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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

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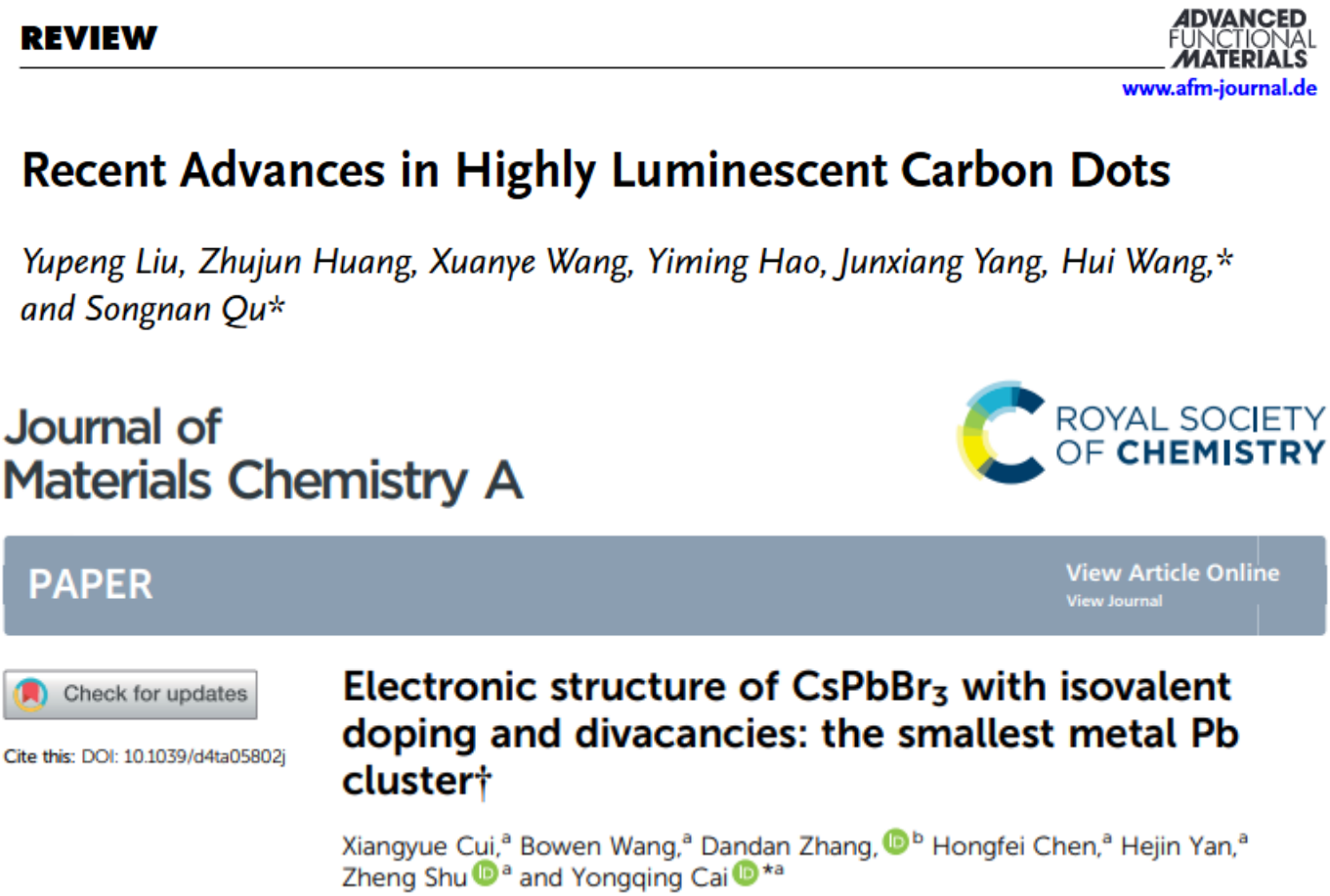
✧ Content

