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IAPME Newsletter

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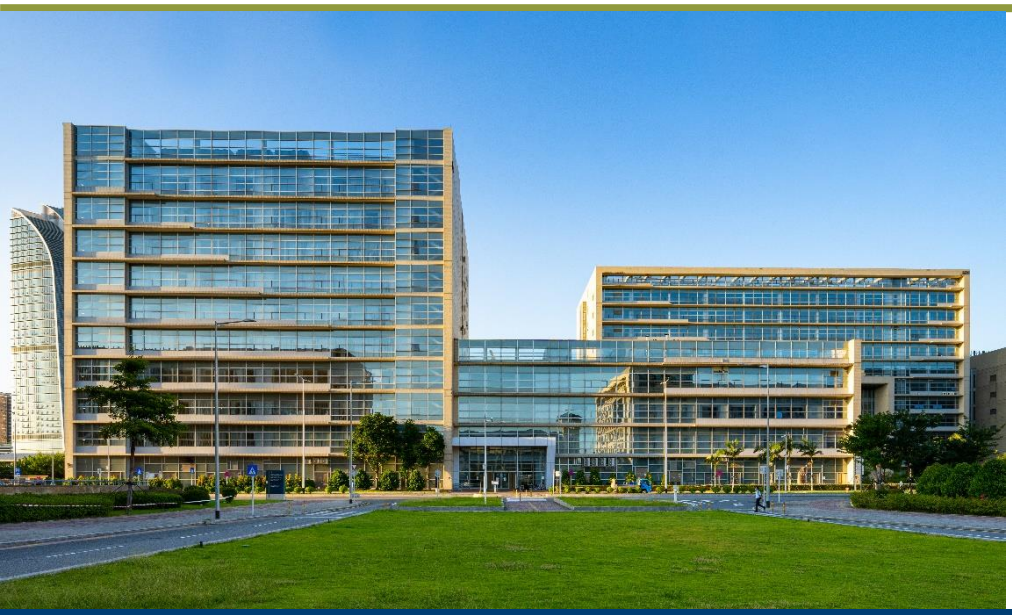


ISSUE 39

18 June 2025

✧ Content

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

1. **Hao Ouyang,** Rui Li, Yongqing Cai, Jilei Liu, Heng Li*, Shen Lai, **Shi Chen*.** Succinonitrile-Driven Cathode-Electrolyte Interface Modulation for Stable and High-Rate Prussian White Cathode in Potassium-Ion Batteries. *Journal of Energy Chemistry* (2025). DOI: 10.1016/j.jechem.2025.05.042. [2024 IF = 14.0]

Journal Pre-proofs

Research article

Succinonitrile-driven cathode-electrolyte interface modulation for stable and high-rate Prussian white cathode in potassium-ion batteries

Hao Ouyang, Rui Li, Yongqing Cai, Jilei Liu, Heng Li, Shen Lai, Shi Chen

PII: S2095-4956(25)00435-8
DOI: https://doi.org/10.1016/j.jechem.2025.05.042
Reference: JECHEM 4750

