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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. **Zirui Zhao**, Junchao Xia, Si Wu, Xiaoke Wang, Guanping Xu, Yinghao Zhu, Jing Sun, and **Hai-Feng Li***. Insights into dendritic growth mechanisms in batteries: A combined machine learning and computational study. *Battery Energy, e70015* (2025). DOI: 10.1002/bte2.20240088. [2023 IF=9.0]

Battery Energy

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BATTERY ENERGY

RESEARCH ARTICLE OPEN ACCESS

Insights Into Dendritic Growth Mechanisms in Batteries: A Combined Machine Learning and Computational Study

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❖ Research Stories

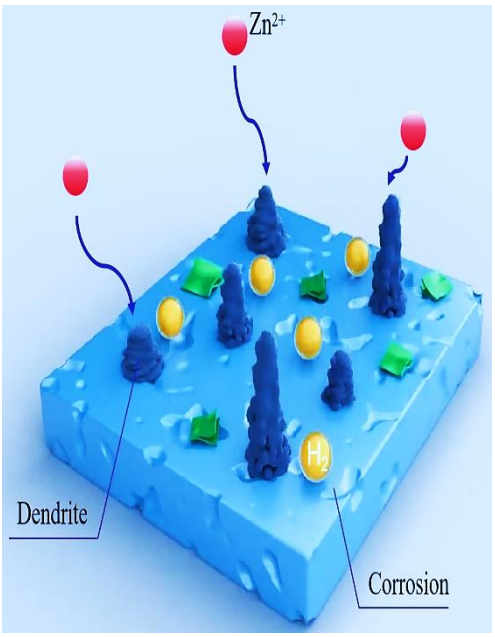
UM Research Team Successfully Develops Physics-Informed Hybrid Model for Dendrite Growth Prediction in Lithium Batteries

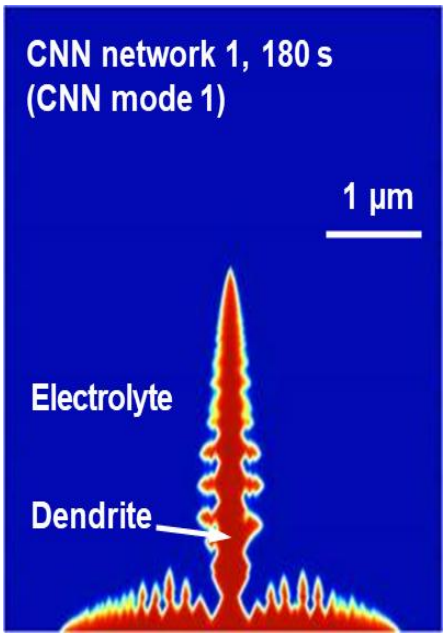
- This study presents a systematic investigation of dendrite growth mechanisms in lithium batteries through a hybrid framework combining convolutional neural networks (CNN) with phase-field simulations.
- By integrating electrochemical parameters, the model achieves 80% accuracy in predicting the evolution of dendritic morphology, revealing anisotropic growth patterns at different current densities.

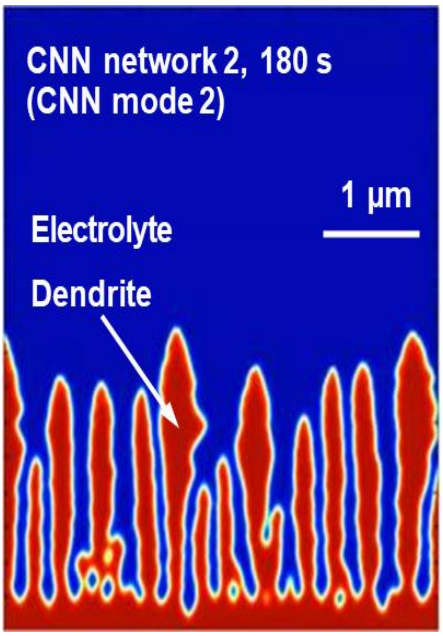
Mr. Zirui Zhao
(趙梓睿)

Prof. Hai-Feng Li
(李海峰)

- By inputting the relevant physical parameters of a particular battery configuration, our model can predict dendritic behavior, making it suitable for a wide range of battery chemistries and applications. and moreover, underscore the potential of machine learning models in advancing our understanding and prediction of battery behavior.
- Our models offered a deeper insights into the impact of physical factors on dendritic growth. improved model effectively captures the dynamic nature of dendrite formation, exhibiting high accuracy and sensitivity.







Zirui Zhao, Junchao Xia, Si Wu, Xiaoke Wang, Guanping Xu, Yinghao Zhu, Jing Sun, and **Hai-Feng Li***. Insights into dendritic growth mechanisms in batteries: A combined machine learning and computational study. *Battery Energy, e70015* (2025). DOI: 10.1002/bte2.20240088. [2023 IF=9.0]

Prof. Hai-Feng Li is the corresponding author of this study, with Mr. Zirui Zhao, a Ph.D. student at the IAPME, serving as the first author. This work was supported by the Science and Technology Development Fund, Macao SAR (File Nos. 0090/2021/A2 and 0104/2024/AFJ) and University of Macau (MYRG-GRG2024-00158-IAPME).

