澳門大學
UNIVERSIDADE DE MACAU
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應用物理及材料工程研究院
INSTITUTO DE FÍSICA APLICADA E ENGENHARIA DE MATERIAIS
INSTITUTE OF APPLIED PHYSICS AND MATERIALS ENGINEERING

IAPME Newsletter

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✧ Content

❖ Publications (IF≥8, and/or nature Index; *corresponding author)

1. **Chao Geng**, Senlin Li, Jie Li, Wei Wen, Cuiping Han*, **Hai-Feng Li***, and Hui-Ming Cheng*. Emerging intercalation-type anodes for high-performance rechargeable aqueous batteries. *Nano Energy* **145**, 111407 (2025). DOI: 10.1016/j.nanoen.2025.111407. [2024 IF=17.1]

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Review

Emerging intercalation-type anodes for high-performance rechargeable aqueous batteries

Chao Geng [a,b], Senlin Li [c], Jie Li [b], Wei Wen [d], Cuiping Han [b,c,*], Hai-Feng Li [a,**], Hui-Ming Cheng [b,c,*]

[a] Institute of Applied Physics and Materials Engineering, University of Macau, Avenida da Universidade, Taipa 999078, Macao Special Administrative Region of China
[b] Shenzhen Key Lab of Energy Materials for Carbon Neutrality, Institute of Technology for Carbon Neutrality, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen, Guangdong 518055, China
[c] Faculty of Materials Science and Energy Engineering, Shenzhen University of Advanced Technology, Shenzhen 518107, China
[d] School of Mechanical and Electrical Engineering, Collaborative Innovation Center of Ecological Civilization, Hainan University, Haikou 570228, China

❖ Research Stories

UM & SUAT Research Teams Publish Comprehensive Review on Next-Generation Aqueous Battery Anodes in *Nano Energy*

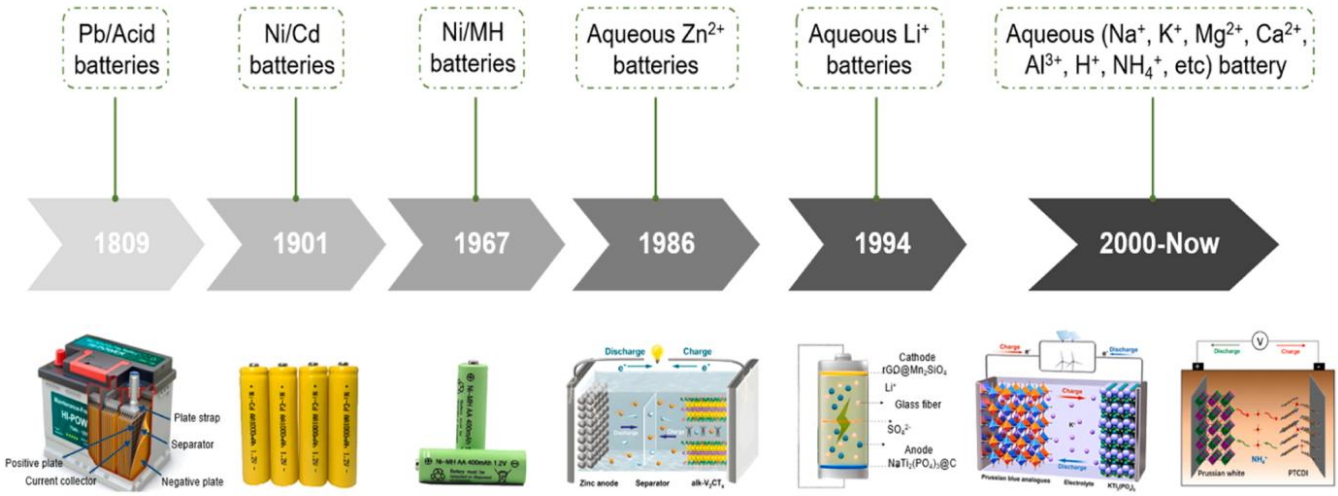
Mr. Chao Geng
(耿超)