To appear in: *Journal of Energy Chemistry*

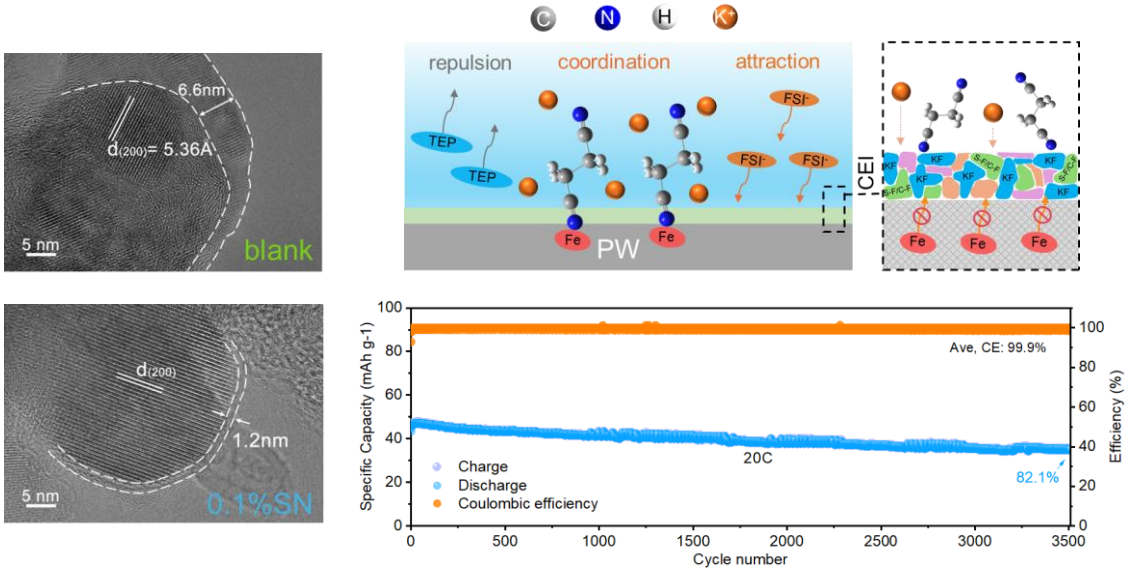
❖ Research Stories

UM research team developed a succinonitrile-driven cathode-electrolyte interface modulation strategy for Prussian White cathode in PIBs

Hao Ouyang
(歐陽昊)

Prof. Shi Chen
(陳石)

- Benefited from the coordination between the cyano groups in succinonitrile (SN) and iron atoms, this molecule can preferentially adsorb on the surface of PW for mitigating iron dissolution. SN also facilitates the decomposition of anions in potassium salt rather than organic solvents in electrolyte due to the attractive reaction between SN and anions.
- The team present a bifunctional electrolyte additive, SN, which effectively promotes the formation of a thin and uniform cathode-electrolyte interphase (CEI) on the PW surface, stabilizes the PW framework and suppresses Fe dissolution. In Graphite||PW full cells, the additive facilitates ultra-stable cycling for 3500 cycles at 20C, with a capacity decay of 0.005% per cycle and an average coulombic efficiency of 99.9%.
- This work provides an effective CEI modulation strategy and opens a new pathway toward the practical application of high-performance PIBs.



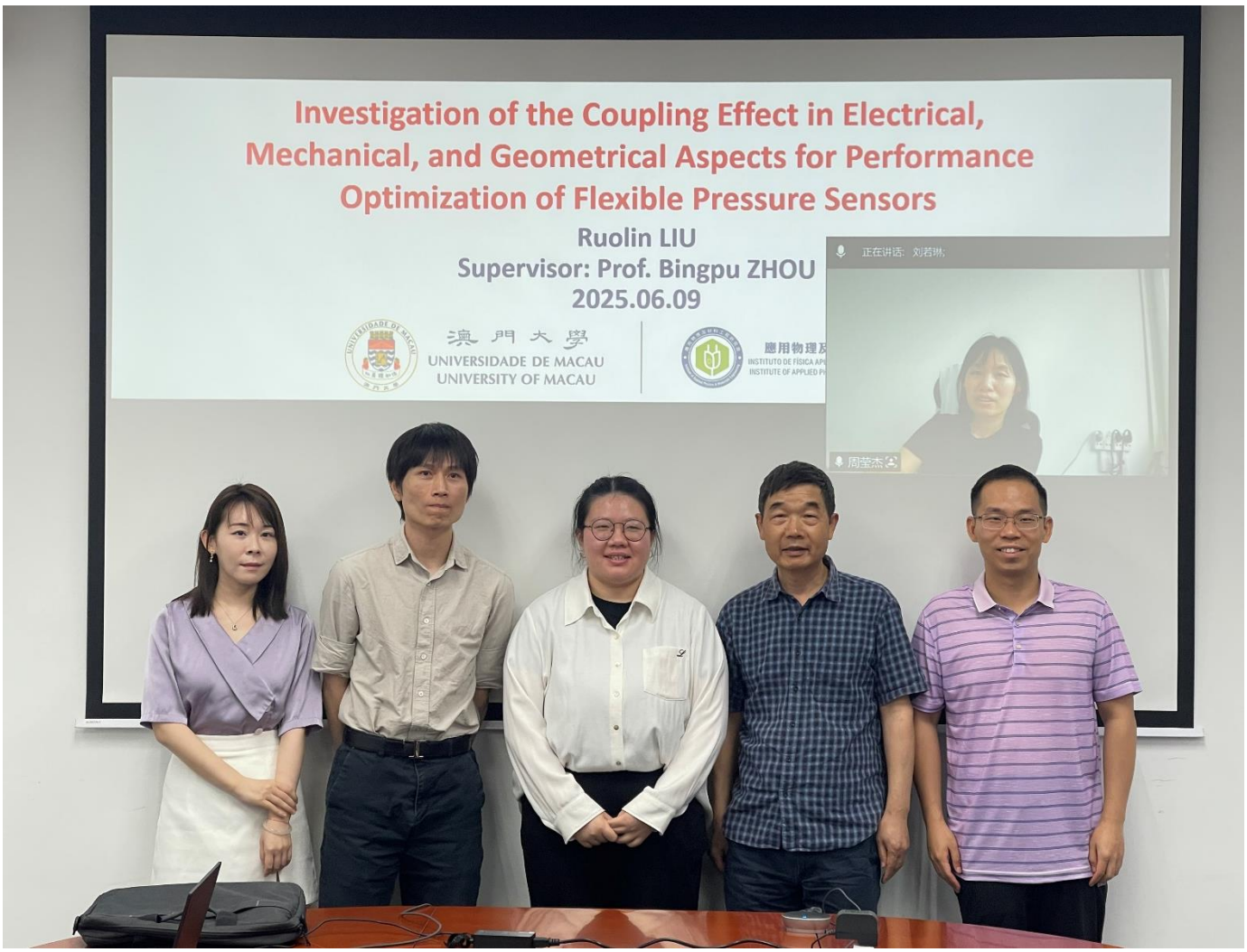
Hao Ouyang, Rui Li, Yongqing Cai, Jilei Liu, Heng Li*, Shen Lai, **Shi Chen***. Succinonitrile-Driven Cathode-Electrolyte Interface Modulation for Stable and High-Rate Prussian White Cathode in Potassium-Ion Batteries. *Journal of Energy Chemistry* (2025). DOI: 10.1016/j.jechem.2025.05.042. [2024 IF = 14.0]

