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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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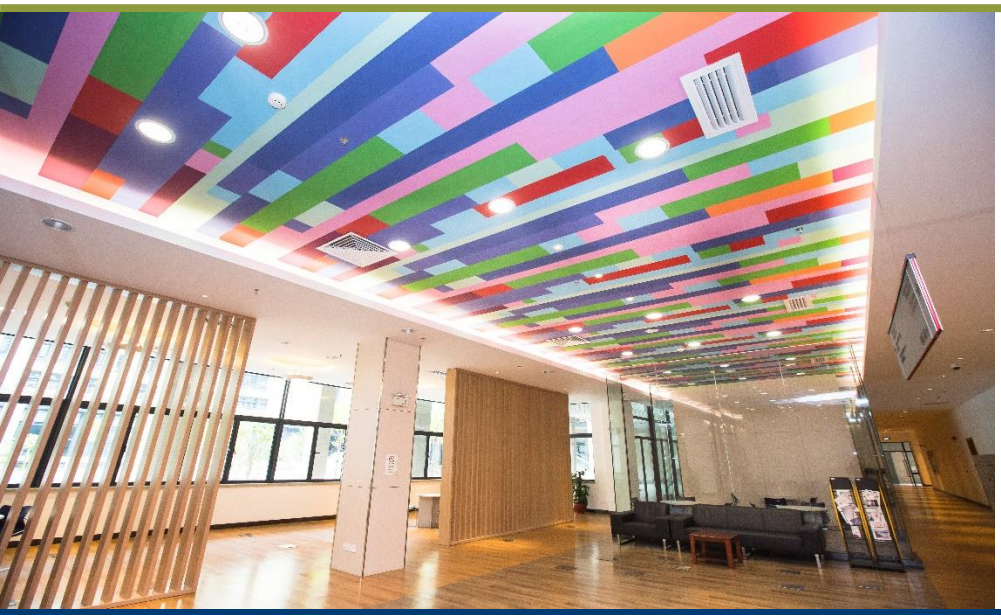

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27 November 2024

✧ Content

❖ Publications (IF≥8; *corresponding author)

1. **Wang Li**, Xiaozhi Bao, Annan Zhu, Hao Gu, Yulin Mao, Bingzhe Wang, Gang Wang, **Jia Guo***, Ying Li*, **Guichuan Xing***. Internal Encapsulation Enables Efficient and Stable Perovskite Solar Cells. *Advanced Functional Materials,* 2414004 (2024). DOI:10.1002/adfm.202414004. [2023 IF=18.5]

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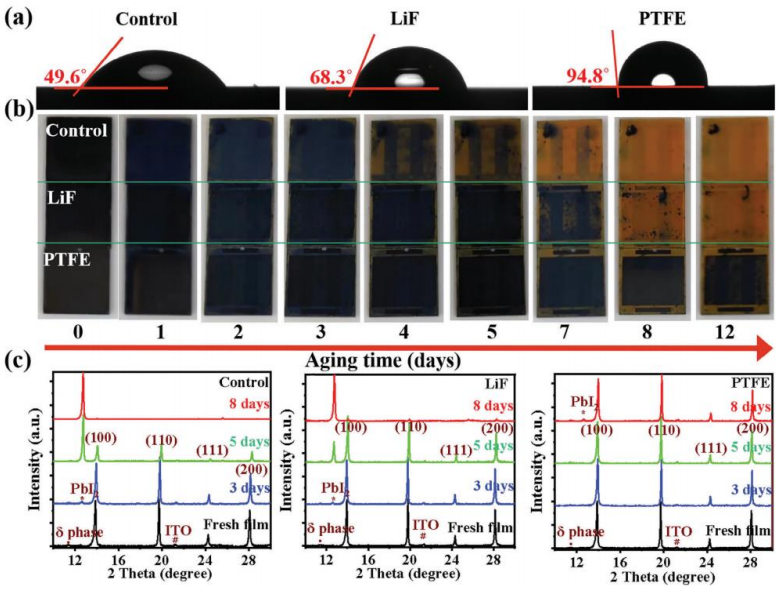
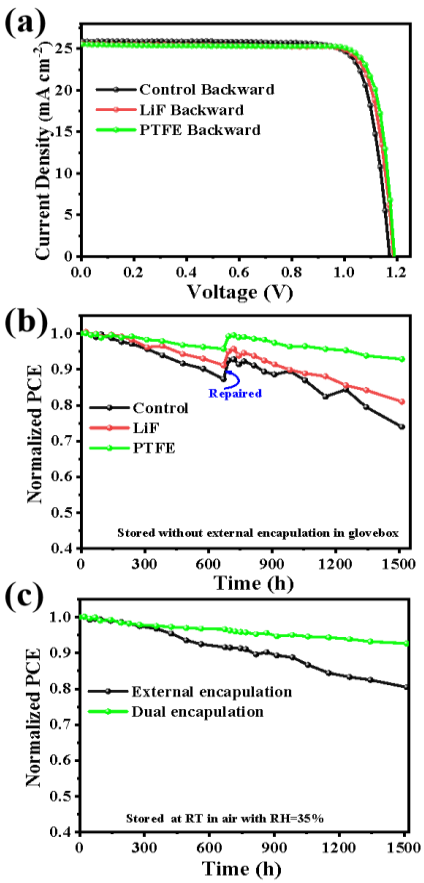
❖ Research Stories

