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UNIVERSIDADE DE MACAU
UNIVERSITY OF MACAU

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. **Jiayi Xu**, **Ming Lei***, Yuanzhe Liang, Biao Qi, Ziyi Dai, Yong Zhao*, and **Bingpu Zhou***. Gourd-Inspired Design of Unit Cell with Multiple Gradients for Physiological-Range Pressure Sensing. *Advanced Functional Materials,* e27243 (2025). DOI: 10.1002/adfm.202527243. [2024 IF=19.0]

RESEARCH ARTICLE | Full Access

Gourd-Inspired Design of Unit Cell with Multiple Gradients for Physiological-Range Pressure Sensing

Jiayi Xu, Ming Lei ✉, Yuanzhe Liang, Biao Qi, Ziyi Dai, Yong Zhao ✉, Bingpu Zhou ✉

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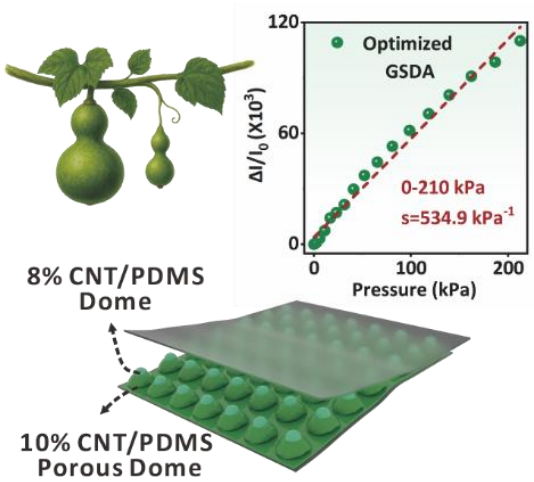
❖ Research Stories

UM research team developed gourd-inspired design of unit cell with multiple gradients for physiological-range pressure sensing

- By mimicking the structural motifs existing in biological systems and combining them with established design principles, the research team can effectively optimize the performance of flexible pressure sensors.
- This study presents gourd-shaped micro-dome arrays that co-grade modulus, conductivity, and geometry at the unit-cell level. The gourd-like architecture possesses intrinsic advantages due to its composition of two dome segments with different dimensions. Under pressure, the stiffness mismatch drives the controlled indentation of the upper dome into the porous base, while pore compression shortens the tunneling separations and multiplies parallel pathways. This process reconstructs the conductive network from a series-dominated to a parallel-dominated configuration, significantly delaying mechanical saturation.
- The device clearly resolves pulse, respiration, and 4-6 Hz tremor signals with a stable baseline. Leveraging the monotonic force-to-amplitude transfer, multiple functions have been realized, such as intensity × location password outputs in a single microstructure, offering a low-cost, scalable route to linear, sensitive, and directly programmable piezoresistive wearables in future developments.

(From left) Ms. Jiayi Xu (許家逸), Dr. Ming Lei (雷銘), and Prof. Bingpu Zhou (周冰朴)



Gourd-shaped micro-dome arrays with coordinated modulus, conductivity, and geometric gradients co-optimize sensitivity and linearity for piezoresistive tactile sensors

Jiayi Xu, **Ming Lei***, Yuanzhe Liang, Biao Qi, Ziyi Dai, Yong Zhao*, and **Bingpu Zhou***. Gourd-Inspired Design of Unit Cell with Multiple Gradients for Physiological-Range Pressure Sensing. *Advanced Functional Materials,* e27243 (2025). DOI: 10.1002/adfm.202527243. [2024 IF=19.0]

Prof. Bingpu Zhou, Prof. Yong Zhao and Dr. Ming Lei are the corresponding authors of this study. The first authors are Ms. Jiayi Xu, master student of IAPME, and Dr. Ming Lei. This work was supported by The Science and Technology Development Fund, Macau SAR (FDCT-0057/2023/RIB2), Macao Centre for Research and Development in Advanced Materials (0002/2024/TFP), and University of Macau (MYRG-GRG2024-00090-IAPME, MYRG-GRG2025-00142-IAPME).

❖ Ph.D. Student Thesis Oral Defenses

Youpeng Cao of Prof. Hui Pan's group presented "Design and Fabrication of Ruthenium-based Catalysts for Hydrogen Electrocatalysis" in his oral defense on January 06, 2026.

Congratulations to Dr. Youpeng Cao!

(from left) Prof. Hongchao Liu (劉宏超), Prof. Guichuan Xing (邢貴川), Prof. Huanyu Jin (金桓宇, SIAT), Dr. Youpeng Cao (曹友鋼), Prof. Hui Pan (潘暉), and Prof. Yongqing Cai (蔡永青)

Wang Li of Prof. Guichuan Xing's group presented "Interface Optimization for Efficient and Stable Perovskite Solar Cells" in his oral defense on January 07, 2026.

Congratulations to Dr. Wang Li!

