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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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ISSUE 46

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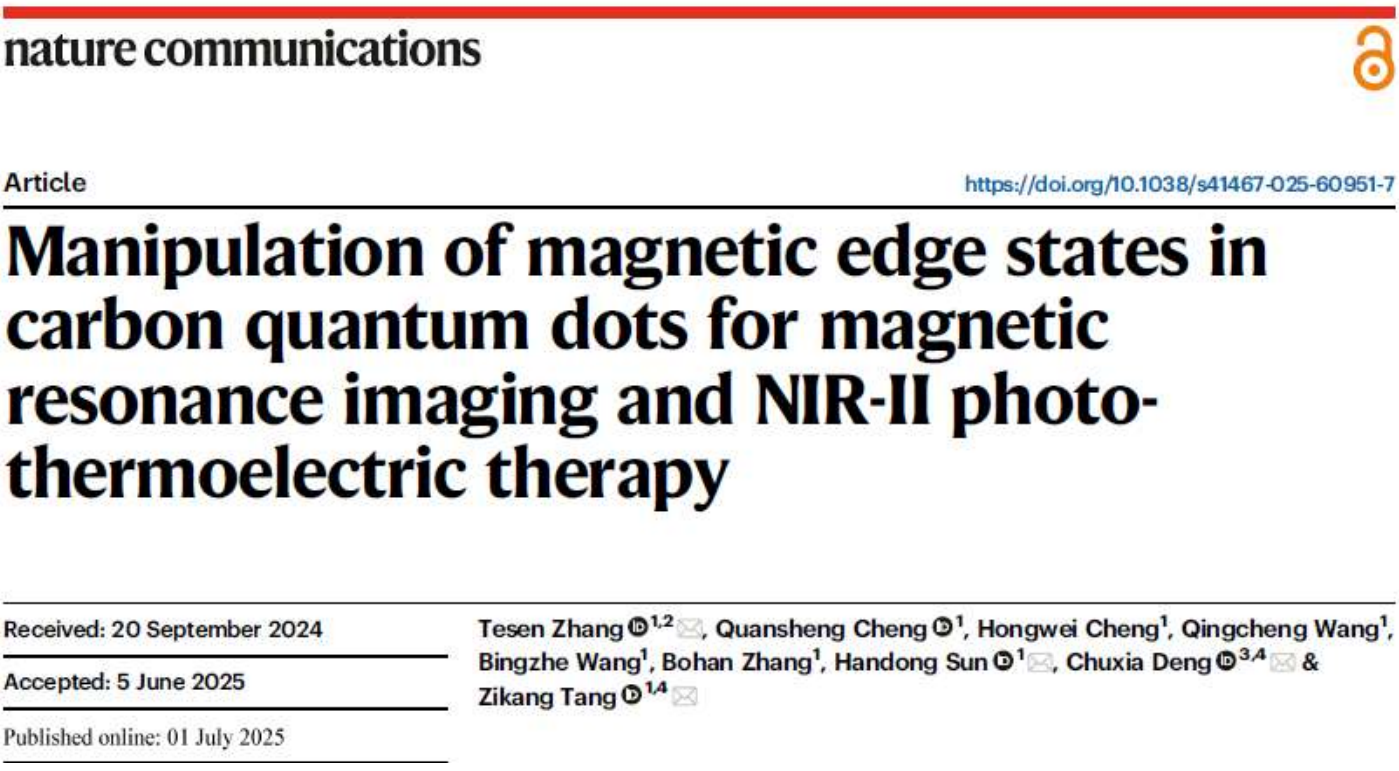
✧ Content

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

1. **Tesen Zhang***, Quansheng Cheng, Hongwei Cheng, Qingcheng Wang, Bingzhe Wang, Bohan Zhang, **Handong Sun***, **Chuxia Deng***, **Zikang Tang***. Manipulation of magnetic edge states in carbon quantum dots for magnetic resonance imaging and NIR-II photo-thermoelectric therapy. ***Nature Communications*** 16, 5867 (2025). DOI: 10.1038/s41467-025-60951-7. [2024 IF=15.7]



nature communications

Article

https://doi.org/10.1038/s41467-025-60951-7

Manipulation of magnetic edge states in carbon quantum dots for magnetic resonance imaging and NIR-II photo-thermoelectric therapy