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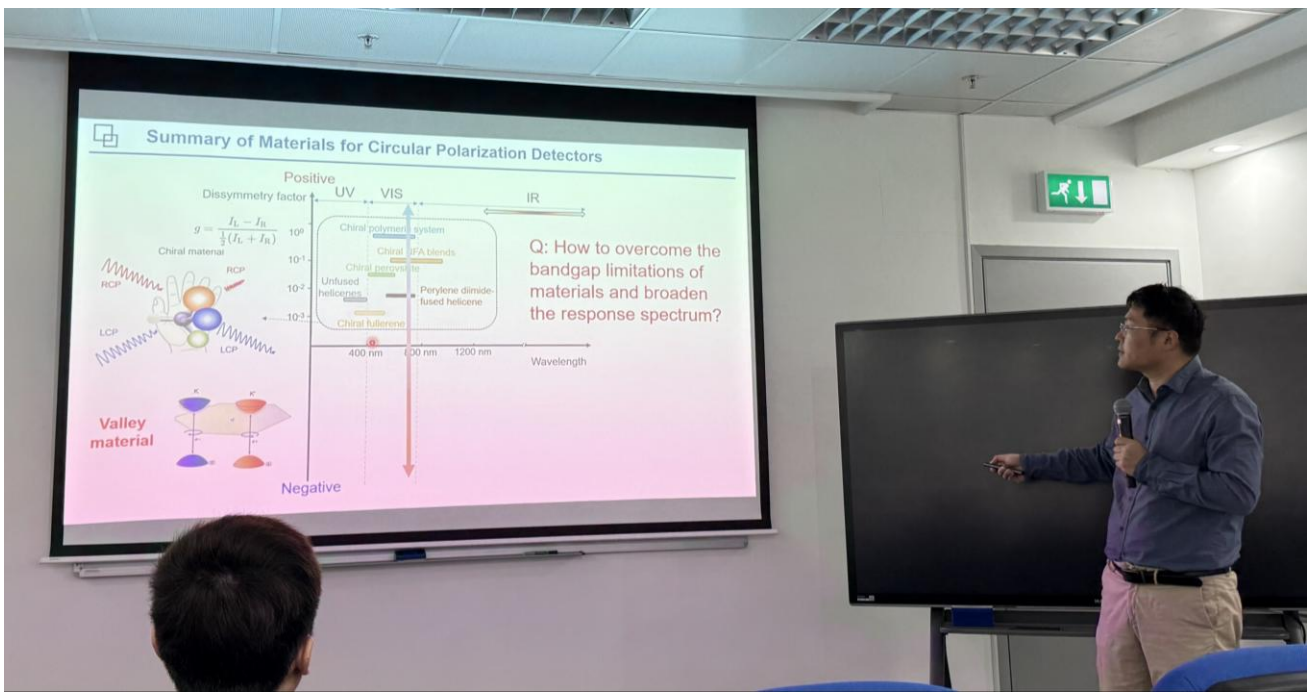
❖ UM Distinguished Visiting Scholar visited IAPME

Invited by Prof. Shen Lai, Prof. Weibo Gao (高煒博) from Nanyang Technological University (NTU), Singapore, visited our institute on 20 March 2025 and delivered a seminar titled "Centrosymmetric Metamaterials for Discerning Chiral Light Based on Metasurface-Assisted Valleytronics".

Prof. Gao obtained his BSc (2005) and PhD (2010) from the University of Science and Technology of China. He conducted postdoctoral research as a Marie Curie Fellow at ETH Zurich from 2010 to 2014. Since joining NTU in 2014, he has been promoted to Tenured Professor and Provost's Chair Professor in Physics (2019), and currently holds the Endowed Professorship jointly in EEE&SPMS since 2024. His pioneering work in quantum photonics and solid-state condensed matter physics has resulted in over 50 publications in Nature/Science journals, alongside prestigious honours including the Singapore President's Young Scientist Award (2017) and the NTU Nanyang Award (2023).



In the seminar, Prof. Gao addressed the critical limitations of conventional circularly polarized light (CPL) detectors—such as narrow spectral response and low discrimination ratios—and unveiled innovative solutions through valleytronic-metasurface integration. He presented a novel approach combining spin angular momentum (SAM) engineering in non-chiral centrosymmetric metamaterials with valley Hall effect transduction, enabling broadband detection spanning visible to infrared regimes. By designing metamaterials that amplify near-field SAM intensity while preserving polarization handedness, SAM-polarized electrons injected into valley materials generate measurable chiral signals. Additionally, he introduced machine learning-driven optimization, where neural networks trained on photocurrent responses achieve wavelength-agnostic recognition of polarization states, bypassing traditional spectral limitations.

During his visit to IAPME, Prof. Gao engaged with faculty members and PhD students on potential collaborations and advanced metasurface design, praising the institute's facilities and achievements.