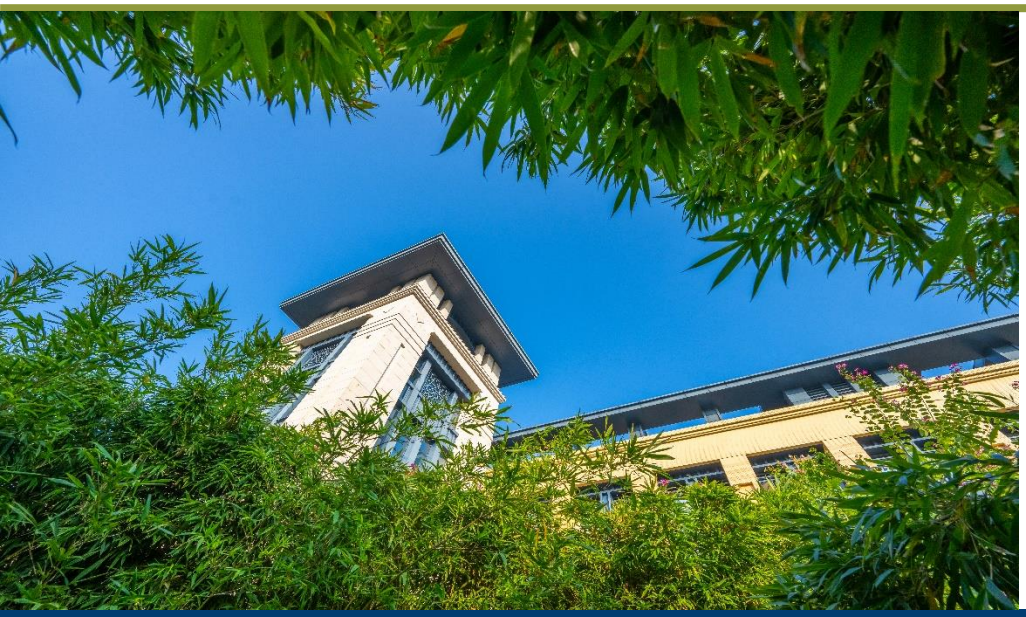
澳門大學
UNIVERSIDADE DE MACAU
UNIVERSITY OF MACAU

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/



ISSUE 15

02 January 2025

✧ Content

❖ Publications (IF≥8; *corresponding author)

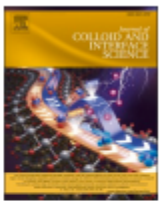
1. **Yingying Shen**, **Yun Zheng**, Jiangmin Jiang, Junpo Guo, Yike Huang, Yinan Liu, Hebin Zhang, Qi Zhang, Jincheng Xu, **Huaiyu Shao***. Li-Si alloy pre-lithiated silicon suboxide anode constructing a stable multiphase lithium silicate layer promoting ion-transfer kinetics. *Journal of Colloid and Interface Science,* 679, 855-867 (2025). DOI: 10.1016/j.jcis.2024.10.038. [2023 IF=9.4]

Journal of Colloid and Interface Science 679 (2025) 855–867

Contents lists available at ScienceDirect

Journal of Colloid And Interface Science

journal homepage: www.elsevier.com/locate/jcis



Regular Article

Li-Si alloy pre-lithiated silicon suboxide anode constructing a stable multiphase lithium silicate layer promoting Ion-transfer kinetics

Yingying Shen [a,1], Yun Zheng [a,1], Jiangmin Jiang [a,b], Junpo Guo [c,d], Yike Huang [a], Yinan Liu [a], Hebin Zhang [a,e], Qi Zhang [a,e], Jincheng Xu [a], Huaiyu Shao [a,*]

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IAPME Newsletter

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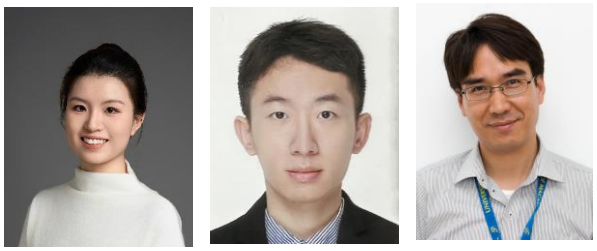
❖ Research Stories

UM research team developed novel SiO_x-based anode materials with high ICE and cycling stability

