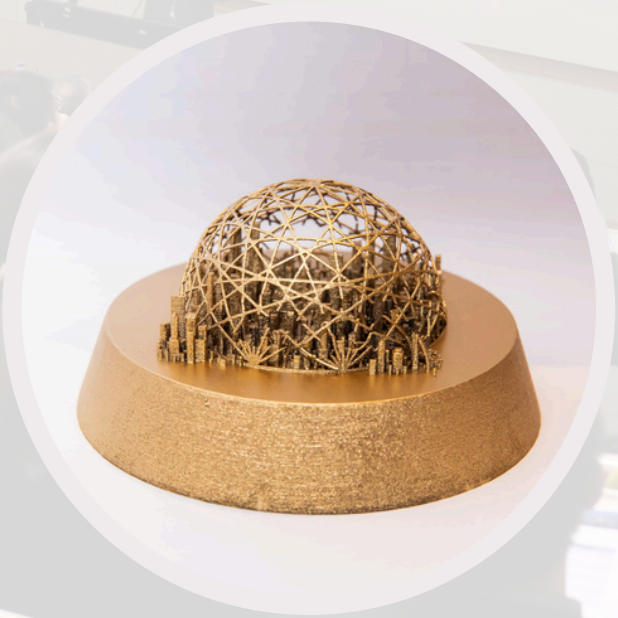
Department of Mechanical Engineering
香港城市大學
City University of Hong Kong

Issue No.7
Apr 2024

MNE Newsletter

In this issue, we share some of our most notable research highlights from prestigious journals such as *Nature Materials* and *Nature Water*. The department has also organized various activities for students and faculty members. It has been such a delight to share a fruitful first season with you all.



Department of Mechanical Engineering
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People Stories

Prof YANG Yong

Professor

Research Interests

- Design of advanced structural alloys
- Aerospace materials and mechanical metamaterials
- Additive manufacturing

Prof. YANG is currently a full professor of MNE. He obtained his bachelor's degree in mechanics from Peking University in 2001, MPhil from HKUST in 2003, and PhD in mechanical and aerospace engineering from Princeton University in 2007. His primary research interest is in the development and mechanical behavior of advanced structural materials, such as metallic glasses, high entropy alloys, and high temperature alloys. His recent research interest extends to materials informatics, low dimensional metals/ceramics, and mechanical metamaterials.

Prof DUAN Penghao

Assistant Professor

Research Interests

- CFD Simulation
- Mesh Generation
- CAE Software Development
- Aircraft Gas Turbine Engine Design and Optimization
- Fluid Mechanics

Prof. DUAN Penghao is currently an Assistant Professor of MNE. He obtained his doctoral degree from the University of Oxford and undertook postdoctoral research there during 2021-2022. Before joining Oxford, he studied for his master's degree at ETH Zürich and wrote his master's thesis at the MIT Gas Turbine Lab as a ZKS-funded visiting scholar. He completed a dual bachelor's degree in mechanical engineering at Tongji University and Politecnico di Milano. He has also served as an adjunct professor at Nanjing University of Aeronautics and Astronautics.

Prof. DUAN is a reviewer for several journals (*JoT*, *PoF*, *JPE*, *JTSEA*, *Aeronaut. J*, *IJHFF*, etc.) and has chaired sessions at academic conferences such as ASME TurboExpo, GPPS, and CITC. He is also a young editorial member for the *Propulsion & Energy* journal. Recognitions in his early career include awards from the ASME IGTI, both as a student and an early career engineer. His research primarily focuses on the design optimization of aircraft engines, multiphase/multiscale fluid computations, computational grid generation, and fluid computational software development.

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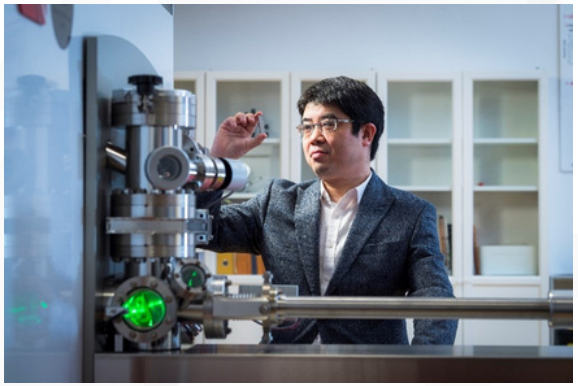
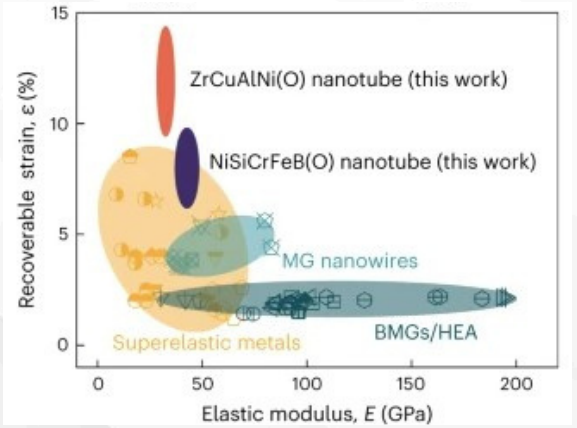
Research Highlights