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Tesen Zhang[1,2], Quansheng Cheng[1], Hongwei Cheng[1], Qingcheng Wang[1], Bingzhe Wang[1], Bohan Zhang[1], Handong Sun[1], Chuxia Deng[3,4] & Zikang Tang[1,4]

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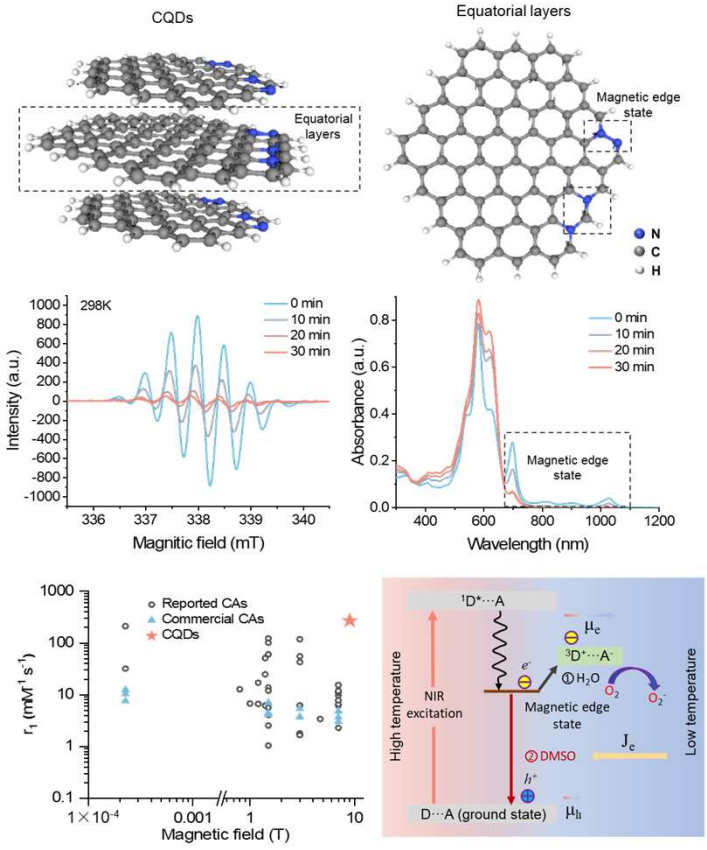
❖ Research Stories

UM research team developed magnetic edge states in carbon quantum dots for MRI and NIR-II photo-thermoelectric therapy

- The magnetic quantum phenomena triggered by electrons in carbon-based materials are challenging to decipher and exploit, thus sparking extensive research interest. Carbon quantum dots (CQDs), emerging candidates in nanomedicine, exhibit fascinating behaviors related to electron spin, relaxation and migration.
- For the first time, the team has developed a unique magnetic edge state structure within nonmetallic CQDs that generate hyperfine interaction (HFI) and zero-field splitting (ZFS). By modulating the surface ligands, relaxation rates are accelerated through spin averaging, which results in CQDs serving as desirable T_1 contrast agents with the highest relaxivity for magnetic resonance imaging (MRI) and NIR-II cancer therapy agents. Combining these characteristics, the research team proposes an MRI-guided approach to precision cancer therapy that offers a pathway for the rapid advancement of nanomedicine.
- This study serves as a valuable reference for carbon-based materials striving to achieve efficient spin averaging, HFI, and ZFS. The team demonstrated that by adjusting the intrinsic structure, ligands, and external environment of CQDs, it is feasible to achieve electron relaxation and migration properties superior to those of metal-based nanomaterials, thus presenting compelling evidence for prospective quantum and biological applications of carbon-based materials.