Prof. Cuiping Han
(韓翠平)

Prof. Hai-Feng Li
(李海峰)

Prof. Hui-Ming Cheng
(成會明)

- This study provides a comprehensive and in-depth review of the latest advances in **intercalation-type anodes** for high-performance rechargeable aqueous batteries. It systematically analyzes anode materials for systems using various metal ions (Li^+, Na^+, Zn^{2+}) and non-metal ions (H^+, NH_4^+), offering a crucial resource for the future development of safe and sustainable energy storage.
- The review thoroughly discusses the fundamental storage mechanisms, design guidelines, and electrochemical performance of these anodes. It further identifies key challenges, such as structural instability and slow reaction kinetics, and proposes strategic solutions involving material engineering, electrolyte optimization, and interface design to enhance performance.
- By integrating insights from multiscale simulations and experimental data, the work outlines a clear pathway for the rational design of next-generation aqueous batteries. It emphasizes the development of sustainable materials and the importance of creating a closed-loop, environmentally friendly lifecycle for future battery technologies, aligning with global goals for green energy storage.



Chao Geng, Senlin Li, Jie Li, Wei Wen, Cuiping Han*, **Hai-Feng Li***, and Hui-Ming Cheng*. Emerging intercalation-type anodes for high-performance rechargeable aqueous batteries. *Nano Energy* **145**, 111407 (2025). DOI: 10.1016/j.nanoen.2025.111407. [2024 IF=17.1]

Chao Geng, a Ph.D. student co-supervised by IAPME and SUAT. The research was supported by the Science and Technology Development Fund, Macao SAR (File Nos. 0090/2021/A2 and 0104/2024/AFJ), and the University of Macau (MYRG-GRG2024–00158-IAPME).

❖ Physical Society of Macau Accepted as Member Society of the Association of Asia Pacific Physical Societies (AAPPS)

In a significant step for the regional physics community, the Physical Society of Macau has been formally accepted as a Member Society of the Association of Asia Pacific Physical Societies (AAPPS). **The acceptance was confirmed in an official communication from AAPPS President, Prof. Hyoung Joon Choi, to Prof. Handong Sun, President of the Physical Society of Macau.**
The membership will become fully effective on January 1, 2026. From that date, the Society will hold voting rights at the AAPPS Ordinary General Meeting and will actively contribute to the association's activities, fostering greater collaboration and exchange within the Asia-Pacific physics community.

This milestone enhances Macau's profile in the international scientific arena. As the Society is rooted in the University of Macau's Institute of Applied Physics and Materials Engineering (IAPME), it directly opens new avenues for faculty and students to engage with leading peers and institutions across the Asia-Pacific region.

AAPPS
Association of Asia Pacific Physical Societies

PSM
The Physical Society of Macau

❖ Congratulations to Mr. Guanping Xu on Winning the Outstanding Poster Presentation Award

We are pleased to announce that Mr. Guanping Xu (徐官平), our PhD student, has been awarded the "**Outstanding Poster Presentation Award**" at the recently concluded "2025 Joint Annual Conference of the Guangdong-Hong Kong-Macau Physical Societies & Quantum Science and Technology Forum" in Dongguan, Guangdong.

This award recognizes excellent research presented during the poster session. Mr. Xu's achievement highlights his solid research work, clear academic communication, and innovative scientific thinking, which were highly commended by the conference organizers and review committee.

The Joint Annual Conference of the Guangdong-Hong Kong-Macau Physical Societies is a high-level regional academic event co-organized by the Physical Societies of Guangdong, Hong Kong, and Macau, attracting numerous renowned scholars and young researchers. Mr. Xu's outstanding performance at this forum fully demonstrates the research vitality and talent cultivation quality of IAPME in cutting-edge physics fields.

We extend our warmest congratulations to Mr. Xu Guanping, his supervisor Prof. Hai-Feng Li, and the research team! We look forward to continued excellence and more achievements from our members in future academic endeavors!

