenerator with ultrahigh power density. This invention has set a record for high-power output amoung similar nanogenerators as it can generate over 1,000 volts of electricity. This powerful nanogenerator has great potential for energy harvesting through application to school floors, shopping malls and the city-highways.

Mr. LO Wai Kin, PhD student (left), Prof.Steven WANG (right)

Mr. ZHANG Zhi, PhD student being interviewed by TVB

Prof. Steven WANG being interviewed by TVB

3.2 Representatives from IRSN visiting MNE

The MNE Department organized a meeting with a delegation from IRSN (French Institute for Radiation Protection and Nuclear Safety) delegation on 12th July 2023. Six representatives from IRSN attended the meeting: Mr. François BARRE and Mr. Olivier MARCHAND, Deputy Director of Safety Research; Mr. Emmanuel ROUGE, Deputy Head of Experimental Department; Ms. Laure CHAPOTET, Head of the Legal Department; Ms. Marine BERTIN, lawyer from the Legal Department and Mr. Robert DALLENDRE, International Cooperation Manager. The meeting was chaired by Prof. LU Jian, Dean of the College of Engineering. Further collaborations were discussed during the meeting.

After the meeting, the representatives visited Low Carbon Energy Education Centre, 3D Atom Probe Tomography Unit, and Nuclear Simulation Lab in CityU.

3.3 Seminars by MNE (MAY - AUG, 2023)

Thirteen seminars were held over the last four months. International experts offered their outstanding lectures to our faculty members and students, in lecture series on Aerospace Engineering, Mechanical Engineering, Nuclear and Risk Engineering, and Academic Publishing.

Date	Guest Speaker	Topic
4 MAY 2023	***Dr. Quentin MEYER*** *UNSW, Australia*	**How to Make Hydrogen Fuel Cells Cheaper and More Efficient**
15 MAY 2023	***Dr. HU Shan*** *Iowa State University, USA*	**Materials and Manufacturing Innovations for Energy and Sustainability: Exploring Process-Structure-Property Relationships**
18 MAY 2023	***Prof. YANG Xin*** *Beijing Institute of Technology, China*	**Aerospace Seminar Series 11 -** **Challenges in Modelling and Testing Ice Crystal Icing at Aero-engine Conditions**
5 JUN 2023	***Dr. TAN Swee Ching*** *National University of Singapore*	**Learning from Nature for Green Energy and Sensory Devices**
15 JUN 2023	***Prof. CHIANG Ren-Tai*** *University of Florida, USA*	**Nuclear & Risk Engineering Seminar Series –** **Overview on Science and Nuclear Engineering Education**
19 JUN 2023	***Prof. JI Dongxu*** *The Chinese University of Hong Kong, Shenzhen*	**Low Grade Thermal Energy Utilisation: Geothermal**
20 JUN 2023	***Prof. ZHANG Limiao*** *Anhui University, China*	**Aerospace Seminar Series 12 –** **A Unifying Criterion of the Boiling Crisis**

Date	Guest Speaker	Topic
20 JUL 2023	***Dr. IFTI Hassan Saad*** *University of Maryland, USA*	**Aerospace Seminar Series 13 - Transpiration Cooling of a Hypersonic Vehicle**
24 JUL 2023	***Dr. TIAN Lu*** *Loughborough University, UK*	**Aerospace Seminar Series 14 - Ammonia as a Fuel? The Impact of Ammonia Substitutions on NOx and Soot Formation**
24 JUL 2023	***Prof. WANG Ran*** *Nankai University, China*	**M.E. Seminar Series 1 - Planning for Cool Cities Under a Rising Temperature**
24 JUL 2023	***Dr. YANG Bijie*** *Imperial College London, UK*	**Aerospace Seminar Series 15 - Unsteady Flow: From System to Component Level**
9 AUG 2023	***Prof. Lisa SMITH*** *Wiley-VCH, Germany*	**Research Publishing**
9 AUG 2023	***Prof. Takashi HIBIKI*** *City University of Hong Kong*	**Overview of the IAEA Comprehensive Report on the Safety Review of the ALPS-treated Water at the Fukushima Daiichi Nuclear Power Station**

