A Journey in Rare Earth Doped Nanoparticles: From Foundational Discoveries to Translational Applications?

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Abstract

Since first reported, luminescent rare earth doped nanoparticles have attracted a great deal of interest. In the last decade, however, the field has rapidly taken off, progressing from the basic understanding of the photophysical properties governing their nanoscale luminescence, in particular upconversion, to their use in a plethora of applications, with considerable focus in biology and medicine. This interest stems primarily from the ability to stimulate these luminescent nanoparticles with near-infrared (NIR) light as well as their diverse emission wavelengths spanning the UV to the NIR. Therefore, with a single NIR excitation wavelength, it is possible to observe higher energy luminescence, known as upconversion, or single photon NIR emission (known as down-shifted luminescence). The former upconversion process proceeds through the sequential absorption of multiple NIR photons through the long-lived 4f electronic energy states of the tri-positive rare earth ions. As a result, upconversion is several of orders more efficient than conventional multiphoton absorption processes. This is especially interesting for applications in theranostics (therapy + diagnostics on the same platform) where the upconverted light can be used to trigger another light activated modality (therapy) while the NIR luminescence can be used for bioimaging and nanothermometry (diagnostics). Here, we present a personal journey of our work on the synthesis and development of various NIR excited (and emitting) core/shell rare earth doped nanostructures/nanoplatforms and demonstrate how their various emissions could be harnessed for applications in biology and nanomedicine.

Speaker CV

Fiorenzo Vetrone is Full Professor at INRS, Université du Québec, and Co-Director of the Quebec Centre for Advanced Materials. A pioneer of rare-earth doped upconverting nanoparticles, he has published several highly cited papers and delivered over 200 invited and plenary lectures worldwide. His distinctions include major awards from NSERC, IUPAC, the Royal Society (UK), ASM International, the Electrochemical Society, the Canadian Society for Chemistry, and the Royal Society of Canada. He is a Fellow of the Canadian Academy of Engineering and Distinguished Fellow of the International Engineering and Technology Institute.

Lanthanide photonics awakens to the influence of charge transfer states

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Abstract

The luminescence of lanthanide (Ln) ions underpins numerous domestic applications. However, its intriguing nature makes the design of Ln chromophores with tailored optical properties quite challenging. A key issue is the weak absorptivity of intraconfigurational f-f transitions which necessitates using the ion's surroundings for light harvesting and subsequent energy transfer onto Ln excited states. This antenna effect, discovered in 1942, has been extensively studied, especially with respect to the role of singlet and triplet states.

However, one critical class of electronic states — charge transfer (CT) states —, remains inadequately described, with the exception of well-characterized ligand-to-metal charge transfer (LMCT) states. The polar nature of ligands enable intra-ligand charge transfer (ILCT) or/and ligand-to-ligand charge transfer (LLCT). More importantly many Ln chromophores possess intricate networks of weak interactions in their crystal structures. These often overlooked interactions are structurally significant and crucially modulate electronic structure, thereby influencing energy transfer processes and efficiency.

Speaker CV

Jean-Claude Bünzli earned a degree in chemical engineering in 1968 and a PhD in inorganic chemistry in 1971 from the Swiss Federal Institute of Technology, Lausanne (EPFL). He then spent two years at the University of British Columbia as a teaching postdoctoral fellow (photoelectron spectroscopy) and one year at the Swiss Federal Institute of Technology in Zürich (physical organic chemistry). He was appointed assistant-professor at the University of Lausanne (UNIL) in 1974 and started a research program on the coordination and spectroscopic properties of f-elements. He was promoted as a full professor of inorganic and analytical chemistry in 1980. In 2001 he transferred to EPFL where he founded the Laboratory of Lanthanide Supramolecular Chemistry. Since 2009 he is also acting as World Class University professor at Korea University, Sejong campus (South Korea).

Bioinspired Superwetting Interfacial Nanomaterials and Beyond:Bionic Ultralow-Energy-Consumption Processes

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Abstract

Through the study of superhydrophobic and superhydrophilic phenomena in lotus leaves and animal corneas, etc., we have discovered that the micro-/nano-structures and surface chemical composition are the physicochemical essence of superhydrophobicity and superhydrophilicity, confirmed that ordered arrangement of water molecules at hydrophilic nanostructured interfaces is crucial for attaining superhydrophilicity, and further defined superwettability as a complementarity of superlyophobicity and superlyophilicity. It is revealed that the intrinsic wetting threshold of the liquid corresponds to the transition point of superlyophobicity and superlyophilicity on nanostructured surface, rather than 90° for all kinds liquids according to Young's equation. A superwetting interfacial nanomaterial system, including 64 combinations, was established and then extended to 13 kinds of liquid systems under different pressures and temperatures. More than 10 superwetting interfacial nanomaterials have been applied in energy, environment, agriculture, resources and information fields. On the other hand, dynamic superwettability is defined as liquids superspreading on two-dimensional surfaces with nanostructures, or directional fluid through one-dimensional micropores/microcones, or even ultrahigh flux of molecules/ions in biological/artificial nanochannels. Based on the study of dynamic superwettability, we posed a fundamental question in the life sciences: how do living systems accomplish ultralow-energy-consumption (UEC) processes such as biosynthesis, energy conversion, and information transmission? Experimental and theoretical studies have evidenced the ordered, directional collective motion of molecules/ions within biological nanochannels was the physicochemical essence for the UEC process. Some bionic UEC applications in biosynthesis, energy conversion, material separation and information transmission are further provided.

Speaker CV

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Dr Lei Jiang is a Professor at Suzhou Institute for Advanced Research. He is an academician of the Chinese Academy of Sciences, Academy of Sciences for the Developing World, National Academy of Engineering (USA), Australian Academy of Science and Academia Europaea. His scientific interests focus on bio-inspired, smart, multi-scale interfacial materials with superwettability. Prof. Lei Jiang has discovered and established the basic principle of the interfacial material systems with superwettability and extended them to successful innovative applications. His work has been followed by more than 1,400 research institutions in 94 countries around the world. He is the most original and influential scientist in the field of material science in China. He has built the interfacial material systems with superwettability and further extend this system to interfacial chemistry. His work pioneers the development of this field, and many of his fundamental technologies have been transferred to practical products in the market.

Persistent luminescent materials: from ps charge transfer to nightlong emission

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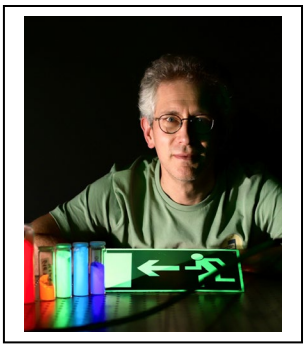
Abstract

Persistent luminescence, i.e. light emission lasting from minutes to hours after the excitation source is turned off, enables a wide range of applications, from safety signage and emergency lighting to bioimaging and outdoor road markings. Such extended emission originates from the trapping of charge carriers in defect states and their gradual thermally driven release, followed by radiative recombination at luminescent centers.

First, we address the fundamental mechanisms of charge trapping and detrapping that govern persistent luminescence efficiency and duration. Using x-ray absorption spectroscopy, we probe valence state changes in lanthanide (co)dopants, while transient absorption spectroscopy combined with lifetime measurements on the model system $SrAl_2O_4$:Eu,Dy provides time-resolved insights into charge and energy transfer processes across picosecond to millisecond timescales. These combined approaches shed light on both the beneficial and loss pathways that define material performance.

The second part focuses on application-oriented studies, assessing the outdoor performance of benchmark and newly developed persistent phosphors under actual illumination and temperature conditions. A dedicated test setup enables continuous evaluation across different seasons, linking laboratory metrics to real-world durability and brightness. The findings contribute to optimizing materials for sustainable, maintenance-free outdoor applications such as road markings, bridging the gap between fundamental physics and practical use.

Speaker CV



Philippe Smet received his Ph.D. in Physics in 2005 on the topic of blue materials for thin film electroluminescence display applications. Later, his research shifted to the study of the lanthanide based phosphors for LED applications and persistent luminescence. By combining multiple analytical techniques, the aim is to better understand the processes underlying the luminescence behaviour. In 2018 he was appointed full professor at Ghent University. He is currently the chair of the programme committee in Physics and Astronomy.

Hybrid Horizons: Thin-Film Engines for Next-Generation Tandem PV

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Abstract

While silicon PV dominates the market, further efficiency gains are essential to cut costs and raise power output. To surpass the single-junction silicon efficiency limit, tandem architectures —pairing silicon with wide-bandgap top cells — offer superior solar spectrum utilisation. The central challenge is manufacturing top cells that meet all key criteria simultaneously: low-cost, long-term stability, and high-efficiency. Expanding the palette of viable wide-bandgap thin-film materials is critical to maximise the likelihood of success in tandem PV. Our learnings and advances in earth-abundant compound semiconductor top cell materials addressing these needs will be discussed.

Speaker CV

Scientia Prof Xiaojing Hao obtained her PhD in the School of Photovoltaic and Renewable Energy Engineering of UNSW in 2010, and currently the full Professor (tenured), ARC Laureate Fellow at UNSW. Prof Hao has focused her research on low-cost, high-efficiency thin film solar cells and tandem solar cells for nineteen years, researching on various energy materials, initially using Si, and then earth-abundant compound semiconductor materials such as chalcogenides and perovskite for both solar photovoltaic and solar fuel applications. Prof Hao now leads a strong group in the above areas, achieving a number of efficiency records on several emerging thin film solar cells. Prof Hao has published >220 peer-reviewed journal papers, including publications in Nature Energy, Nature Photonics, Energy and Environmental Science, with several awards for her research excellence. She was the recipient of Inaugural Australian Renewable Energy Agency Postdoc Fellow, previous ARC DECRA, ARC Future Fellow, inaugural Sciential Fellow at UNSW. She was awarded a number of prestigious national prizes, including 2020 Prime Minister's Prizes for Science: Malcolm McIntosh Prize for Physical Scientist of the Year, 2021 Australian Academy of Science Pawsey Medal. She was elected to Fellow of ATSE in 2022 and Fellow of AAS in 2025.

Short-wavelength infrared emitting phosphors for tracer-based sorting to enhance plastic recycling

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Abstract

Introducing luminescent markers into plastics can allow rapid automated sorting that allows “hard to recycle” polymers to be differentiated beyond the chemical classification of near infrared (NIR)-based sorting. A proposed solution is to add photonic tracers to the polymer to improve sorting purity via tracer-based sorting (TBS). Here, luminescent down-shifting tracer materials that emit in the short-wavelength infrared (SWIR) range (1000–2000nm) are investigated. The micron-scale SWIR-emitting phosphors are typically based on oxide or oxysulfide hosts and rely on 980nm excitation via the ytterbium (Yb3+) ion. The emitting ions include the more classical lanthanides – holmium (Ho3+) at 1190nm, erbium (Yb3+) at 1550nm, and thulium (Tm3+) at 1800nm – while more recent interest has focussed on transition metal ions such as nickel (Ni2+) and chromium (Cr4+), both exhibiting broad emission in the 1100-1600nm range. Key goals include achieving high photoluminescent quantum yields (PLQYs) and high absorption (thus maximising brightness), as well as the resolution at which the luminescence signal can be readout (differentiated). This presentation will discuss the potential for such luminescent taggants for achieving a circular economy, alongside the most important material and photophysical considerations.

Speaker CV

Bryce studied physics at the Victoria Univ. of Wellington (New Zealand) before completing a Masters and PhD in electrical engineering at Univ. of New South Wales (UNSW), Australia, in 1998 and 2002, respectively. He worked as a postdoctoral researcher at both UNSW and the Australian National University. In 2006, he joined Heriot-Watt University (Edinburgh, U.K.) as a lecturer, being promoted to full professor in 2008. Since 2014 he is co-director of the Institute for Microstructure Technology (IMT) and Light Technology Institute (LTI) within the Karlsruhe Institute of Technology (Germany). His primary research areas lie in the development of luminescent materials for up- and down-conversion and their applications in fields such as photovoltaics, solar-powered lasers, biological imaging and improved plastic waste sorting. Bryce is also passionate about the use of solar energy for providing clean drinking water, and works on materials, devices and technologies towards this goal.

Investigation of Various Local Structures and Applications of Short-Wave Infrared Phosphors

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Abstract

The modification of short-wave infrared (SWIR) phosphors plays a crucial role in improving their performance for various optical applications. Two techniques for improving SWIR light emission: cation substitution in spinel structures and energy transfer in codoped phosphors are investigated in this work. The lattice parameters were changed by substituting Ga3+ with Sn4+ in MgGa2O4, consequently boosting SWIR emission and energy transfer efficiency and thereby improving performance in imaging systems using artificial intelligence (AI) system. Additionally, through energy transfer from Cr3+ to Ni2+, Cr3+/Ni2+ codoping in Mg3Ga2GeO8 phosphors greatly improved their luminescent characteristics, producing broad SWIR emissions. These modified phosphors were successfully incorporated into SWIR light-emitting devices, demonstrating their potential in a range of applications, from optical sensing to material identification. This research highlights the importance of phosphor modification in advancing the capabilities of SWIR-based technologies.