荣誉证书

CERTIFICATE OF HONOR

徐官平同学：

您的论文“机器学习结合摩擦纳米发电机优化能量收集”荣获“粤港澳物理学会2025联合年会暨量子科技论坛”优秀张贴报告奖。

特颁此证。

广东省物理学会
香港物理学会
澳门物理学会
2025年9月21日

❖ Seminar

Invited by Prof. Songnan Qu, our Institute hosted a distinguished lecture titled "*Rapid Antibiotic Susceptibility Screening by Super-Resolution Microscopy*", delivered by Prof. Dayong Jin (金大勇) on November 11, 2025.

Prof. Jin is a Fellow of the Australian Academy of Technology and Engineering, a distinguished professor at the University of Technology Sydney (UTS), and a Clarivate Top 0.1% Highly Cited Researcher. His expertise spans biomedical engineering, nanotechnology, microscopy, microfluidics, and analytical chemistry, focusing on enabling rapid detection of cells and molecules. In 2024, he established the Zhejiang Provincial Engineering Research Center for Organelles Diagnostics and Therapy at the Eastern Institute of Technology, Ningbo. Prof. Jin has received numerous accolades, including the 2017 Australian Academy of Science Engineering Science Award and the Australian Prime Minister's Prize for Science. He has published over 300 papers, with more than 40 appearing in *Nature* and its sister journals.

During the lecture, Prof. Jin addressed the global challenge of antimicrobial resistance (AMR), emphasizing the urgent need for rapid antibiotic susceptibility testing. Traditional clinical methods often require more than 72 hours, delaying treatment and increasing risks. Prof. Jin introduced his team's innovative Hydrophobic Agent Permeability Assay (HAPA) platform, which reduces testing time to just 2–4 hours. Clinical validation demonstrated a 97% concordance rate with FDA-approved methods across 75 samples, with an error rate of only 1.51%, well below the FDA threshold of 3%.

The HAPA platform is low-cost, scalable, and automated, making it suitable for deployment in primary healthcare settings. Experts believe this technology could become a critical tool in combating drug-resistant bacteria and transforming clinical treatment models worldwide.

Our Institute welcomed Prof. Zhen Tong (童貞), Assistant Professor at the School of Advanced Energy, Sun Yat-Sen University, for an academic visit on November 14, 2025. During his stay, Prof. Tong delivered a seminar titled "*Glassy Thermal Transport in Crystal Solids*", hosted by Prof. Yongqing Cai.

Prof. Tong earned his bachelor's degree from Huazhong University of Science and Technology in 2014 and his Ph.D. from Shanghai Jiao Tong University in 2019. He has held research positions as a visiting scholar at Purdue University and as a Humboldt Research Fellow in Germany. His work explores the fundamental mechanisms of energy carriers—phonons, electrons, photons, and ions—in micro/nano-scale energy transport, thermoelectrics, radiative cooling, solid-state batteries, and solar-thermal storage.

In his presentation, Prof. Tong discussed recent advances in glass-like thermal transport, which results in ultra-low and weakly temperature-dependent thermal conductivity. The seminar highlighted mechanisms that bridge theory and experiment, offering guidance for designing high-performance thermoelectrics and solid-state electrolytes.

Prof. Tong expressed strong interest in future collaborations with IAPME researchers, particularly in thermal conduction and theoretical studies. Promising joint efforts on phonon anharmonicity were also noted as potential areas for cooperation.