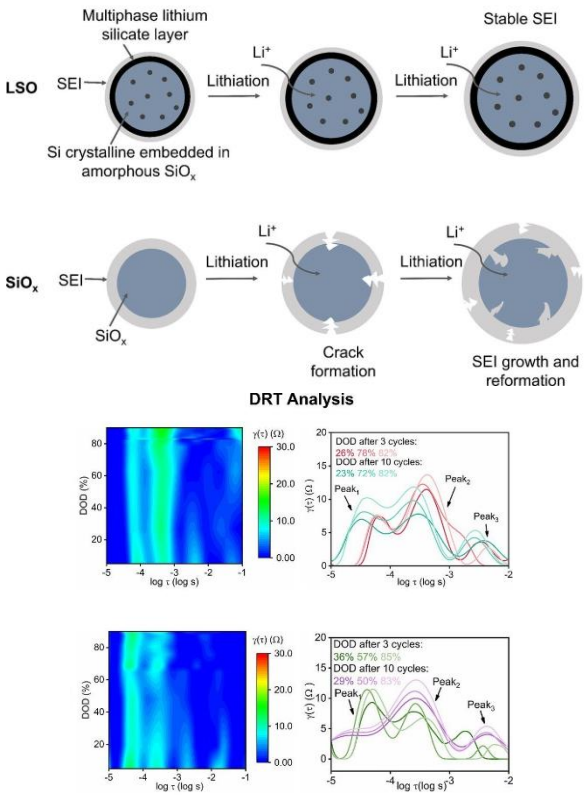
- Enhancing the initial Coulombic efficiency (ICE) and cycling stability of silicon suboxide (SiO_x) anode is crucial for promoting its commercialization and practical implementation.

- The team proposed an economical and effective method for constructing pre-lithiated core–shell SiO_x anodes with high ICE and stable interface during cycling. The lithium silicon alloy ($Li_{13}Si_4$) is used to react with SiO_x in advance, allowing for improved ICE of SiO_x without compromising its reversible specific capacity. The pre-lithiated surface layer contains uniform multiphase lithium silicates (L_2SiO_3, Li_4SiO_4, and $Li_2Si_2O_5$) in the nanoscale. This multiphase lithium silicate layer exhibits mechanical robustness against variation of micro-stress, which can act as a buffer layer to relieve volume variation. The optimal material L10-850 demonstrated an impressive ICE of 85.3 % and a reversible specific capacity of 1511.1 mAh g^{-1}.

- Dynamic electrochemical impedance spectroscopy (dEIS) and distribution of relaxation time (DRT) analysis were performed to investigate the evolution of anode/electrolyte interface and monitor the stability of interface, confirming that multiphase lithium silicate layer coated on d-SiO_x enabled for construction of a stable SEI.



(From left) Ms. Yingying Shen, Dr. Yun Zheng and Prof. Huaiyu Shao



Yingying Shen, **Yun Zheng**, Jiangmin Jiang, Junpo Guo, Yike Huang, Yinan Liu, Hebin Zhang, Qi Zhang, Jincheng Xu, **Huaiyu Shao***. Li-Si alloy pre-lithiated silicon suboxide anode constructing a stable multiphase lithium silicate layer promoting ion-transfer kinetics. *Journal of Colloid and Interface Science,* 679, 855-867 (2025). DOI: 10.1016/j.jcis.2024.10.038. [2023 IF=9.4]

Prof. Huaiyu Shao is the corresponding author of this study. The first authors are Ms. Yingying Shen and Dr. Yun Zheng, they are Ph.D student and postdoctoral researcher in IAPME respectively. This work was supported by the Macau Science and Technology Development Fund (FDCT) for funding (FDCT-MOST joint project No. 0026/2022/AMJ and No. 006/2022/ALC of the Macao Centre for Research and Development in Advanced Materials (2022-2024)), the Multi-Year Research Grant (MYRG) from University of Macau (project No. MYRG-GRG2023-00140-IAPME-UMDF), Natural Science Foundation of Guangdong Province. (Grant No. 2023A1515010765), the Shenzhen-Hong Kong-Macau Science and Technology Plan Project (Category C) (Grant No. SGDX20220530111004028), Science and Technology Program of Guangdong Province of China (Grant No. 2023A0505030001).

❖ IAPME Research Teams Won the 2024 Science and Technology Awards

Recently, the Science and Technology Development Fund (FDCT) announced the list of winners for the 2024 Science and Technology Awards. Our PIs and research team won the Natural Science Award and the Technological Invention Award, respectively.

