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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

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

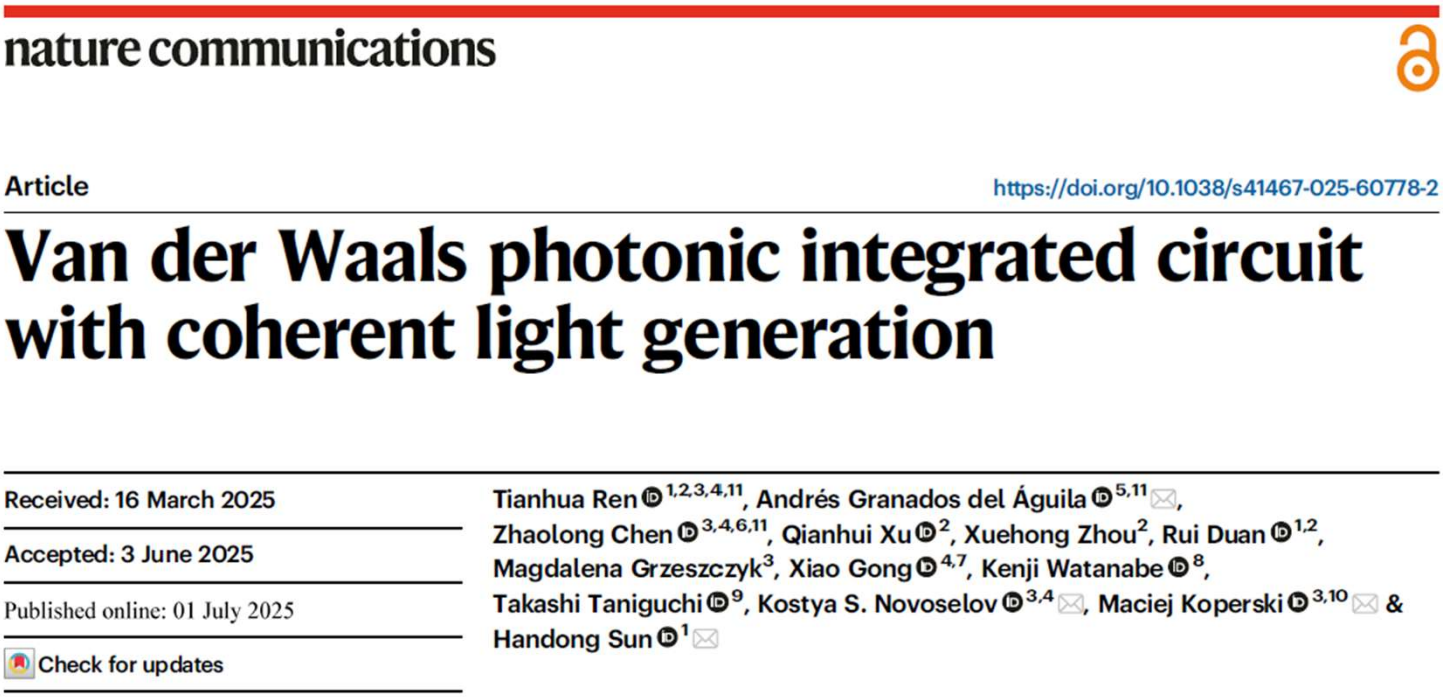
ISSUE 45

30 July 2025

✧ Content

❖ Publications (IF≥8, and Nature Index; *corresponding author)

1. **Tianhua Ren**, Andrés Granados del Águila*, Zhaolong Chen, Qianhui Xu, Xuehong Zhou, Rui Duan, Magdalena Grzeszczyk, Xiao Gong, Kenji Watanabe, Takashi Taniguchi, Kostya S. Novoselov*, Maciej Koperski*, and **Handong Sun***. Van der Waals photonic integrated circuit with coherent light generation. ***Nature Communications***, 16, 5931 (2025). DOI: 10.1038/s41467-025-60778-2. [2024 IF = 15.7]



nature communications

Article

https://doi.org/10.1038/s41467-025-60778-2

Van der Waals photonic integrated circuit with coherent light generation

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Check for updates

Tianhua Ren[1,2,3,4,11], Andrés Granados del Águila[5,11] ✉, Zhaolong Chen[3,4,6,11], Qianhui Xu[2], Xuehong Zhou[2], Rui Duan[1,2], Magdalena Grzeszczyk[3], Xiao Gong[4,7], Kenji Watanabe[8], Takashi Taniguchi[9], Kostya S. Novoselov[3,4] ✉, Maciej Koperski[3,10] ✉ & Handong Sun[1] ✉