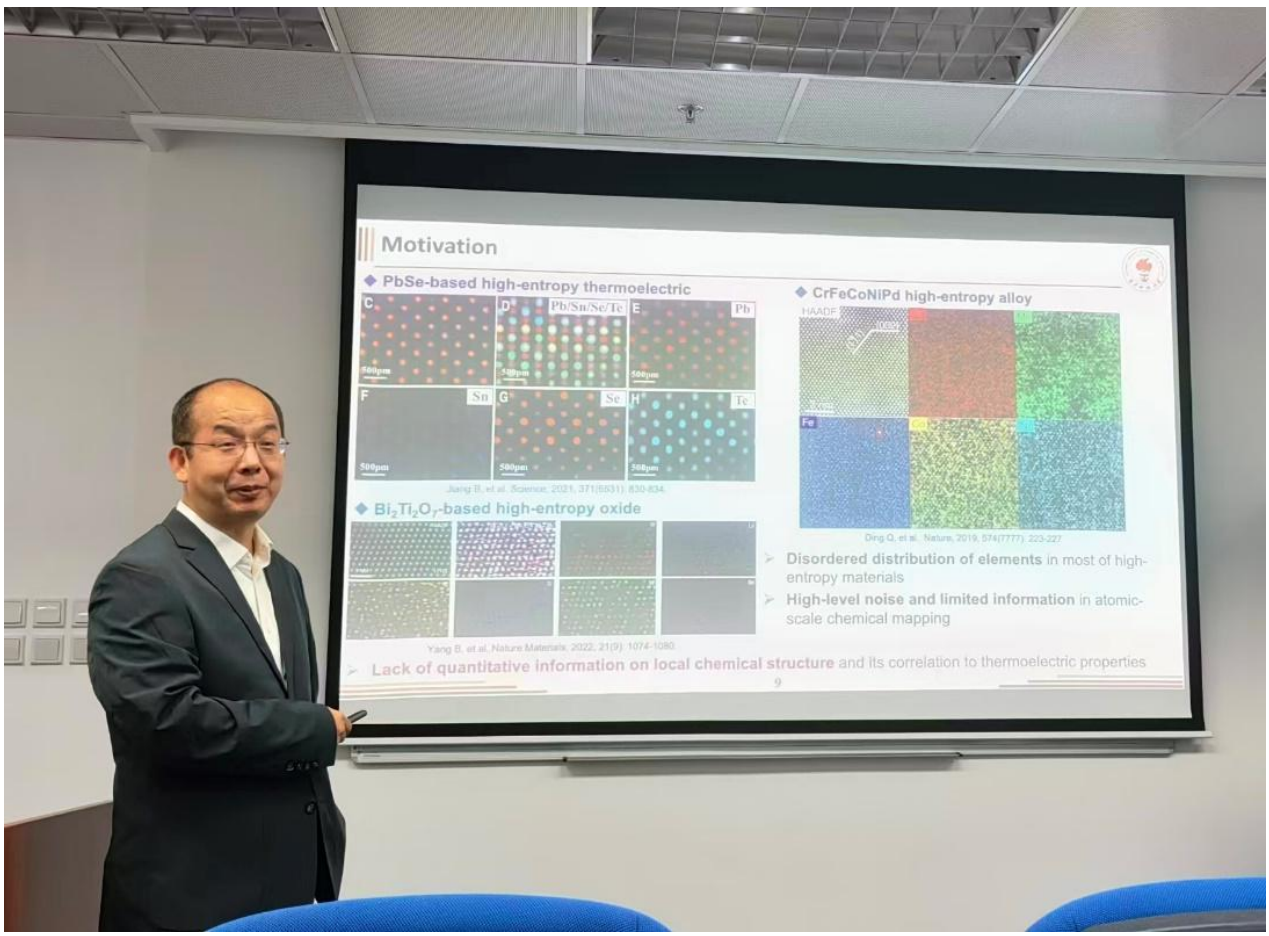
On November 14, 2025, our Institute hosted an insightful seminar as part of its ongoing series, featuring Prof. Jiaqing He (何佳清), Chair Professor in the Department of Physics at Southern University of Science and Technology (SUSTech). The session, hosted by Prof. Hai-Feng Li, focused on cutting-edge developments in thermoelectric technology.

Prof. He is internationally recognized for his pioneering work on thermoelectric and energy materials. His research has introduced transformative paradigms, including multi-scale hierarchical structures, conduction/valence band convergence, phase-separation platforms, high-entropy stabilized phases, and atomic ordering. These strategies have driven breakthroughs in achieving high figure of merit (ZT) and power density across materials such as SnSe, PbTe/PbS, GeTe, BiCuSeO, and low-cost chalcogenides, while ensuring scalability and material availability.

