香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

香港科大能源研究院
The HKUST Energy Institute

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Message from the Director

Facing the environmental challenges, a green energy future is not an option; it is a requirement. To accelerate the clean energy transition relies not only on frontier technologies, but also collective effort from each person. In this issue, I shall share with you some of my viewpoints on creating an environment where sustainability is attainable.

To showcase of the university's achievements in advanced materials, one of the university-level strategic research foci, over the past 35 years, Prof. FAN Zhiyoung, Prof. Yoonseob KIM and I guest-edited a special issue of *Advanced Materials*. I encourage you to read this special issue which highlights recent research activities taking place across the HKUST campus in collaboration with colleagues and alumni.

I am delighted that Peaceful Development Fund Management Limited (CHMT) have signed a Memorandum of Understanding (MoU) with HKUST, marking a pivotal moment in accelerating new energy innovation through industry-academia-research collaboration to co-creating a green future.

We thank for the generous donation by Foundation for Amazing Potentials to set up "The Ying Family PhD Research Award". The Award aims to recognize and reward PhD students who have demonstrated outstanding research performance and achievements in the areas of sustainability, environmental studies, energy technology, green technology or related disciplines. The first award presentation was held in June.

I am proud of our members and their accomplishments, and I believe that Energy Institute can go even further, aided by our members' unwavering commitment, and your sustained collaboration.

Prof Minhua Shao

Director of the HKUST Energy Institute

Cheong Ying Chan Professor of Energy Engineering and Environment

Head and Chair Professor, Department of Chemical and Biological Engineering

On the Road to Net Zero

Creating an Environment Where the Sustainable Is Attainable

Prof. Shao Minhua's fast-rising career in academia and industry has advanced high-performance, cost-effective hydrogen fuel cells and solid-state lithium batteries, driving green transportation.

As a pioneering electrochemist and Head of the Department of Chemical and Biological Engineering, Prof. SHAO Minhua is accelerating the clean energy transition and seeking to fast forward top faculty and young talents in making their own contribution to a resource-friendly world.

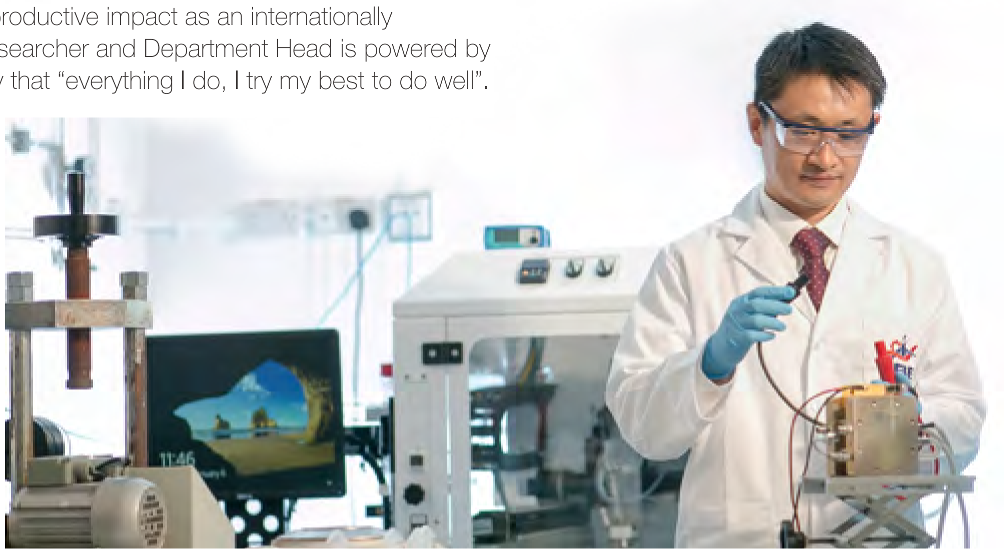
Listening to the news on sustainability and net-zero can be a test for the sturdiest optimist these days. However, listening to Prof. SHAO Minhua, Director of the HKUST Energy Institute, Head and Chair Professor of Chemical and Biological Engineering (CBE), and Cheong Ying Chan Professor of Energy Engineering and Environment, brings the huge and complex global challenge back down to the do-able for each person to make a difference. "The sustainability big picture is certainly really, really big. But I just try to do what I can and what I'm good at. If I can contribute a little bit, then I'm proud of this."

Energizing positive change

In fact, Prof. Shao's individual efforts are actively driving a range of endeavors with major impact potential for a greener world and improved lives. The globally recognized electrochemist's research is powering significant new understanding and applications to spur the clean energy transition in transportation, including leading advances in high-performance, durable, cost-effective hydrogen fuel cells and solid-state lithium batteries with energy densities over 400 watt-hours per kilogram (Wh/kg) for electric vehicles beyond cars. Such work can help boost air quality and cut greenhouse gas emissions. It can also energize the advent of the exciting low-altitude economy, involving electric vertical takeoff and landing (eVTOL) aircraft flying below 1,000 meters and a host of innovative services.

At the same time, as Department Head of CBE since 2023, Prof. Shao is looking to widen development of novel eco-friendly and health technologies through additional faculty to scale up the department's size to and new degree programs that answer the evolving needs of society, job market, and next-generation innovators. Key future directions embrace advanced materials, data science & AI, biotechnology, and biomedical engineering, an inspiring agenda to add to the diverse areas that the department already addresses. Indeed, in less than two years, Prof. Shao has already recruited four senior and five junior faculty members from local and top universities overseas. Potential student applicants can now sample insightful workshops, held in collaboration with secondary schools, and enjoy invitations to the department's labs to see for themselves the work being carried out. In addition, in the 2025-26 academic year, the BEng in Energy and Environmental Engineering will welcome its first cohort. Consolidated from two previous programs (Sustainable Energy Engineering and Chemical and Environmental Engineering), the comprehensive new bachelor's degree has drawn strong interest locally and overseas. "Most of us now care about the environment and renewables," Prof. Shao pointed out. "In addition, after graduation, there are job opportunities there."

Prof. Shao's productive impact as an internationally recognized researcher and Department Head is powered by his philosophy that "everything I do, I try my best to do well".



Seizing opportunities, fueling happiness

In steering such changes so rapidly, Prof. Shao has called on his personal outlook on life. Rather than making a single grand plan that could prove unobtainable and lead to dejection, this approach centers on a readiness to take opportunities as and when they arise and then putting in maximum effort to ensure success. "I don't set big targets for myself," he said. "But everything I do, I try my best to do well. Then, when I have a chance, I will try to grab it – and if you try, you will be happy." A stellar earlier career encompassing research and industry roles at the forefront of clean energy exploration is a further indication of his philosophy's effectiveness.

As an undergraduate at Xiamen University in Fujian, Prof. Shao studied chemistry, but during his master's in Physical Chemistry, also at Xiamen, a passion for electrochemistry started to emerge after being randomly assigned research into metal corrosion and anti-corrosion. On graduation in 2002, he decided to "see what would happen" if he headed for doctoral studies overseas. What happened during his PhD in Materials Science and Engineering at the State University of New York at Stony Brook was a series of "chances" that Prof. Shao managed to grab. When unable to study corrosion due to his professor's lack of funding, he switched to polymers. But finding this area held less appeal for him – "and if you are doing research, you really want to do research you are interested in" – after a year he proactively sought to transfer to Brookhaven National Laboratory, managed by Stony Brook for the US Department of Energy. There, his supervisor set him to work on some intriguing electrochemistry-related studies. "At the time, I wasn't aware of this research area. I was just interested in electrochemistry as a whole. Whether a fundamental or practical research area, I didn't mind as long as it was electrochemistry," he said. The focus was electrocatalysis and materials at the early stage of the hydrogen economy.

Prof. Shao in his undergraduate years at Xiamen University, at a beach near the campus.

Prof. Shao outside the Metropolitan Museum of Art in New York City, taken in his first year of doctoral studies at the State University of New York at Stony Brook.

Prof. Shao at Brookhaven National Laboratory in the US in 2006, following graduation from doctoral studies and alongside the infrared spectrometer frequently used during his PhD.

On the move in industry and academia

After graduation in 2006, he gained another of his “chances”, moving from Brookhaven to UTC Power, the oldest fuel cell company in the world, on the recommendation of his PhD supervisor. Then, right after joining, he was appointed team leader of a multi-year collaborative project with Toyota Motor Company due to the former leader having a baby. This next life-changing opening resulted in a meteoric ascent at UTC Power, a subsidiary of Fortune 500 company United Technologies Corporation and the supplier of fuel cells for NASA’s space missions as well as fuel cell buses and stationary power plants. There, Prof. Shao became the fastest promoted engineer in the history of UTC as a whole, going from fresh engineer to Technical Fellow within five years. He also gained invaluable experience in team supervision, management, and communication, as well as working with other industry and university collaborators. In 2013, he switched to Ford Motor Company to extend his experience to lithium-ion battery electro-vehicles, spending a useful year discovering the core issues and problems facing the EV industry at that milestone time.

However, by then he was already thinking about a return to academia. “I have a lot of ideas, I want to try, but in industry, you don’t have that freedom because everything you do is to fulfill the company’s goal.” He looked at friends in US academia, who seemed highly stressed and consumed with research proposal writing, and decided it was not for him. Prof. Shao had already heard of HKUST’s high standards. In 2013, he ran into an academic friend from the Mainland in Boston, who had previously spent time as a visiting professor at CBE and enjoyed it. So when an opening appeared on the HKUST website, he decided to apply. In 2014, he and his family moved to Hong Kong.

Prof. Shao’s fast-rising career in industry was then echoed at HKUST, where he arrived as an untenured Associate Professor and moved up to endowed Chair Professor and Director of the HKUST Energy Institute by 2022. Beyond the satisfaction of the fuel cell and battery achievements of his research team, the all-round high-flyer has been recognized for his outstanding teaching, as well as his contribution to the field, being elected a Fellow of the eminent Electrochemical Society in 2023. He has also taken the first steps to entrepreneurship with a fuel cell catalyst start-up called Guangzhou Padergy New Energy Co Ltd. Established in 2023, Padergy now has over 10 employees and has secured its first round of investment. A second new business related to batteries is being planned. Yet somehow, on top of all his responsibilities, including two daughters, Prof. Shao still manages to find the bandwidth for running in marathons and playing other sports, including soccer, tennis, badminton, and squash. “I enjoy this time very much because it is your own,” he said. “And, of course, sport is sometimes competitive so any achievement or improvement gives you joy.”