2.1 Oxidation-induced superelasticity in metallic glass nanotubes

The Problem

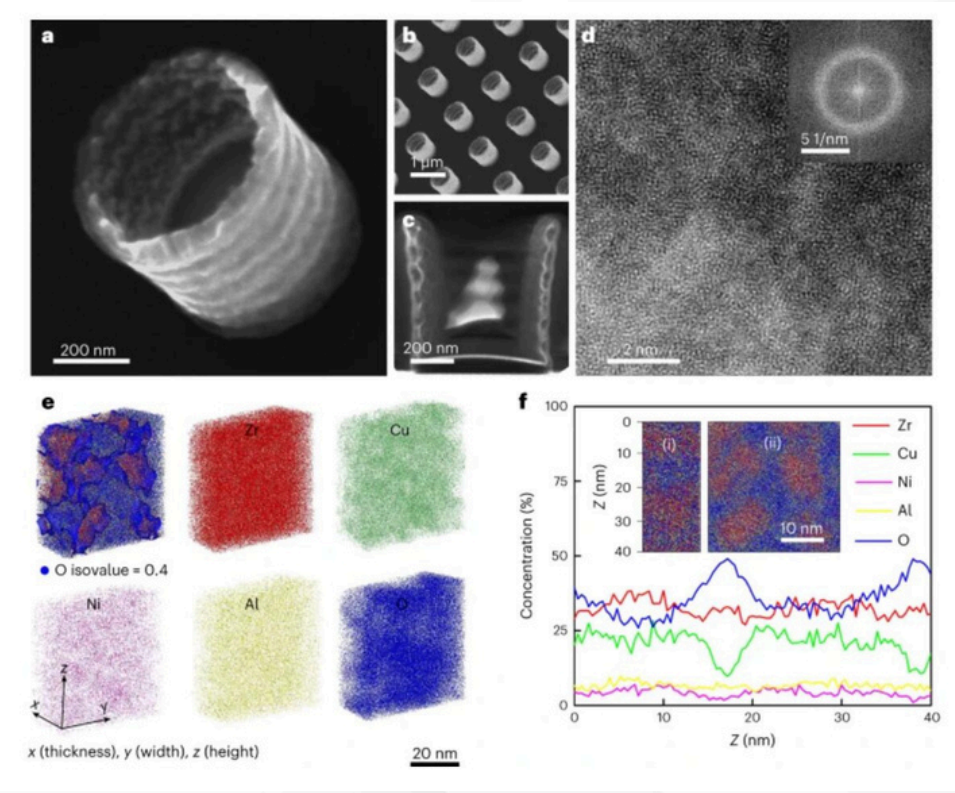
The functional and mechanical properties of low-dimensional metals, including nanoparticles, nanotubes and nanosheets, have garnered attention for their potential applications in small-scale devices, such as sensors, nanorobots, and metamaterials. However, most metals are electrochemically active and susceptible to oxidation in ambient environments, which often degrades their properties and functionalities. In particular, metallic nanomaterials have a high surface-to-volume ratio, which can be up to $10^8\ m^{-1}$. So in principle, they are prone to oxidation.





The Solution

Prof. YANG Yong, in the Department of Mechanical Engineering at CityU, led a research team to study oxidation in nanometals. They found that severely oxidized metallic glass nanotubes and nanosheets can attain an ultrahigh recoverable elastic strain of up to about 14% at room temperature, outperforming bulk metallic glasses, metallic glass nanowires, and many other super-elastic metals. They revealed that the physical mechanisms underpinning the observed superelasticity can be attributed to the formation of a percolating oxide network in metallic glass nanotubes, which not only restricts atomic-scale plastic events during loading but also leads to the recovery of elastic rigidity on unloading.