Speaker CV

Chun Che Lin is an Associate Professor at the Institute of Organic and Polymeric Materials, National Taipei University of Technology (NTUT). He completed his Ph.D. in chemistry at National Taiwan University (NTU) and subsequently held a postdoctoral position at Utrecht University. He later served as an Assistant Professor at the Graduate Institute of Nanomedicine and Medical Engineering, Taipei Medical University, from August 2018 to July 2019. Prof. Lin's research is centered on the synthesis of quantum dots and near-infrared phosphors for optoelectronic applications. His interests extend to multifunctional hydrogels, which exhibit remarkable conductivity, antibacterial properties, and self-healing capabilities. To date, he has authored over 50 SCI-indexed journal articles in renowned publications such as Advanced Functional Materials,Journal of the American Chemical Society, Angewandte Chemie International Edition, Small, and Journal of Materials Chemistry A, achieving over 5,000 citations and an h-index of 34. Additionally, he holds three patents and has contributed two book chapters during his academic career.

Single-chain ultrasmall fluorescent polymer dots enable nanometre-resolution cellular imaging and single protein tracking

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Abstract

High resolution cellular imaging depends on fluorescent probes, yet existing options face intrinsic trade-offs. Organic dyes and fluorescent proteins remain the preferred option for live-cell experiments because they are compact and minimally perturbative. However, they are often dim or unstable for demanding applications. Nanoparticles such as quantum dots or conventional polymer dots became popular because of their extreme brightness and photostability, but they are bulky, with diameters exceeding 10 nm. Such large size hinders efficient labelling of dense cellular assemblies, limiting their use in crowded molecular environments. This size-brightness dilemma has long been a bottleneck in super-resolution microscopy, and a probe combining the compactness of proteins with the brightness of nanoparticles has long been sought after. Here, we develop fluorescent single-chain polymer dots (suPdots) with size below 5 nm, comparable to fluorescent proteins. Fabricated via vitreously frozen conjugated polymer solutions, suPdots enable tuneable fluorescence as well as high-density, specific labelling of multiple subcellular organelles. We demonstrate nanoscopic imaging of continuous ring structures in clathrin-coated pits as well as multi-target STED imaging. Thanks to their high brightness, suPdots enable tracking of individual kinesin-1 stepwise in living cells using standard spinning-disk fluorescent microscopy, with a 16 nm step size and 50 Hz temporal resolution. These demonstrations establish suPdots as powerful, versatile fluorescent probes for nanoscale-resolution biomolecular imaging with increased accessibility and efficiency for diverse bio-applications.

Speaker CV

Jianjun Wang received his Ph.D. in Colloid and Interface Chemistry from the University of Mainz in Germany. He subsequently conducted postdoctoral research at Max-Planck Institute for Polymer Research (MPIP) and later served as a project leader at MPIP from 2007 to 2010. He joined the Institute of Chemistry, Chinese Academy of Sciences (CAS) as a full professor in 2010, and since 2023 he has been a full professor at the Technical Institute of Physics and Chemistry, CAS. He has published more than 120 papers in reputed journals and has been a Fellow of the American Physical Society.

Synthesis of phosphor materials by the water-assisted room-temperature solid-state reaction (WASSR) method

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Abstract

Conventional synthesis of inorganic solids is typically carried out by the solid-state reaction method at high temperatures. Because conventional solid-state reactions proceed very slowly near room temperature, high temperatures are required to enhance the reactivity among raw material powders. However, such high-temperature processing often results in irregular particle morphologies in the obtained ceramic powders.

In contrast, we have proposed a new and simple water-assisted solid-state reaction (WASSR) method. This process is straightforward and enables the synthesis of various nanoceramics simply by mixing raw materials with a small amount of water at temperatures below 500 K. For example, (Cs,Rb)VO_3 and YVO_4:Eu phosphors can be synthesized at room temperature by mixing the raw materials with about 10 wt% of water. The resulting particles typically have average sizes below 100 nm.

In this study, we demonstrate the practicability of the WASSR method for industrial applications in the synthesis of phosphor materials.

Speaker CV

Kenji Toda (Birth date 7, Feb. 1964) is a professor at the Graduate School of Science and Technology, Niigata University, Japan. He works at Graduate School of Science and technology in Niigata University. He received his Ph.D. in 1995 from Niigata University, JAPAN. His main research topics include development of new phosphor and photocatalyst materials and soft chemical synthesis of ceramic.
He has published more than 320 peer-reviewed papers and filed over 120 patents. His awards include the Rare Earth Society of Japan Award (Shiokawa Award), the Outstanding Poster Paper Award at the International Display Workshops (IDW) in 2005, 2010, and 2013, and the Best Paper Award at IDW in 2014.

Rare earth doped crystals for integrated quantum photonics

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Abstract

Systems with both spin and optical transitions offer a range of functionalities for technologies such as quantum communications, computing, and sensing. Among various solid-state systems currently considered, rare-earth doped materials stand out as they combine, at cryogenic temperatures, long-lived optical and spin quantum states. In addition, they offer optical transition in a wide spectral range, including telecom wavelengths, high chemical stability, and easy doping in many hosts, thus enabling using large ensembles of centers with uniform properties. Quantum-grade rare earth doped nanostructured materials such as nanoparticles, thin films, or molecular crystals, aiming at integration into nanophotonics devices have recently raised a strong interest. In this talk, we will present some of our recent results in the field, as well as the challenges to be addressed to bring rare-earth doped materials up to the highly demanding requirements of quantum technologies.

Speaker CV

Philippe Goldner is a CNRS Research Director at Chimie ParisTech–PSL. He has been working for many years on the development of rare-earth-doped materials for applications in quantum technologies. In addition to bulk materials, his current research focuses on the growth and spectroscopy of nanostructured crystals, such as nanoparticles and thin films, which can be integrated into photonic devices. He was recently awarded an ERC Advanced Grant and the Philippe A. Guye Prize of the French Academy of Sciences.

Sintering of phosphor ceramics with less luminescence loss

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Abstract

Laser-driven solid-state lighting promises less power consume, super-high brightness, low étendue, and compactness, enabling it to be used in automotive headlights, high-brightness projectors & cinema, and specialized & industrial Lighting. Phosphor ceramics are superior to phosphor powders and films in thermal conductivity and robustness, but sintering of them is a big challenge when it is required to preserve their photoluminescence properties, typically for nitride phosphors. In this presentation, we will report the preparation and optical properties of several types of phosphor ceramics, including red-emitting (Sr,Ca)AlSiN3:Eu, dual-color YAG:Ce/α-sialon:Eu-Al2O3, and green-emitting porous LuAG:Ce. High-intensity or super-bright light sources will be demonstrated by using sintered phosphor ceramics.

Speaker CV

Rong-Jun Xie obtained his PhD in Ceramics at Shanghai Institute of Ceramics, Chinese Academic of Science in 1998. After carrying out post-doctoral work at National Institute for Materials Science (NIMS, Japan), National Institute for Advanced Industrial Science and Technology (AIST, Japan), and Alexander von Humboldt (AvH) research fellow at Darmstadt University of Technology (Germany), Xie joined National Institute for Materials Science (NIMS) as a Senior Researcher in 2003, and was promoted to Principal Researcher in 2007 and to Chief Research in 2017. In 2018, he moved to Xiamen University as a full professor at College of Materials. Xie's research interests include (i) phosphors for lighting and displays; (ii) mechanoluminescent materials for sensing technologies; and (iii) quantum dots for emissive displays. He has contributed to 300+ published papers, 100+ invited talks, and 50+ patents. He is now the editor of J. Am. Ceram. Soc. and advisory board member of Laser & Photonics Rev.

Advanced Near-Infrared Phosphors for Next-Generation Optical Fiber Communications

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Abstract

This presentation explores breakthrough developments in near-infrared (NIR) phosphor materials for optical fiber communication applications. We discuss three major innovations addressing critical challenges in telecommunications and shortwave infrared (SWIR) technologies. First, we examine Cr^{4+}-doped garnet phosphors with calcium charge compensation, demonstrating broadband emission at 1100–1600 nm that effectively covers water absorption regions in telecommunication bands. The $Y_{2.84}Al_{4.9}O_{12}$:0.1Cr,0.16Ca^{2+} crystal fiber shows superior performance compared to commercial alternatives. Second, we present dual cation-doped garnet phosphors incorporating both Ca^{2+} and Mg^{2+} ions. The YAG:0.1Cr,0.16Ca,0.08Mg system enhances NIR-II emission through improved crystal structure, surface modification, and increased tetrahedral coordination sites for Cr^{4+} ions. Finally, we introduce a bifunctional $(Ga,Ge)_2O_3$:Cr^{3+},Ni^{2+} phosphor system achieving 10.6% internal quantum efficiency with SWIR emission at 1430 nm. This material demonstrates dual functionality for both optical fiber amplifiers and LED applications. These innovations offer enhanced efficiency, broader bandwidth coverage, and improved thermal stability for next-generation optical communication systems, representing significant advances in photonic materials technology.

Speaker CV

Professor Ru-Shi Liu received his Bachelor's degree in Chemistry from Soochow University (Taiwan) in 1981. He got his Master's Degree in nuclear science from the National Tsing Hua University (Taiwan) in 1983. He obtained two Ph.D. degrees in Chemistry from National Tsing Hua University in 1990 and the University of Cambridge in 1992. He joined Materials Research Laboratories at the Industrial Technology Research Institute as an Associate Researcher, Research Scientist, Senior Research Scientist, and Research Manager from 1983 to 1995. Then, he became an Associate Professor at the Department of Chemistry of the National Taiwan University from 1995 to 1999. Then, he was promoted to Professor in 1999. In July 2016, he became the Distinguished Professor.

Phosphor Safari 2026

His research is concerned with Materials Chemistry. He is the author and co-author of more than 677 publications in international scientific journals with total citations >37,277, h-index: 97. He has also been granted more than 200 patents.

Solvent-Modulated Plasticity in Lead-Free Manganese Halides for Advanced Functional Material Design

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Abstract

The development of efficient color conversion layers for μ-LED technology faces significant challenges due to the limitations of binder-containing materials. Binders are typically used to ensure uniform film formation, but they often cause optical losses, increase layer thickness, and introduce long-term stability issues. To overcome these limitations, we synthesized cyclopropyltriphenylphosphonium manganese tetrabromide (CPTP2MnBr4), a novel lead-free metal halide. CPTP2MnBr4 exhibits unique solvent-tuned plasticity, enabling the formation of uniform, binder-free films without heat treatment. This approach eliminates performance degradation associated with conventional binder systems, including optical losses and stability concerns. Structural and optical analyses confirm its high luminescence efficiency and stability, supporting its potential applications in luminescent clays, direct ink writing, pattern printing, and ink drawing. Furthermore, its successful integration into white light-emitting diodes (WLEDs) and scintillators demonstrates that CPTP2MnBr4 can serve as a viable alternative to traditional binder-based systems, addressing key challenges in next-generation displays, lighting, and scintillator technologies.

Speaker CV

Won Bin Im received his Ph.D. in Materials Science and Engineering from the Korea Advanced Institute of Science and Technology, Republic of Korea. He conducted his postdoctoral research at the University of California, Santa Barbara, USA. Since 2010, he has served as Assistant, Associate, and Professor at Chonnam National University, and later joined Hanyang University as a Professor in the Division of Materials Science and Engineering. He currently serves as a Technical Editor for the *ECS Journal of Solid-State Science and Technology*. To date, he has published more than 210 papers in reputed journals.

RE- and TM-Ion-Doped Short-Wave Infrared Luminescent Materials: Advances and Opportunities

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Abstract

Short-wave infrared (SWIR; 900–1700 nm) luminescent materials are attracting strong interest for applications in night vision, non-destructive identification, medical diagnostics, and beyond. Recent advances in lanthanide- and transition-metal-ion-doped phosphors have enabled efficient conversion of blue excitation light into broadband SWIR emission. Key developments include narrowband emissions from lanthanide activators, broadband emissions from transition-metal ions, and co-doping strategies where Cr^{3+} acts as a sensitizer for Yb^{3+} and Ni^{2+}. These approaches have expanded emission tunability, improved quantum efficiency, and enhanced thermal stability. SWIR phosphor-converted LEDs are emerging as compact, efficient light sources for practical applications. In this talk, we will highlight material design strategies, summarize state-of-the-art performance, and discuss challenges and future opportunities for integrating SWIR luminescent materials into next-generation optoelectronic devices.

Speaker CV

Professor Xiaojun Wang received his B.S. in Physics from Jilin University, his M.S. from the Chinese Academy of Sciences, and his Ph.D. in Physics from the University of Georgia, USA. He conducted postdoctoral research at Oklahoma State University and later as an NIH Postdoctoral Fellow at the University of California, Irvine. Since 1995, he has been a Professor of Physics at Georgia Southern University, USA. Professor Wang currently serves as Editor-in-Chief of Materials Research Bulletin and as an Editor of Light: Science & Applications. He is a Fellow of the American Physical Society.

Recent Advances in Lanthanide-Doped Luminescent Nanoprobes for Theranostics

Xueyuan Chen

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Abstract

Lanthanide-doped inorganic nanocrystals with unique electronic structures and tunable optical properties have shown great potentials as a new class of luminescent bioprobes or phototherapeutic agents in biomedical field. In this talk, we shall focus on our most recent advances in the development of luminescent lanthanide nanomaterials for optical diagnosis, therapy, and theranostics towards major diseases [1-7]. Special emphases will be on the ultrasensitive in vitro detection of circulating tumor cells, in vivo tumor-targeted near-infrared II imaging, synergistic lysozyme-photodynamic therapy against multidrug-resistant bacteria, and noninvasive precise phototheranostics of pulmonary biofilm infection.