Carbon-neutral outlook

Looking to future sustainability overall, Prof. Shao is confident that cleaner energy across transportation is now close in Hong Kong. He points to the arrival of a hydrogen-powered Citybus, and notes discussions about electric ferries. At HKUST, he is happy to see front-running emissions initiatives such as University’s Net-Zero Action Plan 2045. Meanwhile, at the big picture level, he feels the UN Sustainable Development Goals and projects are a good way of bringing the myriad aspects of a resource-friendly world together. “Whether we can achieve this, I cannot tell, because not all countries are working toward the same goal. I would say it will be difficult, but there’s obviously progress.”

Prof. Shao (left) enjoying time out from his packed schedule as an educator, researcher, departmental leader, entrepreneur, and family man to join CBE students at the departmental year-end party; and on the football field (top).

Prof. SHAO Minhua Awarded a Battery Project from Otto Poon Center for Climate Resilience and Sustainability

Prof. SHAO Minhua, Director of Energy Institute, Cheong Ying Chan Professor of Energy Engineering and Environment, and Head and Chair Professor of Chemical and Biological Engineering, has been awarded a Battery Project from Otto Poon Center for Climate Resilience and Sustainability, for the project titled "Development of Quasi-Solid-State Lithium-Ion Batteries with a High Energy Density and Safety".

The current lithium-ion batteries (LIBs) suffer from low energy density due to low capacities of both anode and cathode materials, and safety concerns posed by flammable organic solvents. Silicon-based materials stand out as promising contenders for the next generation anode, owing to their high energy densities. Nonetheless, the large-scale commercialization of silicon-based batteries is limited by their serious volume change and poor cycling stability. While solid-state electrolytes combined with high stack pressure hold promise for addressing challenges posed by liquid electrolytes, issues such as interfacial connectivity and excessive costs give rise to new hurdles. Quasi-solid gel electrolytes based on flexible and resilient polymers can solve the severe solid-solid contact problem by transforming liquid electrolytes into solid gel in batteries.

Prof Shao's team aims to develop a polymer-gel electrolytes in silicon-based batteries with high energy density, negligible volume change, long cycling life and high safety. Benefiting from the tremendous resilience and self-healing property conferred by multiple-hydrogen bonding, the silicon-anode developed in this project has limited volume expansion and establishes robust interfacial contact with the electrolyte, thus offering an excellent cycle lifespan. The quasi-solid Ah-scale pouch cells demonstrate unprecedented energy densities of > 350 Wh kg^{-1} without the need for external pressure and long cycling life of 1000 cycles with a capacity retention > 80%. The battery also exhibits significantly improved safety than conventional LIBs. It is expected that the pilot production of products developed in this project can be used in electric vehicles, 3C products, and large-scale energy storage.

Established in 2025 through the generous support of Ir Dr. Otto POON, Founder of the Otto Poon Charitable Foundation, the Otto Poon Center for Climate Resilience and Sustainability (CCRS) unites HKUST's world-class expertise in climate science, advanced modeling systems, artificial intelligence (AI), renewable energy and sustainable policy to deliver scalable and actionable strategies for governments, industries, and communities worldwide.

Future of Green Energy

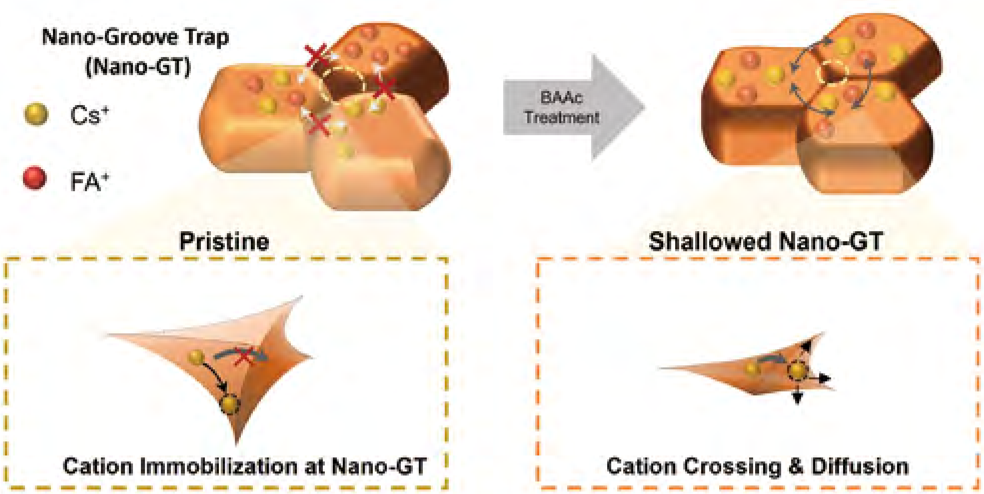
HKUST Engineering Unveils Critical Nanoscale Phenomena for More Efficient and Stable Perovskite Solar Cells

Prof. Zhou Yuanyuan (left) and Dr. Hao Mingwei (right) demonstrate a stability test of their newly developed cation-homogenized perovskite solar cells.

In a significant advancement for boosting renewable energy generation development, the Hong Kong University of Science and Technology (HKUST) has taken the lead in breaking through studies of the nanoscale properties of perovskite solar cells (PSCs). This initiative has resulted in the development of more efficient and durable cells, poised to substantially diminish costs and broaden applications, thereby connecting scientific research with the needs of the business community.

Compared to conventional silicon solar cells, PSCs can potentially attain higher power conversion efficiencies and feature the utilization of lower-cost materials and more sustainable manufacturing processes. Therefore, PSCs have become a cutting-edge research area in energy and sustainability. However, the long-term stability of PSCs when exposed to light, humidity, and thermomechanical stressors remains a major hurdle in commercialization. One key factor causing instability is the inhomogeneous distribution of cations in perovskite thin films, which can trigger an unfavored phase transition that gradually degrades the devices.

A research team led by Prof. ZHOU Yuanyuan, Associate Professor of the Department of Chemical and Biological Engineering and Associate Director of the Energy Institute at HKUST found that the nanoscale groove traps at the perovskite grain's triple junctions serve as geometric traps that capture cations and retard their interdiffusion towards homogenization. The research team used a rational chemical additive approach known as butylammonium acetate and successfully reduced the depth of these nanoscale groove traps by a factor of three. The resultant cation-homogenized PSCs showed an improved efficiency close to 26%. More importantly, these devices demonstrate advantageous



Schematic illustration of the nontrivial cation immobilization at a nanoscale groove trap and the cation relaxation after its shallowing.

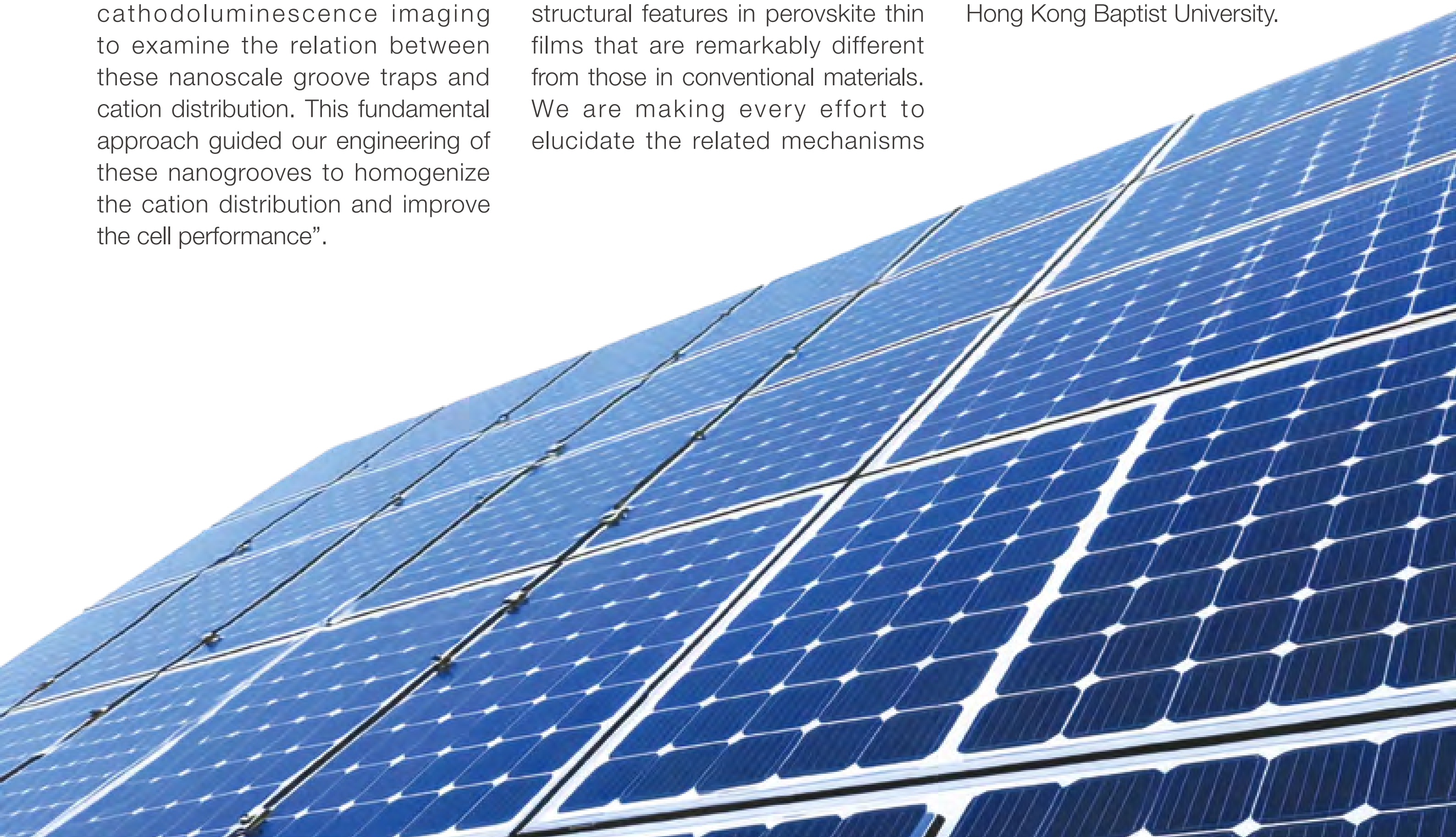
stabilities under various standardized test protocols.