This work supports from the Macau Science and Technology Development Fund (File No.0013/2021/AMJ and 0082/2022/A2) as well as partial support from the multi-year research grants (MYRG2022-00266-IAPME, and MYRG-GRG2023-00224-IAPME) provided by the Research & Development Office at the University of Macau. The authors also wish to thank the National Natural Science Foundation of China (Grant No. 52202328), the Shanghai Sailing Program (22YF1455500), and the Shanghai Magnolia Talent Plan Pujiang Project (24PJD128) for their financial support.

❖ Ph.D. Student Thesis Oral Defenses

Ruolin Liu of Prof. Bingpu Zhou's group presented "Investigation of the Coupling Effect in Electrical, Mechanical, and Geometrical Aspects for Performance Optimization of Flexible Pressure Sensors" in her oral defense on June 09, 2025.

Congratulations to Dr. Ruolin Liu!



(from left) Prof. Yinning Zhou (周胤寧), Prof. Bingpu Zhou (周冰朴), Dr. Ruolin Liu (劉若琳), Prof. Handong Sun (孫漢東), Prof. Hongchao Liu (劉宏超) and Prof. Yingjie Zhou (周瑩杰, DHU)

❖ Delegation from Tsinghua University Shenzhen International Graduate School Visited IAPME

On May 29, 2025, a delegation of over 30 graduate students from Tsinghua University Shenzhen International Graduate School (SIGS), led by Prof. Baohua Li (李寶華, Deputy Director, Institute of Materials Research at SIGS) and Prof. Dong Zhou (周棟), visited the Institute of Applied Physics and Materials Engineering (IAPME).

The delegation was warmly welcomed by Prof. Hui Pan, along with Prof. Qing Li and Prof. Kwan Nam Hui. Prof. Pan provided an overview of IAPME's research focus, state-of-the-art facilities, and PhD recruitment policies, emphasizing opportunities for prospective students. Prof. Baohua Li then introduced the development history and key achievements of the Institute of Materials Research at SIGS, highlighting its pioneering contributions to advanced materials research and technological innovation. The session concluded with Prof. Hui presenting his team's latest research advancements, which sparked lively discussions among the students.

This visit served as a valuable platform for academic exchange, fostering potential future collaborations between the two institutions. Both sides expressed strong interest in deepening research partnerships in the field of materials science and engineering.