2. **Zhenjian Li,** Xue Wu, Lingyun Li, Bingzhe Wang, Guichuan Xing, **Yupeng Liu*, Songnan Qu***. Red and near-infrared emissive nitrogen-sulfur co-doped carbonized nanoparticles for red laser-induced synergistic photothermal and photodynamic tumor therapy. ***Chinese Chemical Letters***, 111501 (2025). DOI: 10.1016/j.cclet.2025.111501. **[2024 IF=8.9]**

Journal Pre-proof

Red and near-infrared emissive nitrogen-sulfur co-doped carbonized nanoparticles for red laser-induced synergistic photothermal and photodynamic tumor therapy

Zhenjian Li , Xue Wu , Lingyun Li , Bingzhe Wang , Guichuan Xing , Yupeng Liu , Songnan Qu

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❖ Research Stories

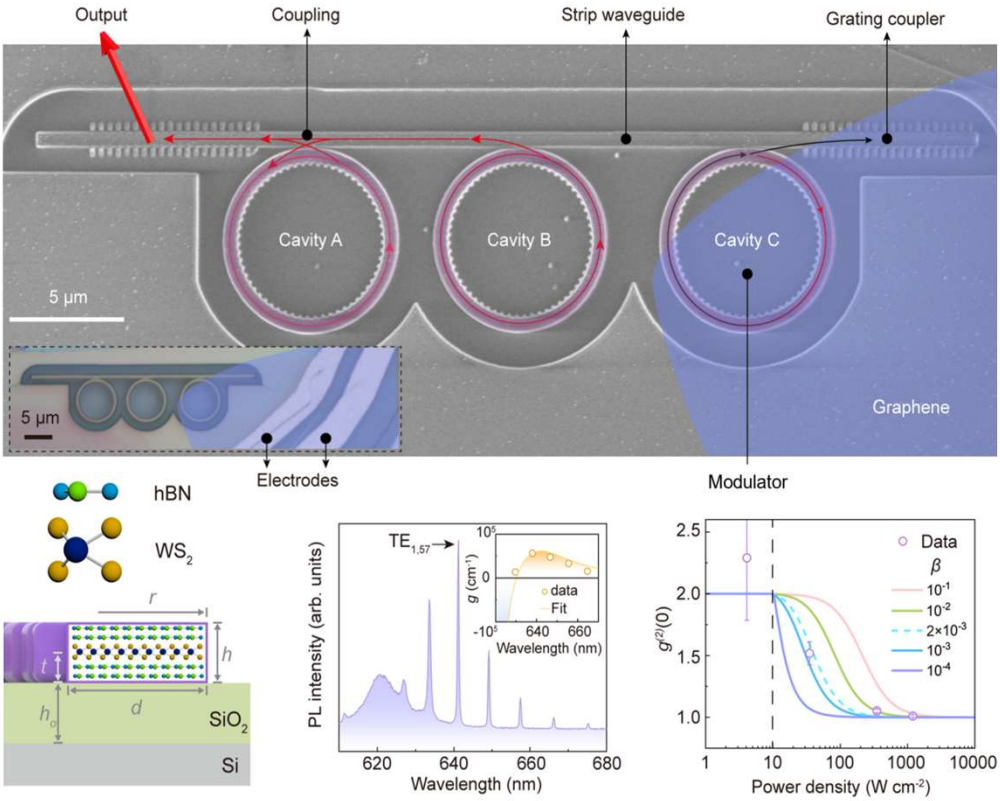
The UM research team demonstrated the first van der Waals photonic integrated circuit, a fully functional on-chip photonic system constructed entirely from a van der Waals heterostructure.