The primary corresponding author of the present study, Prof. Zhou said "Most existing studies focus on the microscopic or macroscopic levels to improve perovskite solar cells. Our team, however, investigated details down to the nanoscale in these PSCs. We used an advanced characterization technique called cathodoluminescence imaging to examine the relation between these nanoscale groove traps and cation distribution. This fundamental approach guided our engineering of these nanogrooves to homogenize the cation distribution and improve the cell performance".

The findings were published in the top nanoscience journal *Nature Nanotechnology,* in a paper titled "Nanoscopic Cross-Grain Cation Homogenization in Perovskite Solar Cells".

HKUST Postdoctoral fellow Dr. HAO Mingwei, the first author of this work, added, "Perovskite is a soft-lattice material. Throughout our experiments, we found notable structural features in perovskite thin films that are remarkably different from those in conventional materials. We are making every effort to elucidate the related mechanisms to promote the commercial viability of perovskite solar cells, pushing forward the development of the renewable energy market with this potential game-changer."

Prof. Mahshid AHMADI from the University of Tennessee, Knoxville is the co-corresponding author of this work. Other collaborators are from Yale University, Oak Ridge National Laboratory Yonsei University, and Hong Kong Baptist University.



Fundamentals-Oriented Device Innovation

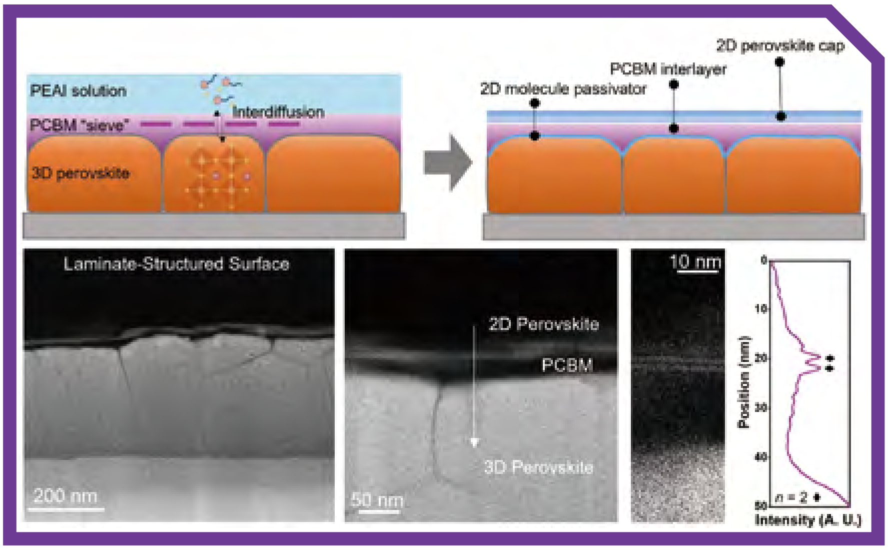
Inspired by Laminate: HKUST and PolyU Researchers Synthesize a Laminate-Structured Material Interface to Improve Perovskite Solar Cells

The lead corresponding author Prof. Zhou Yuanyuan (right) and co-first author Dr. Guo Pengfei (left) are showing a perovskite solar cell prototype made for a proof-of-concept demonstration of the novel laminate-structured interface.

A collaborative research team from the Hong Kong University of Science and Technology (HKUST) and the Hong Kong Polytechnic University (PolyU) has developed an innovative laminated interface microstructure that enhances the stability and photoelectric conversion efficiency of inverted perovskite solar cells.

Perovskite solar cells have considerable potential to replace traditional silicon solar cells in various applications, including grid electricity, portable power sources, and space photovoltaics. This is due to their unique advantages, such as high efficiency, low cost, and aesthetic appeal. The basic structures of perovskite solar cells are classified into two types: standard and inverted. The inverted structure demonstrates better application prospects because the electronic materials used in each layer are more stable compared to those in the standard configuration. However, challenges related to interface science still exist in inverted devices, particularly concerning defect accumulation at the interface between the fullerene-based electron transport layer and the perovskite surface. This defect accumulation significantly impacts the device's performance and stability.

Prof. ZHOU Yuanyuan, Associate Professor in the Department of Chemical and Biological Engineering (CBE) and Associate Director of the Energy Institute at HKUST, leads a team focused on fundamental research into perovskite optoelectronic devices from a unique structural perspective. They collaborated closely with Prof. CAI Songhua's team from the Department of Applied Physics at PolyU. Their research revealed that by uniformly creating a "molecular passivation layer-fullerene derivative layer-2D perovskite layer" — a "three-ply" laminated structure on the surface of the perovskite film — they could effectively reduce the density of interface defects and improve energy level alignment. This advancement



substantially boosts the photoelectric conversion efficiency of the perovskite solar cell and enhances the durability of the interface under damp-heat and light soaking conditions.

Dr. GUO Pengfei, co-first author of this work and a postdoctoral fellow at HKUST's CBE Department, said, "We introduced the concept of composite materials into the interface design of optoelectronic devices, allowing the synergistic effects of each layer in this new interface to achieve results that are unattainable with traditional interface engineering."

Prof. Zhou Yuanyuan, the lead corresponding author of the study, added, "Perovskite is a soft lattice material. We can create microstructural features in this type of material that are difficult to achieve with conventional materials. Our aim is to understand the formation and mechanisms of these microstructures at the nanoscale, or even at the atomic scale, to drive device innovation based on this fundamental understanding."

The team's collaborative research findings have been published in Nature Synthesis, a top journal in the field of synthetic science, in a paper titled "Synthesis of a Lattice-Resolved Laminate-Structured Perovskite Heterointerface".

HKUST Partners with Top US and Swiss Universities to Propose Innovative Strategy Reshaping Stability and Sustainability of Perovskite Solar Cells

Corresponding author Prof. Zhou Yuanyuan (left), holding a crystal model of perovskite, and first author Dr. Duan Tianwei (right) standing in front of solar panels.

A research team from the School of Engineering (SENG) at The Hong Kong University of Science and Technology (HKUST) has introduced comprehensive bio-inspired multiscale design strategies to address key challenges in the commercialization of perovskite solar cells: long-term operational stability. Drawing inspiration from natural systems, these strategies aim to enhance the efficiency, resilience, and adaptability of solar technologies. The approaches focus on leveraging insights from biological structures to create solar cells that can better withstand environmental stressors and prolonged use.

Perovskite solar cells are advantageous due to their low-temperature, solution-based manufacturing process, which has the potential to lower solar energy costs. However, their commercial viability is hindered by several operational issues, including inadequate interfacial adhesion, mechanical fragility, and susceptibility to environmental stressors (e.g., heat, moisture, and UV light). These degradation processes occur across various length scales, from picometers to centimeters, and multiscale structural factors can significantly affect the stability and performance of the final perovskite solar cells.

Rethinking solar cell design through the lens of nature

To tackle the challenges faced by perovskite solar cells, Prof. ZHOU Yuanyuan, Associate Director of Energy Institute (EI) and Associate Professor in the Department of Chemical and Biological Engineering (CBE) at HKUST, along with his research group and collaborators from top institutions in the US and Switzerland, propose leveraging insights from biological systems. They suggest that the hierarchically functional structures found in nature, such as those in leaves, can inspire the development of solar technologies that are efficient, low-cost, resilient, and adaptable to environmental changes.

Multiscale bio-inspired strategy

Their comprehensive strategy spans multiple levels:

- Molecular level: Utilizing bio-inspired molecular interactions for crystallization control and degradation mitigation
- Microscale level: Implementing self-healing and strength-enhancing strategies using dynamic bonds and interfacial reinforcement
- Device level: Adopting functional structures inspired by nature, such as moth eyes, leaf transpiration, and beetle cuticles, to improve light management, heat dissipation, and environmental protection

"Nature provides an abundant reservoir of design solutions to help us build solar materials that can thrive in real-world conditions," said Prof. Zhou. "We've already translated some of these strategies into synthetic energy devices."

Landmark advances: chiral and laminated interfaces

This vision builds on recent breakthroughs in bio-mimicking interfacial design:

1. Chiral-structured heterointerface: Prof. Zhou's team created a chiral interface using R-/S-methylbenzylammonium, where the helically packed benzene rings mimic biological springs, significantly enhancing the mechanical durability of perovskite solar cells. This work was published in *Science.*
2. Laminate-inspired interface: Prof. Zhou's team developed a cell-surface-like multi-layer surface microstructure comprising a molecular passivation layer, a fullerene derivative layer, and a 2D perovskite capping layer, which effectively suppresses defects and enhances energy level alignment, resulting in improved efficiency and damp-heat stability. This work was published in *Nature Synthesis.*

These studies highlight the potential of bio-inspired and hierarchical engineering to address fundamental limitations of perovskite solar cells, including adhesion, fatigue, and interface degradation.

Toward sustainable and scalable solar technologies

The multiscale design framework emphasizes sustainability, prioritizing low-toxicity materials compatible with a circular economy. Prof. Zhou's team proposes that future research will focus on screening bio-inspired molecules for optimal film crystallization and stability, developing self-healing mechanisms activated by operational stress, designing cost-efficient biomicrostructures, and integrating multifunctional encapsulation to enhance the efficiency and lifespan of perovskite solar cells.

Dr. DUAN Tianwei, the first author and Research Assistant Professor at HKUST's CBE Department, stated, "This is not just about new materials; it represents a novel approach to solar technology, inspired by nature itself. By integrating bio-inspired structures, functions, and sustainability, we are excited about the new chapter unfolding in solar energy."