For more information, please visit:
https://www.fdct.gov.mo/en/fund_information_detail/article/m3o51po5.html


Prof. Wei Ge


Prof. Guoxing Sun


Prof. Yongqing Cai


Mr. Hejin Yan


Dr. Hongfei Chen

科學技術發展基金
F | D | C | T

(1)Natural Science Award

Grade of Award	Project No.	Project Name	Principal Persons to Complete the Project	Principal Institutions to Complete the Project
Third Prize	019/2024/AN	Theoretical Study on Interface and Lattice Distortion of Organic-Inorganic Perovskite	**Cai Yong Qing, Yan He Jin, Chen Hong Fei**	University of Macau

(2)Technological Invention Award

Grade of Award	Project No.	Project Name	Principal Persons to Complete the Project	Principal Institutions to Complete the Project
First Prize	007/2024/AI	Preparation of High-Performance Hydrogels from Cement-based Sustained-Release Nanoparticles	**Sun Guo Xing**, Liang Rui, Li Zong Jin	University of Macau
Third Prize	006/2024/AI	Key Technologies and Applications of Flexible Precision-Manipulation Robot Design	Xu Qing Song, **Ge Wei**	University of Macau

❖ IAPME Postgraduates Won the 2024 Scientific and Technological R&D Award

Recently, the Science and Technology Development Fund (FDCT) announced the list of winners for the 2024 Scientific and Technological R&D Award for Postgraduates. Two IAPME members, Mr. Tesen Zhang, an IAPME postgraduate student and Dr. Ziyi Dai, an IAPME graduate, won the 2024 Scientific and Technological R&D Award.

For more information, please visit:
https://www.fdct.gov.mo/en/fund_information_detail/article/m2itb3kz.html

Mr. Tesen Zhang

Dr. Ziyi Dai

科學技術發展基金
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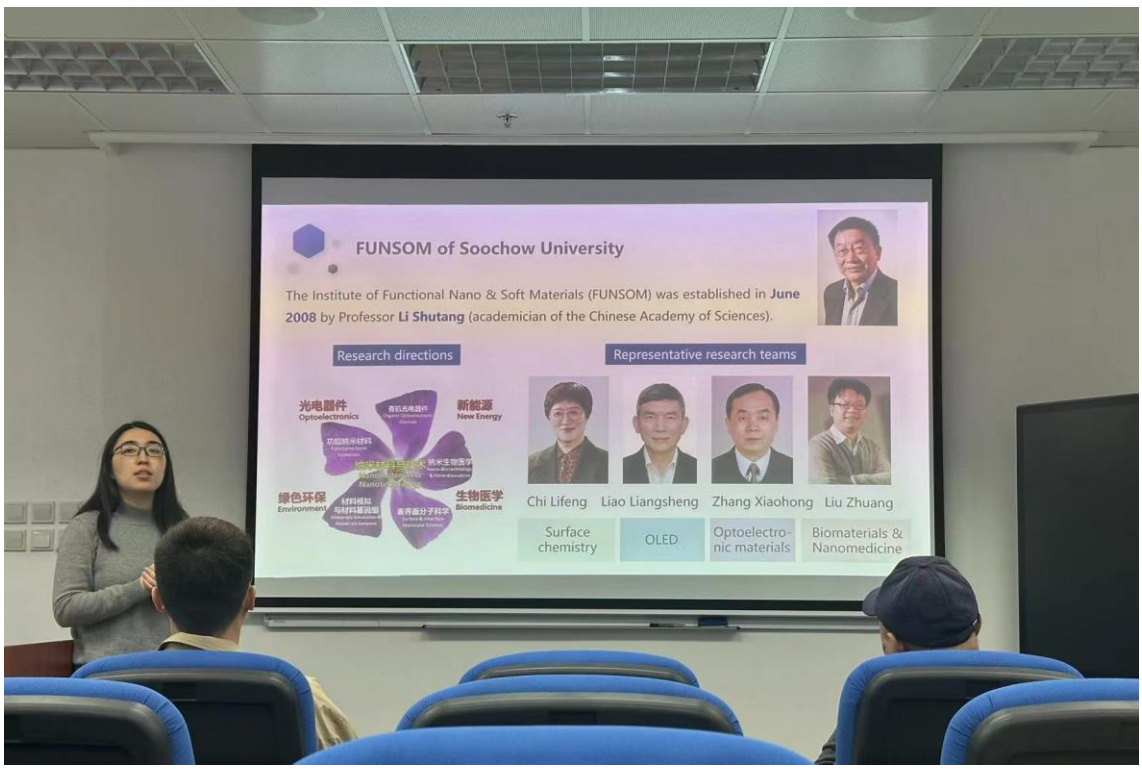
No.	Category	Name	Higher Education Institution
13	Doctoral	**Zhang Te Sen**	University of Macau
18	Doctoral	**Dai Zi Yi**	University of Macau