- This photonic chip employs a new architecture that leverages and combines the optoelectronic properties of different 2D materials reassembled into designer heterostructures, built layer by layer in a precisely chosen sequence, thereby enabling the integration of multiple coherent light sources, waveguides, grating couplers, and an electro-optic modulator on a single silicon chip.

Dr. Tianhua Ren
(任天華)

Prof. Handong Sun
(孫漢東)

- The monolithic photonic integrated circuit achieves room-temperature coherent light generation at an ultralow threshold (~10 W/cm^2) with the benchtop coherence.
- This new chip architecture provides the first definitive solution enabling stable, scalable, and monolithic integration of 2D materials into practical silicon photonic circuitry capable of coherent light generation, opening avenues for next-generation optical computing and quantum photonics.



Tianhua Ren, Andrés Granados del Águila*, Zhaolong Chen, Qianhui Xu, Xuehong Zhou, Rui Duan, Magdalena Grzeszczyk, Xiao Gong, Kenji Watanabe, Takashi Taniguchi, Kostya S. Novoselov*, Maciej Koperski*, and **Handong Sun***. Van der Waals photonic integrated circuit with coherent light generation. ***Nature Communications***, 16, 5931 (2025). DOI: 10.1038/s41467-025-60778-2. **[2024 IF = 15.7]**

The first author is Dr. Tianhua Ren, Research Assistant Professor in IAPME, UM. Co-first authors are Prof. Andrés Granados del Águila from University of Valencia, Spain, and Prof. Zhaolong Chen from Peking University Shenzhen Graduate School. Prof. Handong Sun of IAPME is the corresponding author of this study. Other corresponding authors include Prof. Andrés Granados del Águila from University of Valencia, Spain, Professors Kostya S. Novoselov (Nobel Laureate) and Maciej Koperski from National University of Singapore. This work was supported by the University of Macau (CPG2025- 00034-IAPME and SRG2023-00025), and the Science and Technology Development Fund (FDCT), Macao SAR (0122/2023/RIA2).

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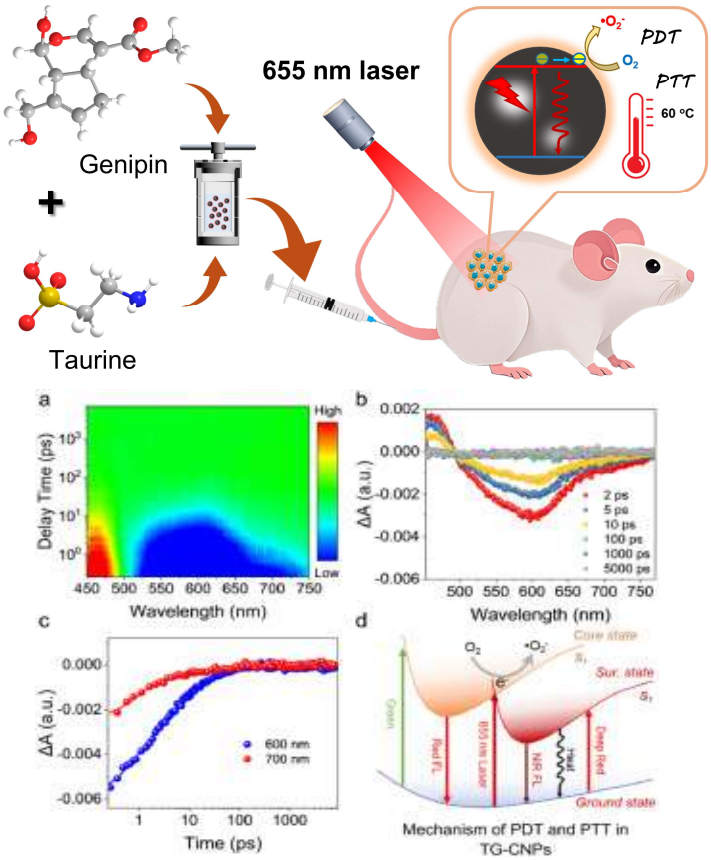
UM research team developed nitrogen-sulfur co-doped carbonized nanoparticles for synergistic photothermal and photodynamic therapy

- In this study, a novel type of nitrogen-sulfur co-doped carbon nanoparticles (TG-CNPs) was synthesized from taurine and genipin using a solvothermal method in dimethylformamide.

