



澳門大學
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

<https://iapme.um.edu.mo/>



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◇ Content

1. Research Highlights

- a. First Prize of Technological Invention Awards
- b. Publications
- c. Research Stories

2. Teaching and Student Affairs

- a. IAPME Postgraduate Association Activities

3. Community News

❖ Prof. Guoxing Sun Wins First Prize in the 2024 Macao SAR Science and Technology Awards (Technological Invention Award)

Prof. Guoxing Sun (孫國星) from IAPME and his team have been awarded the **First Prize of the Technological Invention Award** in the 2024 Science and Technology Awards of the Macao SAR. This award was presented by the Chief Executive of Macao, Mr. Hou Fai Sam.

The winning project, titled “Preparation of High-Performance Hydrogels from Cement-Based Sustained-Release Nanoparticles” pioneers the use of ordinary cement to produce nanoparticles. These nanoparticles are then used to develop a series of highly elastic and superabsorbent hydrogel materials. The innovative hydrogels have already been applied in various fields, including agricultural soil water retention and crack prevention and curing in construction concrete.

The Macao Science and Technology Awards are held **biennially**, and the First Prize is not awarded in every cycle. **Prof. Sun** is one of the two first-class awardees in Macao, and the only one from UM.



❖ First Prize Project in the 2024 Macao SAR Science and Technology Awards (Technological Invention Award)

Preparation of High-Performance Hydrogels from Cement-Based Sustained-Release Nanoparticles

- This project is the first to identify a novel method for producing calcium hydroxide particles with diameters under 5 nm by immersing Ordinary Portland Cement in 0 °C cold water.
- The resulting nanoparticles markedly improve the mechanical properties, water absorption, and swelling behavior of standard hydrogels, even at low concentrations (0.02 wt%).
- The tensile strength of hydrogels increased from 20 kPa to 630 kPa, and the tensile ratio improved from 10 times (irreversible deformation) to 121 times (reversible deformation).
- The nanoparticles can also be used to create a super-absorbent gel material, capable of absorbing up to 13,671 times its own weight in pure water.



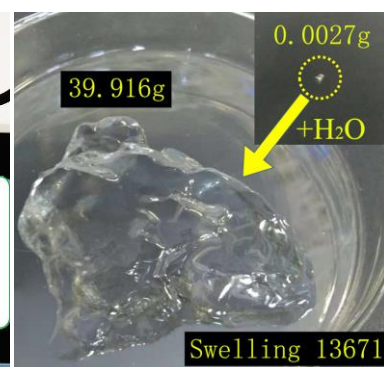
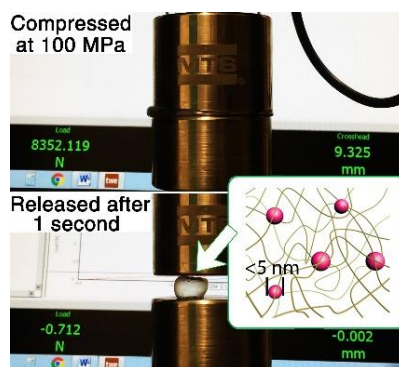
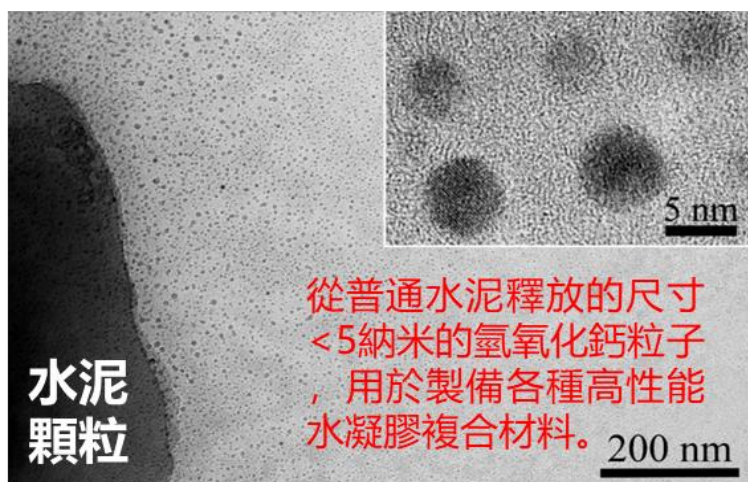
Prof. Guoxing Sun
(孫國星)



Prof. Rui Liang
(梁瑞)



Prof. Zongjin Li
(李宗津)