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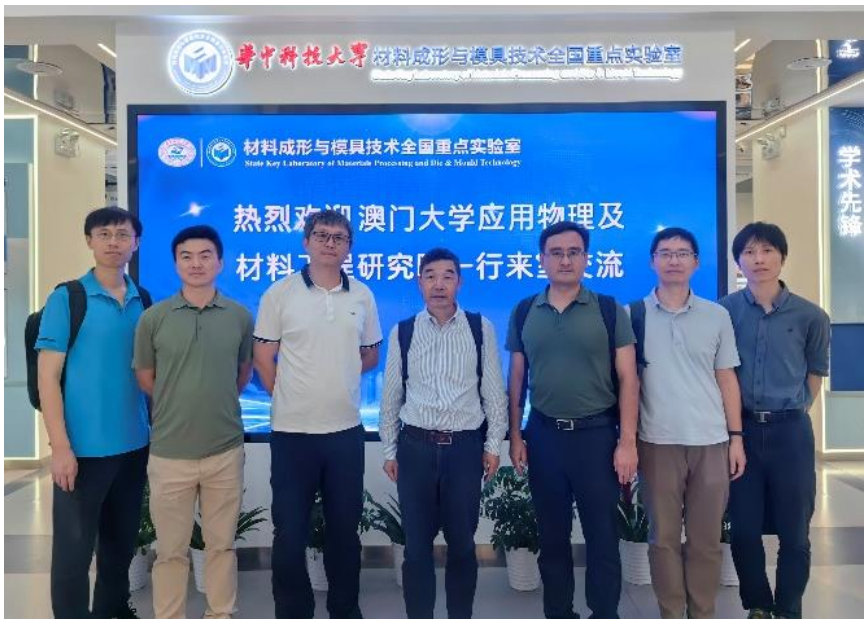
❖ IAPME Visited HUST

An IAPME team, led by Associate Director Prof. Handong Sun, visited Huazhong University of Science and Technology (HUST) and attended the 1st Symposium on New Materials Interdisciplinary Frontiers during 27-29 May, 2025. During the stay in Wuhan, the IAPME team also visited Wuhan National High Magnetic Field Center, and State Key Laboratory of Materials Processing and Die & Mould Technology of HUST.

In the symposium, Prof. Handong Sun (孫漢東), Prof. Songnan Qu (曲松楠), Prof. Bingpu Zhou (周冰朴), Prof. Shi Chen (陳石), Prof. Shuangpeng Wang (王雙鵬), Prof. Haomin Song (宋昊旻), and Prof. Binmeng Chen (陳斌猛), delivered presentations on topics of colloidal nanoplatelets, battery technology, functional materials, and so on. Professors from HUST shared the research on topics such as high-entropy alloy, semiconductor device, and flexible actuators. They also reached consensus on establishing research collaborations in new materials area.

At the School of Materials Science and Engineering (MSE) of HUST, the IAPME team was warmly received by the Dean of MSE, Prof. Huamin Zhou (周華民), along with the Associate Deans, Prof. Tianyou Zhai (翟天佑), and Prof. Cheng Zhang (張誠). During the meeting, both parties introduced the milestones, core research and educations in IAPME and MSE. They also discussed the potential collaborations, including joint funding applications, the promotion of student exchanges, and in-depth research cooperation.



❖ Upcoming Events

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IAPME Seminar

Ligand Engineering for Modulating the Crystal Structure and Optoelectronic Properties of Two-Dimensional Metal Halide Perovskites

23 June 2025

Prof. Zhenyu YANG
Sun Yat-sen University
Venue: N23-3022
Time: 10:30 - 11:30
Hosted by: Prof. Yongqing CAI

Abstract

Two-dimensional (2D) metal halide perovskites are a unique class of organic-inorganic hybrid ionic semiconductors. Their structure can be viewed as 3D perovskite frameworks intercalated with layered organic cationic ligands, making the choice of ligands crucial in determining the properties of 2D perovskites. Ligand selection directly influences the crystal structure, optical characteristics, and electronic behavior of these materials, rendering it a key focus in perovskite research. This presentation will highlight a novel class of organic zwitterionic ligands and related chemical reactions developed by our research group, along with the resulting series of unprecedented 2D perovskite structures. The discussion will cover the discovery and development of these ligands and their reactions, their impact on perovskite dimensionality and bonding modes, as well as the optoelectronic properties of the derived materials.