- The TG-CNPs demonstrated red and near-infrared absorption/emission in aqueous solution. Upon 655-nm laser irradiation, TG-CNPs exhibited strong photothermal performance with a photothermal conversion efficiency of 30% along with the efficient generation of superoxide radicals ($\bullet O_2^-$).

- Notably, following a single round of 655-nm laser treatment, the tumors in the mice were completely eradicated, with no evidence of recurrence observed over the subsequent five months.

Mr. Zhenjian Li (黎鎮堅) Dr. Yupeng Liu (劉鈺鵬) Prof. Songnan Qu (曲松楠)



Zhenjian Li, Xue Wu, Lingyun Li, Bingzhe Wang, Guichuan Xing, **Yupeng Liu*, Songnan Qu***. Red and near-infrared emissive nitrogen-sulfur co-doped carbonized nanoparticles for red laser-induced synergistic photothermal and photodynamic tumor therapy. ***Chinese Chemical Letters***, 111501 (2025). DOI: 10.1016/j.cclet.2025.111501. **[2024 IF=8.9]**

This work was financially supported by the Science and Technology Development Fund of Macau SAR (Nos. 0139/2022/A3, 0002/2024/TFP, 0007/2021/AKP, 0005/2024/AKP) and the University of Macau – Dr. Stanley Ho Medical Development Foundation "Set Sail for New Horizons, Create the Future" Grant 2025 (No. SHMDF-OIRFS/2025/001) and the National Natural Science Foundation of China (No. 62205384).

❖ Ph.D. Student Thesis Oral Defenses

Tianshu Lu of Prof. Haifeng Li and Prof. Defang Ouyang's group presented "Integration of High-throughput Screening and Machine Learning for Developing Binary and Ternary Solid Dispersions" in her oral defense on July 09, 2025.

Congratulations to Dr. Tianshu Lu!

(from left) Prof. Bingpu Zhou (周冰朴), Prof. Yinning Zhou (周胤寧), Prof. Haifeng Li (李海峰), Dr. Tianshu Lu (盧天舒), Prof. Defang Ouyang (歐陽德方, ICMS), Prof. Guichuan Xing (邢貴川) and Prof. Shirui Mao (毛世瑞, SPU)

Zirui Zhao of Prof. Haifeng Li's group presented "Research On Battery Cathode Material Components Based On Deep Learning Technology" in his oral defense on July 10, 2025.

Congratulations to Dr. Zirui Zhao!

(from left) Prof. Binmeng Chen (陳斌猛), Prof. Hongchao Liu (劉宏超), Prof. Handong Sun (孫漢東), Dr. Zirui Zhao (趙梓睿), Prof. Haifeng Li (李海峰) and Prof. Miao Liu (劉淼, CAS)

❖ IAPME Professor Participated in National Conditions Study Program for Young and Middle-aged key Faculty Members of Macao Universities

From June 30 to July 4 in 2025, Prof. Songnan Qu participated in the National Conditions Study Program for Young and Middle-aged key Faculty Members of Macao Universities, hosted by Renmin University of China, and served as the class monitor. The national Conditions Study Program featured expert lectures on Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era, regional economic development and the Guangdong-Hong Kong-Macao Greater Bay Area initiative, China's economic and diplomatic landscape amid Sino-US rivalry, China's anti-Japanese resistance through an international lens, and the new mission of building a strong education nation. Participants also visited the Renmin University History Museum, the Anti-Japanese War Memorial Museum, and the CPC History Exhibition Hall.

❖ IAPME organized 2025 Summer Camp for Outstanding Mainland Students

From July 9 to 12, we successfully organized the 2025 Summer Camp for Outstanding Mainland Students. The event aimed to provide a platform for top students from mainland China to engage in exchanges and gain an in-depth understanding of the academic environment and research capabilities of IAPME.