(From left) Dr. Tesen Zhang (張特森), Prof. Handong Sun (孫漢東), Prof. Chuxia Deng (鄧初夏, FHS), Prof. Zikang Tang (湯子康)



Tesen Zhang*, Quansheng Cheng, Hongwei Cheng, Qingcheng Wang, Bingzhe Wang, Bohan Zhang, **Handong Sun*** , **Chuxia Deng*** , **Zikang Tang***. Manipulation of magnetic edge states in carbon quantum dots for magnetic resonance imaging and NIR-II photo-thermoelectric therapy. ***Nature Communications*** *16*, 5867 (2025) . DOI: 10.1038/s41467-025-60951-7. [2024 IF=15.7]

The first author is Dr. Tesen Zhang (supervised by Prof. Handong Sun and Prof. Zikang Tang) in IAPME. The corresponding authors of this study include Dr. Tesen Zhang, Prof. Handong Sun, and Prof. Zikang Tang from IAPME as well as Prof. Chuxia Deng from FHS. This work was supported by the Science and Technology Development Fund of Macau SAR (0128/2020/A3, 0131/2020/A3, 0007/2021/AKP, 006/2022/ALC, and 0139/2022/A3). Funding from the University of Macau (MYRG2020-00164-IAPME). The Research and Development Grant for Chair Professor Fund from the University of Macau (CPG2020-00026-IAPME, CPG2021-00034-IAPME, CPG2022-00013-IAPME, CPG2025-00034-IAPME, SRG2023-00025-IAPME).

❖ Ph.D. Student Thesis Oral Defenses

Hejin Yan of Prof. Yongqing Cai's group presented "Energetics and Kinetics of Lattice Distortion in Layered Halide Perovskite" in his oral defense on July 30, 2025.

Congratulations to Dr. Hejin Yan!

(from left) Prof. Haifeng Li (李海峰), Prof. Xiaojun Wu (武曉君, USTC), Dr. Hejin Yan (晏和進), Prof. Yongqing Cai (蔡永青), Prof. Guichuan Xing (邢貴川) and Prof. Shi Chen (陳石)

Xue Li of Prof. Guoxing Sun's group presented "Modified High Freeze-Thaw Resistance Cementitious Material" in her oral defense on July 30, 2025.

Congratulations to Dr. Xue Li!

(from left) Prof. Binmeng Chen (陳斌猛), Prof. Haifeng Li (李海峰), Dr. Xue Li (李雪), Prof. Qijun Yu (余其俊, SCUT), Prof. Guoxing Sun (孫國星) and Prof. Guichuan Xing (邢貴川)

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❖ IAPME Research Team Won the Bronze Award in The China International College Students Innovation Competition 2024

Our IAPME research team—comprising Dr. Chunfa Liu (劉春發), Dr. Jinxian Feng (馮錦先), Dr. Haoyun Bai (白皓昀), and Mr. Chengcheng Zhong (仲程程)—won the Bronze Award at the China International College Students Innovation Competition (2024) with their research project titled "Low-Cost, High-Efficiency Electrodes for Industrial Green Hydrogen Production via Water Electrolysis." The project was supervised by Prof. Hui Pan (潘暉) and Prof. Shuangpeng Wang (王雙鵬).

Dr. Chunfa Liu
(劉春發)

Dr. Jinxian Feng
(馮錦先)

Dr. Haoyun Bai
(白皓昀)

Mr. Chengcheng Zhong
(仲程程)

Prof. Hui Pan
(潘暉)

Prof. Shuangpeng Wang
(王雙鵬)

中国国际大学生创新大赛(2024)
China International College Students' Innovation Competition 2024

获奖证书

刘春发、冯锦先、白皓昀、仲程程同学：

你们的作品《低价、高效电极材料用于工业电解水制备绿氢》，在中国国际大学生创新大赛（2024）中荣获

铜奖

指导教师：潘晖、王双鹏
特发此证，以资鼓励。

主办单位：教育部、中央统战部、中央网信办、国家发展改革委、工业和信息化部、人力资源社会保障部、农业农村部、中国科学院、中国工程院、国家知识产权局、国家乡村振兴局、共青团中央、上海市人民政府

承办单位：上海交通大学、上海市闵行区人民政府

中国国际大学生创新大赛组委会
二〇二四年七月
证书编号：20242050G
组织委员会

❖ Visits

A delegation led by Prof. Song Gao (高松), Rector of Sun Yat-sen University, visited IAPME on 11 July 2025. Prof. Hui Pan, Prof. Yongqing Cai, and Prof. Binmeng Chen attended the reception of the visitors.