UM research team developed Internal Encapsulation Enables Efficient and Stable PSCs

- Perovskite solar cells (PSCs) have made significant strides in efficiency, buttheir long-term stability remains a challenge. While external encapsulation mitigates extrinsic degradation and lead leakage, it does not fully address performance decline due to ion migration within the perovskite devices.
- The team introduce the PTFE onto the perovskite film via thermal evaporation. The PTFE-based device achieved an impressive champion PCE of 25.49%. More importantly, the internally encapsulated perovskite device effectively prevents ion migration and water erosion, demonstrating excellent long-term stability even without external encapsulation. .
- This study opens a novel solution to simultaneously reduce non-radiative recombination, inhibit water erosion and ionmigration, to facilitate the fabrication of efficient and stable PSCs.

Dr. Wang Li Prof. Guichuan Xing





Wang Li, Xiaozhi Bao, Annan Zhu, Hao Gu, Yulin Mao, Bingzhe Wang, Gang Wang, **Jia Guo***, Ying Li*, **Guichuan Xing***. Internal Encapsulation Enables Efficient and Stable Perovskite Solar Cells. *Advanced Functional Materials,* 2414004 (2024). DOI:10.1002/adfm.202414004. [2023 IF=18.5]

This work was supported by 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, 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).

❖ Ph.D. Student Thesis Oral Defenses

Minghui Li of Prof. Zikang Tang and Prof. Hou Ian's group presented "Entanglement and Macroscopic Light and Its Applications" in his oral defense on November 21, 2024.

Congratulations to Dr. Minghui Li!

(from left) Prof. Hai-Feng Li, Prof. Shuangpeng Wang, Prof. Zikang Tang, Dr. Minghui Li, Prof. Hou Ian, Prof. Zhirui Gong(SZU) and Prof. Handong Sun

❖ Seminars

On November 20, 2024, IAPME had the privilege of hosting an insightful seminar as part of its ongoing seminar series. The event featured Prof. Jiaqing He, a distinguished Chair Professor in the Department of Physics at Southern University of Science and Technology (SUSTech). He delivered an engaging presentation titled "Decouple Electron and Phonon Transport for High-Performance Thermoelectrics."

Prof. Jiaqing He is renowned for his pioneering research in thermoelectric materials and transmission electron microscopy. He has a strong academic background, having completed his Ph.D. through a joint program between Wuhan University and the Jülich Research Centre in Germany. His illustrious career includes significant tenures at Brookhaven National Laboratory and Northwestern University in the United States.

A Fellow of the American Physical Society, Prof. He has published over 300 high-impact SCI journal papers, including 8 in Science and 3 in Nature, amassing nearly 40,000 citations and achieving an H-index of 93. He has applied for 52 domestic and international patents, of which 32 have been granted. These accomplishments underscore his substantial contributions to the field.

During the seminar, Prof. He provided an in-depth exploration of the challenges and advancements in thermoelectric technology. He emphasized the importance of decoupling electron and phonon transport to enhance thermoelectric performance. He highlighted the figure of merit, ZT, as a critical measure of performance and discussed innovative strategies to optimize it by manipulating material properties. Prof. He illustrated these concepts with examples of emerging nanostructured materials, such as PbQ, GeTe, and AgCrSe. These materials demonstrate significant promise in improving thermoelectric efficiency.