Following the announcement of the application notice in March, we quickly received an enthusiastic response from students at numerous mainland universities. After a rigorous and fair selection process by the Institute, 28 outstanding students from prestigious institutions including Jilin University, Sun Yat-sen University, Tongji University, Wuhan University, South China University of Technology, Northwestern Polytechnical University, Nanjing Normal University, and University of Electronic Science and Technology of China, etc. were ultimately chosen to participate.

The summer camp featured a rich and practical schedule. In addition to campus and laboratory tours, city exploration activities and cultural experiences in Macao were arranged, IAPME professors organized a series of cutting-edge academic lectures and hands-on research courses, allowing participants to deeply engage with and directly experience the core research content and scientific value of our Institute. Furthermore, we specifically arranged face-to-face sessions between participating students and potential supervisors, facilitating students' thorough understanding of the various professors' research directions.

The summer camp participants praised UM's beautiful campus environment and were deeply impressed by IAPME's advanced research facilities and continuous stream of innovative achievements—a testament to the institute's rapid development since its establishment in 2016. Several students even expressed a strong desire to pursue doctoral studies at IAPME in the future.

The successful hosting of this summer camp effectively promoted academic exchanges between students from Macao and mainland universities. It injected new momentum into attracting outstanding research talent, advancing technological innovation, and fostering the diversified development of education in Macao. Furthermore, it strengthened the connections between universities in Macao and those in the mainland.

❖ Upcoming Events

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IAPME Seminar

Introduction of Broadband and modifiable electromagnetic wave absorbing cement-based materials

31 July 2025

Prof. Qijun YU
South China University of Technology
Venue: N23-1004b
Time: 10:30 - 11:30
Hosted by: Prof. Guoxing SUN

Abstract

With the advancement of radar detection technologies, the protection and concealment of engineering structures have become increasingly challenging. Based on the principle of radar detection, it is imperative to conduct research on new cement-based electromagnetic wave-absorbing materials (EWAM) and their environmental compatibility. Currently, existing cement-based composites suffer from issues such as narrow absorption bandwidth, lack of dynamic regulation of wave-absorbing performance, and poor environmental compatibility. In this study, a design method for EWAM based on structural design and component optimization is proposed, and wedge-shaped EWAM with strong absorbing performance are successfully prepared, with effective bandwidths of 15.2 GHz (< -10 dB) and 12.9 GHz (< -20 dB), and an average reflectivity of -27.1 dB. By fabricating magnetofluid tubes and magnetofluid capsules, dynamically modifiable EWAM with flat structures, laminated structures, porous structures, and wedge structures are developed. Dynamic regulation of the minimum reflectivity, average reflectivity, and effective absorption bandwidths have been achieved. In addition, an evaluation method for the compatibility between EWAM and environmental wave-absorbing performance is proposed, and EWAM matching desert and grassland environments are successfully prepared. The development of EWAM with broadband and modifiable wave-absorbing properties is of great significance for mitigating electromagnetic radiation pollution, enhancing the protective capacity of buildings, and safeguarding national and people's lives and property.

Biography

Prof. Qijun YU, obtained his Ph.D. in Engineering, currently a Professor at South China University of Technology, Doctoral 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. Prof. Yu has 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 for a long time. He has published over 300 papers in authoritative journals in the fields of cement, concrete, and solid waste resource utilization, such as Cement and Concrete Research, Cement and Concrete Composites. He has also been granted 58 authorized or published invention patents.

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IAPME Seminar

Design Strategies for In Situ Polymerized Gel Composite Electrolytes

4 August 2025

Prof. Hong GUO
Yunnan University
Venue: N23-4018
Time: 15:00 - 15:45
Hosted by: Prof. Huaiyu SHAO