Speaker CV

Xueyuan Chen (Website: http://fjirsm.cas.cn/xchen) is currently Director of Fujian Key Laboratory of Nanomaterials, Fujian Institute of Research on the Structure of Matter (FJIRSM), Chinese Academy of Sciences, Editor-in-Chief of Journal of Luminescence. and Associate Editor of Sci. China Mater. and Chin. J. Lumin. He earned his B.Sc. from University of Science and Technology of China (1993) and his Ph.D. from FJIRSM (1998). From 2001 to 2005, he was a postdoctoral research associate at the Chemistry Division of Argonne National Laboratory, U.S. Department of Energy. In 2005, he joined the faculty at FJIRSM. His research focuses on the electronic structures, optical properties and applications of inorganic luminescent materials, such as lanthanide nano-bioprobes and LED phosphors.

Plasmonic Nanomaterials for Surface-enhanced Raman Scattering (SERS) based cancer diagnosis

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Abstract

Non-invasive analysis of cancer biomarkers such as circulating tumor cells (CTC), ctDNAs, and small extracellular vesicles (sEVs) from body fluids (so called liquid biopsy) is in high demand because it is the key to achieve the original and intact information from the cells [1]. Thus, non-invasive and in vitro analysis of circulating biomarkers has the benefit of rapid, low-cost and little inconvenience to the patients. However, the achievement of liquid biopsies is challenging due to the rare amount of cancer-relevant circulating biomolecules against a high abundant background of non-biotargets. To overcome this technical hurdle in liquid biopsies, we have proposed the use of plasmonic and surface-enhanced Raman scattering (SERS) spectroscopy as new analytical tools for in vitro cancer diagnosis, owing to the ultra-sensitivity and multiplexing capability of SERS [2-4]. We thus have developed a few new strategies to engineer the functional plasmonic nanomaterials for SERS-based in vitro cancer diagnostic application. In this contribution, I will present our recent results in this evolving field—from the synthesis of cutting-edge plasmonic nanomaterials [3-6] to the design of biosensor platform [7-8], towards the comprehensive clinical evaluation of SERS strategies in cancer diagnosis [8-10]. By taking advantages of the unique properties of plasmonic nanomaterials and the sensor platform (e.g. microfluidic device) in fast sample preparation, we target on simultaneously and selectively detecting a broad panel of cancer biomarkers for cancer diagnosis.

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Speaker CV

Prof Yuling Wang is an ARC Future Fellow at Macquarie University. She is also a Fellow of the Royal Society of Chemistry (FRSC) and a member of ARC College of Expert (2022-2025). Yuling completed her PhD at the Chinese Academy of Sciences in 2009. She was then awarded an Alexander von Humboldt fellowship (2010) and a German Research Foundation fellowship (2012), working at the University of Duisburg-Essen, Germany. In 2014, she received ARC DECRA fellowship and worked at the University of Queensland. Recently, Yuling was awarded the NHMRC Leadership Fellowship to develop novel nanotechnology for personalized cancer management. Her research focuses on platform technology that uses functional nanomaterials for biomarkers sensing, aiming to enhance in vitro diagnostics.

Fluorescent Probe Platforms Enabling Quantitative Imaging of Lipid Droplet Biology

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Abstract

Lipid droplets (LDs) are highly dynamic organelles that regulate lipid storage, energy supply, and cellular stress responses, and their dysfunction is increasingly implicated in metabolic, cardiovascular, and neurodegenerative diseases. Despite their importance, tools to quantitatively interrogate LD composition, polarity, and fate in living systems have been limited, constraining our understanding of their roles in health and disease.

Here, we present a suite of newly developed fluorescent reporters that enable high-resolution and functional imaging of LDs across multiple biological contexts. These tools provide quantitative readouts of LD polarity, viscosity, and lipophagic flux at the single-organelle level, with excellent specificity, photostability, and applicability in both cell culture and whole organisms. Using these approaches, we reveal how LD polarity and composition dynamically change under lipid overload, endoplasmic reticulum stress, and nutrient deprivation, offering new insight into how cells selectively mobilize LDs for lipolysis or degradation via lipophagy. Applied in animal models, these probes permit robust visualization of hepatic LDs and uncover previously unrecognized lipid pathologies that can be modulated pharmacologically.

We further demonstrate the utility of these tools in patient-derived fibroblasts, where they reveal disease-associated alterations in LD number, morphology, and contacts with mitochondria, pointing to disrupted lipid–energy coupling in cellular pathogenesis. In addition, real-time quantification of lipophagic flux exposes lysosomal dysfunction, enabling discrimination of lysosomal storage disorders at the single-cell level with greater sensitivity than conventional staining methods.

Together, these advances establish a versatile chemical biology platform for dissecting LD heterogeneity, organelle crosstalk, and lipid metabolic remodeling in live systems, and open new opportunities for understanding the contribution of LD dysfunction to human disease.

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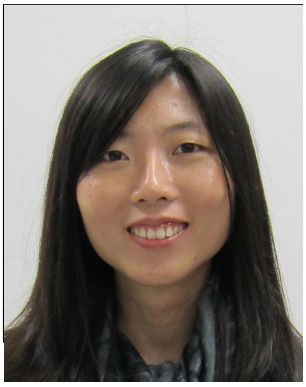
Speaker CV



Dr Yuning Hong is a Professor of Chemistry and an ARC Future Fellow in the Department of Biochemistry and Chemistry, La Trobe Institute for Molecular Science (LIMS), La Trobe University. She was a former ARC DECRA fellow (2017-2020) and McKenzie Fellow in University of Melbourne (2014-2016). Her research at LIMS focuses on developing novel fluorescent chemical probes for protein chemistry and cell biology, and the study of their interplay in the context of neurodegenerative diseases. Dr Hong is the recipient of the Le Fèvre Medal from Australian Academy of Science (2022) and the RACI Rita Cornforth Lectureship Award (2018).

Unlimited NIR photoswitching of nanocrystals for sub-Å accuracy optical imaging

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Abstract

Recently, photon avalanche has been observed in single nanoparticles, offering building blocks for a wide range of applications in high-sensitivity pressure and temperature sensing and super-resolution optical imaging with simple confocal microscopy. In this talk, I will discuss photoswitching behavior of Tm^{3+}-doped avalanching nanocrystals. I will explain the photoswitching mechanism associated with color center generation and address the enhancement of photoswitching capability realized in inorganic nanocrystals. Following that, I will introduce applications of these photoswitchable nanocrystals including 2D and 3D optical patterning using low-cost continuous-wave lasers and super-resolution optical microscopy with sub-angstrom localization accuracy. I will conclude this talk by providing potential future applications of these highly nonlinear photoswitchable nanomaterials.

Speaker CV

Changhwan Lee is an assistant professor of Material Sciences and Engineering at KAIST. He received his Ph.D. in Mechanical Engineering from Columbia University in 2022 and worked as a postdoc at the same university before joining KAIST in 2024. During his Ph.D. and postdoc, he focuses on realizing avalanche effects in lanthanide-doped upconverting nanoparticles and exploring their applications.

Sub-milliwatt upconversion nanoprobes for broadband mid-infrared sensing

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Abstract

Mid-infrared (MIR) detection underpins chemical sensing, thermal imaging and environmental monitoring, yet most existing technologies rely on cryogenic detectors or thermal transduction mechanisms that limit integration, stability and quantitative performance. Lanthanide upconversion offers a room-temperature alternative by converting MIR excitation into near-infrared signals, but current implementations typically require high-power pumping or depend on heating-induced modulation, which constrains sensitivity and prevents accurate MIR readout. Here we introduce sub-milliwatt upconversion nanoprobes that enable broadband MIR sensing across the 6.4 to 8.5 μm range while operating under less than 0.1 mW of 980 nm excitation. MIR illumination reshapes the population distribution between the Er^{3+} green-emitting manifolds, producing a pronounced opposite variation in the two visible emission bands. Temperature-dependent and time-resolved measurements confirm a non-thermal mechanism driven by MIR-induced changes in excited-state population pathways. The resulting ratiometric response provides linear, pump-insensitive and quantitative MIR readout, together with excellent switching stability and high responsivity at very low optical powers. Integrated with a silicon photodetector, the nanoprobes further enable room-temperature MIR imaging. Our work establishes a low-power and non-thermal upconversion strategy that expands the capabilities of lanthanide nanomaterials for compact and chip-integrated infrared sensing technologies.

Speaker CV

Dr. Chaohao Chen is an ARC DECRA Fellow and Chancellor Research Fellow at the University of Technology Sydney (UTS). His research primarily focuses on nanophotonics and biophotonics. He earned his Ph.D. in Physics from UTS in late 2020, followed by postdoctoral research in the Department of Electronic Materials Engineering at the Australian National University. His expertise lies in designing novel luminescent nanomaterials and developing advanced optical imaging systems. Dr. Chen has authored over 30 peer-reviewed journal articles, featured in premier international journals such as Nature

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Communications, Advanced Materials, Nano Letters, and Advanced Science as first or corresponding authors.

Spatiotemporally Activated Rare-Earth Nanoprobes for Bioimaging

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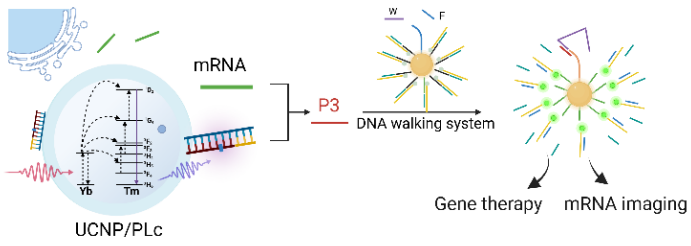
Abstract

Rare-earth-based nanoprobes activated by near-infrared (NIR) light offer precise control over biological processes due to deep-tissue penetration, low background, and high photostability. Here, we present a series of NIR-activated rare-earth nanoprobes for spatiotemporally regulated bioimaging and therapy. By integrating upconversion nanoparticles with photoresponsive DNA and enzyme systems, optical modulation of molecular events at cellular and subcellular levels was achieved. NIR-triggered DNA walkers enabled dynamic microRNA imaging, while DNA nanodevices allowed amplified mRNA detection and on-demand antisense oligonucleotide delivery for gene silencing in tumor cells. Building on this, enzyme- and NIR-activated CRISPR/Cas9 nanoplatforms achieved tumor-selective mitochondrial genome editing with notable therapeutic effects. Additional applications included the reversible sensing of reactive sulfur species during myocardial ischemia–reperfusion injury, NIR-controlled cell–cell assembly, and dual-mode antibacterial imaging and therapy via dye-sensitized nanohybrids with controlled nitric oxide release. These studies demonstrate that NIR-activated rare-earth nanoprobes provide a versatile and controllable platform for manipulating complex biological processes, bridging photonic materials with biomedical applications, and paving the way for next-generation bioimaging and precision therapeutics.



Scheme. Illustration of intracellular NIR photoactivatable UCNPs for survivin mRNA imaging and gene therapy.

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Speaker CV

Cuiling Zhang received her Ph.D. degree in Analytical Chemistry (Bioanalysis) from Wuhan University in 2014. She is currently a professor in the School of Chemistry and Molecular Engineering at East China Normal University. She was also a visiting scholar at the University of Technology Sydney (2022–2023) with Prof. Dayong Jin. Her recent research focuses on near-infrared fluorescent probes (eg.rare-earth nanoparticles), integrated with DNA nanotechnology for ultrasensitive detection, in vivo bioimaging, and biomedical applications.

Nano-engineered narrow-band phosphors for LED applications

Federico Montanarella

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Abstract

Narrow-band line-emitter phosphors offer improved lm/W for white LEDs, while maintaining high CRI. Especially Eu3+-doped phosphors are ideal from an emitter perspective. However, using Eu3+ for practical LEDs is hampered by the lack of absorption in the blue spectral region. To solve this problem, we have developed nano-engineered phosphors harvesting interparticle energy transfer (IFRET), an innovative approach to sensitize Eu3+, and other ions, in the blue spectral range. In this presentation, we will share our progress on our IFRET materials, as well as demonstrate high-quality (high QY and small-size) nano-YAG phosphors.

Speaker CV

Federico Montanarella is the Director of Research at Seaborough BV, a nanotechnology company based in Amsterdam, the Netherlands, focusing on the development of groundbreaking luminescent nanocrystals-based solutions, such as the innovative EuroLED nanophosphors for LED applications. After graduating in 2015 in Materials Science and Engineering (MSc) at the University of Genoa, in Italy, with a thesis on the synthesis and optical characterization of semiconductor nanocrystals, Federico obtained his PhD from Utrecht University in 2019 with a thesis on the optical and structural properties of self-assembled quantum dots; thesis performed under the supervision of Prof. Vanmaekelbergh and Prof. van Blaaderen. After a postdoc at ETH Zurich in the group of Prof. Kovalenko, where he gained familiarity with perovskite nanocrystals, Federico joined Seaborough in 2021 as a Material Scientist, working on the development of nanophosphors. In 2024, Federico was promoted to Director of Research, leading the early-stage development of Seaborough's groundbreaking technologies.