❖ Publications (IF≥8; *corresponding author)

1. **Yupeng Liu**, Zhujun Huang, Xuanye Wang, Yiming Hao, Junxiang Yang, Hui Wang*, **Songnan Qu***. Recent Advances in Highly Luminescent Carbon Dots. *Advanced Functional Materials*, 2420587 (2024). DOI: 10.1002/adfm.202420587 [2023 IF=18.5], Nature Index Journal

2. **Xiangyue Cui**, Bowen Wang, Dandan Zhang, Hongfei Chen, Hejin Yan, Zheng Shu and **Yongqing Cai***. Electronic structure of $CsPbBr_3$ with isovalent doping and divacancies: the smallest metal Pb cluster. *Journal of Materials Chemistry A*, (2025). DOI: 10.1039/D4TA05802J. [2023 IF=10.8]



REVIEW

ADVANCED FUNCTIONAL MATERIALS
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Recent Advances in Highly Luminescent Carbon Dots

Yupeng Liu, Zhujun Huang, Xuanye Wang, Yiming Hao, Junxiang Yang, Hui Wang,* and Songnan Qu*

Journal of Materials Chemistry A

ROYAL SOCIETY OF CHEMISTRY

PAPER

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Electronic structure of $CsPbBr_3$ with isovalent doping and divacancies: the smallest metal Pb cluster†

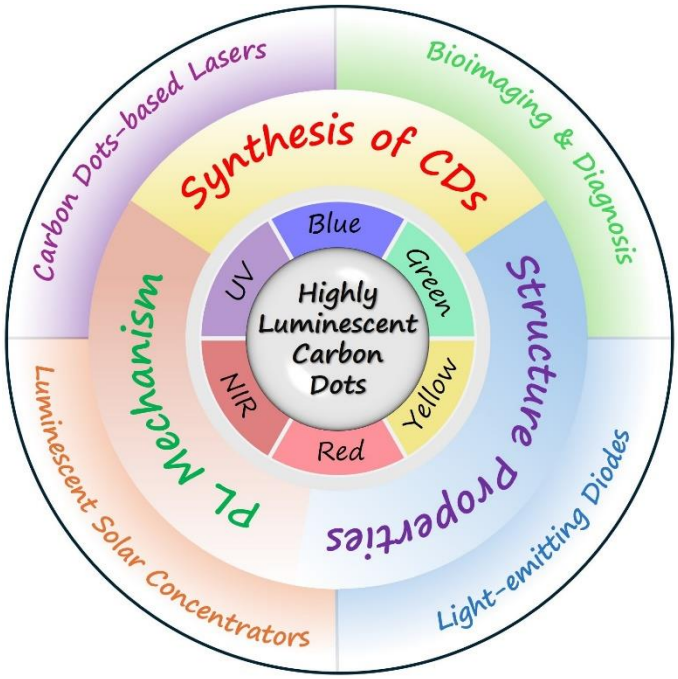
Xiangyue Cui,[a] Bowen Wang,[a] Dandan Zhang,[b] Hongfei Chen,[a] Hejin Yan,[a] Zheng Shu[a] and Yongqing Cai*[a]

❖ Research Stories

UM research team reviewed the research progress of highly luminescent carbon dots

- The photophysical processes of general CDs and highly luminescent CDs, as well as the triplet emission of CDs, including fluorescence, phosphorescence, and delayed fluorescence, were briefly introduced.
- Due to the inconsistent research progress of luminescent CDs across different bands, the lower limit of PLQY for highly luminescent CDs in each band was defined. The information on highly luminescent CDs in various luminescent bands was then statistically summarized into several tables. The selection of synthetic raw materials and the research progress of highly luminescent CDs by band were also reviewed.
- The applications of highly luminescent CDs in luminescence were summarized, which include bioimaging and diagnosis, light-emitting diodes, luminescent solar concentrators, and CDs-based lasers.
- Finally, the current research status was reviewed, existing challenges were analyzed, and feasible directions for future development were suggested.