With an h-index exceeding 100, Prof. He has published extensively in leading journals, including five representative papers in Science and two in Nature, alongside highly cited works in *Nature Chemistry, Nature Communications, Energy & Environmental Science, JACS, and Materials Today*. His integrated "structure–transport–performance–application" research paradigm has significantly advanced the field.

During the seminar, Prof. He explored the challenges and opportunities in thermoelectric technology, emphasizing strategies to decouple electron and phonon transport for enhanced performance. He highlighted ZT as a critical metric and discussed innovative approaches to optimize it through rational material design, combining rigorous physical principles with formula-level innovation. Examples included emerging nanostructured systems such as PbQ, GeTe, and AgCrSe, which exhibit strong potential for improving thermoelectric efficiency.

Prof. He stressed that beyond achieving high performance, understanding the underlying mechanisms through systematic investigation is essential for generalizable progress. The seminar concluded with a dynamic discussion on future directions and applications of thermoelectric materials in addressing global energy challenges, inspiring attendees with the promise of these technologies to transform energy utilization.



On November 17, 2025, our Institute hosted a seminar featuring Prof. Liangliang Li (李亮亮) from the School of Interdisciplinary Studies at Lingnan University. The session, titled "*Design and Optimization of Polymer-Based Electrolytes for Solid-State Batteries*", was chaired by Prof. Kwun Nam Hui.

Prof. Li is a leading researcher in solid-state electrolytes, with prior experience at Applied Materials in the United States and 15 years as a faculty member at Tsinghua University. He has authored more than 100 papers in top-tier journals, including *Advanced Materials, Advanced Energy Materials, and Nano Energy.*

In his presentation, Prof. Li addressed the growing demand for safe, high-energy-density storage technologies capable of operating across wide temperature ranges—an area where solid-state batteries (SSBs) have emerged as promising candidates. He identified solid electrolytes as the primary bottleneck for SSB commercialization and highlighted the advantages of polymer-based electrolytes, particularly those derived from poly(vinylidene fluoride) (PVDF), such as mechanical flexibility, ease of processing, and scalability. However, he noted persistent challenges, including low ionic conductivity, limited oxidative stability, and poor interfacial compatibility with lithium metal.

To overcome these limitations, Prof. Li introduced a series of innovative strategies developed by his research group. These include engineering Li–solvent coordination structures to facilitate ion transport through PVDF chains, optimizing polymeric additives and functional components to enhance ionic conductivity and interface stability, and implementing a thermo–electrochemical interfacial treatment that significantly improves PVDF–Li metal interface performance during cycling.