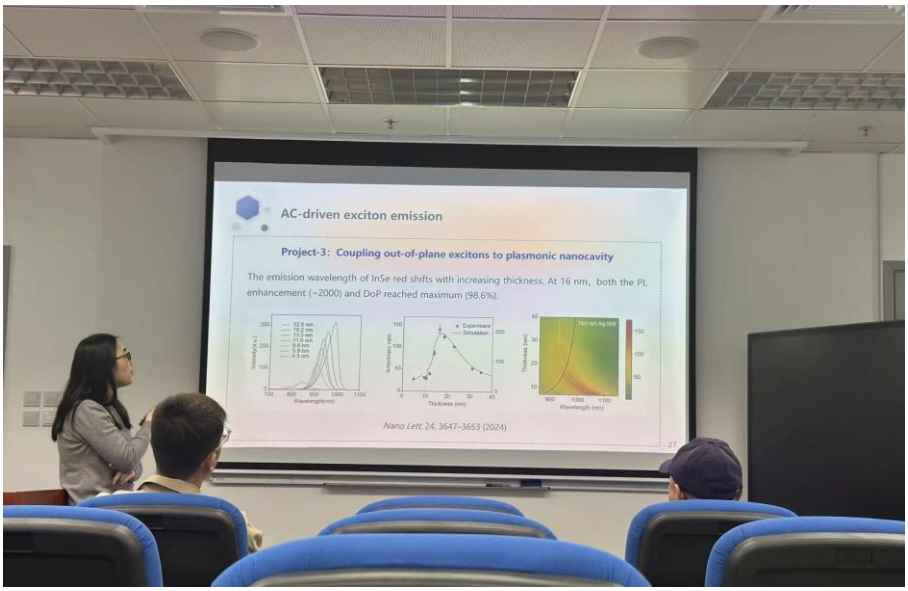
❖ Seminars

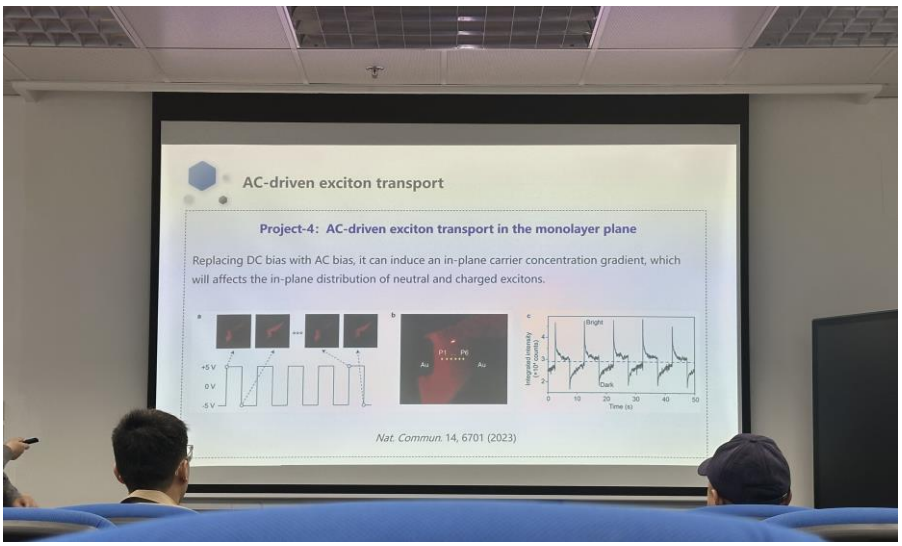
Prof. Wei Du, Full Professor of the Institute of Functional Nano & Soft Materials of Soochow University, delivered an engaging talk on the "AC-driven excitonic devices based on two-dimensional semiconductors" on 11 December 2024. Prof. Du shared her extensive research on Exploring the interactions of electrons, excitons and photons in two-dimensional semiconductors under the alternating current(AC) electric field will provide new information for the design of high-frequency excitonic devices.