(From left)
Dr. Yupeng Liu and Prof. Songnan Qu



Yupeng Liu, Zhujun Huang, Xuanye Wang, Yiming Hao, Junxiang Yang, Hui Wang*, **Songnan Qu***. Recent Advances in Highly Luminescent Carbon Dots. *Advanced Functional Materials*, 2420587 (2024). DOI: 10.1002/adfm.202420587 [2023 IF=18.5], Nature Index Journal

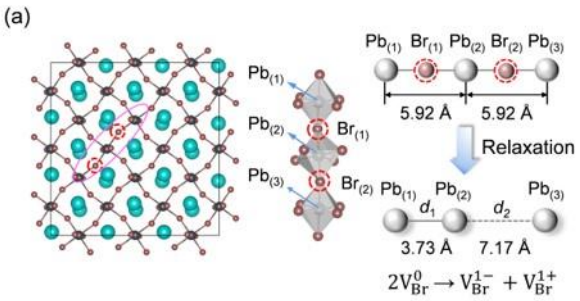
Prof. Songnan Qu is the corresponding author of this study. The first author is Dr. Yupeng Liu, the research assistant in the IAPME. This project was funded by the Science and Technology Development Fund of Macao SAR (File no: 0139/2022/A3, 0007/2021/AKP, and 006/2022/ALC), the Shenzhen-Hong Kong-Macao Science and Technology Innovation Project (Category C) (File no: SGDX20210823103803021 and EF029/IAPME-QSN/2022/SZSTIC).

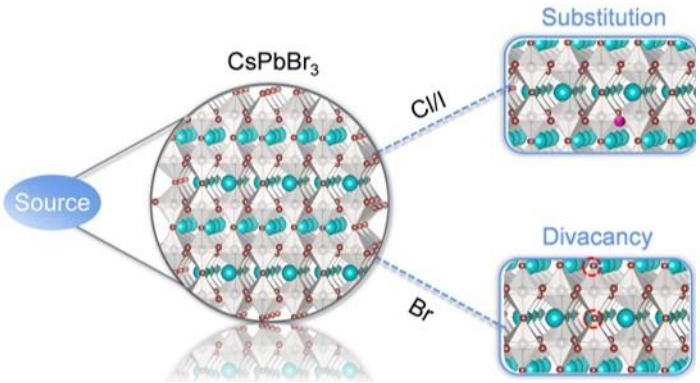
❖ Research Stories

UM research team explored the electronic structure of $CsPbBr_3$ with isovalent doping and divacancies

- By performing first-principles calculations, Br divacancy (DV_{Br}) is calculated to be formed via merging two isolated Br single vacancies and is stabilized in an apical configuration in $CsPbBr_3$. It is likely to be common, particularly in samples subjected to highly radiated, electric field, or Br-poor environments.
- A single Br vacancy tends to be stabilized as -1 charged state, forming a Pb-Pb dimer, especially in p-doped $CsPbBr_3$. This Pb-Pb dimer would be the smallest metal Pb cluster, and likely in other Pb-based perovskites, and is harmful for light emission of its deep localized defective level.
- The substitution of Br by Cl or I dopants is facile due to the low defect formation energy under Pb-rich growth conditions. This conclusion is supported by recent experiment demonstrating the viability of incorporating Cl species in $CsPbBr_3$. (*Sci. Adv.* 10, eado5645, 2024)

(From left)
Ms. Xiangyue Cui and Prof. Yongqing Cai





The formation of apical DV_{Br} in $CsPbBr_3$

Xiangyue Cui, Bowen Wang, Dandan Zhang, Hongfei Chen, Hejin Yan, Zheng Shu and **Yongqing Cai** *. Electronic structure of $CsPbBr_3$ with isovalent doping and divacancies: the smallest metal Pb cluster. *Journal of Materials Chemistry A*, (2025). DOI: 10.1039/D4TA05802J. [2023 IF=10.8]

Prof. Yongqing Cai is the corresponding author of this study. The first author is Xiangyue Cui, a Ph.D. student of IAPME. This work was supported by Natural Science Foundation of Guangdong Province, China (2024A1515011161) and the Science and Technology Development Fund from Macau SAR (FDCT-0163/2019/A3, 0085/2023/ITP2, 0120/2023/RIA2). This work was performed in part at the High-Performance Computing Cluster (HPCC), which is supported by Information and Communication Technology Office (ICTO) of the University of Macau.