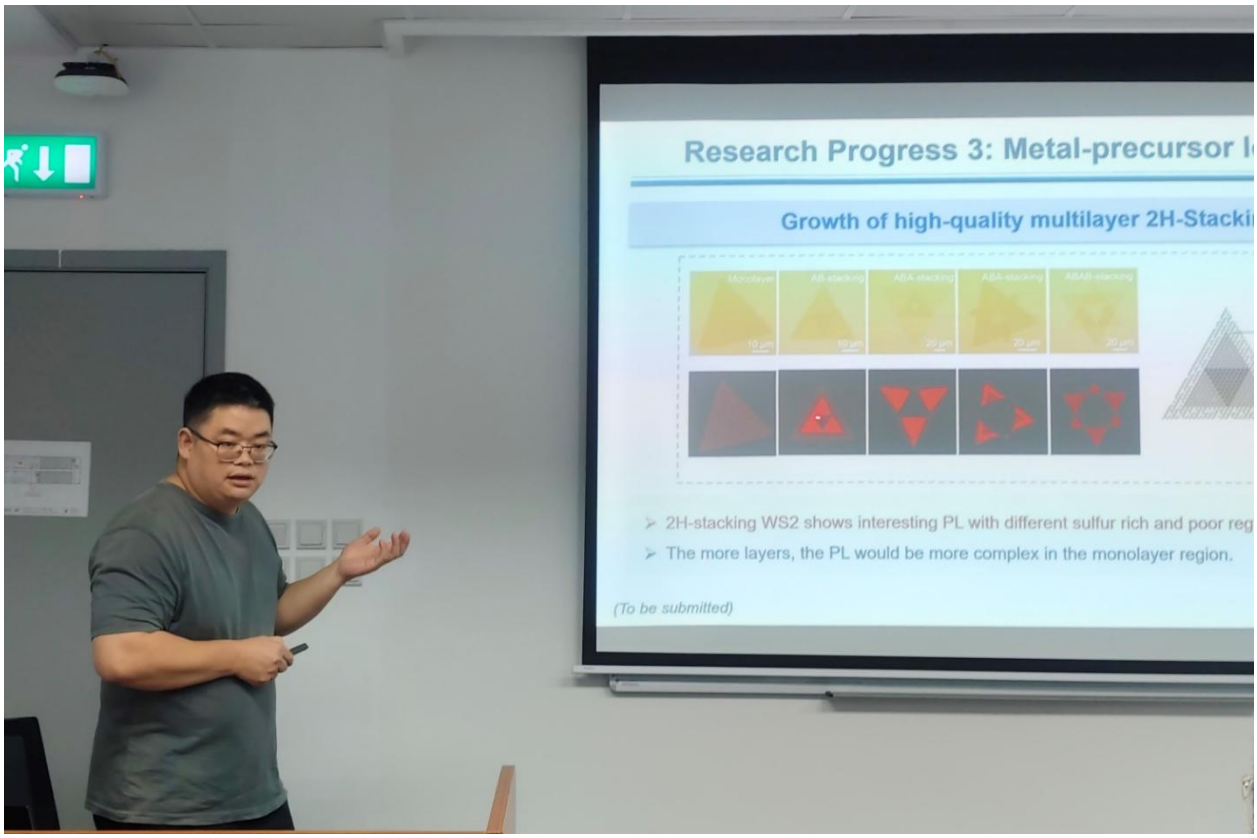
The seminar concluded with an interactive Q&A session, where participants explored topics such as interfacial engineering, polymer design principles, and opportunities for collaborative research. Prof. Li's visit underscored the importance of academic exchange and reinforced a shared commitment to advancing safe, scalable, and high-performance solid-state battery technologies.

On November 18, 2025, our Institute hosted a seminar as part of its ongoing series, featuring Prof. Qinke Wu (吴沁柯) from Hubei University of Technology. The session, titled "*Chemical Vapor Deposition Growth of TMDCs with Ultralow Density of Defects*", took place at N23-4018 and was chaired by Prof. Shen Lai.

Prof. Wu, an Associate Professor at Hubei University of Technology, specializes in the synthesis and property research of advanced two-dimensional materials. His work focuses on chemical vapor deposition and related techniques to produce materials such as graphene for applications in electronics, mechanics, optics, and catalysis. He has published over 30 papers in leading journals, including *Journal of the American Chemical Society, Advanced Materials, and Advanced Functional Materials*, and holds two Chinese patents and three U.S. patents. Prof. Wu also serves as a reviewer for journals such as Thin Solid Films and Small Methods.

In his presentation, Prof. Wu examined the critical influence of defects on the performance of two-dimensional semiconductors, particularly transition metal dichalcogenides (TMDCs), as device dimensions continue to shrink. He compared two key defect characterization techniques—spectroscopic measurement and direct imaging—and detailed growth mechanisms such as solid-state re-sulfurization and iodine-assisted methods for producing high-quality TMDCs with ultralow defect densities. These findings underscore the importance of defect control in enabling next-generation electronic and optoelectronic devices.

The seminar offered deep insights into defect engineering strategies for high-performance two-dimensional semiconductors, emphasizing the role of controllable synthesis in advancing future technologies. Prof. Wu concluded by outlining current challenges and opportunities in defect identification and control, and shared perspectives on the future development of this rapidly evolving field.