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IAPME Newsletter

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04 June 2025

❖ Publications (IF \geq 8, and/or Nature Index; *corresponding author)

1. **Jiaqian Kang**, **Yuxuan Xiao**, Lun Li, Lulu Qiao, Chunfa Liu, Chengcheng Zhong, **Pengzhan Sun***, **Di Liu***, Weng Fai Ip, and **Hui Pan***. Ternary Synergy in Layered Double Hydroxides for Efficient and Stable Nitrate Reduction. *Advanced Functional Materials*, (2025). DOI: 10.1002/adfm.202507619. [2023 IF=18.5]

RESEARCH ARTICLE

ADVANCED
FUNCTIONAL
MATERIALS

www.afm-journal.de

Ternary Synergy in Layered Double Hydroxides for Efficient and Stable Nitrate Reduction

Jiaqian Kang, Yuxuan Xiao, Lun Li, Lulu Qiao, Chunfa Liu, Chengcheng Zhong, Pengzhan Sun,* Di Liu,* Weng Fai Ip, and Hui Pan*

❖ Research Stories

UM research team engineers triply synergistic layered catalysts for industrial-grade nitrate-to-ammonia conversion

- Nitrate pollution poses severe environmental threats, yet existing electrocatalysts struggle to balance activity, selectivity, and stability. Conventional methods like ion exchange leave concentrated nitrate waste, while NO_3RR faces trade-offs in efficiency and activity due to competing reaction pathways and catalyst reconstruction, hindering scalable solutions for nitrate-to-ammonia conversion.
- The team engineered a ternary CuZnFe-layered double hydroxide (LDH) catalyst via compositional tuning and in-situ reconstruction. Copper drives nitrate-to-nitrite conversion, iron promotes nitrite to ammonia, and zinc leaching exposes active sites—synergistically optimizing reaction pathways.
- The CuZnFe-LDH achieves breakthrough performance: 95% Faradaic efficiency for ammonia, industrial-grade current density (0.64 A cm^{-2}), and >100-hour stability at -0.7 V vs. RHE . In-situ spectroscopy confirms stepwise synergy, where metallic Cu initiates reduction, Fe oxides promotes intermediates conversion, and Zn dissolution maximizes active sites—establishing a scalable paradigm for sustainable nitrate remediation and green ammonia synthesis.



Jiaqian Kang
(康家騫)



Dr. Yuxuan Xiao
(肖宇軒)



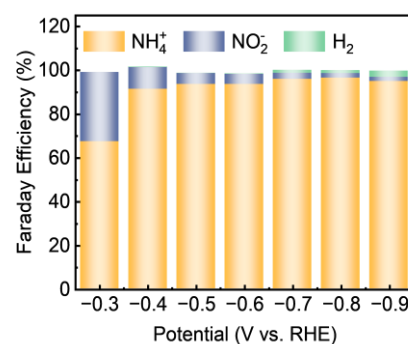
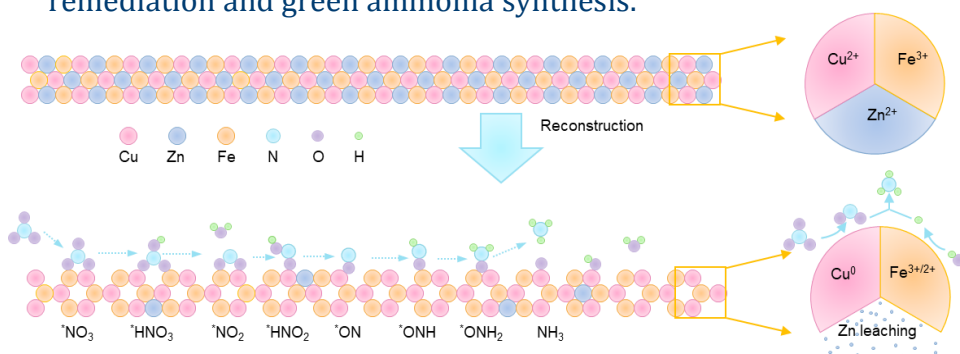
Prof. Pengzhan Sun
(孫鵬展)



Dr. Di Liu
(劉地)



Prof. Hui Pan
(潘暉)



Jiaqian Kang, Yuxuan Xiao, Lun Li, Lulu Qiao, Chunfa Liu, Chengcheng Zhong, Pengzhan Sun*, Di Liu*, Weng Fai Ip, and Hui Pan*. Ternary Synergy in Layered Double Hydroxides for Efficient and Stable Nitrate Reduction. *Advanced Functional Materials*, (2025). DOI: 10.1002/adfm.202507619. [2023 IF=18.5]