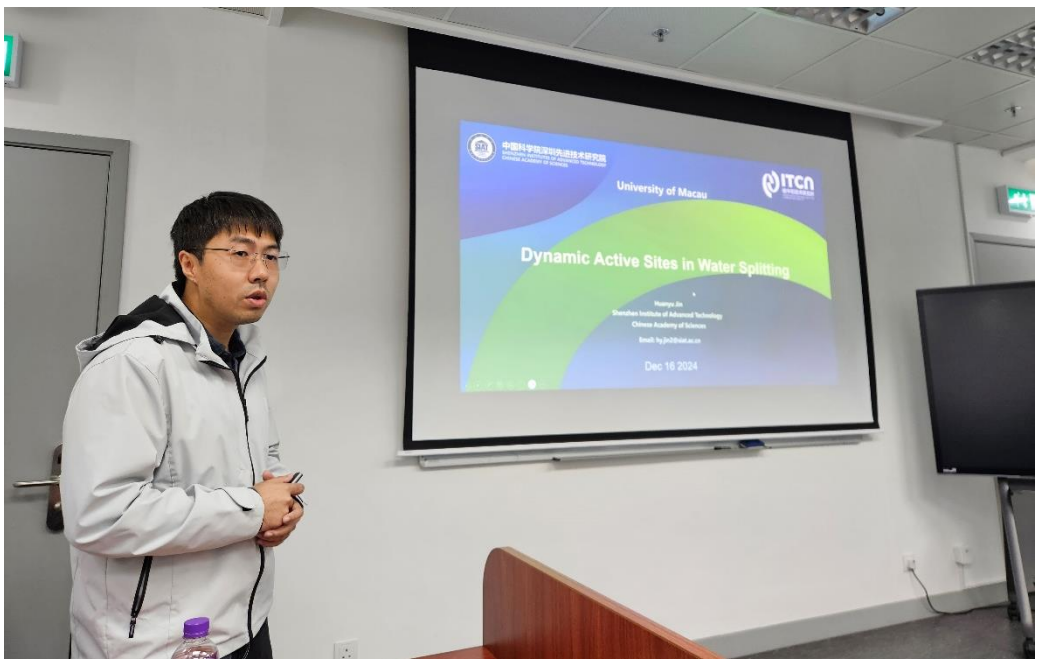
❖ UM team led by IAPME professors won the First Prize in the 10th Chinese Undergraduate Physics Experiment Tournament

Led by Prof. Hongchao Liu, Prof. Hui Pan and Prof. Haomin Song, a team formed by five undergraduate students (Xinqi Li, Chuqi Tang, Mingyu Chen, Chit Hun Mok and Chi Chon Lam) from Department of Physics and Chemistry represented the University of Macau, first-ever participated and won the First Prize in the 10th Chinese Undergraduate Physics Experiment Tournament (CUPET). Started from 2010, CUPET is now the most influential national competition in physics for undergraduate. In this year, there are total 2577 teams from 667 universities in China mainland, Hong Kong and Macau participating the 10th CUPET. After an online preliminary competition in September, 548 teams from 280 universities entered the onsite final competition. As the team leader, Prof. Liu and two undergraduate team members, Chit Hun Mok and Xinqi Li, participated the final competition held in Beihang University (Shahe Campus), November 22-24, 2024, and won the First Prize. Among the total 2577 teams, 370 teams won the First Prize, wherein our UM team is the only one from Hong Kong SAR and Macao SAR.