The structure and characterization of the $Zr_{55}Cu_{30}Al_{10}Ni_5$ MG nanotube

The Impact

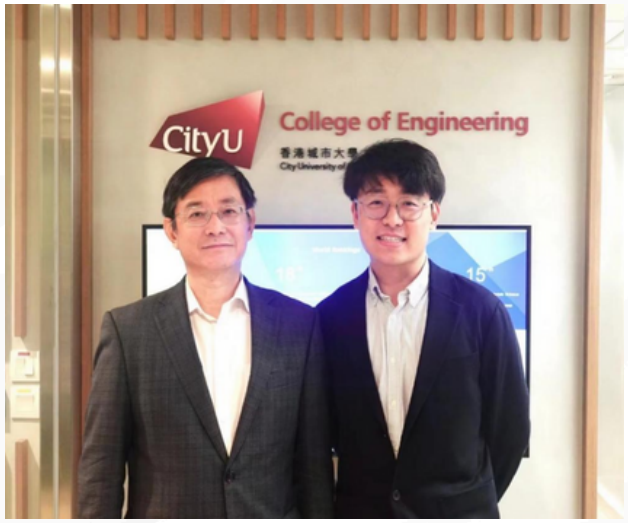
With this finding, we can develop a class of heterogeneous nanostructured ceramic-metal composites by blending metals with oxides at the nanoscale. Such composites have great potential for various future commercial applications and nanodevices working in harsh environments, such as sensors, medical devices, micro- and nanorobots, springs, and actuators.

Read the Full Paper

2.2 Passive interfacial cooling-induced sustainable electricity–water cogeneration

The Problem

Solar energy, the most inexhaustible and environmentally friendly energy source, has attracted tremendous attention for the production of green electricity and clean water. However, there is a lack of research on the energy interaction between the power module and water module or on optimization strategies for enhancing the energy exchange between them. This limitation hinders the attainment of the optimal performance of such cogenerators.



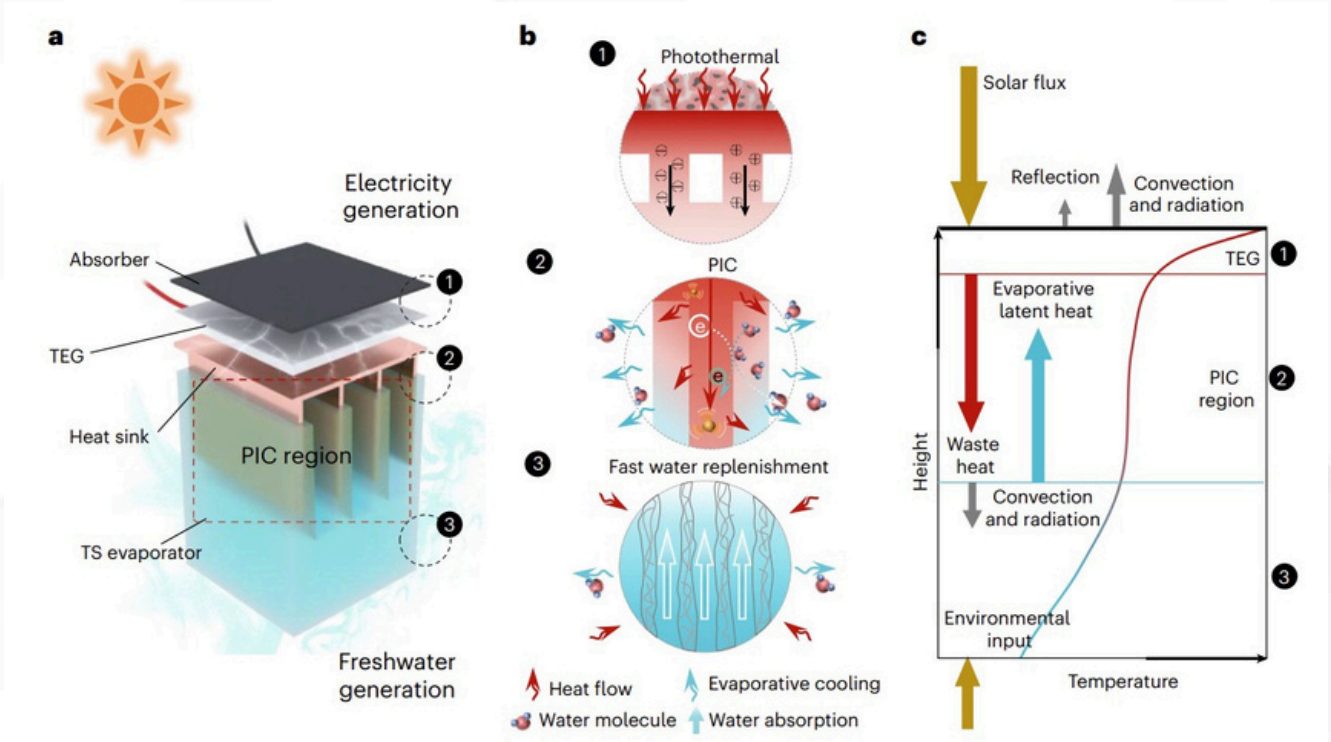
Prof. LU Jian with Postdoc Dr. MAO Zhengyi