(from left) Prof. Yongqing Cai (蔡永青), Prof. Shi Chen (陳石),
Dr. Wang Li (李旺), Prof. Handong Sun (孫漢東)
Prof. Hin Lap Yip (葉軒立, CityUHK), and Prof. Guichuan Xing (邢貴川)

❖ Seminars

On December 18, 2025, our Institute successfully hosted a seminar titled "*Multiscale Hybrid Design to Tune Catalyst Activity*", delivered by Prof. Xingke Cai (蔡興科) from Shenzhen University. The event was chaired by Prof. Qing Li.

Prof. Cai, a leading researcher in materials engineering for energy applications, has authored over 55 first/corresponding author publications in top-tier journals such as *Nature Nanotechnology, Nature Communications, Advanced Materials, Chemical Society Reviews, and Journal of the American Chemical Society*. His work has garnered more than 5,000 citations, underscoring his significant contributions to the field.

In his presentation, Prof. Cai addressed key challenges in multi-electron electrocatalytic reactions, including sluggish kinetics, high overpotentials, and low energy-conversion efficiencies. He explained how electronic structure modulation of active sites through heteroatom incorporation can accelerate reaction kinetics. The seminar further explored three progressively precise structural strategies, including interfacial hybridization, intrinsic doping and atomically precise hybridization. These approaches were illustrated through well-designed material systems, demonstrating their effectiveness in improving catalytic performance.

The session concluded with an engaging discussion, where students and researchers actively exchanged ideas with Prof. Cai on the future directions of catalytic design strategies. The event provided a valuable platform for academic exchange, deepening participants' understanding of how precise electronic structure tuning can advance electrocatalytic technologies.

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❖ IAPME Welcomed Industry and Government Delegation to Explore Battery Innovation Partnerships

On December 30, 2025, our Institute hosted a delegation comprising **Mr. Changchun Cheng**, President of **China BAK Asia Holdings Limited**; **Dr. She** of **BAK Group**; **Ms. Pinko Ip** from **the Macao Trade and Investment Promotion Institute**; and **Mr. Clement Chau** from **the Macao Science and Technology Development Fund (FDCT)**. The delegation was warmly received by Prof. Guichuan Xing, Prof. Haifeng Li, and Prof. Qing Li.

During the meeting, Prof. Qing Li presented a comprehensive overview of IAPME's recent research progress and technological achievements in battery materials and related key technologies. Prof. Guichuan Xing and Prof. Haifeng Li further elaborated on IAPME's distinctive strengths, highlighting its cross-disciplinary research ecosystem, robust institutional support, and strong emphasis on translational research. They also underscored Macao's strategic role as a gateway for international collaboration and its growing importance in promoting high-tech innovation within the Guangdong–Hong Kong–Macao Greater Bay Area.

Discussions subsequently focused on identifying potential avenues for collaboration. Mr. Changchun Cheng and Dr. She outlined BAK Group's strategic vision and development priorities in the battery industry, noting strong alignment between the company's industrial technology demands and IAPME's research directions. Ms. Pinko Ip and Mr. Clement Chau contributed insights on practical mechanisms to advance industry–academia–research cooperation and technology commercialization, drawing on Macao's investment promotion initiatives and scientific research funding frameworks.

All parties expressed strong interest in deepening collaboration and reaffirmed a shared commitment to integrating IAPME's research expertise, BAK Group's industrial capabilities, and policy and platform support from the Macao government. The discussions reflected a joint aspiration to accelerate technological innovation and industrial deployment in the battery sector, fostering mutually beneficial outcomes and collective progress.

❖ Upcoming Events

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IAPME Seminar

Multi-Scale Modeling of Electrochemical CO_2RR

21 January 2026

Prof. Yaqiong SU
Xi'an Jiao Tong University
Venue: N23-4018
Time: 10:00 - 11:30
Hosted by: Prof. Hui PAN

Abstract

Electrochemical reduction reactions of carbon dioxide (eCO_2RR) is an important way to realize carbon neutrality. However, the atomic understanding of eCO_2RR mechanism at the interface between catalysts and electrolytes remains obscure. We combine constant-potential simulations and molecular dynamics modeling to systematically investigate the dynamic evolution of active sites and chemical space under reaction conditions, as well as their influence on eCO_2RR performance. We unraveled the activity origin of eCO_2RR to C_{2+} products and clarified the importance of intermediate CO coverage on product selectivity. Besides, we also developed the coarse-grained modeling framework to explore the effect of mass transfer of electrolyte components on electrochemical performance.

Biography

Prof. Yaqiong SU received his Master degree from Xiamen University in 2014 and PhD degree from Eindhoven University of Technology in 2018, and then did his postdoctoral research at Eindhoven University of Technology. He worked as a visiting scholar in 2011-iChEM, Xiamen University from January 2020 to August 2020. He is now a Distinguished Professor and Principal Investigator at School of Chemistry, Xi'an Jiaotong University. His research involves theoretical chemistry, computational catalysis and spectroscopic electrochemistry. He is the editorial board member of some journals, including Journal of Supercritical Fluids, ChemCatChem, Journal of Materials Informatics, AI for Materials, Current Catalysis, Photocatalysis: Researches and Potential. He has published 300 papers, including Science(2), PNAS(1), Nature Comm.(8), JACS(12), Angew. Chem.(20), Adv. Mater.(5), Energy Environ. Sci.(2), ACS Catal.(12), and so on.

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