Hybrid Glass Fiber and Its Optical Applications

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Abstract

Combining the merits of the high efficient luminescence of nanocrystals and the excellent fiber-drawing ability of the glass matrix, transparent nanocrystal-doped glasses and fibers have been considered as potential candidates for various optical applications. Our group designed the glass system based on glass genetic engineering prediction, and controlled the formation of low phonon energy nanocrystals in the glass matrix through external field induction. The high performance nanocrystal-doped glass fibers were fabricated by novel fiber-drawing method. Importantly, enhanced visible and infrared laser output is realized in nanocrystal-doped glass fibers, strongly manifesting that the obtained hybrid glass fiber is a promising gain material for fiber lasers. Furthermore, our works also expanded the potential applications of nanocrystal-doped glass and fiber in fields of amplifier, sensor, detecting, etc.

Speaker CV

Guoping Dong received his PhD degree from Shanghai Institute of Optics and Fine Mechanics (Chinese Academy of Sciences) in 2010, where he received the “Chinese Academy of Sciences President Award”. He is currently a full Professor (2014-) at the State Key Laboratory of Luminescent Materials and Devices, South China University of Technology (SCUT), China. He has coauthored about 200 peer-reviewed papers with around 14000 citations. He is the author of 2 book chapters and >30 authorized patents. He has been Session Chair/Organizing Committee Member for more than 40 conferences. He was also invited to give >50 Plenary/Keynote/Invited talks in various conferences, including International Congress on Glass (ICG), International Ceramics Congress (ICC), Phosphor Safari etc. His current research interests are focused on the design, fabrication and photoelectronic properties of novel photonic material and devices.

Research on the Design, Preparation and Application of High-Efficiency Full-Spectrum Phosphors

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Abstract

To address the demand for full-spectrum lighting, a single-particle phosphor solution has been proposed. By utilizing heterogeneous interfaces to block energy migration, a highly efficient single-particle full-spectrum phosphor with internal and external quantum efficiencies reaching 76.1% and 56.2%, respectively, has been achieved. Additionally, a single-phase ultra-broadband full-spectrum phosphor with a full width at half maximum (FWHM) of 330 nm has been developed. Based on this phosphor, a miniaturized spectral detection system was constructed, and combined with machine learning, it enables accurate identification of multiple types of dyes. This research breaks through the efficiency and miniaturization bottlenecks of full-spectrum lighting devices, providing a material foundation for healthy lighting and portable sensing applications.

Speaker CV

Zhou Lei is currently an Associate Professor at the School of Chemical Engineering and Technology, Sun Yat-sen University, and was introduced as a talent through the University's Hundred Talents Program. In 2023, he was awarded the Pearl River Scholarship by the Guangdong Provincial Department of Education. He received his Bachelor's degree from Sun Yat-sen University in 2009 and his Ph.D. in Inorganic Chemistry from the same university in 2016 under the supervision of Professor Hongbin Liang. During his postdoctoral research, he worked with Professor Mingmei Wu and Academician Xiaogang Liu of the National University of Singapore. He has led five research projects, including those funded by the National Natural Science Foundation of China, and participated in seven national and provincial-level projects. He has published over 50 SCI papers, including Adv. Mater. and Angew. Chem. Int. Ed. which have been cited more than 3,000 times, achieving an H-index of 26. He also holds four authorized invention patents.

Highly Ordered Quantum Dot Assembles for Superbright Emission

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Abstract

Halide perovskite quantum dots have been considered as next generation of emitters since they have unit photoluminescence quantum yield, and high defect tolerance factor and widely tunable emission spectra via flexible chemical composition and size control. However, the vulnerability and disordered assembles of halide perovskite quantum dots limit their diverse applications. To fully unlock the potentials, highly ordered 2D and 3D assembling structures were constructed through ligand engineering by my group, which not only demonstrated superbright emission ranging from visble to near infrared spectra, buy only robustness against water and ultraviolet soaking. Therefore, highly ordered assembles would provide a revolutionary platform for emitting technologies in terms of light emitting diodes, luminescence solar concentrators and photodetectors.

Speaker CV

Dr Long Hu completed his PhD degree in Optical Engineering from Wuhan National Lab for Electronics, Huazhong University of Science and Technology under the supervision o f Prof Jiang Tang in 2016. He is currently working at UNSW funded by ARC DECRA Fellow. His major research is focused on designing advanced semiconductor nanomaterials and novel structures for high-performing optoelectronics.

Hot or not? How to tailor nonradiative transitions for wide-range luminescent thermometers

Markus Suta

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Abstract

Usually, photoluminescence is concerned with an optimization of the spontaneous radiative decay pathway, whose foundations were already laid down by the advent of (cavity) quantum electrodynamics and led to the vibrant field of photonics. In contrast, the non-radiative pathway, i.e. the coupling of the transition dipole moment to vibrational modes, has only got into a closer focus since the early 1970s. One major finding was the energy gap law for multi-phonon transitions with a limited temperature dependence, while broad-band emission is thermally very labile due to a so-called non-radiative crossover. Theoretical approaches to the non-radiative channel have ever been tackled but often require very sophisticated techniques and still do not satisfactorily agree even in the order of magnitude with experimental data. An interesting impetus was given by Burshtein in 2010 that, after pioneering works by Orlovskii, Pukhov and others as well as Ermolaev and Sveshnikova, indicated that non-radiative transition rates should also be related to transition oscillator strengths. From a quantum field theoretical perspective, this would be very intuitive and implies that many control parameters known for radiative transitions should also hold for non-radiative transitions. Such an understanding is key to the design of luminescent thermometers, but could even open up new avenues to control the quantum efficiency of phosphors in general.

Within this lecture, I will give a brief historical account on major theoretical and experimental breakthroughs in the understanding of radiative and non-radiative decay in phosphors and demonstrate how theoretical approaches to the non-radiative transition can be explicitly tested with Boltzmann and crossover-type thermometers. Selected examples among various (in)organic emitters demonstrate what are critical experiments in the proof of selection rules of non-radiative transitions, what other impacts there are besides the energy gap law and how this can be used to additionally tailor the performance of luminescent materials.

Speaker CV

Phosphor Safari 2026

Markus Suta studied Chemistry (MSc) at the University of Siegen, Germany, and obtained his PhD degree in Chemistry in the group of Claudia Wickleder in 2017. He followed up with a second degree in Physics (MSc) with specialization in Theoretical Physics in the group of Thomas Mannel in Siegen. From 2018 to 2021, he has been working as a postdoctoral researcher in the group of Andries Meijerink at Utrecht University, The Netherlands. Since 2021, he has been holding a tenure track position for Inorganic Photoactive Materials at the Heinrich Heine University Düsseldorf, Germany. His interests lie in the development and a fundamental understanding of new inorganic phosphors for various applications such as LEDs, luminescent thermometry, upconversion, as well as a better understanding of nonradiative transitions. For that purpose, he and his group combine inorganic synthesis and structural chemistry in solid-state systems with advanced optical characterization by means of luminescence spectroscopy as well as theoretical modelling.

Resonantly Enhanced Upconversion with Silicon for Short-Wave Infrared Detection

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Abstract

Silicon (Si) photodetectors have limited responsivity at short-wave infrared (SWIR) wavelengths, hindering their application in telecommunications, biomedical imaging, and surveillance. Lanthanide-doped upconversion nanoparticles (UCNPs) can sensitize Si to SWIR light by converting the infrared light into visible light. Here, we present our efforts in utilizing optical cavities to address two bottlenecks in upconversion: weak infrared absorption of UCNPs and loss at the Si-UCNP interface. We report a hybrid metasurface in which nanocylinders made of low-index UCNPs are embedded in a conformal, high-index amorphous-Si layer. A flatband resonance near 980 nm, originating from collective Mie oscillations, not only enhances the excitation field in the UCNPs over a wide range of incident angles but also accelerates photo-induced passivation of interfacial loss channels, leading to significant improvement in upconversion. Next, we present a dual-resonance, linearly variable Fabry-Pérot cavity that enables efficient, tunable, and broadband upconversion from 1530 nm to 1570 nm. Combining this with a standard Si CMOS camera, we demonstrate SWIR imaging with sub-10 μm spatial resolution, on multi-layer Si wafers and in a smoke-obscured environment, respectively, highlighting the potential of this platform for semiconductor manufacturing and LiDAR technologies.

Speaker CV

Dr Mengfei Wu received her PhD in Electrical Engineering from Massachusetts Institute of Technology, following a Bachelor's and a Master's degree from the University of Cambridge. She holds joint positions as a Principal Investigator at the Institute of Materials Research and Engineering in A*STAR, and an Assistant Professor at the Department of Materials Science and Engineering in the National University of Singapore. Dr Wu's research lies at the intersection of materials science and nanophotonics. She aims to develop novel and efficient optoelectronic devices, such as photon upconverters and lasers, by exploiting the unique properties of nanomaterials interfacing with photonic structures.

Advancing Understanding and Performance of Organic Light-Emitting Diodes

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Abstract

Organic light emitting diodes (OLEDs) have become the mainstream display technology owing to its unique advantages such as true black, high contrast, wide viewing angles, and flexibility. Despite their commercial success, challenges still remain regarding device lifetime, stability and large-area fabrication. Light emission in OLEDs arises from the radiative decay of excitons, whose formation depends on balanced charge transport and a properly positioned recombination zone. Understanding charge carrier dynamics is therefore essential for improving device performance and stability. Charge extraction by linearly increasing voltage using metal-insulator-structure (MIS-CELIV) is a powerful tool to probe the charge carrier mobility, although it has limitations such as injection barrier and complicated measurement parameters. We have systematically studied this tool and extended it to multiple derivatives, for example, photo-induced MIS-CELIV, injection-MIS-CELIV, charge accumulation by linearly increasing voltage (CALIV), etc. These methods have been successfully applied to a series of iridium-based emissive materials, advancing the understanding of charge transport in solution-processed OLEDs. Key outcomes include the establishment of standardised measurement conditions for CELIV, identification of distinct hopping distances for charge transport and exciton quenching, development of a method capable of simultaneously determining both hole and electron mobilities and free carrier generation efficiency, investigation of dendron effects on charge mobility and device efficiency, and insights into the degradation mechanisms of blue-emitting materials.

Speaker CV

Dr Mile Gao received his Ph.D. in 2022 from the University of Queensland and is now an ARC DECRA Fellow. His research focuses on developing novel techniques for measuring charge transport in organic optoelectronic devices, including OLEDs and organic solar cells, to facilitate the development of highly efficient devices. His work has led to methods that provide deeper insights into charge generation, recombination, and transport mechanisms, contributing to the advancement of organic semiconductor technology. With nearly 30 publications, he collaborates extensively to advance sustainable optoelectronic technologies.

Engineering Metal Halide Perovskite Films for Photovoltaic Devices

Selengesuren Suragtkhuu, Purevlkham Myagmarsereejid, Solongo Purevdorj, Abraham Adenle, Ikhbayar Batsukh, Yu Lin Zhong, and Munkhbayar Batmunkh*

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Abstract

Metal halide perovskites have shown great promise for a broad range of applications due to their fascinating optical, chemical, physical and optoelectronic properties. A classic example of perovskites' applications is photovoltaic (PV), which converts sunlight directly into electricity. Despite the great promise and advancements, the commercialization of perovskite solar cell technology is limited due to the issues associated with the stability of perovskite in ambient conditions and heat. Engineering strategies such as additive engineering, defect engineering and surface passivation are promising approaches for not only improving the stability of perovskite solar cells, they are also widely used for enhancing the PV performances. In this talk, I will present our recent work focused on engineering metal halide perovskite using oxygen-inducing effect and surface passivation methods and their application in solar cells.

Speaker CV

Dr. Batmunkh received his PhD degree from the School of Chemical Engineering at the University of Adelaide in 2017. Dr. Batmunkh is a currently Senior Lecturer in the School of Environment and Science at Griffith University. He is an Australian Research Council (ARC) Future Fellow (2026-2030) and leads an active independent research group working on functional materials, solar cells, detectors and their integrated systems. He is a former ARC DECRA fellow (2022-2025). Dr Batmunkh is a QLD 2025 Young Tall Poppy.

Visible to near-infrared II nanoscale emitters for quantum sensing

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Abstract

Nanoscale emitters like fluorescent color centers in diamond, hexagonal boron nitride (hBN) and silicon carbide have emerged as powerful tools for quantum sensing in biology and beyond. In nanoscale materials like nanodiamonds, these emitters enable the measurement of magnetic and electric signals and temperature at the subcellular level based on optical readout of their quantum properties. Most emitters explored for applications today fluoresce in the visible or near-infrared wavelength range below 900 nm, which is outside the second near-infrared biological transparency window (1000 nm – 1700 nm, NIR-II). Furthermore, as quantum sensing technologies based on established visible emitters like the nitrogen-vacancy (NV) center in nanodiamonds mature, integrating these emitters with other materials becomes critical for developing real-world applications. This presentation will discuss our recent progress in two areas. 1. The discovery and application of new emitters that fluoresce from the visible to NIR-II spectral regions. 2. The integration of nanoscale quantum emitters into polymers and surface coatings for the development of 2D and 3D biosubstrates for optical quantum sensing.