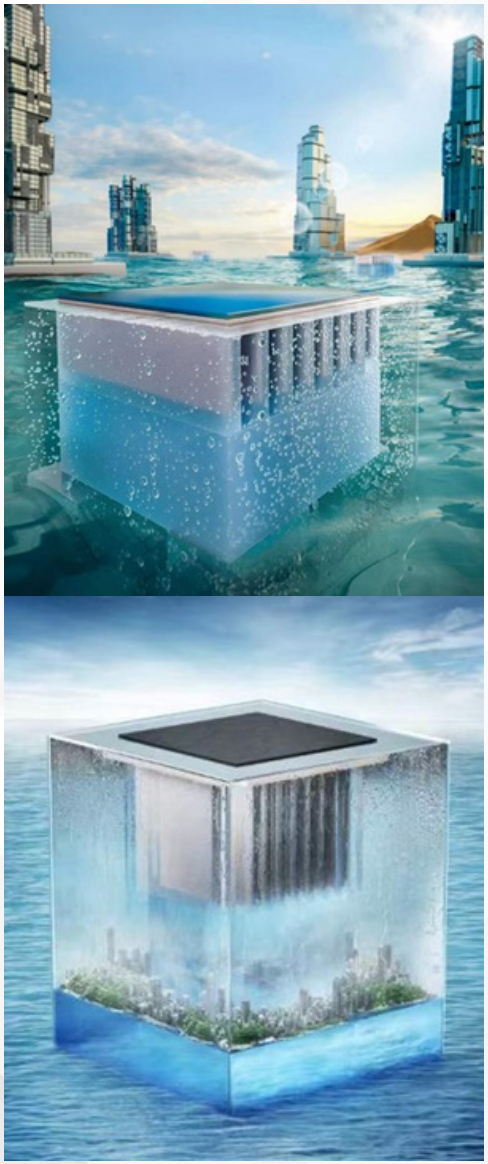
The Solution

A research team led by Prof. LU Jian from City University of Hong Kong, presents a rationally designed hybrid system based on the passive interfacial cooling (PIC) strategy. This strategy intensifies energy exchange between the power generation and water generation modules, thereby boosting the utilization of waste heat and latent heat from the hybrid modules and minimizing the energy loss to air. The system with the PIC effect shows 328% greater power density and 158% higher water evaporation rate than such devices without the PIC effect.

The Impact

The proposed PIC effect shows great potential for application in various water–energy nexus systems. For example, the integration of a photovoltaic panel with the PIC strategy would enable it to attain higher power outputs for charging real commercial electrical devices such as smartwatches, signboards and mobile phones. The output power can be further enhanced by incorporating a concentrating Fresnel lens, highlighting an opportunity for alleviating global energy–water supply challenges.





Novel technique for electricity–water cogeneration

2.2 Passive interfacial cooling-induced sustainable electricity–water cogeneration

nature water

Read the Full Paper

Article

https://doi.org/10.1038/s44221-023-00190-6

Passive interfacial cooling-induced sustainable electricity–water cogeneration

Received: 20 July 2023

Accepted: 14 December 2023

Zhengyi Mao[1,2], Yao Yao[3], Junda Shen[4], Jiahua Liu[4], Yuhan Chen[2], Binbin Zhou[5], Yingxian Chen[4], Qiliang Wang[3] ✉ & Jian Lu[1,2,6] ✉

Read the Insightful Comment

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News & Views | Published: 08 February 2024

Process integration

Cool down and power up

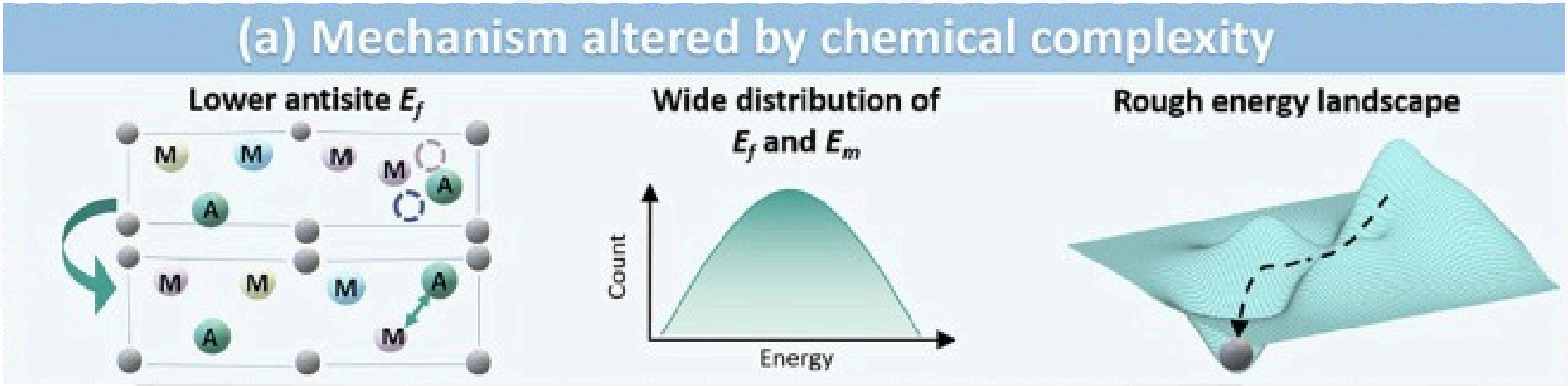
Alessio Lavino ✉

Nature Chemical Engineering **1**, 138 (2024) | Cite this article

2.3 Irradiation performance of high entropy ceramics: A comprehensive comparison with conventional ceramics and high entropy alloys