The team's research work, titled "Bio-Inspired Multiscale Design for Perovskite Solar Cells", has been published in the prestigious journal *Nature Reviews Clean Technology,* in collaboration with Yale University, École Polytechnique Fédérale de Lausanne, and Lawrence Berkeley National Laboratory.

HKUST Engineering Develops World's First Kilowatt-Scale Elastocaloric Green Cooling Device

Setting to Reshape Air Conditioning Industry with its Zero Emissions and High Energy Efficiency

Prof. Sun Qingping (second right) and Prof. Yao Shuhuai (second left), both Professors of the Department of Mechanical and Aerospace Engineering (MAE), MAE Postdoctoral Research Associate Dr. Zhou Guoan (first left), and MAE PhD student Li Zexi (first right) with the world's first kilowatt-scale elastocaloric green cooling device they develop.

Researchers at the Hong Kong University of Science and Technology (HKUST) have developed the world's first kilowatt-scale elastocaloric cooling device. The device can stabilize indoor temperatures at a comfortable 21-22°C in just 15 minutes, even when outdoor temperatures reach between 30-31°C, marking a significant breakthrough toward the commercial application of elastocaloric solid-state cooling technology. The research findings have been published in the leading international science journal Nature, offering a promising solution to combat climate change and accelerate low-carbon transformation of the global cooling industry.

As global warming intensifies, the demand for air conditioning and cooling has been growing, with cooling already accounting for 20% of global electricity consumption. Mainstream vapor compression cooling technology relies on refrigerants with high global warming potential (GWP). As an eco-friendly alternative, solid-state cooling technology based on the elastocaloric effect of shape memory alloys (SMAs) has drawn substantial focus from both academia and industry due to its zero greenhouse gas emissions and high energy efficiency potential.

However, the maximum cooling power of previous elastocaloric cooling devices was around 260 watts, which could not meet the kilowatt-scale requirement for commercial air conditioning. The HKUST research team, led by Prof. SUN Qingping and Prof. YAO Shuhuai, both Professors from the Department of Mechanical and Aerospace Engineering (MAE), identified that this bottleneck stems from two core issues: (1) the difficulty in balancing the specific cooling power (SCP) of the refrigerant with the total active mass; and (2) insufficient heat transfer efficiency during high-frequency operation.

To overcome these limitations, the research team proposed an "SMAs in series – fluid in parallel" multi-cell architecture design (Figure 1a). This architecture serially connects 10 elastocaloric cooling units along the direction of force application, with each unit containing four thin-walled nickel-titanium alloy tubes, totaling a mass of only 104.4 grams. The nickel-titanium tubes feature a high surface area-to-volume ratio of 7.51 mm^{-1} that significantly improves heat exchange efficiency. Meanwhile, the parallel fluid channel design keeps system pressure below 1.5 bar, ensuring stable high-frequency operation.

Another key innovation is replacing traditional distilled water with graphene nanofluid, a cutting-edge heat transfer medium with exceptional thermal conductivity. Experiments showed that graphene nanofluid, at just 2 grams per liter concentration, conducts heat 50% more efficiently than distilled water (Figure 1d). The diameter of its nanoparticles (0.8 micrometers) is much smaller than the width of the fluid channels (150-500 micrometers), avoiding blockage risks. X-ray tomography (Figure 2b) confirmed that the nickel-titanium tubes maintained uniform compressive deformation under a stress of 950 megapascals without buckling failure.

At a high frequency of 3.5 Hz, the device achieved a specific cooling power of 12.3 W/g and a total cooling power of 1,284 watts (under zero temperature lift conditions), demonstrating its practical viability in real-world conditions.

In practical application tests, the device successfully cooled a 2.7 m^3 model house (Figure 3) in a summer outdoor environment with temperatures between 30-31°C, stabilizing the indoor temperature at a comfortable 21-22 °C in 15 minutes.

Compared with existing solid-state cooling technologies (Figure 4), this pioneering device leads in terms of cooling power and temperature lift performance. Its SCP value (12.3 W/g) nearly triples the previous record of liquid heat transfer elastocaloric devices (4.4 W/g), and it has for the first time broken through the kilowatt-scale cooling threshold.

Prof. Sun Qingping said, "This achievement demonstrates the potential for large-scale application of elastocaloric cooling technology. We are working with the industry to drive its commercialization. As global regulations on hydrofluorocarbons (HFCs) tighten, this zero-emission, energy-efficient cooling technology is poised to reshape the air conditioning industry and provide a key technical solution for carbon neutrality. Consumers will also benefit from lower energy bills while the technological advancements enable more compact cooling devices that save valuable indoor space."

Prof. YAO Shuhuai said, "In the future, the system's cooling performance can be further improved by developing new elastocaloric materials and optimizing the rotary drive architecture. These improvements can help achieve larger cooling powers, meaning indoor environments can be cooled down in significantly less time."

This innovation has come as another major breakthrough by the research team in less than a year. It builds on their previous success with a multi-material elastocaloric device that sets a record of 75 K temperature lift, as published in the prestigious journal Nature Energy in 2024. This paper, titled "Achieving Kilowatt-Scale Elastocaloric Cooling by a Multi-Cell Architecture", has been published in the leading international science journal *Nature*.

This research was supported by the Strategic Topics Grant (STG) and General Research Fund (GRF) projects of the Hong Kong Research Grants Council, Innovation and Technology Commission (ITC) projects, Shenzhen-Hong Kong research collaboration project and the projects of the National Natural Science Foundation of China. Relevant technologies have been applied for multiple international patents, and the industrialization process is accelerating.

The research work was conducted by Prof. Sun and Prof. Yao (both corresponding authors), Postdoctoral Research Associate Dr. ZHOU Guoan (first author and 2023 PhD graduate of MAE), MAE PhD student LI Zexi, in collaboration with Guangdong Eco-engineering Polytechnic's ZHANG Lingyun (2020 MSc graduate of MAE), and Harbin Institute of Technology's Prof. HUA Peng (2019 PhD graduate of MAE).

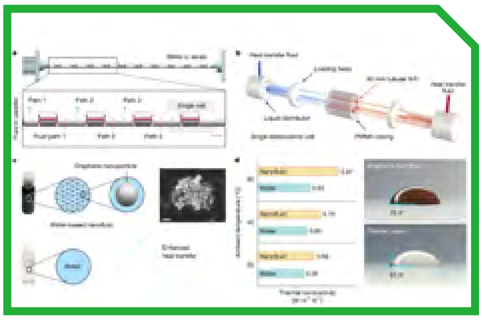


Figure 1: Illustration of the kilowatt-scale elastocaloric cooling device
(Photo credit: Nature Press)

Figure 2: Assembly and operation of the elastocaloric cooling device
(Photo credit: Nature Press)

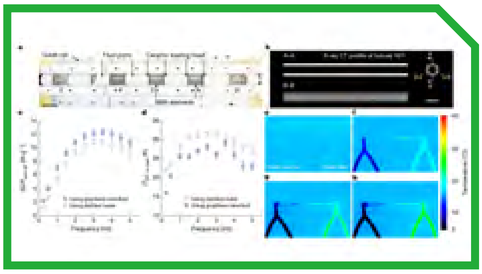


Figure 3: Application of the kilowatt-scale elastocaloric cooling device
(Photo credit: Nature Press)

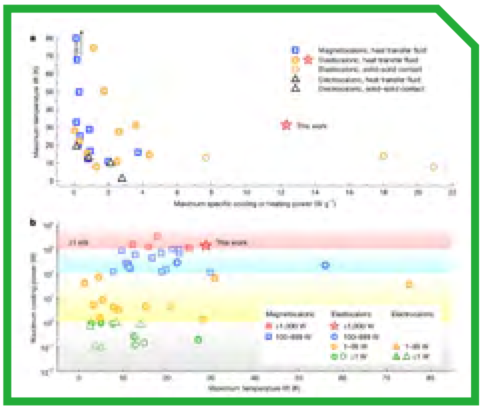
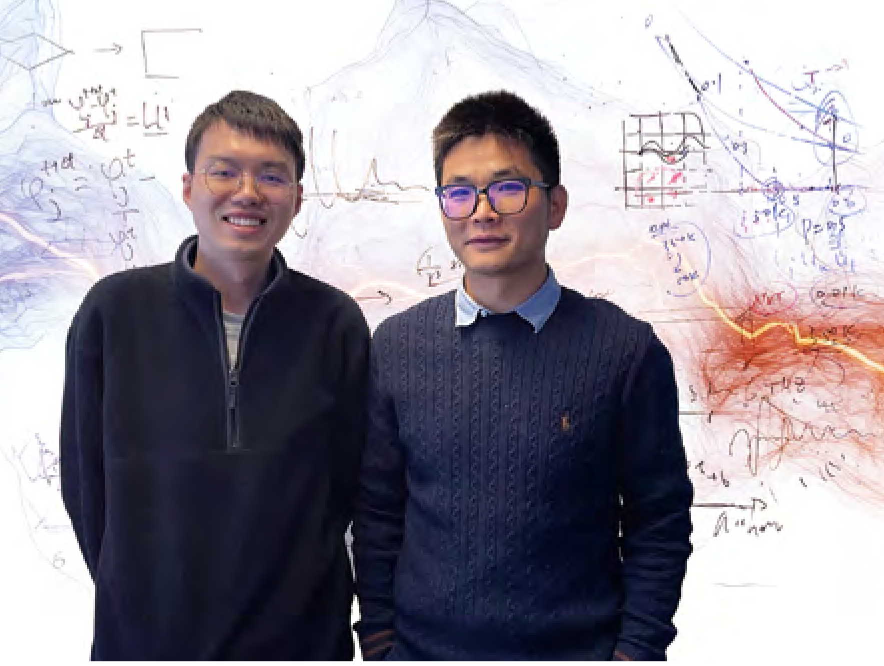


Figure 4: Comparison of refrigeration performance
(Photo credit: Nature Press)

Unveiling Thermal Transport Mechanisms in Superionic Crystals

Prof. ZHOU Yanguang's Research on Energy Transport in Superionic Crystals Published in Physical Review Letters



Prof. Zhou Yanguang (right) and his PhD student Liu Wenxiang (left) proposed a rigorous concept based on the Onsager reciprocal theorem to describe the thermal transport behaviors in superionic crystals.