Speaker CV

Philipp is a Vice Chancellor's Senior Research Fellow at RMIT University and a research leader in materials science and photonics, specialising in developing new materials for optical quantum technologies. He graduated in Physics from the University of Munich (LMU), received his PhD in Materials Engineering from Monash University, Melbourne, in 2014, and was awarded an Australian Research Council DECRA Fellowship in 2019.

Dye-coupled lanthanide nanocrystals for advanced optical biosensing and photodynamic therapy

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Abstract

The unique optical properties of lanthanide-doped inorganic nanocrystals make them promising candidates for a variety of applications, including light energy harvesting, emission, biosensing, therapeutics, and photocatalysis. Surface modification with organic dye molecules offers a powerful strategy to fine-tune these properties, enabling the discovery of novel optical phenomena within organic-inorganic composite systems. Developing highly efficient lanthanide-based nanoconjugates addresses limitations of traditional nanomaterials, paving the way for enhanced functionality in emerging applications. In our recent work, we focus on the fabrication and mechanistic exploration of lanthanide nanocrystals featuring unique lattice structures and core-shell architectures. By investigating energy transfer processes at the nanocrystal surface, we aim to optimize these materials for use in nanotherapeutics. This presentation highlights our advancements in dye-coupled lanthanide nanomaterials, emphasizing excitation dynamics modulation and their transformative potential in diverse applications.

Speaker CV

Dr. Renren Deng is a professor at the School of Materials Science and Engineering, Zhejiang University. In 2014, He received Ph.D. in Chemistry from National University of Singapore (NUS) under the supervision of Prof. Xiaogang Liu. From 2014−2016, he subsequently worked as a postdoctoral researcher at NUS and Cavendish Laboratory at Cambridge University. His research focuses on developing luminescent nanomaterials for applications in photovoltaics and biomedicine and understanding energy transfer through organic molecule−inorganic nanocrystal hybrid systems. Dr. Deng has published over 40 peer-reviewed papers in a range of prestigious journals including Nature, Nature Nanotechnology with 11,000+ combined citations. He has several awards including 2021 NSFC Excellent Young Scholars, and 2022 DPC's Sturge Prize.

Regulation of Excited States in Lanthanide-Molecule Hybrid Systems

Sanyang Han

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Abstract

The excited-state energy transfer process is crucial for determining key functionalities of lanthanide-molecule hybrid systems, including luminescence, charge carrier transport, and catalytic activity. However, due to the complexity of lanthanide energy level structures, significant differences in excited-state dynamics between components, and uncertainties in nanointerface structures, the mechanism of interfacial energy transfer in such systems remains unclear. Achieving highly efficient energy transfer and strong electronic coupling has become a critical challenge. To address this issue, this presentation systematically introduces our research progress in regulating excited states in lanthanide-based systems. We have successfully developed a novel class of lanthanide-molecule hybrid systems with exceptional performance. The report will focus on fundamental mechanistic insights, including the dynamics of interfacial energy transfer pathways and elucidation of electronic coupling mechanisms. This work not only provides new perspectives and a theoretical foundation for understanding and controlling lanthanide-molecule hybrid systems, but also demonstrates their broad application potential in optoelectronic devices, catalytic conversion, bio-imaging, and other fields.

Speaker CV

Sanyang Han is currently an associate professor at the Tsinghua University Shenzhen International Graduate School, Tsinghua University. He received his Ph.D. in Chemistry from the National University of Singapore in 2014, and subsequently conducted postdoctoral research at the Cavendish Laboratory, University of Cambridge, UK. He has been recognized as a Marie Skłodowska-Curie Fellow, a National High-Level Young Talent, and a Distinguished Appointee under the "Pengcheng Peacock Plan." Currently, his research focuses on the preparation and photophysical studies of lanthanide luminescent materials, spanning multiple disciplines such as chemistry, physics, materials science, interface spectroscopy, and biology. In recent years, he has published over 60 scientific papers in prestigious international journals, including Nature, Nature Photonics, Nature Communications, Angewandte Chemie, Advanced Materials and so on. His research achievements were selected as one of the "Top Ten Rare Earth Science and Technology News in China in 2017" and received a "Nomination Award for China's Top 10 Optical Advances in 2021."

Morphology Control of Upconversion Nanoparticles

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Abstract

The advancement of nanomaterials engineering relies on achieving atomic-level precision in composition and structure, which is crucial for next-generation nanophotonics, biosensing, and display technologies. While significant progress has been made in synthesizing uniform luminescent nanoparticles, the current frontier lies in the controlled fabrication of hybrid and heterogeneous nanostructures that integrate multiple functionalities.

Our research has elucidated the dynamic regulatory role of oleate ligands (OAH/OA^-) during the growth of rare-earth fluoride nanocrystals. By precisely tuning the OAH/OA^- ratio, we achieve selective promotion or etching of specific crystal facets, enabling the guided growth of complex morphologies. Building on this, we have developed a ligand-mediated, site-selective epitaxial growth strategy combined with quantitative lattice-mismatch engineering for the precise construction of multi-component heterostructures.

In this presentation, we will detail this control strategy. We will demonstrate its application in synthesizing single heterogeneous nanorods and achieving their super-resolution optical differentiation. Furthermore, I will introduce a three-dimensional heterogeneous nano-architecture comprising 14 distinct segments, assembled via a "Tetris-like" stacking process.

Speaker CV

A/Prof. Wen Shihui currently serves as an Associate Professor and Ph.D supervisor in the College of Science at Eastern Institute of Technology, Ningbo. His academic journey encompasses a Master's degree from Donghua University and a Ph.D. degree from the University of Technology Sydney. Dr. Wen was honored with Australian Research Council (ARC) Discovery Early Career Researcher Award (DECRA) in 2021. His career has revolved around design and synthesis of nanoprobes, tuning their magnetic and luminescence properties and integrating the multiple functions for nanophotonics and biomedical applications. He has published over 100 peer-reviewed papers in top-tier SCI journals, including Nature, Nature Nanotechnology, Nature Photonics, Nature Communications, and the others.

Near infrared emissive lanthanide nanothermometers for theranostic applications

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Abstract

The detection of biological temperature is of great significance for gaining deep insights into physiological and biochemical mechanisms, as well as for developing diagnostic and therapeutic approaches for diseases. Although various contact and non-contact temperature measurement methods have been developed, they still suffer from limitations such as invasiveness and restricted spatial–temporal resolution. In recent years, lanthanide luminescent nanoprobes have been applied in bioimaging and sensing. Here, we have developed a series of near-infrared lanthanide luminescent nanomaterials that serve as nanothermometers based on the temperature-responsive properties of emissions, enabling minimally invasive and high-precision temperature imaging and detection in living systems. The temperature measurement results are further applied to disease diagnosis and therapeutic monitoring. By constructing heterogeneous structures and modulating the energy transfer between luminescent centres and energy acceptors, we designed temperature-responsive probes operating within the second near-infrared biological window. Benefiting from their long emission wavelengths, the probes achieve improved spatial resolution for precise temperature observation of fine biological structures. Furthermore, by integrating the nanothermometers with photothermal therapeutic agents, the luminescence signal provides feedback on nanoscale temperature variations, enabling accurate regulation of photothermal effects at the microscopic level and the use of controllable thermal modulation to influence biological processes for disease treatment.

Speaker CV

Xingjun Zhu received his Ph.D. in Chemical Biology from Fudan University, China. He conducted postdoctoral research at Stanford University. Since 2020, he has been an Assistant Professor at School of Physical Science and Technology, ShanghaiTech University, China. He currently focuses on the development of lanthanide luminescence nanomaterials for biomedical applications. He has published more than 60 papers with over 5000 citations in reputed journals.

Improving the photoluminescent property via the micro-structure design in Phosphors

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Email:

Abstract

Light-emitting diodes (LEDs) have gained widespread attention around the world due to their versatile applications. Today, LEDs have become a mainstream lighting solution and are being increasingly embraced across various fields. Phosphor materials are essential in driving the advancement of LED technology. Common strategies for tuning luminescent properties of phosphor include atomic substitution, the solid solution structure design, the energy transfer process design and so on. However, there is still limited research on how micro-structure, such as vacancies, interstitials, or ion pairs, affect the luminescent behavior of phosphors. In recent years, I explore the possibility of regulating phosphor luminescence by controlling these micro-structure, I would introduce some of our interesting exploration cases in the report. For examples, the temperature stability is enhanced by introducing cation vacancies in Eu^{2+}-doped β-Al_2O_3 phosphors; the luminescent efficiency $(Ga,Sc)_2O_3$:Cr is improved by incorporating interstitial oxygen.

Speaker CV

Yichao Wang received his Ph.D. degree in 2020 from the School of Physics and Technology at Lanzhou University. He is currently working as an associate professor and master's supervisor at the College of Science, Dalian Maritime University. The main research contents include the design of novel visible-NIR emission Eu2，Ce3+, Cr3+ doped phosphors and metal halide luminescent materials, the exploration of their luminescence mechanisms, and relative first-principles calculations. In recent years, a large number of explorations have been carried out in the performance regulation of luminescent materials through the design of solid solution structures, defect structures, and the control of energy transfer processes.

Dynamic optical control in Layered MoS_2

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Abstract

Two-dimensional (2D) transition metal dichalcogenides (TMDs), represented by molybdenum disulfide (MoS_2), exhibit layer-dependent electronic and optical properties that enable tunable luminescent behaviours in the few-layer regime. In this talk, I will present two complementary approaches for dynamically controlling the optical responses of few-layer MoS_2 nanostructures through electrochemical and plasmonic modulation. The first approach demonstrates active and reversible control of photoluminescence (PL) intensity via electrochemical ion intercalation of Li^+, Na^+ and K^+.[1] Ion insertion induces lattice expansion and a reversible 2H↔1T phase transformation, resulting in pronounced and reversible PL quenching and recovery, showing the strong coupling between ionic transport and excitonic recombination. The second approach explores tunable plasmonic resonances in MoS_2 nanoflakes, where carrier density and dielectric environment determine localized surface plasmon resonance (LSPR) features across the visible–UV spectrum.[2,3] The experimentally observed resonance shifts agree with Mie–Gans and Drude modelling, confirming the role of free carriers introduced by chemical or electrochemical doping. Together, these studies establish few-layer MoS_2 as a model platform for electrically and chemically tunable luminescent and plasmonic materials, revealing how phase composition, carrier concentration and dielectric screening collectively determine optical emission and absorption in layered semiconductors. These studies provide design principles for reconfigurable photonic components, optical modulators and hybrid luminescent devices based on 2D materials.

References

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Phosphor Safari 2026

Speaker CV

Dr. Yichao Wang is an Associate Professor and ARC Future Fellow at School of Science, RMIT University. He is the lead chief investigator on an ARC Discovery Project and serves as the principal investigator for several successful beamtimes at the Australian Synchrotron. His research focuses on the synthesis of low-dimensional nanomaterials and their broad applications in agriculture, sensing, catalysis, energy conversion and drug delivery. He has authored over 90 peer-reviewed publications, which have received more than 6,700 citations and an h-index of 43. He has received multiple research awards and continues to advance interdisciplinary collaborations at the interface of nanotechnology and applied science.

Cross-Relaxation and Energy Cascade Modulated Lanthanide Doped Upconverting Nanoparticles

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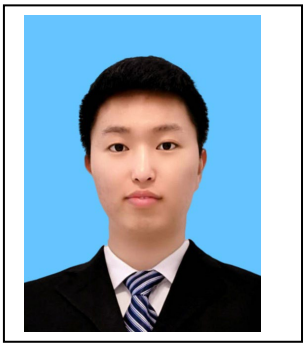
Abstract

Cross-relaxation of lanthanide ions refers to the non-radiative energy transfer between two identical or different ions, where one ion is de-excited and another is excited. This process typically leads to significant concentration quenching and a reduction of emission intensity. In recent years, cross-relaxation has also been recognized as an effective strategy to modulate the population of excited-state energy. By regulating the energy transfer pathways between ions, it can enhance the characteristic wavelengths emission and enable the modulation of output colors. Previously, the introduction of dopant ions enabled modulated cross-relaxation in Er^{3+} upconverting systems, achieving efficient tuning and enhancement of red-yellow-green emission. In Tm^{3+} doped systems, adjusting the interionic distance allowed controlled cross-relaxation, leading to efficient accumulation of excited-state energy at specific energy levels and population inversion. This, in combination with efficient coupling of microcavity, enabled low-threshold continuous-wave pumped upconverting lasing output. Typically, cross-relaxation results in the de-excitation of high-energy levels, and achieving low-power-density pumping for high-energy-level upconverting emission in lanthanide ions has long been a challenge in the field. We reveals that cross-relaxation can modulate the population of intermediate energy levels in Ho^{3+} doped systems. By constructing core-shell nanostructure and regulating excited-state energy transfer pathways, blue upconverting emission in Ho^{3+} ions has been achieved for the first time, along with the first realization of R/G/B trichromatic white lasing output in a Ho^{3+} upconverting system.

Speaker CV



Yunfei Shang received his Ph.D. in Chemical Engineering and Technology from Harbin Institute of Technology, China (2020) and Physics from University of Technology Sydney, Australia (2022). Since 2024, he has been an associate Professor at Harbin Institute of Technology. His research focuses on the design and application of functional crystals, specifically including lanthanide doped nanocrystals and micro-nano lasers, ultrafast scintillators and high-energy ray/particle discrimination, etc. He has published more than 36 papers in reputed journals.