❖ Seminars

Invited by Prof. Kwun Nam Hui, Prof. Huanyu Jin, from the Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, presented a talk titled "Dynamic Active Sites in Water Splitting" at the Institute of Applied Physics and Materials Engineering on December 17, 2024.

Prof. Jin is a Full Professor at the Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences (CAS). Before joining CAS, he served as a lecturer at the Institute for Sustainability, Energy, and Resources at the University of Adelaide. His research is dedicated to the development of innovative nanomaterials for sustainable chemical production, water splitting, and various other applications in energy conversion and utilization. He has published over 60 papers in renowned international academic journals, over 30 as the first/corresponding author, in journals such as Chem. Rev., Sci. Adv., Nat. Commun., Adv. Mater., and Angew. Chem. He has garnered 10,000 total citations and an H-index of 41. He has received awards such as the Stephen Wilkins Medal and the JMCA Emerging Investigator. Prof. Jin is listed as Highly Cited Researcher and "Stanford/Elsevier's Top 2% Scientist".



During the seminar, Prof. Jin underscored the potential of dynamic active sites as a cutting-edge technology in water splitting and outlined important future directions for this emerging field, addressing challenges such as inadequate electrocatalyst performance and instability issues. His presentation delved into essential material and device innovations crucial for advancing electrocatalysts, emphasizing a self-adaptive approach to electrocatalyst design. Prof. Jin concluded that dynamic active sites remain stable even in harsh conditions like acidic water oxidation, paving the way for the development of next-generation electrocatalysts and electrolyzers for commercial applications.

❖ Seminars

Invited by Prof. Songnan Qu, a talk titled “Light is beyond a journal”, by Dr. Ying Zhang, was shared to IAPME members on December 18, 2024. Dr. Ying Zhang is the Director of Light Publishing Group at Changchun Institute of Optics, Fine Mechanics and Physics (CIOMP), Chinese Academy of Sciences (CAS). He was a visiting scholar at the Institute of Optics, University of Rochester during 2017-2018. Dr. Zhang currently serves as the executive editor-in-chief of Chinese Journal of Liquid Crystals and Displays as well as scientific editor of Light: Science & Applications.

Dr. Zhang was elected as young talents of China Science and Technology Journal Excellence Action Plan, outstanding talents in the field of journal publishing by Chinese Academy of Sciences, high-level talents of Jilin Province. He won the first prize and outstanding contribution award of project supported by STM Journal Society, CAS. He participated in organizing and editing Handbook of Laser Technology and Applications (2nd Ed.) published by CRC, Taylor & Francis Group, as well as collection Publishing Ethics of STM Periodicals organized by China Association for Science and Technology.