The Problem

High entropy ceramics (HECs) are promising candidates for advanced nuclear reactors. However, the current understanding of their irradiation response is based solely on experience from high-entropy alloys (HEAs) by analogy. Detailed examination and analysis of the role of increased chemical complexity in different HECs is lacking. Such knowledge is vital to the rational design of irradiation tolerant HECs.



2.3 Irradiation performance of high entropy ceramics: A comprehensive comparison with conventional ceramics and high entropy alloys

The Contributions

Prof. ZHAO Shijun from City University of Hong Kong led a team with Prof ZHANG Yanwen from Idaho National Laboratory to write an important review on this topic. They systematically reviewed the recent progress in the irradiation response of HECs, including high entropy carbides, high entropy pyrochlore oxides, high entropy MAX phases, and high entropy nitride films. They examined the influence of chemical complexity on the irradiation properties of HECs by comparing them with their single-component ceramic counterparts.

Read the Full Paper

ELSEVIER

Progress in Materials Science

Volume 143, June 2024, 101250

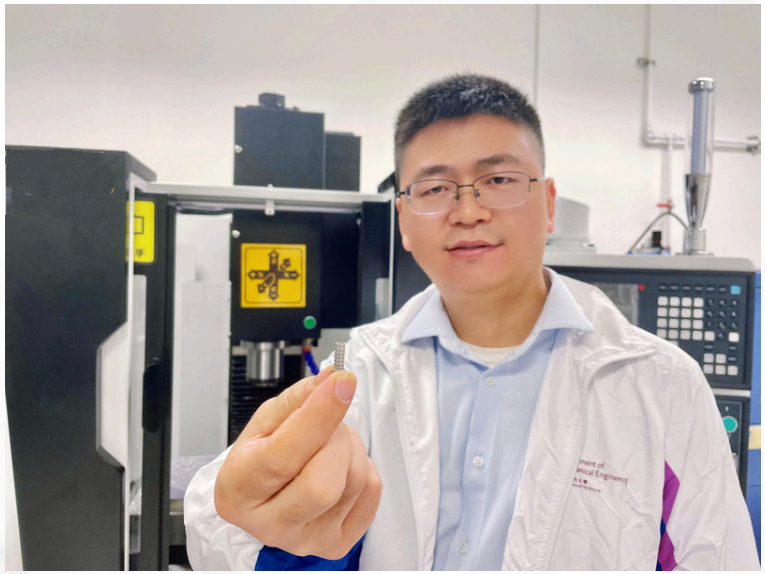
Irradiation performance of high entropy ceramics: A comprehensive comparison with conventional ceramics and high entropy alloys

Shasha Huang [a], Jun Zhang [a], Haijun Fu [a], Yaoxu Xiong [a], Shihua Ma [a], Xuepeng Xiang [a b], Biao Xu [a], Wenyu Lu [a], Yanwen Zhang [c], William J. Weber [d], Shijun Zhao [a]