Enhanced upconversion in Er3+ doped tellurite glass under pulsed laser excitation: a new avenue for 3D volumetric display

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Abstract

The two step, two frequency (TSTF) upconversion in rare earth ions (REI) doped solids is a well-established strategy to achieve 3D volumetric display for various applications across the defence, healthcare, education, manufacturing and entertainment industries. Early studies have primarily focused on REI-doped fluoride glasses or single crystals, which efficiently support TSTF upconversion due to their low phonon energy. However, these materials are challenging to produce at the size and quality required for commercial applications. In this project, we explore tellurite and germanate glasses as scalable, low-phonon-energy alternatives by benchmarking their TSTF upconversion performance against fluoride glass for Er3+ green emission. Tellurite and germanate glasses exhibit dimmer green emission under continuous-wave excitation, while tellurite glass unexpectedly outperforms fluoride glass when both lasers are pulsed with properly adjusted modulation parameters. Rate equation-based simulations are used to explain these findings. To demonstrate the up-scalability of tellurite glass, we also fabricate successfully a ~4x4x4 cm3 Er3+ doped tellurite glass cube with high optical quality. This study provides new insight into pulsed-excitation-enhanced upconversion and offers a promising route for developing imaging chamber materials and laser systems for 3D volumetric displays.

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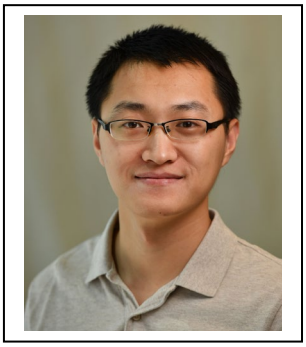
Speaker CV



Dr. Yunle Wei received his Ph.D. in Physics from the University of Adelaide, Australia, where he continues his postdoctoral research. His work spans multiple discovery-driven and industry-focused projects aimed at developing advanced solutions for applications including mid-infrared fibre lasers, 3D volumetric displays, medical diagnostic and imaging instruments, next-generation global networks, and mobile solar module technologies.

Crystallisation Control and Interface Engineering for Efficient and Stable Perovskite PV Devices

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Abstract

Perovskite photovoltaics are widely regarded as a leading candidate for next-generation solar technologies due to their high efficiency, low-cost processing, and tuneable bandgaps suitable for tandem integration. Nevertheless, the transition from laboratory-scale demonstrations to industrially relevant large-area modules is still constrained by two fundamental challenges: achieving uniform, defect-controlled crystallisation over large areas and ensuring long-term stability that satisfies the 25-year reliability standards of the PV industry. This talk will provide an overview of recent progress in advancing scalable and stable perovskite films through molecular interface design and process engineering. Key strategies—such as tailored self-assembled monolayers, improved precursor-solution stability, and cooperative crystallisation via co-deposition—have enabled more controlled film formation, enhanced interfacial robustness, and improved reproducibility across both small-area cells and large-area submodules. These developments collectively illustrate a practical route for bridging the gap between record laboratory performance and manufacturable perovskite photovoltaics, offering new insights for materials design, device engineering, and future commercial deployment.

Speaker CV

Dr Zhen Li is a DECRA Research Fellow at the School of Photovoltaic and Renewable Energy, UNSW Sydney. He received his PhD in Chemistry from City University of Hong Kong in 2023. His research focuses on high-efficiency and stable perovskite photovoltaics, with particular emphasis on functional materials design, interface engineering, crystallisation control and scalable device development. He has published over 45 peer-reviewed papers, including Science and Nature Energy, with an H-index of 36. His work advances the translation of perovskite photovoltaics by simplifying device architectures and developing novel functional materials for scalable and commercially relevant technologies.

PLQY and Structural Insights into Ln^{3+}-Activated Phosphors: Yb^{3+} Sensitization for Enhanced Luminescence

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Abstract

Lanthanide-activated phosphors are key materials for photonic applications including photovoltaics, sensing, and anti-counterfeiting. Their performance, however, is often constrained by weak optical absorption and concentration quenching. In this work, we show that Yb3+ sensitization is an effective strategy to address these limitations, enabling stronger upconversion and infrared (IR) luminescence in a variety of host materials.

We synthesized and studied a series of Yb3+-sensitized phosphors co-doped with lanthanides (Er3+, Tm3+, Ho3+) and the transition metal Ni2+, using Bridgman crystal growth and high-throughput solid-state synthesis. Photoluminescence quantum yield (PLQY), absorption cross-sections, and brightness (B) were systematically evaluated. In BaF2:Yb3+,Er3+ single crystals, Yb3+ sensitization enhanced absorption in the 900–1000 nm region, leading to efficient upconversion with higher PLQY and brightness under concentrated solar excitation, relevant for photovoltaic applications. Similarly, in Li3Ba2Gd3(MoO4)8 powders co-doped with Yb3+/Er3+, Yb3+/Tm3+, and Yb3+/Ho3+, we observed strong 980 nm absorption and high IR luminescence efficiency. Moreover, in Y2Al2Ga3O12 hosts, Yb3+-mediated energy transfer effectively sensitized Ni2+ IR emission, achieving PLQY values up to 40% and significantly higher brightness compared to direct Ni2+ excitation.

These results highlight the versatility of Yb3+ as a sensitizer for both lanthanide and transition-metal dopants, enabling precise control of luminescence pathways. Potential applications include tracers for plastic recycling, light-conversion layers for IR LEDs, and anti-counterfeiting tags. Importantly, for such applications, careful control of particle size on the micrometer scale is essential to maximize the performance (PLQY and B) of luminescent markers.

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Speaker CV

Dr. Andrey Turshatov received his Ph.D. in Chemistry from the University of Nizhny Novgorod, Russia. He conducted postdoctoral research at the Clausthal University of Technology, Germany and later at the Max-Planck-Institut for Polymer Research, Germany. Since 2014, he has been a group leader of Materials for Spectral Conversion at the Karlsruhe Institute of Technology, Germany. He has published more than 100 papers in reputed journals.

Direct photolithography of quantum dots via photoclick chemsitry for high-resolution QLEDs

Chaoyu Xiang

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Abstract

Quantum dot light-emitting diodes (QLEDs) have emerged as pivotal candidates for next-generation displays, owing to tunable emission wavelengths, narrow spectral bandwidth, high brightness, and solution-processability. However, achieving high-precision quantum dot (QD) patterning remains a critical bottleneck for industrial implementation. Conventional inkjet printing suffers from limited resolution (<5 μm) and coffee-ring artifacts, whereas traditional photolithography compromises QD performance during photoresist processing. Direct photolithography has recently emerged as an innovative approach to bypass these limitations by simplifying traditional photolithographic workflows. This methodology integrates QDs with photosensitive molecules, enabling efficient fabrication of ultra-high-resolution patterns with large-area uniformity while maintaining compatibility with semiconductor manufacturing protocols. Nevertheless, existing direct lithography techniques require stringent environmental controls and precise exposure parameters. Developing an air-processable direct lithography method compatible with large-scale semiconductor manufacturing therefore holds critical significance.

Leveraging photo-click chemistry's advantages of mild reaction conditions, high selectivity, and rapid kinetics, we propose a UV-triggered azide-alkyne cycloaddition strategy for QD patterning. Distinct from prior inert-atmosphere-dependent methods, our approach utilizes ambient air conditions with standard 365 nm UV irradiation, ensuring seamless integration with semiconductor fabrication lines. The reaction achieves efficient QD film crosslinking, enabling submicron-resolution patterning while preserving intrinsic optoelectronic properties. Notably, the crosslinked QD layers achieved a record external quantum efficiency (EQE) of 20.05% in QLED devices, attributed to suppressed interfacial defects and optimized charge balance. By synergizing click chemistry precision with semiconductor-grade manufacturability, we establish a universal platform for high-resolution optoelectronic patterning, accelerating industrial adoption of QLEDs and related quantum dot technologies.

We further extend this direct photolithography to functional layers including PEDOT:PSS and metal oxides (WO_x, MoO_3). Through controlled photochemical processes involving crosslinking and ligand exchange, we achieved solubility modulation of these materials, enabling ultrahigh-resolution patterning exceeding 3,300 PPI. This advancement

demonstrates compatibility with multilayer device architectures and addresses a critical challenge in RGB full-color QLED commercialization.

Speaker CV

Chaoyu Xiang received his Ph.D. in the University of Florida. He possesses 15 years of R&D expertise in OLED and QLED display technologies. A pioneer in deep blue QLED research, he has repeatedly set world records for device efficiency and operating lifetime, which have basically reached the threshold of industrialisation. He has published more than 50 SCI papers and more than 100 granted patents. The related research results have been applied to the world's first 5-inch full-colour AM-QLED and 31-inch full-colour AM-HQLED prototypes, forming a series of core device preparation technologies with independent intellectual property rights.

Red, green, and blue luminescence from an upconversion nanophosphor

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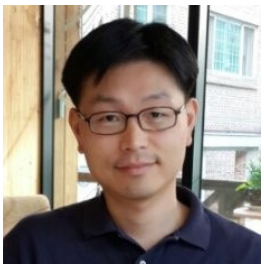
Abstract

Upconversion nanophosphors (UCNPs), consisting of inorganic host nanocrystals and rare earth dopants, exhibit large anti-Stokes shift luminescence via energy transfer from sensitizers to activators. When the UCNPs are doped with a specific activator ion, they emit a single luminescence color determined by the type of activator ion. Thus, to achieve multicolor emissions from the UCNPs, various activator ions–such as Tm3+ for blue luminescence and Er3+ for green or red luminescence–need to be doped into the host nanocrystals. By co-doping Tm^{3+} and Er^{3+} ions and adjusting their concentrations, the emission color of UCNPs can be tuned. However, to produce various luminescence colors, different compositions of UCNPs should be synthesized. On the other hand, when UCNPs are doped with multiple types of activator ions that are spatially separated in the UCNPs, multiple luminescence colors can be generated from a single UCNP. In this presentation, we will introduce red, green, and blue luminescence from a single UCNP with a core/multi-shell nanostructure and demonstrate its application in transparent displays.

Speaker CV



Ho Seong Jang received his Ph.D. in Materials Science and Engineering from the Korea Advanced Institute of Science and Technology, Republic of Korea. He conducted postdoctoral research at Purdue University, Indiana, USA. He joined the Korea Institute of Science and Technology (KIST), Republic of Korea, as a Senior Research Scientist in 2010 and currently serves as a Principal Research Scientist. He has published more than 120 papers in reputed journals.

The Crystal Structure Design of Hybrid Metal Halide Fluorescent Materials

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Abstract

Stimuli-induced fluorescent change materials, as a class of smart systems with mechanical stimulus-responsive characteristics, exhibit reversible changes in their luminescence color/intensity upon grinding, shearing, or applying pressure. This optical behavior arises from the mechanical force-induced molecular packing reconstruction, breaking/reorganization of non-covalent interactions (hydrogen bonds, π-π stacking), or crystal-to-amorphous phase transitions, which significantly affect the material's excitation state dynamics and emission characteristics. Despite the widespread application of organic-inorganic hybrid metal halides in fields such as solar cells and lasers, their stimulus-responsive luminescent behavior remains underexplored. This paper reports a notable mechanochromic luminescence phenomenon in the novel antimony-chloride hybrid material $C_7H_{18}N_2SbCl_5$. Mechanical grinding transforms the material from a single emission state to a dual-emission state. Experimental results confirm that the crystal structure framework remains intact before and after the color change, and the change in the local symmetry of the Sb coordination polyhedron is the primary cause of the luminescence property variation. This study provides new insights into the structure-performance relationship of hybrid metal halides and opens up new pathways for the design of novel mechanically responsive smart materials.

Speaker CV

Jing Zhao is currently a professor at the University of Science and Technology Beijing, specializing in hybrid perovskite materials, crystal structure design, and their optoelectronic properties for light-emitting devices and solar cells. She earned her PhD in Inorganic Chemistry from the Technical Institute of Physics and Chemistry, Chinese Academy of Sciences, in 2013. From 2015 to 2017, she conducted postdoctoral research at Northwestern University in the group of Prof. Mercouri G. Kanatzidis.

Anomalous Dual Luminescence in Eu2+-Doped (Ca,Sr,Ba)HfO3 Perovskites toward Pressure–Temperature Sensing

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3 Graduate School of Advanced Science and Technology, Japan Advanced Institute of Science and Technology (JAIST), Nomi, Japan
4 Faculty of Chemistry, Adam Mickiewicz University, Poznań, Poland
5 Institute of Experimental Physics, Faculty of Mathematics, Physics and Informatics, University of Gdańsk, Gdańsk, Poland
6 Department of Molecular Sciences and Nanosystems, Ca'Foscari University of Venice, Mestre-Venezia, Italy
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Abstract

Dual luminescence of Eu2+-doped BaHfO3 represents an unusual phenomenon while the mechanism is still not fully understood. In this work, Eu2+-activated (Ca,Sr,Ba)HfO3 solid solutions were systematically investigated to clarify the origin of this anomalous emission behavior. With increasing A-site ionic radius, the Eu2+: 5d–4f emission gradually shows blue-shift from 610 nm (CaHfO3) to 470 nm (BaHfO3), while an additional broad band assigned to impurity-trapped exciton (ITE) luminescence appears for Ba-rich compositions (>40 %) at cryogenic temperatures, and shifts from 620 to 590 nm with increasing Ba content. Temperature- and pressure-dependent photoluminescence (PL) measurements reveal that the two emissions are in strong competition. At ambient conditions, only the 5d–4f transition is observed, whereas under low temperature or high pressure conditions, the 5d–4f emission is strongly quenched while the ITE component becomes dominant. The intensity ratio between the 5d–4f and ITE bands provide a reliable luminescence-intensity-ratiometric (LIR) that can be applied separately for pressure and temperature sensing. BaHfO3:Eu2+ exhibits a relative pressure sensitivity Sr(P) = 6.5 kbar-1 at 30 kbar and a thermal sensitivity Sr(T) > 1 K-1 between 70 and 180 K. These results elucidate the origin of the anomalous dual luminescence in Eu2+-doped alkaline-earth metal hafnate perovskites and demonstrate

its potential as a unified LIR-based platform for ratiometric sensing under variable thermodynamic conditions.