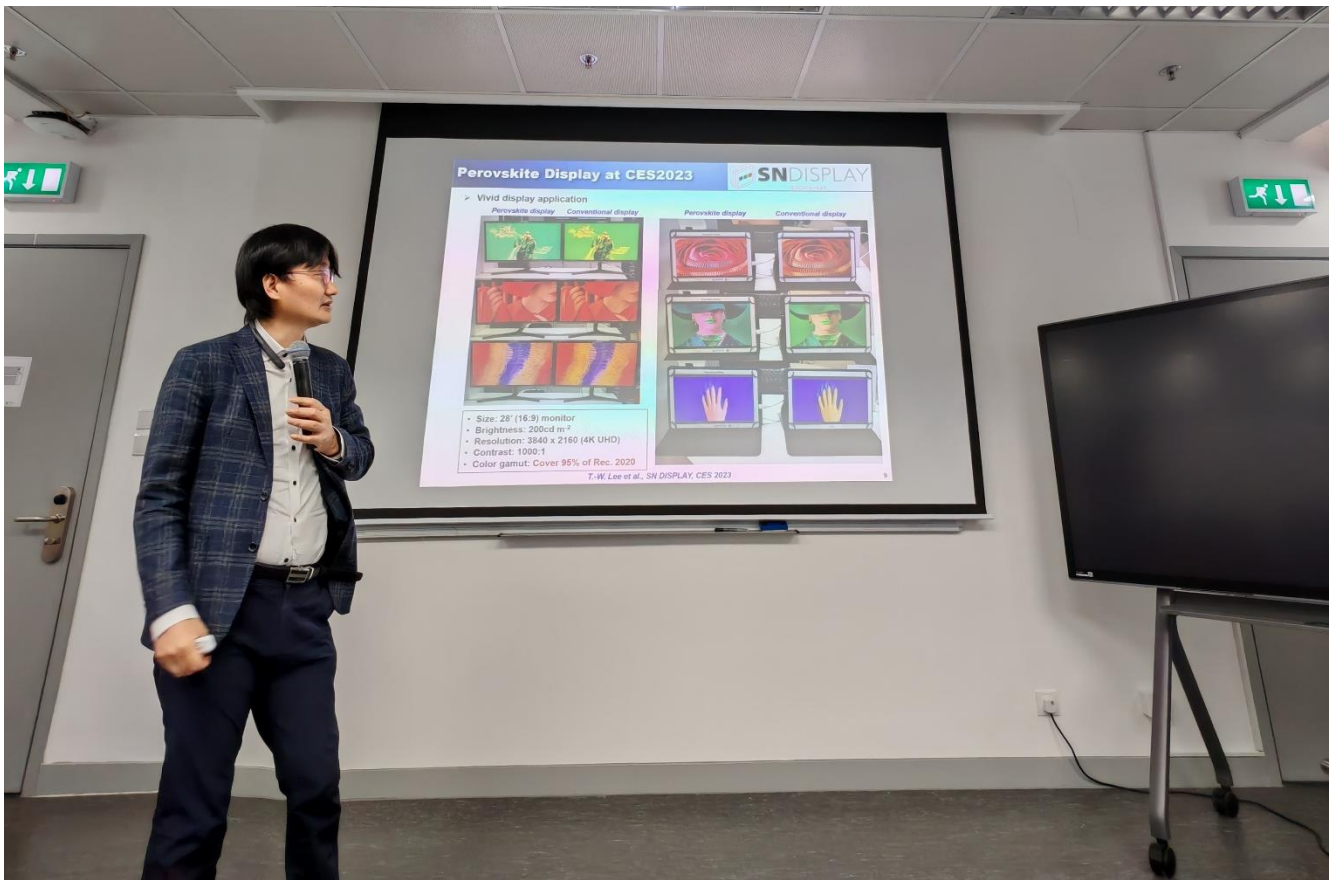
During the talk, Dr. Zhang firstly introduced the world-class journal Light: Science & Applications, co-published by CIOMP, CAS and Springer Nature, ranked among the top three optical journals over the past decade with the latest impact factor of 20.6. Then, Dr. Zhang introduced the basic situation, publishing practices, and brand development strategy of the Light-brand journal cluster, which is led by the world-class journal Light: Science & Applications, supported by the Light sister journals, and backed by high-quality Chinese journals.

Finally, Dr. Zhang discussed with the audiences by sharing how to write high quality manuscript and improve the acceptance of submission and encouraged researchers to submit their latest groundbreaking scientific research results to Light: Science & Applications.

❖ Seminars

Invited by Prof. Guichuan Xing, Prof. Tae-Woo Lee, from Seoul National University of Korea, delivered a talk titled “Perovskite Nanocrystals for Next-Generation Display Technologies" at the Institute of Applied Physics and Materials Engineering on December 19, 2024.

Prof. Lee is an internationally recognized expert in materials science and engineering. He is a Distinguished Professor in the Department of Materials Science and Engineering, the Department of Chemical and Biological Engineering, and the Interdisciplinary Program in Bioengineering at Seoul National University. Prof. Lee is a Fellow of the Materials Research Society and has made significant contributions to the fields of organic light-emitting diodes (OLEDs), organic thin-film transistors (OTFTs), and advanced photonic materials.