2.4 Post-Processing Techniques for Metal-Based Additive Manufacturing Towards Precision Fabrication

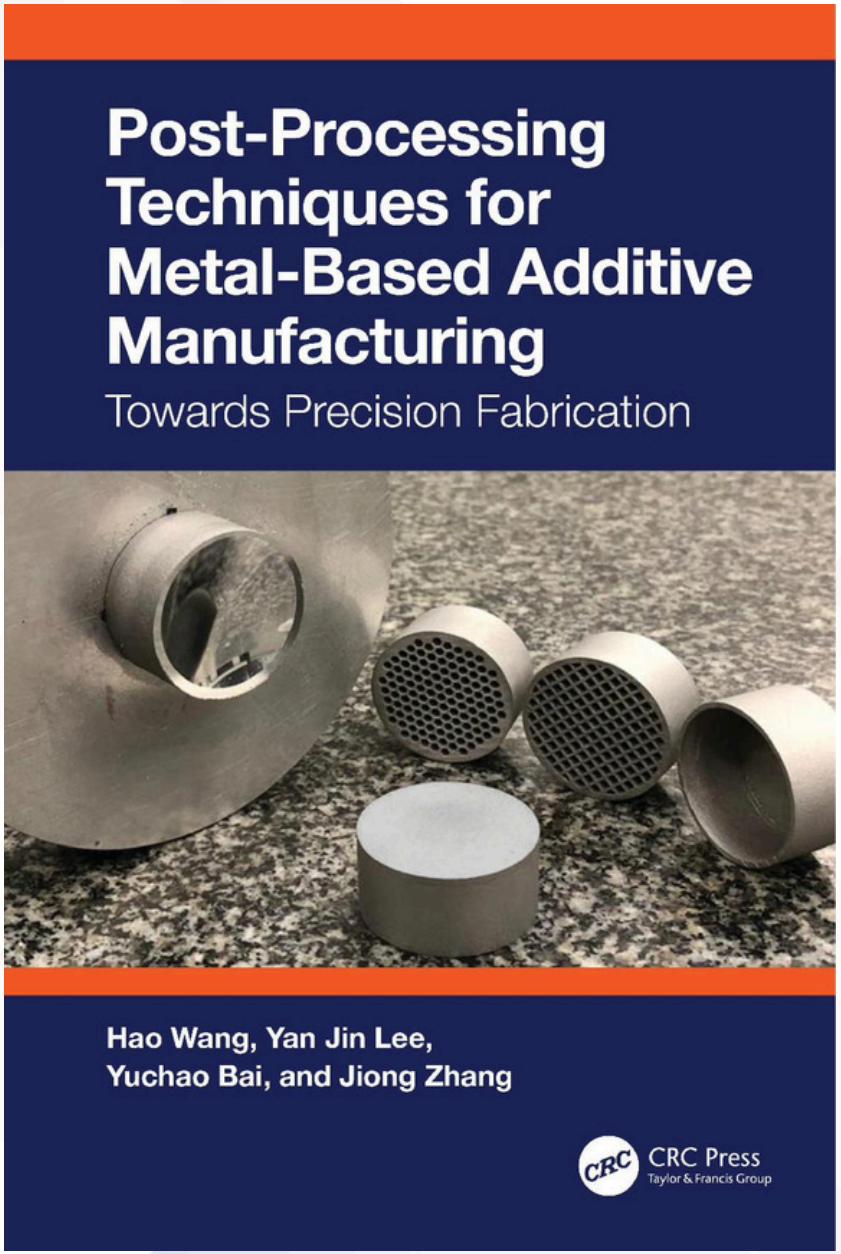
Prof. ZHANG Jiong, together with a team led by Prof. WANG Hao from the Department of Mechanical Engineering at the National University of Singapore published a book titled "Post-Processing Techniques for Metal-Based Additive Manufacturing" in Taylor & Francis Group.

This is the first book on post-processing of additive manufactured components. It shares insights on post-processing techniques adopted to achieve precision-grade surfaces of additive manufactured metals including material characterization techniques and the identified material properties. Post-processes are discussed from support structure removal and heat treatment to material removal processes, including hybrid manufacturing.



Prof. ZHANG holding the stent structure after post-processing

2.4 Post-Processing Techniques for Metal-Based Additive Manufacturing Towards Precision Fabrication



- Addresses the critical aspect of post-processing for metal additive manufacturing

- Provides systematic introduction of pertinent materials

- Demonstrates post-process technique selection with the enhanced understanding of material characterization methods and evaluation

- Includes in-depth validation of ultra-precision machining technology

- Reviews precision fabrication of industrial-grade titanium alloys, steels, and aluminium alloys, with additive manufacturing technology

3

Department Activities

3.1 CLP Power Low-Carbon Invention Competition

The worsening effects of climate change have prompted a concerted effort to promote low-carbon living to address the problem. To raise environmental awareness among our younger generation, the CLP Power Low-Carbon Energy Education Centre (LCEEC), which was established jointly by CLP Power Hong Kong Limited (CLP Power) and the City University of Hong Kong (CityU), recently held a “Low-Carbon Invention Competition” to harness students’ creativity on this important issue.

More than 1,100 primary and secondary school students took part in the competition. After the first round of judging, 100 students were selected for the second round, in which they attended workshops to learn how to use 3D drawing software to transform their designs into 3D products.

This is the first time LCEEC has held the competition. The adjudicators were full of praise for the students’ inventions. They hoped this would serve as a starting point for nurturing student’s environmental awareness and encouraged the participants to share their inventions with their friends to spread the message of low-carbon living.

Group photo of the judges with the award winners

Group photo of the judges with the award winners

3.1 CLP Power Low-Carbon Invention Competition

Some of the winning entries featured renewable energy that harnesses wind and solar power and uses energy storage devices. Other entries aimed to reduce carbon emissions through greening. **YU Tsz Yin**, a secondary two student from the Hong Kong University Graduate Association College, won the championship in the secondary school category for her invention that featured a semi-spherical structure built with water pipes spanning the city's skyline. The structure supported the growth of aquatic plants, absorbing carbon emissions and enhancing urban greening. YU said, "Amidst the challenges posed by global warming, I am eager to contribute to environmental protection with my design, which mitigates the impact of urbanisation and enhances air quality." **Jovi CHAN**, a primary four student from Ying Wa Primary School, was the champion in the primary school category. His winning entry used the wind tunnel effect to drive wind turbines built between high-rise buildings to generate electricity. CHAN said, "I encountered strong wind between two buildings when typhoon signal No. 10 was hoisted. The experience inspired me to design this appliance and I hope my design will support decarbonization in the community."