Speaker CV

Jiazheng Li is a Ph.D. student in the Division of Material Science, Graduate School of Human and Environmental Studies, Kyoto University. He is a student member of the Ceramic Society of Japan, the Rare Earth Society of Japan, and the Japan Society of Powder and Powder Metallurgy. His research focuses on luminescent perovskite oxides, NIR phosphors for LEDs, and luminescent pressure–temperature sensors. He obtained his B. Eng. in Materials Chemistry from Qingdao University of Science and Technology in 2021, M. S. from Kyoto University in 2024 and has been pursuing his Ph.D. course in Kyoto since Apr. 2024.

Programmable Spatial Stacking Growth of Hierarchical Heterogeneous Nanocrystals

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4 Department of Chemistry, School of Science and Key Laboratory for Quantum Materials of Zhejiang Province, Research Center for Industries of the Future, Westlake University, Hangzhou, 310030 P. R. China

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Abstract

Precise control over the morphology, structure, and composition of nanocrystals is essential for designing advanced functional materials. Herein, we establish a general paradigm for the programmable synthesis of hierarchical heteronanocrystals by synergistically integrating ligand-mediated site-selective epitaxy with lattice mismatch engineering. We demonstrated that the curvature-dependent distribution of surface ligands on hexagonal nanorods can control the site-selective growth of epitaxial material, leading to the formation of secondary satellite nanocrystals along the ridges formed by the intersection of prismatic side facets, such as {100} and {010}. Strong ligand binding is identified as a key factor governing this ordered epitaxial process. By employing 8 kinds of rare-earth ions (from Yttrium to Cerium) as epitaxial material, the interfacial lattice mismatch dictates three distinct growth regimes: a mismatch below 1.4% results in uniform coating, a mismatch between 2.0% and 5.1% leads to island formation, and a mismatch exceeding 7.1% induces independent nucleation, also known as homogeneous nucleation. Harnessing these principles, we implement a spatially programmable hierarchical stacking strategy to precisely integrate 4 distinct elements onto a heterogeneous nanorod, constructing a complex 3D hierarchical architecture with 14 segments within a 160 nm × 50 nm framework. This work provides deeply fundamental insights into the growth mechanics of heterogeneous nanocrystals, thus will open new avenues for the on-demand fabrication of sophisticated nanostructures.

Speaker CV

Rui Wang earned her Ph.D. in Biomedical Engineering from Harbin Institute of Technology, China, with joint training at Yale University, USA. She conducted postdoctoral research at University of Science and Technology of China and Eastern Institute of Technology, Ningbo. She has published multiple first-author papers in high-impact journals such as Carbohydrate Polymers and Journal of Functional Foods, and co-authored a paper in Nature. Her research focuses on natural products for bone loss and controllable synthesis of rare-earth upconversion nanocrystals for biomedical applications.

Advancing efficiency and stability of quantum dot light-emitting diodes

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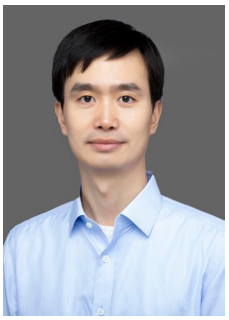
Abstract

Ultra-high-resolution (UHR) display technologies are among the most strategically significant emerging industries, with a global market projected to reach hundreds of billions of US dollars. Quantum dots—recognized by the 2023 Nobel Prize in Chemistry as a groundbreaking light-emitting material—offer distinct advantages, including high color purity, wide color gamut, and compatibility with low-cost, large-scale printing fabrication. However, a key challenge in quantum dot light-emitting devices remains unresolved: how to engineer quantum dot films with both high stability and high conductivity through precise surface chemical treatment. Overcoming this barrier is essential for reducing carrier injection and transport losses. This presentation will focus on strategies to address this critical issue.

Speaker CV



Ya-Kun Wang obtained his Ph.D. in Chemistry from Soochow University (International Visiting Graduate Student in Edward Sargent group from 2018-2020). He conducted postdoctoral research at the University of Toronto and Soochow University. Since 2025, he has been a Professor at Soochow University, China. He has published more than 70 papers in reputed journals.

Ultrabright and Stable Red Perovskite Nanocrystals in Micro Light-Emitting Diodes Using Flow Chemistry System

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Abstract

Addressing the efficiency and stability challenges of red perovskite nanocrystals is essential for their successful implementation in display and lighting technologies. In this work, the structural dynamics of red perovskite quantum dots (PQDs) are investigated using a flow chemistry system to overcome these hurdles. Ultrabright red-emitting $CsPb(Br,I)_3$ PQDs were obtained by precisely tuning the ligand distribution of oleic acid and oleylamine in conjunction with varying flow rates and precursor equivalence ratios. The resulting PQDs exhibited an impressive photoluminescence quantum yield (PLQY) of 95%. As widely reported, the poor stability of mixed-halide perovskites primarily arises from halide ion migration. To mitigate this issue, zinc—featuring a lower dissociation energy than lead—was introduced during synthesis to supply additional halide ions and thereby enhance PQD stability. Consequently, a highly stable $CsPb(Br,I)_3@Cs_4Pb(Br,I)_6$ core–shell structure with a PLQY of 92% was successfully achieved. This facile and controllable approach to synthesizing $CsPb(Br,I)_3@Cs_4Pb(Br,I)_6$ core–shell PQDs offers a promising pathway toward the scalable fabrication of perovskite-based micro light-emitting diodes for next-generation display and lighting applications.

Speaker CV

Yen-Huei Lin, Department of Chemistry, National Taiwan University. Passing the recommended interview, he enrolled in the doctoral studies program of Chemistry and joined the Materials Chemistry Laboratory under the supervision of Distinguished Prof. Ru-Shi Liu. He is a 3rd-year Ph.D student in Prof. Ru-Shi Liu's lab. He has published 6 papers in reputed journals.

Ion-Doping-Induced Broadband Near-Infrared Emission in Bismuth Halide Double Perovskites

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Abstract

A novel NIR light-emitting phosphor, $Cs_2KBiCl_6:Ag^+$, has been designed and synthesized. Investigations of its crystal structure and photoluminescent properties reveal that, under 362 nm excitation, this bismuth halide perovskite exhibits broadband NIR emission ranging from 550 nm to 1200 nm. Density functional theory (DFT) calculations further demonstrate that the doping of Ag^+ ions can significantly reconstruct the band structure of Cs_2KBiCl_6, and create new energy levels within the band gap, thereby enhancing its photoluminescent performance. Finally, a NIR-LED device was fabricated by coating the synthesized phosphor with a near-UV LED chip, which demonstrates the potential application of this broadband NIR light emitting phosphor in the field of NIR light emitting diode.

Speaker CV

Ziwang Zhang received his Ph.D. in Inorganic Chemistry from Sun Yat-sen University, China, and continued as a postdoctoral fellow in the School of Materials at the same university. He now focuses on synthesis and designing single-phase white-light phosphors for high colour performance LEDs and NIR emitting metal-halide perovskite for NIR LED devices. Utilizing crystal structure engineering and energy-transfer pathways, we achieves spectral modulation, paving the way for next-generation solid-state lighting and NIR optoelectronic devices.

Near-infrared scintillation properties of Nd-doped WO3-Al2O3-SiO2 glasses

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Abstract

Scintillators are a type of phosphor that converts ionizing radiation into low-energy photons through luminescence. The popular scintillators exhibit UV-Vis photoluminescence and scintillation, which are suitable for the sensitivity of common photodetectors, such as PMTs and Si-PDs. On the other hand, photodetectors having sensitivity in the Near-infrared (NIR) region have become popular, and NIR scintillators have been studied actively in recent years. One of the proposed applications of NIR scintillators is high-dose field monitoring, which can remotely monitor high-radiation areas using optical fibers to connect the scintillator and a photodetector. In the application, NIR emission is more suitable than UV-Vis emission since NIR emission has a high transmittance efficiency. Furthermore, Cherenkov radiation, which is observed in the UV-Vis region, is often generated in high-dose areas. There is a possibility that Cherenkov radiation may be detected as noise, but NIR emissions can be easily distinguished from it. Based on the above, in this study, we synthesized and investigated the Nd-doped WO3-Al2O3-SiO2 glasses and their scintillation properties to develop a new NIR scintillator.

Speaker CV

Akihiro Nishikawa is a doctoral student in the Division of Materials Science at the Nara Institute of Science and Technology (NAIST). He earned his master's degree from NAIST and is currently in the second year of his doctoral program under the supervision of Professor Takayuki Yanagida. His research focuses on glass scintillators and dosimetric materials.

Near-infrared scintillation properties of Nd-doped Ba3Y(PO4)3 single crystals

Haruaki Ezawa*, Kai Okazaki, Takumi Kato, Daisuke Nakauchi, Noriaki Kawaguchi, and Takayuki Yanagida

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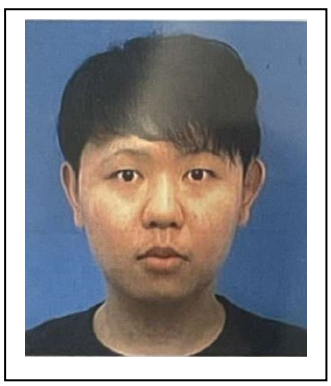
Abstract

Scintillators are materials that promptly convert absorbed X- and γ-ray energy into numerous low-energy photons. Near-infrared (NIR) scintillators have recently attracted attention for high-dose field monitoring, such as real-time in vivo dose measurement during radiotherapy. In such applications, scintillators are positioned near the target tumor, and the emitted NIR photons can be detected by a sensor placed outside the patient's body. Moreover, NIR scintillators are promising for monitoring nuclear reactors. For these purposes, remote monitoring systems employing quartz optical fibers have been proposed, since NIR photons exhibit lower transmission losses in optical fibers compared with visible photons, thereby enabling dose measurements over a wide dynamic range. Ba3Y(PO4)3 is a promising host material owing to its favorable characteristics, including the ease of growing large single crystals suitable for mass production, excellent optical quality, moderate electrical conductivity, and strong mechanical and chemical stability. Ba3Y(PO4)3 doped with rare-earth ions has recently garnered significant interest due to its potential applications in phosphor materials. The combination of good optical and chemical properties makes Ba3Y(PO4)3 an attractive candidate for optical applications. However, to the best of our knowledge, the scintillation properties of Nd-doped Ba3Y(PO4)3 have not yet been reported. In this study, Nd-doped Ba3Y(PO4)3 single crystals were synthesized, and their photoluminescence and scintillation properties were systematically investigated.

Speaker CV



Haruaki Ezawa is a doctoral student in the Division of Materials Science at the Nara Institute of Science and Technology (NAIST). He earned his master's degree from NAIST and is currently in the first year of his doctoral program under the supervision of Professor Takayuki Yanagida. His research focuses on single crystal scintillators and dosimetric materials.

Unveiling the mechanism of NIR/SWIR emission in CaAl12O19: The role of mixed-valence Cr3+/Cr4+

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Abstract

Achieving simultaneous near-infrared (NIR) and shortwave infrared (SWIR) emissions from single-phase phosphors is difficult due to the different electronic configurations and local coordination environments needed for these emissions. Multivalent transition-metal doping allows for various optical transitions from multiple oxidation states. In this study, we showed that the coexistence of Cr3+ and Cr4+ ions in a CaAl12O19 host results in broad NIR and SWIR emissions, respectively. The Cr3+ ions were stabilized in octahedral sites and produced broadband NIR emission through the spin-allowed 4T2(4F) → 4A2(4F) transition, while the Cr4+ ions occupied tetrahedral or distorted sites and contributed broadband SWIR emission via the 3T2→3A2 transition. Crystal field parameters from a Tanabe–Sugano diagram analysis (Dq/B values of 2.1 and 1.6 for Cr3+ and Cr4+, respectively) confirmed the octahedral and tetrahedral environments and explained the dual emissions. We propose an emission mechanism where the interaction between Cr3+ and Cr4+ enables efficient dual-band NIR–SWIR luminescence.

Speaker CV

Jeong Hui Kim received his B.Sc. in Chemistry from Dankook University, Republic of Korea. Since 2025, he has joined Won Bin Im's laboratory at Hanyang University, which integrates Ph.D. course candidates. He is interested in the find and synthesis of novel luminescent materials, especially new phosphor compositions, and their optical application.

