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 Nature Index; *corresponding author)

1. **Annan Zhu**, Hao Gu, Wang Li, Jia Guo, Shengwen Li, Gang Wang, Junmin Xia, Chao Liang, Shi Chen, and **Guichuan Xing***. Efficient Inverted Perovskite Solar Cells Utilizing Inorganic Composite Multiple Electron Transport Layers. ***Small***, e11978 (2025). DOI: 10.1002/smll.202411978. [2025 IF=12.1]

RESEARCH ARTICLE

NANO · MICRO small
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Efficient Inverted Perovskite Solar Cells Utilizing Inorganic Composite Multiple Electron Transport Layers

*Annan Zhu, Hao Gu, Wang Li, Jia Guo, Shengwen Li, Gang Wang, Junmin Xia, Chao Liang, Shi Chen, and Guichuan Xing**

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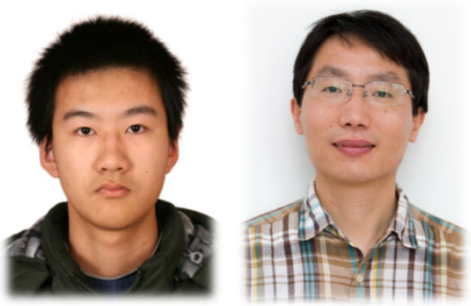
❖ Research Stories

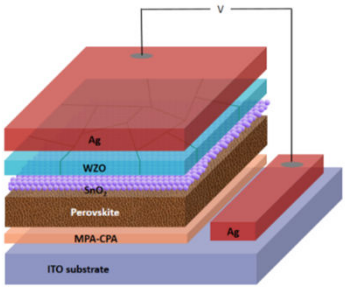
UM research team prepared inorganic composite multiple electron transport layers for inverted perovskite solar cells

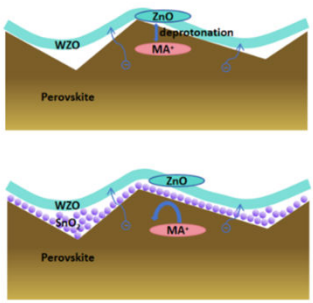
- Electron transport layers (ETLs) featuring optimal film coverage and favorable electronic properties play a critical role in high-performance perovskite solar cells (PSCs). In contrast to organic ETLs, which have high material costs, inorganic metal oxide ETLs are considered as promising alternatives for efficient inverted PSCs because of their low cost, high carrier mobility, and excellent stability. However, fabricating high-quality top inorganic ETLs that preserve the active perovskite layer remains a challenge.
- The team introduced a composite electron transport bilayer comprising atomically coherent interfaced tin dioxide (SnO_2) nanoparticles and tungsten-doped zinc oxide (WZO), which further facilitates charge extraction and mitigates detrimental interfacial deprotonation reactions. The tungsten doping ratio could be precisely controlled by adjusting the co-evaporation parameters. Results reveal that tungsten enhances charge extraction by fine-tuning the energy levels, whereas the SnO_2 layer simultaneously passivates the perovskite/ETL interface defects and inhibits deprotonation reactions.

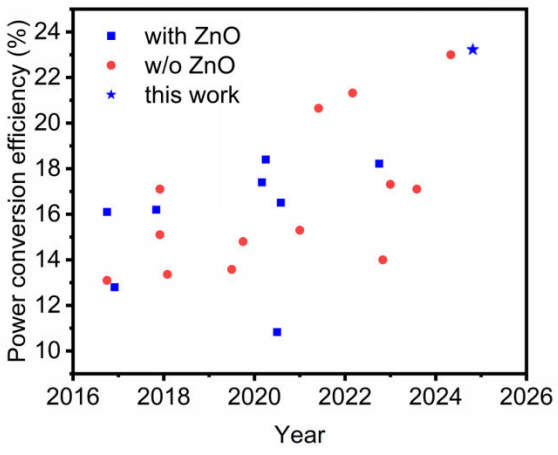


Dr. Annan Zhu (朱桉楠) Prof. Guichuan Xing (邢貴川)

- Utilizing this inorganic composite multiple architecture, a record efficiency of 23.19% was achieved for inverted PSCs with an all-inorganic ETL. This cost-effective approach provides a viable pathway for industrial-scale production of high-performance PSCs.







Annan Zhu, Hao Gu, Wang Li, Jia Guo, Shengwen Li, Gang Wang, Junmin Xia, Chao Liang, Shi Chen, and **Guichuan Xing***. Efficient Inverted Perovskite Solar Cells Utilizing Inorganic Composite Multiple Electron Transport Layers. *Small,* accepted (2025). **[2025 IF=12.1]**

Annan Zhu and Hao Gu contributed equally to this work. The authors acknowledge the Science and Technology Development Fund, Macao SAR (File no. FDCT-0082/2021/A2, 0010/2022/AMJ, 0060/2023/RIA1, 0136/2022/A3, 006/2022/ALC, 0122/2024/AMJ, EF044/IAPME-HG/2022/MUST), UM's research fund (File no. MYRG2022-00241-IAPME, MYRG-GRG2023-00065-IAPME-UMDF, MYRG-CRG2022-00009-FHS), the research fund from Wuyi University (EF38/IAPME-XGC/2022/WYU), and the Natural Science Foundation of China (61935017, 62175268, 62288102, 22405010).

❖ Ph.D. Student Thesis Oral Defenses

Runxing Lin of Prof. Yinning Zhou's group presented "Flexible Sensors for Biomedical Monitoring and Personalized Medicine" in her oral defense on August 04, 2025.

Congratulations to Dr. Runxing Lin!