4
Student Achievement

Mr. HUSSAIN Iftikhar
Doctor of Philosophy (Student)

4.1 An interview with the outstanding MNE student Mr. HUSSAIN Iftikhar, Doctor of Philosophy

Q & A
Mr. HUSSAIN Iftikhar
(Outstanding PhD student)

By
MNE Department

1. **Please tell us about the research you are doing now.**
   I am an HKPFS awardee doing my PhD candidacy. I am currently doing research on nanomaterials for batteries and supercapacitors. I work on nanomaterials with different chemistries and structures that make charging and discharging these devices more efficient.

2. **Why did you choose Hong Kong and the City University of Hong Kong?**
   I first went to Hong Kong when I visited for a conference during my Master's studies in South Korea. Hearing a lot of talks and perspectives from leading scientists, appreciating the beauty of the busy streets, eating a lot of good food, and experiencing the diverse culture in Hong Kong made me think about doing my PhD here.

   Hong Kong is a very diverse place where I can work with international collaborators and renowned professors in the energy storage field. I admire the busyness of the streets where people casually go on with their hectic day-to-day activities. While the city is an attraction itself, the hikes on the mountains are what I enjoy most. Almost every weekend, I go with friends to hike and enjoy the sunsets. I have also met new friends from different countries and cultures.

   While City University of Hong Kong gave me the opportunity to live and study in Hong Kong, the university has offered me a great experience. CityU is ranked within the top 100 universities worldwide by QS World University Rankings. Being a student at such a globally prestigious university gives me a head start in my professional career that I will treasure forever.

3. How has your experience in the MNE Department been so far?

The MNE Department has always been supportive throughout my PhD career. The MNE Department, their staff and my supervisor Prof. ZHANG Kaili have given me a lot of opportunities to hone my research skills and professional development. With their assistance and support, I was able to publish and co-author scientific papers recognized globally. In fact, I always ask the staff of MNE Department whenever I have difficulties or questions.

The MNE Department not only helped me through my research but also allowed me to meet plenty of friends. The department also gave me teaching opportunities that I want to develop at this stage of my career.

4. What are the challenges that you have been facing as a PhD student and how do you overcome those challenges?

Honestly, I was quite taken aback by how the pandemic rolled over the world, not just in Hong Kong. Despite taking extreme measures to safeguard myself, it was challenging to work on my PhD in the middle of the pandemic. Naturally, I faced difficulties in research and course work, but my friends, collaborators and lab mates helped me a lot. If there is a problem or challenge, I usually work on it as soon as possible instead of avoiding it.

Happily, I got a lot of support from my friends, family, collaborators and my research group. I worked on my schedule so I can still study full-time and do all of my research in a timely manner.

Now I am writing my thesis and it is very time-consuming. Even though writing my thesis takes a lot of time and concentration, I make sure to finish my target goals every day, and always give myself time to relax and unwind.

5. **What is your plan after graduating?**
   Most of my research experiences is related to supercapacitors. I plan to apply for a postdoctoral fellowship and learn more about batteries. Batteries have given the scientific community a lot to consider in terms of renewable energy devices. But these two topics can be merged to develop the high capacity and fast charging batteries that will be necessary in the future. Along with my research plans, I want to explore the world and enjoy all the natural beauties of many more countries.

6. **Any suggestions for current and future students?**
   Be patient, and while you are still a student, learn everything you can from the university, from the professors, from other students, from everything. Every person is like a book from whom we can learn about their life experiences, whether they are our seniors or juniors.
   The university is a place where you nourish yourself with all the knowledge you may need in the future. This can be scientific knowledge, improvement of your character, new hobbies or new aspirations. Don’t forget to be kind, enjoy the experience, meet new friends, discover the unexplored and learn from everything.

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