YU Tsz Yin (left), champion of the secondary school category, together with Mr. LEUNG Wing Mo, Guest Judge of the activity and Hong Kong Meteorological Society Spokesperson

The work of YU Tsz Yin

Jovi CHAN (left), champion in the primary school category, with Prof PAN Chin, Head of MNE and CLP Power Chair Professor of Nuclear Engineering

The work of Jovi CHAN

3.2 Networking night with the Institution of Mechanical Engineers

This year, MNE organized a networking night on 23 Feb, in CityU Chinese Restaurant, to provide a platform for interaction and exchange between professors and students from the MNE department and IMechE committee members.

The Institution of Mechanical Engineers provides life-long learning opportunities for 115,000 members worldwide, many of whom will achieve professionally registered status. The institution provides the opportunity to meet, exchange ideas and innovate, supporting their members and the wider engineering community in developing their skills throughout their careers.

We are honored to have the participation of four esteemed academic talents: Professor PAN, Professor Lawrence LI Kwok Yan, Professor YANG Yong, and Dr. LUK Bing Lam. Also, 14 of the participants were engineering students from CityU, while another 6 participants were representatives from the IMechE Hong Kong Branch.

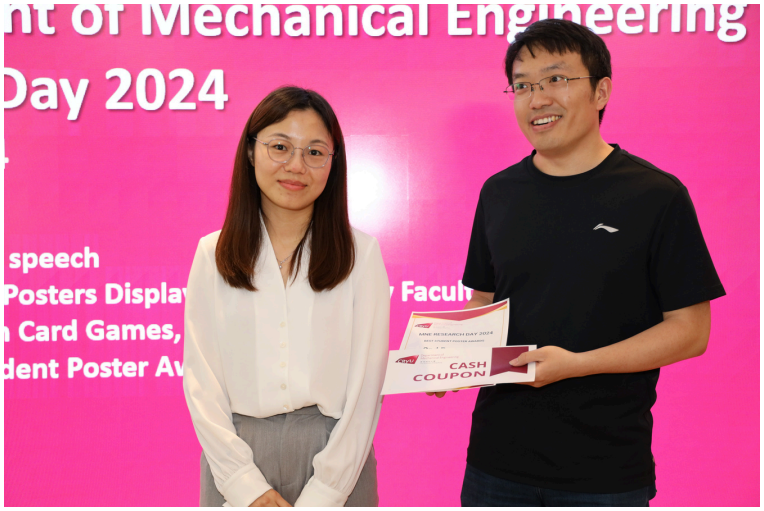
One of the main goals of the student chapter at CityU is to foster closer ties and collaboration between the mechanical engineering industry and academia. As we begin the new session of CityU student chapter 2023/2024, we would like to propose a Networking Night 2024 co-organised by IMechE HKB and CityU Department of Mechanical Engineering on a weekday evening in 2024.

Group photo of 14 MNE students, 4 faculty members from MNE,, and 6 IMechE representatives

3.3 MNE Research Day 2024

MNE Research Day 2024 was organized on 17 April 2024 in CityU lounge and was a great success. The research day event aims to provide opportunities for our PhD students to interact with our faculty members during the tea-gathering, and it showcases the research outputs by displaying Student Posters. At the end of the event was a ceremony for the Best Student Poster Awards. This year, 44 participants spent a warm and meaningful afternoon.

A group photo of all 44 participants



Prof. LI Jing (left), who is a graduate of MNE and an Assistant Professor in MSE, gave a speech and helped present the award to 2nd runner up Mr. BO Xiangkun (right).

Prof. ZHU Pingan (left) and Prof. YANG Yong (right) together present the award to 1st runner up Miss. ZHOU Ying (middle).

3.3 MNE Research Day 2024

Prof. YANG Yong (left) and Prof. PAN Chin (right) together present the award to Champion student Mr. WANG Hang (middle).