❖ Delegation from Jiangsu Advanced Materials Center Visited IAPME

On November 12, 2025, a delegation from the Regional University-Industry Technology Transfer Center for Advanced Materials of Jiangsu Province visited our Institute to explore potential partnerships in technology transfer and industrial applications of advanced materials.

The delegation was led by Deputy Director Ms. Tiekai Zhang (張鐵鍇) and received by our Institute's members including Prof. Guoxing Sun, Prof. Shen Lai, Prof. Qing Li, and Prof. Yinning Zhou. The visit featured a comprehensive presentation by Prof. Sun, who outlined the Institute's development trajectory and core research strengths. He highlighted successful industrial applications of technologies such as foam concrete and water-retaining agents, underscoring the institute's commitment to bridging scientific innovation with real-world utility.

Ms. Zhang provided insights into the Center's mission to facilitate technology transfer in the field of advanced materials. She emphasized the Center's established market channels and downstream industry networks, noting their alignment with IAPME's research capabilities. "The Center's established market channels and downstream industry networks create natural synergies with our Institute's research capabilities," Ms. Zhang stated, adding that both institutions possess complementary strengths in translating research into commercial impact.

In a gesture aimed at deepening collaboration, Ms. Zhang extended an invitation to our Institute's researchers to visit the Center in Jiangsu for further discussions on concrete partnership opportunities.

Both parties expressed a strong commitment to forming a strategic alliance. The envisioned partnership aims to leverage the Institute's research excellence and the Center's commercialization expertise to accelerate technology transfer and drive innovation in the advanced materials sector.

❖ Upcoming Events

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IAPME Seminar

High energy density cathode materials and advanced characterization

1 December 2025
Prof. Jun LU
Zhejiang University
Venue: N23-4018
Time: 10:30 - 11:30
Hosted by: Prof. Kwun Nam HUI

Abstract

The development of new energy vehicles has imposed higher requirements for lithium-ion batteries in terms of energy density and cycle life. However, the unclear failure mechanisms of current battery materials have introduced significant uncertainties into material design and modification. In the development of next-generation high-specific-energy cathode materials, we systematically investigated the performance failure mechanisms of layered cathode materials by combining multiple advanced synchrotron radiation characterization techniques. We revealed the intrinsic correlation between stress-strain and lattice microcracks in layered cathode materials, elucidating that localized stress and strain during lithium intercalation and deintercalation are the root causes of structural distortion and performance degradation. This breakthrough has resolved a long-standing global challenge that has puzzled researchers for years, establishing a novel strategy for structural stress regulation. Through innovative material structural design at the lattice scale, we have effectively mitigated this intrinsic defect and achieved the development of ultra-low strain layered cathode materials.

Biography

Prof. Jun LU is a Chair Professor at Zhejiang University and the Dean of Quzhou Power Battery and Energy Storage Research Institute. His research interests focus on the electrochemical energy storage and conversion technology, with main focus on beyond Li-ion battery technology. He has published more than 600 papers including Nature, Science, Nature Energy, Nature Nanotechnology, Nature Catalysis, Nature Sustainability, Nature Review Material, Nature Communication, Chemical Reviews, etc. (Google Scholar, Total citations: >99,000 times, H-index 141). He also filed more than 30 US patents and patent applications. He also received numerous awards throughout his career including IBA Research Award (2022), ECS Battery Division Technology Award (2022); Research Excellence Award in Electrochemical Energy Storage (EES Award), ACS ENFL Division (2022); IBA Early Career Award (2020); R&D 100 Award (2019); Emerging Researcher Award of ACS ENFL (2019). He was ranked as the Global Highly Cited Researchers by Clarivate Analytics in 2018–2024. He also serves as Editor-in-Chief of Battery Energy and Associate Editor of ACS Applied Materials & Interfaces.

Enquiry: iampe.enquiry@um.edu.mo

Contact Us

Email
iapme.enquiry@um.edu.mo