A research paper titled "Energy Transport in Superionic Crystals", authored by Assistant Professor ZHOU Yanguang from the Department of Mechanical and Aerospace Engineering and his PhD student LIU Wenxiang, was recently published in *Physical Review Letters,* a premier journal in physical and multidisciplinary science and the flagship publication of American Physical Society.

In their study, the team proposes a rigorous concept based on the Onsager reciprocal theorem to describe the thermal transport behaviors in superionic crystals. The results show that thermal energy in superionic crystals can be transferred through the conduction of atomic vibrations, the enthalpy diffusion caused by ions' diffusion and the thermodiffusion coupling. Their work unveils the thermal transport mechanisms in superionic crystals, which explains the long-standing and confusing thermal conductivity temperature dependence of superionic crystals.

HKUST and CHMT Forge Strategic Partnership to Advance National Green Energy Goals Through Industry-Academia-Research Collaboration

The group photo of HKUST President Prof. Nancy IP (middle), Vice-President for Research and Development Prof. Tim CHENG (fourth left), Dean of Engineering Prof. Hong LO (third left), Director of Energy Institute Prof. SHAO Minhua (second left), and the 10th ALL-China Federation of Returned Overseas Chinese and the President of China Peaceful Development General Summit of Hong Kong Macao Taiwan Diaspora Dr. LO Man-Tuen (fourth right), President of the Chinese Manufacturers' Association of Hong Kong and CHMT Chairman Dr. LO Kam-Wing (third right), and Executive President of China Peaceful Development General Summit of Hong Kong Macao Taiwan Diaspora Mr. LUO Xianping and other members of management teams from both parties.

The Hong Kong University of Science and Technology (HKUST) and Peaceful Development Fund Management Limited (CHMT) have signed a Memorandum of Understanding (MoU) on Aug 7, 2025, marking a pivotal moment in accelerating new energy innovation through industry-academia-research collaboration. By combining HKUST's world-class research capabilities with CHMT's market expertise, the partnership will bridge laboratory breakthroughs with commercial deployment. The initiative seeks to drive advancements in new energy technology and sustainable development in line with the carbon neutrality ambitions in the 14th Five-Year Plan.

The signing ceremony, held at HKUST, was witnessed by HKUST President Prof. Nancy Ip and Dr. Lo Man-Tuen, Vice-chairman of the 10th All-China Federation of Returned Overseas Chinese and President of the China Peaceful Development General Summit of Hong Kong, Macao & Taiwan Diaspora. The MoU was signed by HKUST Vice-President for Research and Development Prof. Tim Cheng and Dr. Lo Kam-Wing, Chairman of CHMT and President of the Chinese Manufacturers' Association of Hong Kong.

The partnership will foster energy innovation, explore pathways for translating scientific research into market-ready solutions, and broaden cooperative networks through cross-sector collaboration.

Academic-Industry Collaboration: Co-creating a Green Future

HKUST Vice-President for Research and Development Prof. Tim CHENG said, "Energy transition and sustainable development are critical global priorities. Through this partnership, HKUST and CHMT will synergize cutting-edge research — from next-gen energy storage to renewable energy and system optimization solutions, with industrial scalability, directly supporting the nation's strategic priorities and positioning Hong Kong as a global leader in energy innovation. The HKUST Energy Institute is committed to fostering breakthroughs that enhance energy resilience, reduce carbon intensity and contribute to the Greater Bay

Witnessed by HKUST President Prof. Nancy IP (right in back row) and Vice-chairman of the 10th ALL-China Federation of Returned Overseas Chinese and the President of China Peaceful Development General Summit of Hong Kong Macao Taiwan Diaspora Dr. LO Man-Tuen (left in back row), HKUST Vice-President for Research and Development Prof. Tim CHENG (right in front row), and President of the Chinese Manufacturers' Association of Hong Kong and CHMT Chairman Dr. LO Kam-Wing (left in front row) signed the MoU. This collaboration will foster research, education, and technological advances in new energy technology to promote sustainable development.

Area's development as a global hub for green innovation. Backed by rich resources, deep expertise, and a vast business network, CHMT—guided by its mission to foster peaceful development across Hong Kong, Macao, Taiwan, and the diaspora—will strongly support HKUST in translating research into practical solutions."

Dr. LO Kam-Wing, President of the Chinese Manufacturers' Association of Hong Kong and the Chairman of CHMT, remarked, "As an investment firm with extensive fund management expertise, CHMT has successfully supported and nurtured multiple projects with significant social impact. We are excited to collaborate with HKUST, leveraging our combined strengths while aligning with the HKSAR Government's innovation policies to drive research commercialization and pioneer new energy solutions. This partnership will champion a government-industry-academia-research-investment model, transforming lab innovations into market-ready solutions and contributing to green, low-carbon progress for Hong Kong and the nation."

Focusing on New Energy Technology and Translating Scientific Research into Market-ready Solutions

New energy technology is a strategic emerging industry put forth in the 14th Five-Year Plan. Developing advanced new energy technology industries helps combat global climate challenges, accelerates the achievement of carbon neutrality targets, and drives sustainable development. The HKUST-CHMT partnership will focus on three key areas:

- Research Commercialization: Explore collaborative ventures in energy and sustainability development, and leveraging CHMT's incubation platform to commercialize HKUST's innovations;
- Innovative Energy Solutions: Co-develop novel energy technologies applicable to CHMT's needs, advancing sustainable energy development locally and nationally;
- Knowledge Exchange Hub: Deepen knowledge sharing through diverse projects and activities.

The HKUST Energy Institute and CHMT will collaborate closely to harness industry-academia-research synergies to drive energy transition and shape a sustainable future. Established in 2014, the HKUST Energy Institute offers an interdisciplinary platform through energy-focused research and programs, contributing expertise to build future economic, reliable, and sustainable energy systems. CHMT, founded in 2017, brings extensive investment fund management experience, having managed projects worth over HKD 40 billion while providing comprehensive capital-raising and advisory services.

About C.H.M.T. Peaceful Development Fund Management Limited

C.H.M.T. Peaceful Development Fund Management Limited ("CHMT") was founded in 2017. It has expertise in managing investment funds and possesses extensive experience in managing various projects, with managed assets exceeding HKD 40 billion. CHMT also specializes in providing comprehensive fund-raising and related advisory services. This year, the holding subsidiary of CHMT, Hong Kong International Automobile & Supply Chain Expo Company Limited, organized the 2025 AUTOHK Expo. In the future, the company will continue to increase investment in the new energy field, empower scientific innovation linkage, and promote development.

Faculty - New Members

HKUST has a wealth of expertise in energy comprising top-notch scholars at the frontiers of energy-related research. As part of the university-wide initiative to promote energy research and education, the Energy Institute (EI) brings together innovative, world-class scientists from a wide range of disciplines. In the past year, 2 new members joined the EI family.

Guohua CHEN

Chair Professor of Chemical and Biological Engineering

Research Area
- Energy storage and distribution
- Energy utilization and conservation

Research Interests
- Advanced materials
- Battery
- Electrochemistry
- Energy conservation
- Electrochemical energy technologies
- Drying of solids
- Environmental electrochemical technologies
- Environmental pollution treatment
- Functional polymer
- Lithium ion batteries
- Mass transfer
- Materials synthesis and characterization
- Municipal solid waste recycling (MSW) processing
- Nanotechnology
- Waste treatment processes
- Energy and environment
- Electric vehicles
- Energy production and storage

Alicia Kyoung Jin AN

Professor of Chemical and Biological Engineering

Research Area
- Energy generation

Research Interests
- Advanced Materials
- Waste treatment processes
- Filtration and separation

Prof. SHAO Minhua
Director
HKUST Energy Institute
Head and Chair Professor
Chemical and Biological Engineering

Prof. FAN Zhiyong
Chair Professor
Electronic and Computer Engineeing
Chemical and Biological Engineering

Prof. Yoonseob KIM
Associate Professor
Chemical and Biological Engineering

EI Faculty Contributed Guest-Edited Special Issue of Advanced Materials

In a distinguished showcase of research excellence in advanced materials, one of the university-level strategic research foci, Energy Institute Director, Prof. SHAO Minhua, together with Prof. FAN Zhiyong, and Prof. Yoonseob KIM from the Department of Chemical and Biological Engineering guest-edited a special issue of Advanced Materials, titled "35th Anniversary of Materials Research at the Hong Kong University of Science and Technology" (Volume 37, Issue 23, 2025). This landmark publication presents a curated collection of cutting-edge materials science research by HKUST faculty members, alumni and their research collaborators, celebrating the university's achievements in this field over the past 35 years.

This special issue focuses on transformative advancements in the field, featuring innovative studies on nanomaterials, next-generation energy storage solutions, and sustainable technologies. These research contributions address pressing global challenges, such as renewable energy development and environmentally friendly material design, aligning with HKUST's mission to drive impactful scientific progress. The issue brings together world-class researchers whose work exemplifies the forefront of materials innovation, making it a vital resource for academics, industry professionals, and policymakers alike.

In the field of energy generation and conversion, He Yan and co-workers (adma.2412327) present how polymeric charge-transporting materials can be used for realizing efficient, stable, and large-area inverted perovskite solar cells. The authors systematically unveil the materials' molecular structures and modification strategies to adjust energy levels and improve charge extraction. Zhengbao Yang and co-workers (adma.202407395) present ultrasound power transfer technology as an emerging and promising solution for the sustainable development of implantable medical devices. The authors not only analyze existing efficiency models but also propose an energy flow diagram of a general ultrasound power transfer system for the first time. Bin Yang and co-workers (adma.24175G7) summarize strategies to promote C–C coupling strategies to generate C_2+ Products in the CO^2 electrochemical reduction reactions while bridging microscopic insights and macroscopic applications in the field of CO^2 electroreduction. Jiaying Wu and co-workers (adma.2409212) report a way of molecular control of the donor/acceptor interface to suppress charge recombination and enable high-efficiency single-component organic solar cells. An optimized DCPY2 interface realized an efficiency of 13.85%, maintaining a high fill factor without the short circuit. Yang Hou and co-workers (adma. 240910G) summarize strategies and approaches regulating catalytic reaction interface microenvironment, designing flow electrolyzers, and developing stepwise catalysis approaches with the flow electrolyzers to enhance COx electroreduction for alcohol production.