Abstract

Solid-state batteries (SSBs) are promising next-generation energy storage solutions due to their high safety and energy density. Gel polymer electrolytes (GPEs), particularly 1,3-dioxolane (DOL)-based systems, offer advantages like mechanical flexibility, high ionic conductivity, and lithium dendrite suppression, but face challenges including limited mechanical strength and interfacial instability. To address these, Prof. Hong GUO's team developed enhanced DOL-based GPEs through multidimensional optimization. First, an in-situ polymerized PDOL-based gel electrolyte with interfacial inducer formed a stable CEI/SEI bilayer, enabling Li||Li symmetric cells to cycle stably for 2,500 hours and NCM811 full cells to retain 88.6% capacity after 300 cycles at 1C. Subsequently, titanium-based MOFs were incorporated as functional scaffolds, improving mechanical strength and Li^+ transport (ionic conductivity: 1.36×10^{-3} S cm^{-1}; Li^+ transference number: 0.71), with excellent performance in LFP/NCM90 cells. Further improvement came from integrating Co-Ti bimetallic MOFs via combined in-situ polymerization and solution casting. The resulting redox potential gradient facilitated charge transfer and activated inactive lithium, achieving 97% lithium utilization in Li||Cu cells. NCM90 and LFP full cells delivered high initial capacities (198.8 mAh g^{-1} at 1C; 139.5 mAh g^{-1} at 2C/50°C). In-situ characterization and simulations confirmed the MOF structure suppresses inactive Li^0 formation and enhances Li^+ transport kinetics, providing a feasible design pathway and theoretical foundation for high-energy-density SSBs.

Biography

Prof. Hong GUO received his Ph.D. degree at the School of Materials Science and Engineering at the University of Science and Technology Beijing in 2008, and obtained the nomination of national outstanding doctorate dissertation. He was a visiting scholar in State Key Laboratory of Fire Science in Japan from 2002/10 to 2004/9. Prof. Guo has been appointed as a Professor in School of Chemistry Science and Engineering at Yunnan University by Talents Introduce Project in 2010. He was a visting scholar at Western University in Canada from 2016/9 to 2017/10. Prof. Guo serves as Fellow of the Vebleo, a member of a council of the Chinese society of silicate solid ion branch, a member of the electrochemical society (ISE), a member of a council of the International Academy of Electrochemical Energy Science (IAOEES), and obtained the Science and Technology Award in Yunnan province.

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IAPME Seminar

Electrocatalysis on Structure Ordered Intermetallics

4 August 2025

Prof. Deli WANG
Huazhong University of Science & Technology
Venue: N23-4018
Time: 16:00 - 16:45
Hosted by: Prof. Huaiyu SHAO

Abstract

The performance of fuel cells is largely affected by the property of catalysts. However, the commonly used electrocatalysts in fuel cells are still platinum (Pt) based materials. Due to the shortage of Pt and its high price, the high cost of fuel cells greatly limits their large-scale commercial application. Therefore, it is necessary and meaningful to carry out in-depth research on the catalysts. There are two ways to solve this problem: one is to improve the utilization rate of platinum based catalysts; the other is to develop non-platinum based catalysts. In terms of improving the utilization rate of Pt, our group mainly aims to build a novel series of Pt based ordered intermetallic compounds. Changing the types, proportions and post-treatment temperatures of Pt and transition metal atoms is applied to optimize the surface structure, alloy degree and electronic structure of Pt based catalyst, resulting in regulating their electrocatalytic performance. On the other hand, the morphology regulation of ordered intermetallic compounds has always been a major challenge in this field. We have made preliminary attempts in morphology regulation.

Biography

Prof. Deli WANG is currently a Professor of Huazhong University of Science & Technology (HUST). She received her Ph.D. from Wuhan University in 2008. She joined Nanyang Technological University and Cornell University as a Postdoctor from 2009 to 2012. She was elected as Overseas High-Level Talents Program of Organization Department of the CPC Central Committee, MOE New Century Excellent Talent, Chemistry and Chemical Engineering Youth Innovation Award of Hubei Province. Her research interests mainly focused on the structure design and electrochemical performance tuning of nanomaterials applied for energy conversion and storage. She has published more than 100 peer-reviewed papers in well-known academic journals, including *Nat. Mater., Nat. commun., JACS, Angew, AM* and other internationally journals in the fields of chemistry, materials and electrochemistry. She has owned 12 Chinese invention patents, and 2 US invention patents. She is the associate editor of Journal of Chemical Physics and editorial board member of journals including *Chinese Chemical Letter*、*Nano Materials Science*、*Energy&Fuels*、*J. Phys Energy*、*Energy Storage Science and Technology*.

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