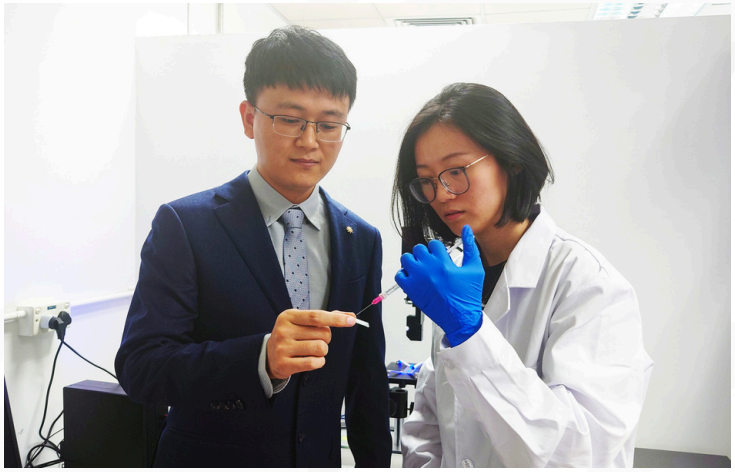
Participants gathering and enjoying afternoon tea

The participants gathering and discussing the posters

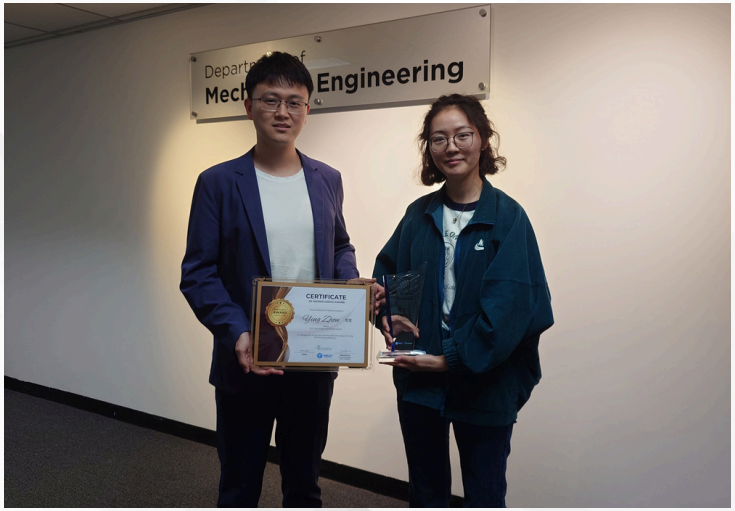
4

Outstanding Students

4.1 Ph.D student ZHOU Ying received the prestigious Microfluidic Award 2023



Miss ZHOU Ying, a PhD student under the supervision of Prof. ZHU Pingan, has been honored with the prestigious Microfluidics Award 2023 in the PhD student category. This recognition is a testament to her exceptional research achievements showcased in her groundbreaking work “Suppression of Hollow Droplet Rebound on Super-repellent Surfaces”, which was published in the esteemed journal *Nature Communications* in 2023.



Miss ZHOU Ying (right) with Professor ZHU Pingan

4.2 Nicola WONG Yim Kiu attended the 68th session of the United Nations Commission on the Status of Women

A Year-4 MNE undergraduate student Nicola WONG Yim Kiu was nominated to participate in the 68th session of the United Nations Commission on the Status of Women (UN CSW68) at the United Nations Headquarters in New York. She was one of the students presenting in the discussion sessions, advocating for women's empowerment. This global platform provided an invaluable opportunity and showcased CityUHK's unwavering dedication to promoting gender equality.

UN CSW68 took place from 11 to 22 March, 2024, under the priority theme "Accelerating the achievement of gender equality and the empowerment of all women and girls by addressing poverty and strengthening institutions and financing with a gender perspective".

During her sharing session, Nicola pointed out that the lack of affordable, high-quality childcare services is a significant challenge faced by working mothers in Hong Kong. To address this issue, she proposed the establishment of a collaborative network connecting working mothers with experienced housewives. Offering housewives compensated caregiving roles would enable working mothers to pursue their careers full-time.

"Throughout our journey, we had the privilege of attending diverse official events, as well as parallel events held by organisations from different countries," said Nicola. "The encounters and discussions on women empowerment were truly enlightening. I'm grateful for the invaluable help and support provided by CityUHK."

4.2 Bachelor student Nicolas Wong Yim Kiu attended 68th session of the United Nations Commission on the Status of Women

"Many of the MNE teachers invent different products to solve problems in society, they inspired me to do the same." - Nicola

The MNE department was happy and proud to invite Nicola for an interview, to better understand how the young lady has come this far.

"I think all teachers in MNE are being really helpful on this voyage." Nicola said. She is particular thankful to Prof. Patrick WONG. "Patrick helped me on writing a recommendation letter to my exchange University, The University of Sheffield, and gave a lot of suggestion to me. Studying and living abroad in England for a few months really broadened my horizon."

The international exposure made Nicola rethink the opportunity single mothers need to gain back their position in the market. "In England, it is more friendly for single mothers to get their old jobs back. The Government is very supportive in every aspects of releasing manpower." Growing up with a similar experience, Nicola understands the difficulties that women with children face in Chinese society because of social norms. She believes the situation can be improved in the future.

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