In the field of energy storage, Minhua Shao and co-workers (adma.2410199) report introducing tris(trimethylsilyl)-based additives to the electrolyte can construct a homogeneous and robust polymer-rich cathode-electrolyte interphase to achieve stable cells with $LiCoO_2$ cathode –95% capacity retention after 500 cycles with a high cut-off voltage of 4.G V. Leiting Zhang and co-workers (adma.2407852) provide perspective on understanding proton activities in aqueous batteries could improve the performance as protons always exist in the electrolyte due to the spontaneous ionization of water and they can interrupt the main charge-storage mechanism, triggering unwanted side reactions and thus deteriorated cell performance. Khalil Amine and co-workers (adma.2411311) discuss how defects in the cathode materials can affect the development of high-voltage cathodes for high-energy lithium-ion batteries. The authors discuss fundamental understandings, such as the classifications, formation mechanisms and evolution of defects, and cutting-edge characterization techniques, and engineering strategies, such as composition tailoring, morphology design, interface modification, and structural control. Francesco Ciucci and co-workers (adma.241779G) summarize opportunities and strategies for realizing fast-charging solid-state lithium batteries. The authors examine various solid electrolytes, including ceramics, polymers, and composites, and analyze methods to enhance ion transport through crystal structure engineering, compositional control, and microstructure optimization. Donghai Wang and co-workers (adma.2407724) report all-solid-state lithium-sulfur batteries with high cycling stability and rate capability enabled by a self-lithiated Sn-C interlayer. The lithiated Sn-C interlayer promoted homogeneous Li+ transport across the interlayer, enhancing electrochemical/structural stability to enable stable Li plating/stripping over 7000 h and full cell stability of over 300 cycles (capacity retention of ≈80%) under low applied pressure (<8 MPa). Shi-zhang Qiao and co-workers (adma.2407738) summarize mechanistic understanding and quantitative parameters of the key components in sulfur-based cathode to advance all-solid-state lithium-sulfur batteries. The authors not only analyze electrode parameters, including specific capacity, voltage, and sulfur mass loading but also evaluate the progress in enhancing lithium ion and electron percolation and mitigating electrochemical-mechanical degradation in sulfur-based cathodes. Haiyan Wang and co-workers (adma.2408918) report Na superionic conductor-based cathode to realize high-performance sodium-ion batteries. $Na_4Fe_3(PO_4)_2(P_2O_7)$/$Na_2VTi(PO_4)_3$ cathode showed a stable multielectron reaction. It thus contributed to demonstrating a high reversible capacity of 155.3 $mAhg^{-1}$ at 20 $mAhg^{-1}$ and outstanding cycling stability with 82.9% capacity retention over 2500 cycles at 1 A g^{-1}.

In the field of optoelectronic materials, Zhiyong Fan and co-workers (adma.2405418) summarize the development of perovskite quantum wires, perovskite nanorods, and perovskite nanocrystals for applications in high-efficiency perovskite light-emitting diodes. The authors cover the synthesis of the unique qualities of the aforementioned materials while exploring their vital roles in applications. Yang Chai and co-workers (adma.240747G) discuss how massive and unstructured sensory data can be transmitted from sensors to computing units along with power efficiency, transmission bandwidth, data storage, time latency, and security. Particular focus is on how optoelectronic devices can compress and structure multidimensional vision information for in-sensor visual processing. Qicheng Zhang and co-workers (adma.202407G42) provide insights into how photonic devices, leveraging shorter phonon wavelengths, can be promising for radio frequency applications. The authors suggest that advances in photonic modulators, amplifiers, and other devices could enable integrated circuits, reducing signal conver- sion needs and enhancing miniaturized communication, quantum science, and biomedical applications. Jonathan E. Halpert and co-workers (adma.24077G4) summarize the recent development of blue perovskite light-emitting diodes, especially deep-blue (≤4G5 nm) nanomaterials in various structural forms. The authors highlight challenges in producing efficient deep-blue perovskite light-emitting diodes and suggest strategies for next-generation display technology to overcome these challenges. Haipeng Lu and co-workers (adma.240909G) discuss opportunities using colloidal quantum dots for photocatalytic organic transformation reactions, including unique characteristics of quantum dots, such as quantum size effect, compositional and structural diversity, tunable surface chemistry, and photophysics, expecting to tackle organic reactions that are previously unattainable with small molecules.

In the field of advanced materials synthesis and manufacturing, Ben Zhong Tang and co-workers (adma.2407707) summarize the recent development in aggregation-induced emission as a versatile tool for bacterial studies through fluorescence visualization, focusing on four major areas, understanding bacterial interactions, antibacterial strategies, diverse applications, and synergistic applications with bacteria. Baoling Huang and co-workers (adma.2409738) summarize challenges and opportunities in achieving radiative cooling through structural design, material selection, and fabrication processes. The authors also guide future research and industrial development of radiative cooling technology. Zhengtang Luo and co-workers (adma.2404013) report how layer engineering synthesis of integrated pristine van der Waals junctions consisting of 2H-$MoTe_2$ can realize self-powered image sensors. The technology shows new insights into developing large-scale applications for two-dimensional materials in advanced electronics and optoelectronics.

In the field of bio/medicine materials, Fei Sun and co-workers (adma.2413957) report a thermally responsive hydrogel system utilizing recombinant spider silk protein to deliver protein therapeutics in a minimally invasive, safe, and sustained manner without resorting to viral delivery systems. The technology here is a generalizable material system for injectable and sustained delivery of protein therapeutics for neuroprotection and regeneration. Hnin Yin Yin Nyein and co-workers (adma.240845G) summarize the recent trends in developing stretchable electrical interconnects for wearable bioelectronics. The review includes a broad class of recently researched and developed materials and engineering methodologies and their respective attributes, limitations, and opportunities in designing stretchable interconnects for wearable bioelectronics. Danqing Zhu and co-workers (adma.2414882) review recent developments in engineering CAR-T therapeutics for enhanced solid tumor targeting and address the challenges and methods associated with T cell delivery and in vivo reprogramming in solid tumors. The authors examine both experimental and computational strategies, such as protein engineering coupled with machine learning, developed to enhance T cell specificity.

Prof Shao pointed out that, “This special issue highlights the recent research activities taking place across the HKUST campus in collaboration with colleagues and alumni. Our research exemplifies HKUST’s vision and mission—to advance learning and knowledge and to establish the university as a leader with a significant international impact while maintaining a strong local commitment. The vibrant environment, openness to collaboration, and the presence of high-caliber researchers contribute to our goal of making positive contributions both locally and globally. Over the past 35 years, we have been dedicated to pioneering advanced materials research, and we will continue to push the boundaries to achieve breakthroughs. All the authors appreciate the financial support from the HLUST Provost’s office.

Finally, the guest editors express their gratitude for the support from the editors of *Advanced Materials*, Jos Lenders, Duo- duo Liang, and Tianyu Liu, as well as to all the contributing authors, referees, and editorial staff who facilitated the publication of this special issue.”

The special issue of *Advanced Materials*, titled “35th Anniversary of Materials Research at the Hong Kong University of Science and Technology” (Volume 37, Issue 23, 2025).

To read the full version, scan here

EI Professors Achieved Remarkable Success at the 50th International Exhibition of Inventions Geneva

The Hong Kong University of Science and Technology (HKUST) achieved a record-breaking success at the 50th International Exhibition of Inventions Geneva concluding today. Thirty-seven HKUST teams won a total of 38 awards, including two special grand prizes, 22 Gold Medals (of which seven received Congratulations of the Jury), and multiple Silver and Bronze Medals, showcasing the University's outstanding performance across different fields including life and health technologies, artificial intelligence (AI) and data science, advanced manufacturing, new energy technologies and aerospace engineering. HKUST outshone other local universities and smashed its own record with this extraordinary haul of awards, reaffirming its status as a powerhouse of creativity and invention.

Among the accolades, the research team led by Prof. SUN Qingping from the Department of Mechanical and Aerospace Engineering (MAE) won the Prize of the Technical University of Cluj-Napoca – Romania, as well as the Gold Medal with Congratulations of the Jury, for developing new elastocaloric freezing technology. Their solid-state sub-zero Celsius freezer can replace vapor-compression refrigerators, potentially reducing up to 650 million tonnes of carbon dioxide (CO^2) emissions every year if adopted worldwide. Another winning team led by Prof. Hao LIU, an HKUST alumnus from the Department of Computer Science and Engineering who is currently an Assistant Professor of the Artificial Intelligence Thrust at HKUST (Guangzhou), received the special Swiss Automobile Club Prize – ACS and a Gold Medal. The team has developed an AI-based traffic signal

control system that could optimize urban traffic flow by using Large Language Models to process real-time traffic data.

Many of this year's submissions are impactful projects arising from partnerships with government departments and industry, demonstrating the University's commitment to translating research into practical solutions. These cross-sectoral cross-disciplinary innovations, including three developed by the AI Chip Center for Emerging Smart Systems (ACCESS) and the Hong Kong Generative AI R&D Center (HKGAI) – HKUST-led research center participated by international institutions under the InnoHK initiative, aim to build a stronger foundation for resolving real-life challenges in medicine, climate predictions, automotive and robotics, traffic management, flood monitoring system and passenger behavior, among other areas.

HKUST Vice-President for Research and Development Prof. Tim CHENG expressed excitement about this remarkable achievement on the international stage. "AI is transforming every aspect of our lives. As a leading institution in AI education and research, HKUST is committed to driving advancements with the latest AI technologies in areas such as health, medicine, electronics and sustainable energy. Nearly 40% of our submissions this year have deployed AI solutions, and our significant achievements at the Geneva Inventions are a testament to our global reputation for translating innovations into impactful results. As we continue to strengthen collaborations with governments, industries, as well as research and academic partners, we seek to further contribute to the development of new quality productive forces, ultimately aiming to create a positive, sustainable future for all," he said.