With a prolific publication record, Prof. Du has authored 19 peer-reviewed journal papers, So far, she has published 19 papers as the first or corresponding author, including Nature Photonics (2), Nature Communications (1), Journal of the American Chemical Society (1), Nano Letters (3), Advanced Vaterials (1), Small (2) etc., and has been granted 5 patents. In May 2021, she joined the Institute of Functional Nano and Soft Materials of Soochow University, and won the National Overseas High-level Talent Youth Program in the same year.



In her presentation, Prof. Du provided a comprehensive overview of AC-driven exciton emission and AC-driven exciton transport. She delineated the specific advantages of the study, which include: 1. Open structure, easy to couple with optical microcavity or plasmonic nanocavity. 2. Potential applications in electrically pumped excition polaritions orpolariton lasers. Recent research highlights also include, using ultrafast pump-probe techniques, characterizing the transient dynamic behavior of exciton-plasmon coupling in two-dimensional semiconductor materials, which provides the possibility of ultrafast modulation of surface plasmon signals.





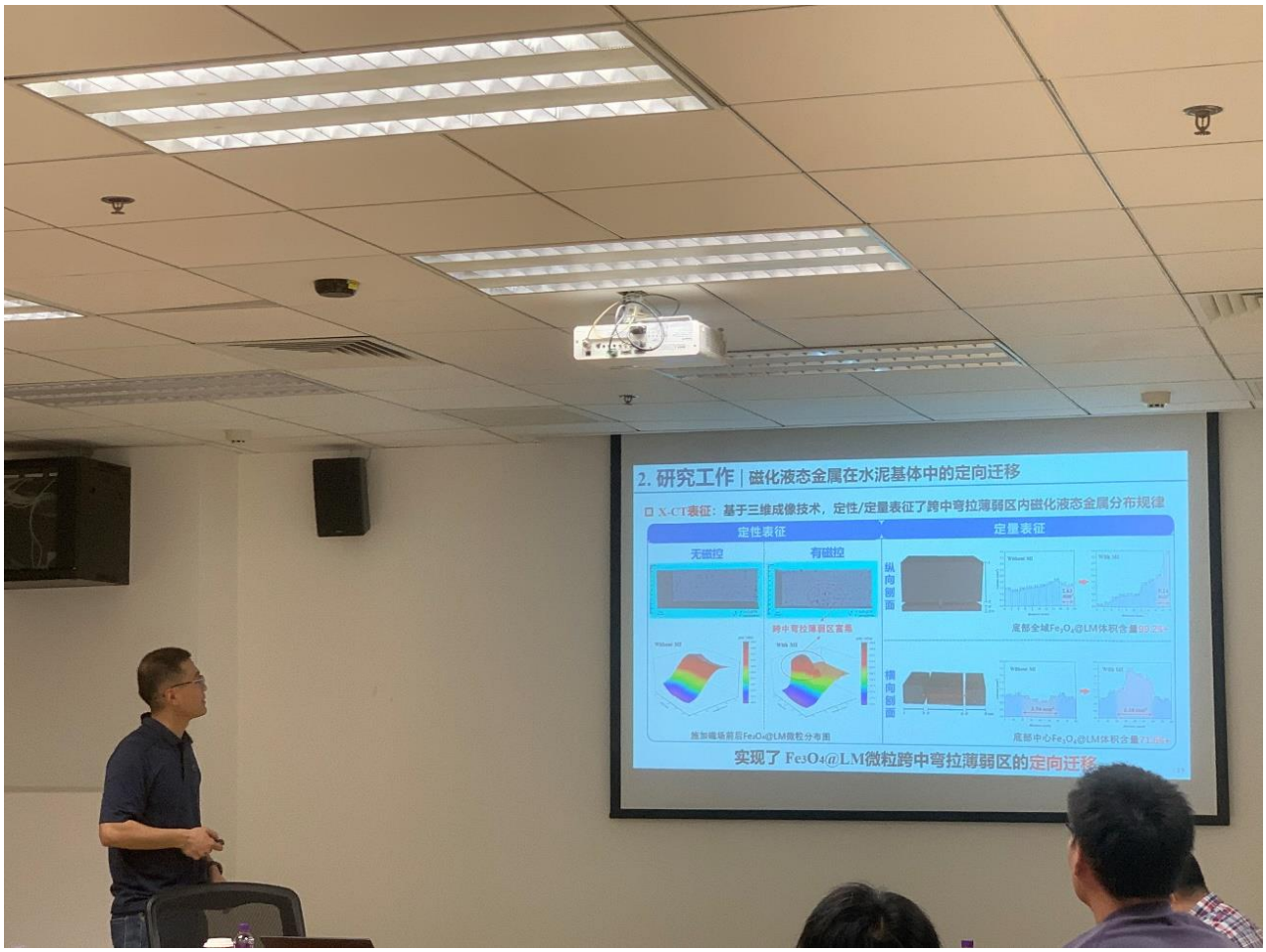
❖ Seminars

Prof. Zeyu Lu, visited IAPME on December 11, 2024. During his visit, he delivered an insightful presentation titled “Design Theory and Performance Enhancement Mechanisms of Low-Carbon Cement-Based Materials.” The seminar was hosted by Prof. Guoxing Sun who extended the invitation to Prof. Zeyu Lu.