During the visit, Prof. Pan first gave an introduction to IAPME, covering its development history, teaching areas, and research areas. Regarding research, Prof. Pan provided a detailed overview of current developments and achievements. He then showcased products derived from IAPME's research, which greatly impressed and interested the visitors. Finally, Prof. Gao invited IAPME members to visit Sun Yat-sen University to further promote exchanges and collaboration in the future.

❖ Upcoming Events

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IAPME Seminar

Heterogeneous Integration of GaN optoelectronics with Si microelectronics

7 August 2025

Prof. Anthony H. W. CHOI
University of Hong Kong
Venue: N23-4018
Time: 15:00 - 16:00
Hosted by: Prof. Handong SUN

Abstract

In the past decades, GaN and its AlN, and InN alloys have been attracting the interests of the optoelectronics industries. GaN optoelectronic devices, including LEDs, photo-detectors (PD), micro-LED displays, etc., have been demonstrated to have advantages over their counterparts in the aspects of efficiency, and lifetime, amongst others.

To operate the GaN optoelectronic devices, systems involving such devices also include Si microelectronics in the form of integrated circuits (IC), such as drivers, amplifiers and many other types of ICs. Conventionally, the GaN optoelectronic devices and Si microelectronics are individually packaged, which are then soldered onto printed circuit boards (PCB) to form functional circuits, as illustrated in Fig. 1(a). Although commonly adopted, such types of integration tend to make the circuits and systems more bulky than is needed.

In this talk we present the heterogeneous integration GaN optoelectronics devices (such as LEDs and photodiodes) with Si-based electronics at the chip-scale level. This includes the integration of GaN LEDs and LED arrays with CMOS driving circuit, and GaN photodetectors with CMOS transimpedance amplifiers.

Biography

Prof. Anthony H.W. CHOI is Professor and Associate Head with the Department of Electrical and Electronic Engineering at The University of Hong Kong. He received his PhD from the National University of Singapore under the supervision of Professor Soo Jin Chua and completed his postdoctoral training in Professor Martin Dawson's team at the University of Strathclyde, Glasgow, where he contributed to pioneering development work on III-Nitride emissive micro-light-emitting diode arrays, demonstrating applications in the areas of micro-displays and high-efficiency light sources. His current research interests include microdisk lasers, chipscale color micro-LED displays and GaN-Si heterogeneous integration.

Enquiry: iapme.enquiry@um.edu.mo

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IAPME Seminar

The Device Analysis of QLED toward Industrialization

11 August 2025

Prof. Hai-Zheng ZHONG
Beijing Institute of Technology

Venue: N23-1004b
Time: 10:00 - 11:00
Hosted by: Prof. Shuang-Peng WANG

Abstract

With the rapid improvements of external quantum efficiency and operating lifetimes in QLED's research, it approaches to the gate of industrialization for flat display applications. As one of the most important challenges, the operational stability of QLED limited the industrial applications of OLEDs. In the past few years, we have tried to investigate the operation of QLEDs. In this talk, I will introduce recent progress of the methodology, models and material characterization for device analysis. I hope the talk can inspire more efforts to promote the device analysis of QLEDs.

Biography

Prof. Hai-Zheng ZHONG is a Professor of photonic materials in the school of materials science and Engineering at Beijing Institute of Technology (BIT). He obtained his B.E. degree in 2003 from Jilin University, and then undertook his Ph.D. studies at the Institute of Chemistry, Chinese Academy of Sciences (ICCAS) from 2003 to 2008. After that, he worked as a postdoc in the University of Toronto during 2008–2010. He joined School of Materials Science & Engineering at Beijing Institute of Technology (BIT) as an Associate Professor in 2010 and was promoted to Full Professor in 2013. His current research interests are in the area of colloidal quantum dots for photonics and optoelectronics. His recent awards include the National Science Foundation for Excellent Young Scholars (2017), Beijing Science and Technology Award (2018, 2/10), 2019 IDW best paper award. Since 2019, he serves as senior editor for Journal of Physical Chemistry Letters, and moved to executive editor in 2020.

Enquiry: iapme.enquiry@um.edu.mo