The 50th International Exhibition of Inventions Geneva – the world's largest annual event devoted exclusively to inventions, showcased nearly 1,050 submissions from 35 countries and regions of inventors, universities, institutes and companies during April 9 to 13 this year in Switzerland, among which 299 inventions come from Hong Kong.

This remarkable achievement underscores the exceptional research performance and contributions of our faculty and their devoted teammates. Congratulations to:

Prof. YAO Shuhuai

Gold Medal with Congratulations of the Jury

Greenhouse-gas-free Elastocaloric Freezer

Prof. YEUNG King Lun

Gold Medal with Congratulations of the Jury

Methods of Preparing Inorganic Matrices for Dosing Dissolvable Sodium Chlorite for Controlling Algal Growth in Water

Prof. HUANG Baoling

Gold Medal

Optimizing Vehicle Cooling Systems: Energy-Saving Strategies for Efficiency Enhancements Via Ultra-Band Spectrum Manipulation

Prof. FAN Zhiyong

Gold Medal

Biomimetic Olfactory

Prof. Leung Yuk Frank LAM

Silver Medal

Smart Fish for Rapid Detection of Multiple Types of Microplastics in the Ocean

Faculty Achievement

Congratulations to our faculty members who have received numerous honors and accolades!
(The list of awards below shows some of our faculty awards. It is not exhaustive.)

Prof. Minhua SHAO

+ Director of Energy Institute
+ Chair Professor of Chemical and Biological Engineering

- 2025 Highly Cited Researchers by Clarivate
- 2024-25 SENG Excellence Awards

Prof. Zhiyong FAN

+ Chair Professor of Electronic and Computer Engineering
+ Chair Professor of Chemical and Biological Engineering

- Gold Medal, the 50^{th} International Exhibition of Inventions Geneva
- Frontier Materials Scientist Award at the International Conference on Frontier Materials 2025 (ICFM)

Prof. Jianwei SUN

+ Chair Professor of Chemistry

- 2025 Senior Croucher Fellowship

Prof. Henry He YAN

+ Chair Professor of Chemistry

- 2025 Highly Cited Researchers by Clarivate

Prof. King Lun YEUNG

+ Chair Professor of Chemical and Biological Engineering
+ Chair Professor of Environment and Sustainability

- Gold Medal with Congratulations of the Jury, the 50^{th} International Exhibition of Inventions Geneva
- Research.com's Best Scientists in the World by Discipline

Prof. Tianshou ZHAO

+ Chair Professor of Mechanical and Aerospace Engineering

- 10^{th} in China (Engineering and Technology discipline) by Research.com

Prof. Baoling HUANG

+ Professor of Mechanical and Aerospace Engineering

- Gold Medal, the 50^{th} International Exhibition of Inventions Geneva

Prof. Shuhuai YAO

+ Professor of Mechanical and Aerospace Engineering
+ Professor of Chemical and Biological Engineering

- Gold Medal, the 50^{th} International Exhibition of Inventions Geneva

Prof. Stephane REDONNET

+ Assistant Professor of Mechanical and Aerospace Engineering

- UROP Faculty Research Award 2025

Prof. Leung Yuk Frank LAM

+ Assistant Professor of Engineering Education of Chemical and Biological Engineering

- Silver Medal, the 50^{th} International Exhibition of Inventions Geneva
- Thetos Teaching Award Honorable Mention 2024-25

Student Achievement

The Ying Family PhD Research Award Presentation Ceremony 2025

Mr. Steven Ying (front row, center), Director of the Foundation for Amazing Potentials, Prof. Shao Minhua (front row, third right), Director of HKUST Energy Institute, and the inaugural recipients of The Ying Family PhD Research Award Liu Guimei (front row, first right), PhD student of Chemical and Biological Engineering, and Zhao Chen (front row, second right), PhD student of Ocean Science

With a generous donation by Foundation for Amazing Potentials, HKUST Energy Institute launched the "The Ying Family PhD Research Award 應家族博士生傑出研究獎" (Previously Steven Ying PhD Research Award 應琦泓先生博士生傑出研究獎) (the "Award") in 2025. The Award aims to recognize and reward PhD students who have demonstrated outstanding research performance and achievements in the areas of sustainability, environmental studies, energy technology, green technology or related disciplines. Each awardee will receive a one-off cash prize of HK$50,000. A total of two awardees were chosen from 23 applicants across the campus in this round by a selection committee.

The Award Presentation Ceremony was successfully held on June 6, 2025. Mr. Steven YING, Director of the Foundation for Amazing Potentials and Prof. SHAO Minhua, Director of HKUST Energy Institute, Cheong Ying Chan Professor of Energy Engineering and Environment, and Head and Chair Professor of Chemical and Biological Engineering, presented the cheques to acknowledge the two winners for their exceptional research performance:

- LIU Guimei, Year 4 PhD student, Department of Chemical and Biological Engineering
- ZHAO Chen, Year 3 PhD student, Department of Ocean Science

At the ceremony, on behalf of the Hong Kong University of Science and Technology (HKUST) and Energy Institute (EI), Prof. Shao expressed deepest gratitude to Mr. Ying and Foundation for Amazing Potentials for a donation to establish The Ying Family PhD Research Award. Prof. Shao said, "HKUST has committed to sustainability research and aims to become a net-zero campus. This Award not only recognizes students' outstanding sustainability-related research, but also encourages students to participate more in international exchange activities, such as conference and research exchange program."

Mr. Steven Ying shared with the audience by evoking the three key dimensions of observation and analysis in Chinese philosophy – 天時 (timing), 地利 (location/place), and 人和 (talent/people). He pointed out that HKUST and EI are unity placed on top of a fast-changing world. AI is the main driver of transforming technologies nowadays. HKUST and EI should grasp the opportunities and own advantages to foster the green energy technology development. Mr. Ying further encouraged students to polish their talent and to exert themselves well to make the world change.

The awardees Liu Guimei and Zhao Chen demonstrated their research work and thanked Mr. Steven Ying, the Energy Institute and their supervisors Prof. Shao and Prof. HE Ding, Assistant Professor of Ocean Science, for supporting their research journey.

Ocean Science PhD student Zhao Chen (center) was presented The Ying Family PhD Research Award by Mr. Steven Ying (right) and Prof. Shao Minhua (left).

Chemical and Biological Engineering PhD student Liu Guimei (center) was presented The Ying Family PhD Research Award by Mr. Steven Ying (right) and Prof. Shao Minhua (left).

Pursuing a Professorship

Academia can be very challenging and yet rewarding. Becoming a professor is a significant achievement that reflects years of hard work, dedication, and a deep commitment to the pursuit of knowledge. In this issue, Dr. Qinbai Yun shared with you his passion to become a professor.

Qinbai YUN

Assistant Professor

- Sustainable Energy and Environment Thrust, The Hong Kong University of Science and Technology (Guangzhou)
- Research Assistant Professor, HKUST (2025)

Qinbai Yun is currently an Assistant Professor in Sustainable Energy and Environment Thrust at The Hong Kong University of Science and Technology (Guangzhou). He obtained his B.E. and M.E. degrees from Tsinghua University, China, and then earned his Ph.D. degree from Nanyang Technological University, Singapore. After that, he worked as a Postdoc and Research Assistant Professor at City University of Hong Kong and The Hong Kong University of Science and Technology, respectively. His research interest focuses on the precise synthesis of low-dimensional metallic materials for applications in electrochemical energy conversion and electrosynthesis of fine chemicals. He has published 74 academic papers, including 23 papers as the (co-) first/corresponding author in *Chem. Rev., Adv. Mater., Angew. Chem. Int. Ed., J. Am. Chem. Soc., Adv. Funct. Mater. and ACS Nano.* The total citation has reached over 6600 times (Web of Science). He serves as Editor or Young Editorial Board Member for journals including *Chem. Res. Chin. Univ., eScience, Energy Mater. Devices, Front. Energy Res., and MetalMat*. He has been awarded "World's Top 2% Scientists" (by Stanford University, 2024-2025), Chinese Government Award for Outstanding Self-Financed Students Abroad (2019), and The 1st Class Award of the Natural Science Award of Guangdong Province (2019, Rank: 9/15).

Motivation/vision/expectation to become a professor: I chose a career as a professor because I value the freedom it offers to pursue my passions. I enjoy exploring nanomaterials with novel structures, particularly metal nanomaterials, and investigating their structure-performance relationships. My aim is to utilize these nanomaterials as highly efficient electrocatalysts for sustainable applications, advancing clean energy technologies and contributing to carbon neutrality. For me, being a professor also entails a sense of responsibility. I aspire to cultivate young students into individuals equipped not only with professional knowledge but also with transferable skills such as critical thinking, communication, teamwork, and resilience. I am committed to learning and striving to achieve these goals.

Congratulations to our students who have received numerous awards and honors!

(The list of awards below shows some of our student awards. It is not exhaustive.)

Guimei LIU

2025 The Ying Family PhD Research Award
2025 HKUST Redbird Academic Excellence Award

Mohammad FARHADPOUR

2025 HKUST Redbird Academic Excellence Award

Yat Cheung HO

IMechE HK Branch Best Student Design Award

Wing Yat WONG

IMechE HK Branch Best Student Design Award

Siu-Ting YEUNG

2025 Kerry Holdings Limited Undergraduate Research Opportunities Program (UROP) Award: First Runner-Up

Chunye MA

Best Paper Awards of VEH 2025

Yan SUN

2025 HKUST Redbird Academic Excellence Award

Chak Fung Kevin KWAN

IMechE HK Branch Best Student Design Award

Pak Hei LEUNG

IMechE HK Branch Best Student Design Award

Hongzhao FAN (PhD(SEE) of HKUST(GZ))

2024 Rare Metals Best Paper Award

Qinqin HE

Best Paper Award of VEH 2025

Ziyan QIAN

Best Paper Awards of VEH 2025

IAS-EI Joint Seminar

Catalysis: Advancing Affordable and Clean Energy

by Prof. WANG Yong

Prof. WANG Yong, Regents Professor and Voiland Distinguished Professor of Chemical Engineering at Washington State University (WSU) and Acting Director of the Institute for Integrated Catalysis at Pacific Northwest National Laboratory (PNNL), gave an IAS distinguished lecture on “Catalysis: Advancing Affordable and Clean Energy” on September 19, 2025.