The first authors are Jiaqian Kang, Ph.D. student in the IAPME, and Dr. Yuxuan Xiao, a post-doctoral fellow in the IAPME. This work was supported by the Science and Technology Development Fund (FDCT) from Macau SAR (0050/2023/RIB2, 0023/2023/AFJ, 006/2022/ALC, 0087/2024/AFJ and 0111/2022/A2), and Multi-Year Research Grants from Research & Development Office at University of Macau (MYRG-GRG2023-00010-IAPME and MYRG-GRG2024-00038-IAPME. P.Z.S. acknowledges support from the Natural Science Foundation of China (52322319) and UM research grant (MYRG-GRG2024-00064-IAPME).

❖ IAPME Postgraduate Association Hosts "BBQ Night"

On May 11, 2025, the IAPME Postgraduate Association (IAPMEPA) hosted a vibrant "BBQ Night" at the University of Macau Barbecue Site. The event drew enthusiastic participation from a large number of postgraduate students, who came together to enjoy an evening of delicious food, laughter, and camaraderie.

The gathering was graced by the presence of Prof. Hui Pan, Prof. Guichuan Xing, Prof. Shuangpeng Wang, and Prof. Bingpu Zhou, who joined the master's and doctoral students for a night of grilling and engaging conversations. The relaxed atmosphere provided a perfect backdrop for meaningful exchanges on both academic topics and everyday life.

To enhance the festive mood, the student association organized a series of fun games and played lively music, keeping the energy high and the smiles wide throughout the night.

Participants shared that the event not only deepened friendships but also offered a refreshing break from their demanding academic routines. It fostered a strong sense of community and belonging within the institute.

Looking ahead, IAPMEPA remains committed to organizing diverse and enriching activities that promote connection, well-being, and personal growth among postgraduate students.



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IAPME Newsletter

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04 June 2025



❖ IAPME Receives the Science and Technology Awards

The Institute of Applied Physics and Materials Engineering (IAPME) received 5 awards at the awards ceremony of the 2024 Science and Technology Awards of the Macao SAR, which was held by the Macao SAR government on May 28, 2025. The awards include 3 Science and Technology Awards and 2 Scientific and Technological R&D Awards for Postgraduates.

IAPME received 1 third prize in the Natural Science Award category and 1 first prize, 1 third prize in the Technological Invention Award category. In addition, 2 IAPME doctoral students received the Scientific and Technological R&D Awards for Postgraduates.



Details of the IAPME recipients of the Science and Technology Awards and their projects are as follows:

Type of Award	Grade of Award	Project Name	Recipient
Natural Science Award	Third Prize	Theoretical Study on Interface and Lattice Distortion of Organic-Inorganic Perovskite	Yongqing Cai, Hejin Yan, Hongfei Chen
Technological Invention Award	First Prize	Preparation of High-Performance Hydrogels from Cement-based Sustained-Release Nanoparticles	Guoxing Sun, Rui Liang, Zongjin Li
	Third Prize	Key Technologies and Applications of Flexible Precision-Manipulation Robot Design	Qingsong Xu, Wei Ge



(from left) Dr. Hongfei Chen (陳泓妃), Prof. Yongqing Cai (蔡永青), Prof. Guoxing Sun (孫國星), Prof. Wei Ge (葛偉), Prof. Zongjin Li (李宗津, MUST), Prof. Rui Liang (梁瑞, MUST) and Mr. Hejin Yan (晏和進)



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IAPME Newsletter

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04 June 2025

Type of Award	Category	Recipient
Scientific and Technological R&D Awards for Postgraduates	Doctoral	Tesen Zhang
	Doctoral	Ziyi Dai



Dr. Tesen Zhang (張特森)



Dr. Ziyi Dai (戴子憶)



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❖ IAPME Professors Lead Macao Delegation to Saudi Arabia for the 25th Asian Physics Olympiad (APhO 2025)

From May 3 to 13, 2025, the Education and Youth Development Bureau (DSEDJ) organized a delegation of Macao students to participate in the 25th Asian Physics Olympiad (APhO 2025), held in Saudi Arabia. The Macao student team was led by Prof. Kar Wei Ng (吳嘉偉) from the Institute of Applied Physics and Materials Engineering (IAPME) at the University of Macau, along with Deputy Leader Prof. Hou Ian (殷灝). The team members ultimately received Honorable Mention awards.



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