The seminar concluded with a lively discussion on the future of thermoelectric materials and their potential applications in addressing global energy challenges. Attendees gained valuable insights into the latest advancements and were inspired by the potential of these technologies to transform energy utilization. Prof. He's presentation not only showcased cutting-edge research but also highlighted the collaborative efforts necessary to push the boundaries of current scientific understanding.

The event was a resounding success, fostering knowledge exchange and sparking new ideas for future research collaborations. Prof. Hai-Feng Li aims to continue his tradition of hosting such informative and impactful seminars, contributing to the advancement of science and technology.

❖ Seminars

Prof. Danfeng Li, the Associate Dean at the City University of Hong Kong, is renowned for his groundbreaking research in condensed-matter physics and materials science. He delivered a presentation titled "Superconductivity in Thin-film Infinite-layer Nickelates" on November 21, 2024.

Prof. Li has an impressive academic background, having received several prestigious awards, including the AAPPS-APCTP Chen-Ning Yang Award in 2023 and the Oxide Electronics Prize for Excellence in Research in 2024. His research interests focus on the atomic-scale fabrication of oxide heterostructures and nanomembranes. Prof. Li's significant contributions to the field are reflected in his inclusion in Stanford's List of World's Top 2% Scientists in 2023 and 2024.

During the seminar, Prof. Li explored the challenges and advancements in the study of superconductivity in infinite-layer nickelates. He discussed the similarities and distinctions between nickelates and cuprates, highlighting their phase diagrams, electronic phases, and superconducting properties. Prof. Li also introduced novel synthetic approaches and examined the role of rare-earth elements in these materials.

The seminar concluded with a lively discussion on the future research of nickelate superconductors, lasting nearly two hours. Attendees gained valuable insights into the latest advancements and were inspired by the potential of these technologies. The event fostered knowledge exchange and sparked new ideas for future research collaborations.

❖ Visits

Prof. Xuchuan Jiang, Dean and Professor of the School of Materials Science and Engineering and Dean of the Institute of Smart Materials and Engineering at the University of Jinan in Shandong, China, and recognized as a National Specialist of China, Double Creative Talent of Jiangsu Province, Double-Thousand Talent of Jiangxi Province, as well as an Australia Research Council (ARC) Future Fellow and ARC Queen Elizabeth II Fellow, the distinguished guest visited IAPME on November 19, 2024.

During the visit, Prof. Jiang presented insights on the industrial applications of advanced nanomaterials for thermal coatings in mobile transportation and agricultural development. Discussions also involved potential collaborations encompassing joint projects, student exchange programs, and co-organized workshops. Prof. Jiang further toured the Energy Storage Conversion Laboratory and Materials Characterization Facilities.

(from left) Prof. Kwun Nam Hui and Prof. Xuchuan Jiang

❖ Upcoming Events

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IAPME Seminar

Giant Optical Nonlinearity of Interlayer Excitons in WSe_2/MoS_2 Moiré Superlattices

3 December 2024

Prof. Qinghai TAN
University of Science and Technology of China
Venue: N23-4018
Time: 14:00 - 15:00
Hosted by: Prof. Shen LAI

Abstract

Semiconductor moiré superlattices, created by stacking monolayer transition metal dichalcogenides, provide an ideal platform for exploring abundant correlated insulating states, the anomalous quantum Hall effect, and giant optical responses. These properties enable them promising for various applications, such as quantum simulator and ultrasmall on-chip laser.

In this talk, I will discuss our recent work on study of optical nonlinearity of interlayer excitons in WSe_2/MoS_2 Moiré superlattices. Through energy- and time-resolved photoluminescence measurements, we observed quantum cascade transition between interlayer excitons. We achieved interlayer exciton population inversion at higher-energy moiré levels. Furthermore, we demonstrated that the coherence of moiré interlayer excitons can be enhanced through boson excitonic correlation and effects of Fermions correlated insulating states. Our findings highlight the potential applications of semiconductors moiré materials in exciton quantum cascade lasers, quantum information protocols.

Biography

Prof. Qinghai TAN is a professor in School of Microelectronics at University of Science and Technology of China. Prof. Tan received his PhD from Institute of Semiconductor, Chinese Academy of Science in 2018. After that, he worked as a research fellow in Weibo Gao's group at Nanyang Technological University, Singapore from 2019-2023 and then a senior Scientist at A*STAR, Singapore. Currently, his research focuses on the novel quantum states in 2D semiconductor moiré systems and advanced optoelectronic devices based on two dimensional semiconductors and semiconductor moiré materials.

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