Catalysis speeds up chemical reactions and plays a key role in producing cleaner, more affordable fuels. In this talk, we explore two exciting areas of research. First, Prof. Wang presented their latest findings on the Fischer-Tropsch process—a method developed nearly a century ago that converts coal, natural gas, or biomass into liquid fuels. His research revealed that this process naturally oscillates between periods of high and low activity, an unexpected behavior that could pave the way for more efficient fuel production in the future. Next, he addressed the challenge of reducing harmful emissions from fuel combustion used to power transportation. For example, catalytic converters in internal combustion engines rely on precious metals like platinum, palladium, and rhodium to clean exhaust gases and lower emissions. His research group’s latest work focused on developing highly stable catalysts made from single atoms of these metals, which could lower costs and make better use of these limited resources. Together, these studies show the transformative potential of advanced catalysis to revolutionize fuel production and emission control, paving the way for cleaner and more efficient energy systems.

EI - CIAC-HKUST JLHE Joint Seminar

Heat and Mass Transfer Considerations for Advancing Fuel cells and Electrolyzers

by Prof. Aimy BAZYLAK

On January 6, 2025, Prof. Aimy BAZYLAK, Professor of Mechanical Engineering at the University of Toronto, where she is the Canada Research Chair (Tier 1) in Clean Energy and a Dorothy Killam Fellow, visited HKUST. She gave a lecture on “Heat and Mass Transfer Considerations for Advancing Fuel cells and Electrolyzers”.

Hydrogen continues to gain traction as an energy carrier of the future, and fuel cells provide the ideal partner technology – using hydrogen fuel to produce on-demand, zero-emission power. However, there are still key challenges to commercializing fuel cells and electrolyzers for clean energy.

At the Lecture, Prof. Bazylak shared her consideration of heat and mass transfer for several materials over a range of length scales, and how these considerations are important for informing next generation device development. And, talked about how her team’s work from the flow field and gas diffusion layer have informed our approach to the catalyst coated membrane. She then focused on X-ray techniques that provide high spatial and temporal resolution for examining experimental performance and materials characterization. She discussed the advancement they were making in characterizing the spatio-chemical speciation of custom catalyst layers. Specifically, they probe the carbon, fluorine, and oxygen spectral K-edges on commercial catalyst layers using near-edge X-ray absorption fine structure spectroscopy (NEXAFS) in conjunction with scanning transmission X-ray microscopy (STXM) to provide a comprehensive two-dimensional map of the PEM fuel cell catalyst layer. I will discuss the structural characteristics of the CL, which will be highly valuable for informing the design of next generation PEM fuel cell catalyst layers.

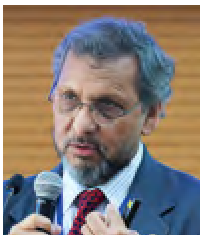
This seminar was co-organized by Energy Institute, and CIAC-HKUST Joint Laboratory for Hydrogen Energy.

EI - CIAC-HKUST JLHE Joint Seminars

On June 25, 2025, Energy Institute and CIAC-HKUST Joint Laboratory for Hydrogen Energy invited Prof. Nicolas ALONSO-VANTE, Chair Professor at the College of Smart Energy of Shanghai Jiao Tong University (SJTU), Shanghai, China, and Prof. MA Jiwei, Tenured Professor at Tongji University in Shanghai, China to share their latest findings at a networking seminar.

The Adsorption and Charge Donation Trade-off in Electrocatalysis

by Prof. Nicolas Alonso-Vante



In recent decades, research has focused on carbon-free hydrogen production. In this context, electrocatalytic and/or photo-electrocatalytic materials play an important role in reducing the reaction barriers for key reactions such as oxygen reduction reaction (ORR), oxygen evolution reaction (OER) constituting the so-called oxygen electrode; and hydrogen evolution reaction (HER), hydrogen oxidation reaction (HOR) constituting the so-called hydrogen electrode. These systems are essential for the development of environmentally friendly energy conversion devices. Efforts have therefore been devoted to identify suitable supports, e.g., oxides, graphitic carbon that can offer stronger interactions with the catalysts and, as a result, favor enhanced charge transfer. With several case studies, this principle has been examined in Prof. Alonso-Vante's group in France and China.

Defect Chemistry for Energy Storage and Conversion

by Prof. MA Jiwei

The defect chemistry plays an important role for activating metal ion intercalation and interfacial catalytic property in materials, providing important support for energy storage and conversion systems. The underlaying challenge is the modulation of crystal and electronic structures of materials to facilitate the ion intercalation and catalytic activity. The core lies in revealing the role of defects and the electronic structure modification on the intercalation mechanism of ion and catalytic activity of materials. In this regard, Prof. Ma's group developed a new approach concerning vacancy-mediated ion intercalation in batteries. And, they revealed a general electronic modulation strategy for the oxygen reactions in fuel cells and water electrolyzers. Furthermore, they provided multidimensional evidence for mechanistic insights under operando conditions by advanced spectroscopies.

EI - CIAC-HKUST JLHE Joint Seminar

Ion Exchange Membranes: from Microphase-Separation to rigid Ultramicropore Confinement

by Prof. XU Tongwen

On August 20, 2025, Prof. XU Tongwen, Chair Professor of Chemistry Engineering at University of Science and Technology of China (USTC), gave a seminar on “Ion Exchange Membranes: from Microphase-Separation to rigid Ultramicropore Confinement”.

Environmental and energy-related technologies, including redox flow batteries, fuel cells, water electrolysis, electrochemical carbon capture, and electrodialysis-based ion separation, are pivotal in achieving the dual objectives of peak carbon emissions and carbon neutrality. These technologies rely fundamentally on electromembrane processes, where ion exchange membranes (IEMs) play a critical role by enabling selective ion transport and separating anode and cathode reactions. Traditional IEMs, such as those based on perfluorocarbon Nafion and hydrocarbon polyelectrolytes, are well-established and feature microphase-separated structures. However, they are hindered by the well-known conductivity/selectivity trade-off, which limits their performance in advanced applications. To address this challenge, Prof Xu’s research group has pioneered a new paradigm in membrane design: utilizing rigid confined micropores as ion channels. This innovative approach has been realized through membranes fabricated from charged polymers of intrinsic microporosity, hyper-crosslinked polymers, and ultramicroporous polymer frameworks. The rigidly confined micropores in these next-generation membranes offer a unique combination of high size-exclusion-imposed ion selectivity and high free volume-induced permeability. Remarkably, by leveraging rigid pore confinement and multi-interaction mechanisms between ions and the membrane, triazine framework membranes have achieved near-frictionless ion flow, setting a new benchmark for ion transport efficiency. As next-generation IEMs, these micropore-confined membranes have already demonstrated exceptional performance in organic redox flow batteries and water electrolysis systems. Prof Xu is confident that their potential extends to a wide range of other electromembrane processes, further advancing the development of sustainable energy technologies. In this presentation, we will provide an overview of traditional IEMs developed in our laboratory and highlight the groundbreaking applications of next-generation IEMs in flow batteries and water electrolysis.

This seminar was co-organized by Energy Institute and CIAC-HKUST Joint Laboratory for Hydrogen Energy.

Visiting Scholars and Delegations

Energy Institute warmly welcome contacts and collaborations, from cutting-edge research projects, to education, to sharing and experience exchange, and more….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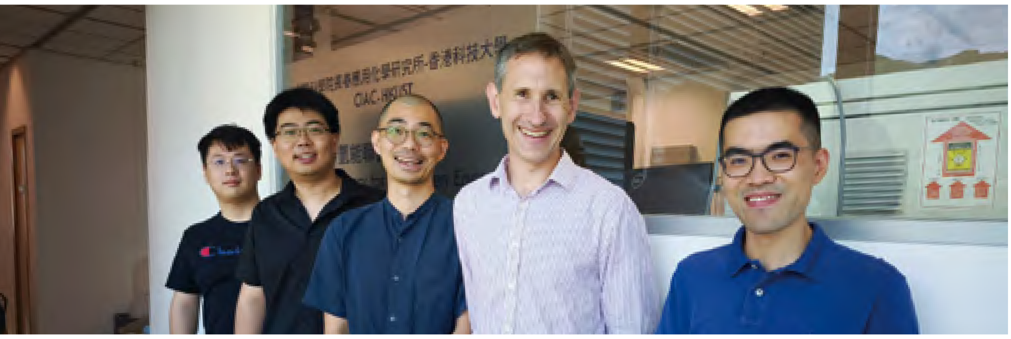

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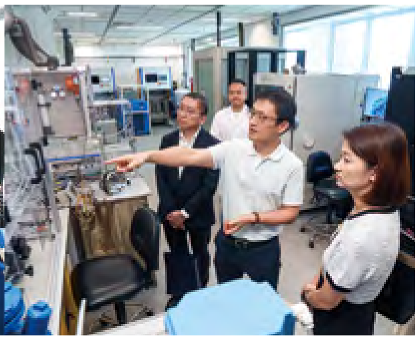

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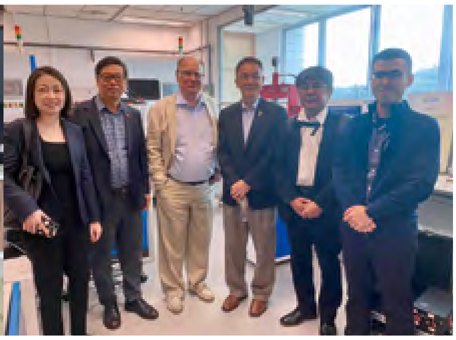
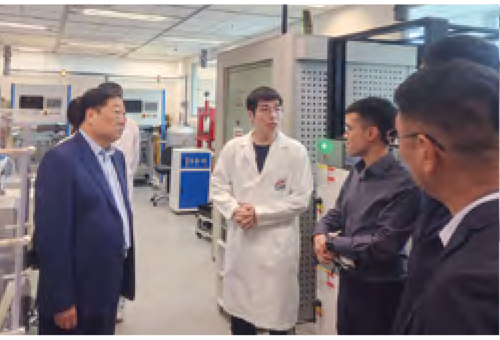


Visitors of the Electric Vehicle Summit

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