Prof. Zeyu Lu, currently a Youth Chief Professor at Southeast University, PhD supervisor, a "Youth Thousand Talents" recipient from the Organization Department of the CPC Central Committee, and a "Dual-Innovation Talent" in Jiangsu Province, has long been engaged in fundamental and applied research on the microstructure regulation and low-carbon design of high-performance cement-based materials. Prof. Lu earned his PhD from the Hong Kong University of Science and Technology in 2016.

In his speech, focused on the precise regulation methods of cement-based material microstructures, with an emphasis on the enhancement mechanisms of organic hydrogels, inorganic titanium dioxide, and liquid metals on the hydration process, pore structure, and mechanical properties of cement. These insights provided new approaches for the development of low-carbon, high-performance cement-based composites.

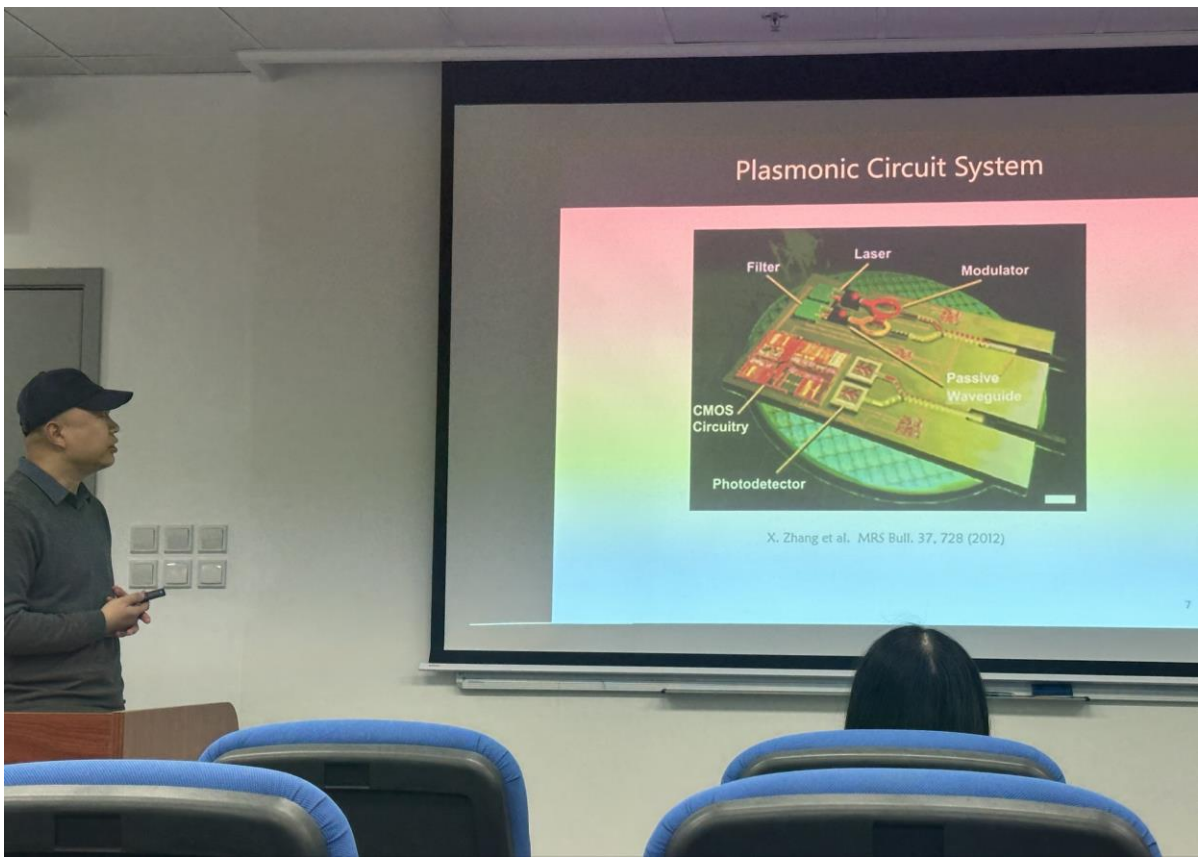
The seminar provided attendees with a comprehensive understanding of the latest advancements in Low-carbon cement-based materials. Prof. Lu has led seven research projects, including the National Natural Science Foundation of China (NSFC) Youth Fund, NSFC General Program, sub-projects of the National Key R&D Program, and the Key Basic Research 173 Project under the Fundamental Strengthening Plan.