Biography

Prof. Zhenyu YANG is a Professor and Doctoral Advisor at Sun Yat-sen University. He obtained his B.Sc. from Nankai University in 2009 and later pursued his Ph.D. at the University of Alberta under the supervision of Prof. Jonathan Veinot, a leading expert in solid-state silicon chemistry. After earning his doctorate in 2014, he joined the laboratory of Prof. Edward Sargent at the University of Toronto as a postdoctoral researcher. In 2018, he was awarded the National "Young Thousand Talents Plan" Fellowship and returned to China to establish his independent research group at Sun Yat-sen University. His current research focuses on the synthesis and surface chemistry of silicon/germanium semiconductors, as well as the design and optimization of related optoelectronic devices. Prof. Yang holds four international patents and six domestic patents. As a corresponding author, he has published over 20 papers in prestigious journals such as Nature Communications, Journal of the American Chemical Society, Angewandte Chemie, Nano Letters, and ACS Nano, with total citations exceeding 10,000. He serves as a Youth Editorial Board Member for Journal of Semiconductors and Materials Futures. Additionally, he has been recognized as a Young Top Talent in the Pearl River Talent Program and listed as a Highly Cited Researcher by Clarivate Analytics.

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IAPME Seminar

The first decade of colloidal perovskite quantum dots: Quo Vadis?

24 June 2025

Prof. Maksym V. Kovalenko
ETH Zürich
Venue: N23-4018
Time: 11:00 - 12:00
Hosted by: Prof. Handong SUN

Abstract

This year marks the first decade of colloidally synthesized lead halide perovskite quantum dots (LHP QDs), defining QDs as size- and shape-uniform ensembles with tunable quantum confinement and single-photon emission. Gradually, during this period, practically the entire compositional within a general formula APbX3 was thoroughly studied, with A being cesium (Cs), methylammonium (MA), formamidinium (FA), and azeridinium (AZ) was produced as high-quality nanocrystals. This journey is, arguably, at its very beginning. The LHP QDs are vastly different from conventional, more covalent semiconductors – they are ionic compounds with much lower formation energies, entropically stabilized, and structurally dynamic. The design of surface capping ligands turned out to be decisive for their stabilization at the nanoscale and for taming their photophysics. Currently, LHP NCs are prototyped as primary green emitters for television displays owing to facile and scalable production, higher emissivity-per-mass under blue excitation, and narrow emission linewidth. Their excitonic characteristics exceed initial expectations in many regards, opening opportunities as quantum light sources. In particular, at cryogenic temperatures, LHP QDs exhibit long excitonic coherence times, which start to match the fast sub-100 ps radiative rates. Both characteristics are optimized, to our surprise, in larger CsPbX3 QDs beyond the quantum confinement, namely, 20-40 nm, owing to the single-photon superradiance effect (giant oscillator strength at the single-exciton per NC regime). Single-component and multicomponent QD superlattices exhibit collective emission, known as superfluorescence, characterized by the oscillating, ultrafast (10-30 ps) radiative decays. This presentation will walk you through both the most essential progress over this first decade, including our current work, and outline future prospects.

Biography

Prof. Maksym V. Kovalenko is a Full Professor of Functional Inorganic Materials at ETH Zurich. He studied chemistry at the Chernivtsi National University in Ukraine from 1999 to 2004. He completed his doctoral studies at the University of Linz, Austria (2004-2007), and his postdoctoral training at the University of Chicago, USA (2008-2011). He then joined ETH Zurich as a tenure-track rofessor and became a tenured Associate Professor in 2017; promoted to Full Professor in 2020. Currently, he serves as the head of the Institute of Inorganic Chemistry. He is also an associate editor of the Chemistry of Materials and ACS Materials Au. The research activities of M. Kovalenko and his group focus on chemistry, physics and applications of inorganic solid-state materials and nanostructures.

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IAPME Seminar

Multicomponent Superlattices of Lead Halide Perovskite Nanocrystals

24 June 2025

Prof. Maryna I. Bodnarchuk
ETH Zürich
Venue: N23-4018
Time: 14:00 - 15:00
Hosted by: Prof. Handong SUN

Abstract

The past decade has seen the discovery and the rapid development of colloidal lead halide perovskite nanocrystals (LHP NCs) of APbX3 stoichiometry. They offer unprecedented characteristics of their highly intrinsic excitonic photophysics: fast radiative rates and long excitonic coherence, as well as giant oscillator strength effects. LHP NCs are, therefore, attractivebuilding blocks for devising collective luminescence phenomena, such as superfluorescence, through self-assembly into superlattices. We reported a broad structural diversity in multicomponent, long-range ordered superlattices (SLs) comprising highly luminescent cubic CsPbBr3 NCs (and FAPbBr3 NCs) co-assembled with the spherical, truncated cuboid, and disk-shaped NC building blocks such as Fe3O4, PbS, NaGdF4, and LaF3 NCs [1,2]. These mesostructures also exhibit superfluorescence, characterized by high excitation density, by emission pulses with ultrafast radiative decay. The formation of such SLs was rationalized using entropy-maximization arguments and ligand-deformability. In the multicomponent LHP NC-only SLs comprising CsPbBr3 NCs of different sizes as building blocks, efficient NC coupling and Förster-like energy transfer from strongly confined 5.3 nm CsPbBr3 NCs to weakly confined 17.6 nm CsPbBr3 NCs were observed [3]. The presentation will extend to the most recent work, wherein NCs are co-assembled with molecular entities or plasmonic NCs.