During the seminar, Prof. Lee briefly introduced their research efforts on promoting the metal-halide perovskite nanocrystals for next generation light emission and display applications. At the beginning, he gave a brief introduction of the developing history of metal-halide light emitting diodes and the main challenges faced by this research community. Then he illustrated the unique advantages of in-situ formed perovskite nanocrystals and their efforts on exploring the unique benefits and approaches in utilizing these nanocrystals for display technologies.

The seminar provided valuable insights into the challenges and opportunities in the field of perovskite nanocrystals. Prof. Lee's presentation fostered a deeper understanding of the unique properties of these materials and their applications in next-generation displays. Afterwards, Prof. Lee also answered questions from the audience and had a lively discussion with everyone.

❖ Seminars

Prof. Xiangping Xian, Assistant Professor of the Department of Architecture and Civil Engineering of City University of Hong Kong, visited IAPME on December 26, 2024. During his visit, he delivered an insightful presentation titled “The improvement of corrosion resistance of wet-cast concrete subjected to early-age ambient pressure carbonation curing”. The seminar was hosted by Prof. Binmeng Chen, who extended the invitation to Prof. Xian.

Prof. Xian obtained his master‘s degree in 2017 and Ph.D. in Civil Engineering in 2021 from McGill University. In 2023, he was awarded a Marie Sklodowska-Curie Future Roads Fellowship, supervised by Professor Abir Al-Tabbaa of Cambridge University. His research focuses on developing eco-friendly and functional cement-based products using OPC, industrial waste, municipal solid waste incineration, etc., through Carbon Capture, Utilization, and Storage (CCUS) techniques, contributing to environmental protection and sustainable development. Additionally, Prof. Xian also has interests in automated construction, 3D printing of green building materials, the engineering applications of durable materials and so on.

During lecture, Prof. Xian emphasized the potential of developing early-age ambient pressure carbonation curing as a means to mitigate corrosion risk and enhance resistance. This approach involves preventing deep CO_2 penetration and chemically and physically densifying concrete surface layer. He then presented two methods for evaluating the effectiveness of ambient pressure carbonation on the corrosion resistance of concrete. These methods not only underscore the efficacy of his work but also highlight its potential contributions to sustainability and the promotion of a circular carbon economy.

Prof. Xian also engaged in a lively discussion with several students on topics such as accelerating the carbonation of concrete. The seminar provided attendees with a comprehensive understanding on corrosion resistance of wet-cast concrete.

❖ The School of Materials Science & Engineering of Beijing Institute of Technology visit IAPME

On December 16, 2024, a delegation led by Chunlin He, Associate Dean of the School of Materials Science & Engineering of Beijing Institute of Technology (BIT) visited the Institute of Applied Physics and Materials Engineering (IAPME) and the Department of Physics and Chemistry of the Faculty of Science and Technology (FST), where both parties had in-depth discussions on further strengthening academic cooperation and undergraduate student exchanges, and agreed on the following collaborative intentions:

1. Undergraduates exchanges: both parties intend to carry out undergraduate exchange programmes on the basis of the framework cooperation agreement between the BIT and the UM, in order to promote academic exchanges between students of the two universities. This includes, but is not limited to, undergraduate summer camps, graduation design, and short-term mutual visits and exchanges of undergraduate students;

2. Outstanding undergraduate graduates to do research in Macao: School of Materials of BIT will recommend outstanding undergraduate graduates to apply for master's and doctoral programmes offered by the IAPME, UM. The aim is to provide a broader academic development platform for outstanding students and to promote the co-operation between the two universities in the cultivation of high-level talents.

Both sides agreed that the implementation of the above co-operation projects will further strengthen the academic ties between the two universities in the field of materials science and engineering, and promote the common development of the two sides in scientific research, teaching and talent cultivation.