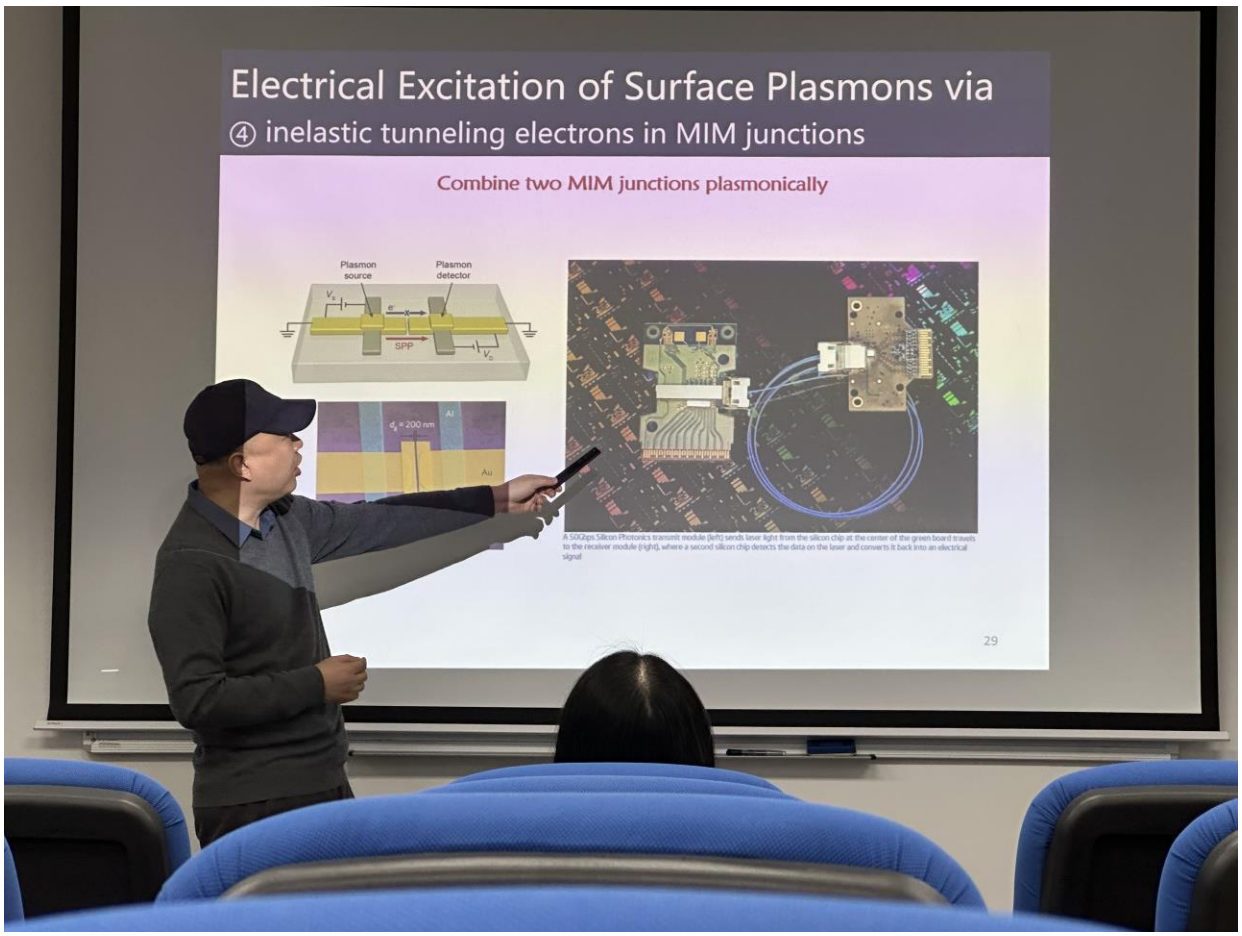
❖ Seminars

Prof. Tao Wang, Full Professor of the Institute of Functional Nano & Soft Materials of Soochow University, delivered an engaging talk on the "Electrically-driven nano-light sources based on tunnel junctions" on 11 December 2024. Prof. Wang shared his extensive research on Utilizing plasma circuits, with the ability to guide photons in sub-difiractional dimensions, as an alternative to photonic circuits, especially at the micro- or nano-scale.

With a prolific publication record, Prof. Wang has authored peer-reviewed journal papers, So far, he has published 40 papers as the first or corresponding author, including Nature Photonics (2), Nature Communications (1),Nao Letters (4),Advanced Materials (1), Advanced Science(l), Small (3)etc., and has been granted 5 patents. In May 2019, he joined the Instinute of Functional Nano and Soft Materials of Soochow University.



In his presentation, Prof. Wang provided a comprehensive overview of the basic physical properties of plasmon on electrically excited surfaces of tunneling junctions (scanning tunneling microscope tunneling junctions, metal-oxide-metal tunneling junctions, monolayer tunneling junctions). These results show the potential of tunnel junction as a miniaturized light source with low energy consumption, which can be integrated with controllable electric drive, and provide light source conditions for the further development of miniaturized integration of nano optical chips.



❖ Upcoming Events

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IAPME Seminar

Current research trends for target-oriented WGS reactions dealing with diverse types of resources

9 January 2025

Prof. Hyun-Seog ROH
Yonsei University
Venue: N23-4018
Time: 15:30 – 16:30
Hosted by: Prof. Hui PAN

Abstract

Extensive studies are being carried out for new and renewable energies. Hydrogen is receiving special attention, and research on upcycling energy resources, including natural gas, coal, waste, and biomass, is in the spotlight. Catalytic reactions are often essential for producing high-value chemicals from these resources. The water–gas shift (WGS, $CO + H_2O \rightarrow