References

[1] I. Cherniukh, et al., Nature, 2021, 593, 535.
[2] I. Cherniukh, et al., ACS Nano, 2022, 16, 7210
[3] T. V. Sekh, et al., ACS Nano, 2024, 18, 11, 8423

Biography

Dr. Maryna Bodnarchuk received her PhD degree in natural sciences from the Johannes Kepler University Linz (Austria) in 2009 under Prof. Wolfgang Heiss, she then worked as a postdoctoral fellow at the University of Chicago in the group of Prof. Dmitry Talapin. In 2011 she joined the Laboratory of Inorganic Chemistry of ETH Zurich as a Marie Heim-Vögtlin fellow and then as an Ambizione Energy fellow (junior PI) supported by SNSF. In 2016, she was appointed as group leader in the laboratory of Thin Films and Photovoltaics at Empa. Her research interests and areas of expertise include synthesis, self-assembly, and characterization of novel inorganic nanostructures. These materials find applications in optoelectronic devices and energy storage.

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IAPME Seminar

Recent Improvements of Perovskite Nanocrystals for Light-Emitting Devices

24 June 2025

Prof. Andrey L. Rogach
City University of Hong Kong
Venue: N23-4018
Time: 15:00 - 16:00
Hosted by: Prof. Handong SUN

Abstract

Chemically synthesized metal halide perovskite nanocrystals have emerged as a new class of efficient light emitting materials which are particularly interesting for development of light-emitting diodes (LEDs). Stability of perovskite-based LEDs is still an issue, which can be partially mitigated by proper interface design, such as the use of inter-layer amine terminated carbon dots. As for many other nanocrystals, proper surface passivation is a key to ensure high colloidal stability and processability of perovskites; this can be achieved by employment of chelating ligands. Very recently, we employed the lead-free CsSnI3 perovskites for efficient and rather stable near-infrared LEDs. There have been plenty of efforts towards synthesis of core-shell perovskite nanocrystals with anticipated enhanced optical properties and stability, which is however not an easy task; some recent examples of such efforts on-going in my group will be demonstrated.

Biography

Prof. Andrey L. Rogach is a Yeung Kin Man Chair Professor in Photonics Materials at the Department of Materials Science and Engineering, and the Founding Director of the Centre for Functional Photonics (CFP) at City University of Hong Kong. He received his Diploma in Chemistry (1991, with honors) and Ph.D. in Physical Chemistry (1995) from the Belarusian State University in Minsk studying formation and properties of silver nanoparticles in different media. He worked as a postdoc (with Horst Weller) and then as a staff scientist at the Institute of Physical Chemistry of the University of Hamburg, Germany from 1995 to 2002. From 2002–2009 he held a tenured position of a lead staff scientist at the Department of Physics and Centre for NanoScience of the University of Munich, Germany, where he completed his habilitation in Experimental Physics on light emission and harvesting with semiconductor nanocrystals. He joined City University of Hong Kong as a Full Professor in 2009 and has been advanced to Chair Professor in 2012. His research focuses on synthesis, assembly and optical spectroscopy of colloidal semiconductor and metal nanocrystals and their hybrid structures, and their use for energy-related and optoelectronic applications. His distinctions include the RGC Senior Research Fellowship (Hong Kong, 2023), the Croucher Senior Research Fellowship (Hong Kong, 2019), the Carl Friedrich von Siemens Research Award of the Alexander-von-Humboldt Foundation (Germany, 2018), to name but a few. He holds honourable appointments at Trinity College Dublin (Ireland), Xi'An Jiaotong University, and Soochow University (China). Andrey Rogach is a Foreign Member of the Academia Europaea, and a Fellow of the Electromagnetic Academy, USA. He served as an Associate Editor of ACS Nano in 2011-2023.

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