(from left) Prof. Shen Lai (賴屾), Prof. Yinning Zhou (周胤寧), Dr. Runxing Lin (林潤星), Prof. Jianwei Zhong (鍾健偉, SCUT), Prof. Guichuan Xing (邢貴川) and Prof. Bingpu Zhou (周冰朴)

❖ Introduction of New Staff

It's our great pleasure to introduce, Dr. Weng Fu Io (姚泳芙), UM Macao Fellow, who has recently joined IAPME.

Dr. Weng Fu Io obtained her BSc, MPhil and PhD from The Hong Kong Polytechnic University. Dr. Io has a strong academic record with five first-authored papers. One of them was published in Nature Communications, which is one of the top journals in her field and a Nature Index journal. The remaining four papers are published in SCI index journals, such as *Materials Science and Engineering: R: Reports* (IF = 31.6), *Nano Energy* (IF = 16.8), etc. This demonstrates her research abilities and potential in her chosen field. She was also the recipient of the Hong Kong PhD Fellowship and the Scholarship under the Higher Education Financial Assistance Scheme at the Education and Youth Development Bureau in 2021.

Let's welcome Dr. Weng Fu Io and we highly appreciate your support to Dr. Io.

For more information of Dr. Io, please visit:
https://iapme.um.edu.mo/people/research-staff/io-wengfu/

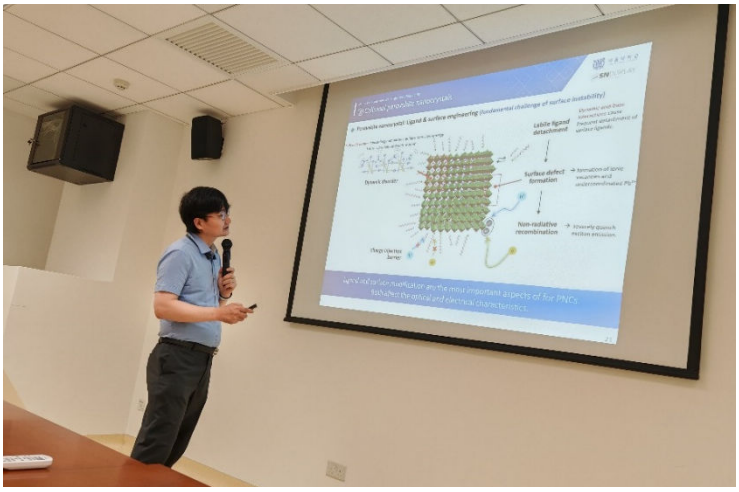
❖ IAPME Hosts Distinguished Lecture by World-Renowned Perovskite Expert

We were honoured to welcome Prof. Tae-Woo Lee from Seoul National University as a Distinguished Visiting Scholar. On 28 July 2025, Prof. Lee delivered a seminal seminar titled "Metal Halide Perovskite for Photonics and Electronics" to a captivated audience of over 30 faculty members, researchers, and students at IAPME. The session was hosted by Prof. Guichuan Xing.

Prof. Lee unveiled cutting-edge strategies to advance perovskite light-emitting diodes (PeLEDs), emphasizing their exceptional color purity and tunability, which are critical for next-generation AR/VR displays and Rec. 2100 standards. He highlighted innovations such as guanidinium doping, bromide-based surface passivation, and core/shell nanocrystals that enhance device efficiency and stability. Revolutionary concepts like hybrid tandem PeLEDs and neuromorphic display systems— integrating perovskite LEDs with organic synaptic transistors to mimic biological neural processing—sparked vibrant discussions.

The seminar further explored ultra-stable perovskite nanocrystals achieving >95% Rec. 2020 color gamut coverage and their potential in quantum technologies, including room-temperature single-photon sources. Attendees engaged in dynamic Q&A sessions, raising insightful questions on scalability and industrial integration. The event underscored IAPME's commitment to fostering global academic exchange. "Prof. Lee's work bridges fundamental science and disruptive applications," noted Prof. Xing. "His insights align perfectly with our mission to pioneer sustainable photonic technologies."

Prof. Lee, a fellow of MRS, SPIE, and the Korean Academy of Science, holds 445 patents and has authored 300+ high-impact papers. His visit further strengthens IAPME's collaboration with Seoul National University in next-generation optoelectronics.



❖ Seminars

Prof. Qijun Yu (余其俊), Professor at South China University of Technology, visited IAPME on July 31, 2025 and gave an insightful presentation titled "Introduction of Broadband and modifiable electromagnetic wave absorbing cement-based materials". The seminar was hosted by Prof. Guoxing Sun, who extended the invitation to Prof. Yu.

Prof. Yu, is currently a PhD supervisor, Distinguished Professor of the Pearl River Scholars Program in Guangdong Province, Outstanding Teacher of Guangdong, and Recipient of the State Council's Special Allowance. He has long been engaged in fundamental and applied research on solid waste comprehensive utilization, composite cement chemistry, low-energy consumption preparation and efficient application of cement, and the environmental impact of the cement industry.

In his presentation, Prof. Yu focused on the enhancement technology of wave-absorbing performance in cement-based materials, particularly elaborating on the mechanisms of cement-based structure design and optimization of wave-absorbing components in improving wave-absorbing performance. These insights provided new approaches for the design and performance enhancement of cement-based wave-absorbing materials.

The seminar provided attendees with a comprehensive understanding of the latest advancements in electromagnetic wave-absorbing cement-based materials. Prof. Yu has led over 40 research projects, including the National "973 Program," "863 Program," National Science and Technology Support Program, National Key R&D Program, National Natural Science Foundation of China, and various provincial and ministerial-level projects.