CO_2 + H_2$) reaction is one of the most useful catalytic pathways for upcycling various types of synthesis gas. Currently, the application range of WGS reactions has further expanded to the upcycling of waste, biomass, and coal-derived synthesis gas. However, the reaction conditions and catalysts should be carefully customized for each resource by considering their characteristics. In this study, we have focused on the reaction conditions and catalysts for the WGS reactions that have dealt with various types of feed gases over the last 10 years to understand the development progress. Based on the categorization (by the type of feed gas), we carefully compare the tested catalysts, capacity, temperature, feed gas composition, steam-to-carbon ratio, and catalyst performance. We provide insight into the current research trends and perspectives for target-oriented WGS reactions in each type of feed gas source, which can give clues for customization.

Biography

Professor Hyun-Seog Roh received his Ph.D. in Chemical Engineering from Yonsei University in Seoul, South Korea, in 2001. Currently, he is a Director of the BK 21 FOUR project and a Full Professor of the Department of Environmental and Energy Engineering at Yonsei University in Wonju, South Korea. He began his career at Yonsei University in 2008, after a research career at the Korea Research Institute of Chemical Technology, Pacific Northwest National Lab. in Richland, and the Korea Institute of Energy Research. Professor Roh serves on the editorial boards of Journal of CO2 Utilization, Catalysts, and Applied Sciences. His achievements include the publication of more than 237 papers in scientific literature and 29 patents. For the fourth consecutive year, he has been named in the world's top 2 percent of scientists list selected by Professor John Ioannidis from Stanford University published in PLOS Biology. His research interests are primarily in environmental catalysis, including catalyst design, manufacture, characterization, and application, as well as reactor design for hydrogen production through reforming and the water-gas shift reaction.

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