Engineering Rare-Earth Luminescent Nanothermometers for Precision Focused-Ultrasound Thermotherapy

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Abstract

Focused ultrasound (FUS) ablates solid tumors clinically, but the high acoustic intensities (≈1–20 kW cm^{-2}) required to reach cytotoxic temperatures often overheat healthy tissue along the beam path. We report multilayer core–shell $NaGdF_4$:Yb,Er@$NaYF_4$:Yb@$NaGdF_4$:Nd,Yb@$NaGdF_4$ nanoparticles (LN-STNPs) that act simultaneously as (i) potent sonothermal sensitizers and (ii) quantitative luminescent nanothermometers. Under 808-nm excitation, the Er^{3+} green emission band delivers a luminescence-intensity ratio (I_{525}/I_{545}); the Yb^{3+} lifetime at 980 nm affords NIR-II thermometry suitable for deep-tissue imaging. In tissue-mimicking phantoms, FUS raises the nanoparticle micro-temperature up to 8 K higher than the concurrently measured bulk temperature, confirming, for the first time, a nanoscale thermal gradient produced by viscous and phonon-layer interactions. Time-gated NIR lifetime imaging in tumor-bearing mice verifies microscopic heating in vivo: LN-STNPs + FUS elevate intratumoral micro-temperature to therapeutic levels while the macroscopic surface temperature remains below 42 °C. Consequently, tumors are completely eradicated within 14 days, matching the efficacy of higher power FUS but with negligible collateral damage.These results establish luminescent lifetime nanothermometry as a robust tool for closed-loop, low-power sonothermal therapy and open avenues for precision FUS treatments mediated by functional nanomaterials.

Speaker CV

Lingkai Meng received his B.S. from Guangxi University, China. He is currently a doctoral candidate at ShanghaiTech University, Shanghai, China. He has authored a first-author publication in Nano Letters and has co-authored more than ten papers in renowned journals such as Nature Communications and Small.

Development of Nanoparticle Scintillators for in vivo applications

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Abstract

Scintillators are phosphors that can be used for real-time radiation detection. In addition, recently, scintillators have been utilized in in vivo applications. For example, recent reports have shown that scintillators can be used in optogenetics technologies. In such applications, scintillators are preferable because prompt emission of photons can be used in optogenetics. To obtain efficient emission by external X-ray irradiation, high density and high effective atomic number are required for scintillators. In addition, scintillators of small sizes are preferable from the viewpoint of non-invasive introduction of the scintillators. To fulfill these requirements, we have developed garnet-based nanoparticle scintillators. To achieve efficient scintillation in wide wavelength ranges, Ce, Eu, or Pr have been used as the dopants. Also, as the host materials, different kinds of host compositions have been used. The nanoparticles were synthesized using the sol–gel method. The particle size of less than 100 nm has been achieved. High photoluminescence quantum yields have also been achieved. The developed nanoparticles can be applied to biological research as the light source within biological bodies, enabling the introduction of the scintillator nanoparticles in a less invasive manner. Furthermore, nanoparticles exhibiting scintillation at different wavelength ranges can be selected among the developed nanoparticles according to the absorption wavelength of the photoreceptor molecules to be used in the optogenetics technologies.

Speaker CV

Prof. Koshimizu received his Ph.D. in Engineering from the University of Tokyo, Japan. He was a member of the Department of Applied Chemistry, Tohoku University, Japan, until March 2022. Since April 2022, he has been a Professor of the Research Institute of Electronics at Shizuoka University, Japan. He currently serves as an Editor of the Japanese Journal of Applied Physics and Applied Physics Express. He has published more than 240 papers in reputed journals.

Eu(II)-Eu(III) Intervalence Charge Transfer in Rb3Y(PO4)2:Eu for multifunctional applications

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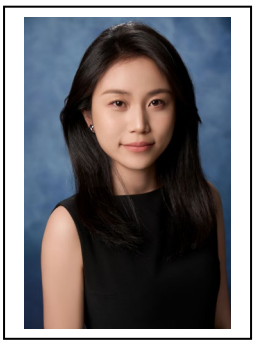
Abstract

Abnormal luminescence induced by Eu2+-Eu3+ intervalence charge transfer (IVCT) has the characteristics of broad bandwidth, a large Stokes shift, and a long lifetime. Introducing Eu2+-Eu3+ IVCT emission into rare earth-doped inorganic luminescent materials offers broad opportunities for engineering Eu2+-activated phosphors with unprecedented optical properties. However, Eu2+-Eu3+ IVCT remains rarely discovered owing to the challenge of precisely controlling the local structure and interionic distance required for efficient charge transfer. In this study, we successfully triggered Eu2+-Eu3+ IVCT emission (612 nm) in blue-violet-emitting Rb3Y(PO4)2:Eu by strategic Ba2+ doping. The Ba2+ incorporation effectively reduces the interionic distances of Rb1-Y and Rb2-Y, thereby shortening the distances of Eu2+-Eu3+, which enhances orbital overlap for more efficient charge transfer. The resulting blue-red dual emission perfectly matches the absorption spectra of plant phytochromes, demonstrating its potential for advanced agricultural lighting applications. Moreover, the IVCT emission exhibits inherent thermal instability, producing a noticeable luminescence color variation from red to blue-violet with increasing temperature, which highlights this material as an excellent candidate for industrial visual thermometry. This work demonstrates an innovative approach to creating multifunctional phosphors with exceptional luminescence properties by rationally designing IVCT emission.

Speaker CV



Ming Zhao received her Ph.D. in Materials Science and Engineering from University of Science and Technology Beijing, China. She is currently an associate professor in the School of Physics and Optoelectronic Engineering at Beijing University of Technology, China. Her research focuses Eu2+-doped inorganic luminescent materials and their multifunctional applications. She has published several papers in Light Sci. Appl., Sci. Adv., Adv. Mater. and Angew. Chem. Int. Ed, etc.

CsI Single Crystals Doped with either Nd, Ho, or Er as Infrared Scintillation Materials

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Abstract

Scintillation materials emit light when exposed to ionizing radiation, and they are used in combination with photodetectors to measure ionizing radiation. Infrared scintillation materials are advantageous for remote radiation measurements in high-dose fields using optical fibers, as their wavelengths are highly transparent to optical fibers and do not interfere with Cherenkov light generated in high-dose fields. CsI single crystals doped with either Nd, Ho, or Er were prepared using the vertical Bridgman method. Emission spectra of the prepared samples under X-ray irradiation were evaluated, and broad emissions around 310 and 430 nm were observed in all the samples. According to the previous study on undoped CsI, these emissions originate from self-trapped exciton (STE) of CsI. In addition, CsI:Nd showed emission peaks around 900, 1080, and 1350 nm, CsI:Ho showed emission peaks around 550, 640, 990, 1200, 1320, and 1490 nm, and CsI:Er showed emission peaks around 530, 550, 660, 990, and 1530 nm. These emissions can be explained by the 4f-4f transitions of Nd3+, Ho3+, or Er3+ ions. X-ray detection tests were performed by placing the samples on one end of an optical fiber and connecting the other end to an InGaAs photodetector. The lower detection limits for CsI:Nd, CsI:Ho, and CsI:Er were 37, 7, and 18 mGy/h, respectively. The CsI:Ho sample showed the highest sensitivity among the samples.

Speaker CV

Noriaki Kawaguchi received his Ph.D. in Science from the Tohoku University, Japan. He worked as a chief researcher at Tokuyama Corporation before moving to academia. Since 2016, he has been an Associate Professor of materials chemistry at Nara Institute of Science and Technology, Japan. He has published more than 680 papers in reputed journals and received awards such as the 26th Presentation Award of the Japan Society of Applied Physics, the 47th Presentation Award of the Japan Electronic Materials Technology Association, and the 24th JSAP Ionizing Radiation Division Encouragement Award.

LSPR-Driven Enhancement of Upconversion Luminescence in UCNP-Metal Oxide Heterostructures for Sensitive Imaging Application

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Abstract

Photon upconversion luminescence (UCL), in which multiple low-energy photons are converted into a single high-energy photon, has emerged as a promising mechanism for infrared-to-visible light conversion in optical sensing and imaging. Lanthanide-doped sodium yttrium fluoride (NaYF4) upconversion nanoparticles (UCNPs) are one of the most efficient UCNPs. However, the practical application of upconverting materials is limited owing to their extremely weak and narrow band absorption. Here, we applied the localized surface plasmon resonance (LSPR) effect of indium tin oxide (ITO) NPs to enhance the 1550 nm absorption of NaYF4:Er3+ NPs. We successfully synthesized core-shell NPs with particle size distribituion of 15 nm via co-precipiration synthesis method. Further, we integrated those NPs with 7 nm particle sized ITO NPs (Sn 5 mol%) which exhibit intense LSPR effect in the range of 1400 to 1800 nm that perfectly overlap with 1550 nm excitation of Er3+ ions. We characterized structural, morphological properties with XRD, TEM, XPS measurement and optical properties with absorbance, PL, TRPL measurement of those UCNP@ITO heterostructured nanoparticles. Also, to verify plasmonic effect induced UCL enhancement, we measured pump power dependent PL and conducted FDTD simulation. Finally, films of UCNP@ITO were fabricated, demonstrating the potential for this material in imaging sensor devices.

Speaker CV

Sung Woo Jang completed his bachelor's degree in the Division of Materials Science and Engineering at Hanyang University and is currently pursuing an integrated Ph.D course in the same department under the guidence of professor Won Bin Im. His primary research interests include the synthesis of III-V, I-III-VI group quantum dots and lanthanide-based upconversion nanoparticles, thin-film deposition such as pulsed laser deposition, thermal evaporator and their related optical applications.

Development of Plastic Scintillators Utilizing Thermally Activated Delayed Fluorescence to Achieve High Scintillation Light yield

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Abstract

Scintillators are widely used for real-time radiation detection. They emit thousands of visible photons upon interaction with ionizing radiation. Among inorganic and organic scintillators, plastic scintillators offer fast response and scalability. However, they have low scintillation light yields of ~10000 photons/MeV, which are significantly lower than those of inorganic scintillators. Plastic scintillators consist of a host polymer and organic fluorescent molecules. In plastic scintillators, ionizing radiations generate singlet and triplet excited states in the host polymer. These excited states can transfer their energy to fluorescent molecules, which subsequently emit visible photons. However, since the transition from the triplet excited state to the ground state is spin-forbidden, the conversion of the triplet excitation energy into scintillation has been difficult, and most of the triplet excited states are lost. Meanwhile, in the field of organic light-emitting diodes (OLEDs), thermally activated delayed fluorescence (TADF) is gaining attention as a method to achieve an internal quantum efficiency approaching 100% by utilizing both singlet and triplet excitations. In molecules exhibiting TADF, non-emissive triplet excitations can be converted into emissive singlet excitations via reverse intersystem crossing. In this study, we used a TADF molecule, BMes-1, as the fluorescent molecule to utilize triplet excitation to develop plastic scintillators with high scintillation light yields. As a result, we achieved a scintillation light yield of 19200 photons/MeV: this value is approximately twice that of the commercially available EJ-212 (scintillation light yield: 10000 photons/MeV). In addition, it was found that TADF contributed 65−85% of the total scintillation.

Speaker CV

Taiyo Kanenari graduated from Ryugasaki 1st High School in March 2020. He enrolled at Shizuoka University in April 2021 and graduated in March 2025. He enrolled at Shizuoka University Graduate School in April 2025.

Near-infrared scintillation from Pr, Nd. Ho, Er, Tm and Yb doped Lu2O3 single crystal

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Abstract

Scintillators have been used for ionizing radiation detectors in many fields including medical diagnostics, security, non-destructive study of cultural objects, environmental monitoring, oil-logging, and high energy physics. Up to now, most scintillators show emission at UV-VIS wavelength because conventional photodetectors such as photomultiplier tube and Si photodiode have a high sensitivity at UV-VIS range. In addition to these conventional scintillators with UV-VIS emission, recently, NIR-emitting scintillators have attracted attentions since they can be applicable for new applications, including high dose monitoring at nuclear power plant, monitor during radiation therapy, bio-imaging, and nuclear battery.

In this study, as a new NIR-emitting scintillator, Pr, Nd. Ho, Er, Tm and Yb doped Lu2O3 single crystal were synthesized by the floating zone method. These samples were evaluated in photoluminescence and scintillation properties in NIR range, and all the samples showed NIR emission by 4f-4f transitions of rare earth ions. Following these experiments, scintillation detector was fabricated under combination with InGaAs photodiode and optical fiber. The detector property was compared with the lower detection limit under X-ray irradiation, and among them, Yb:Lu2O3 showed the best performance of 0.2 mGy/h.

Speaker CV

Prof. Takayuki Yanagida received his Ph.D. in Physics from the University of Tokyo, Japan. After passing several positions, he has been a full professor at Nara Institute of Science and Technology (NAIST), Japan since 2015. He currently serves as Editor of Journal of Luminescence, Journal of Materials Science: Materials in Electronics, and Sensors and Materials. He has published more than 1100 papers in reputed journals and had been a head of Ionizing radiation division of Japanese Society of Applied Physics (JSAP).

Development of Organic Radiophotoluminescence Dosimeters Utilizing Radiation-Induced Reactions in Polymers Containing Photobase Generators and Fluorescein

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Abstract

Production of phosphor molecules or luminescent centers by ionizing radiation is called radiophotoluminescence (RPL) and results in an increase in the fluorescence intensity with dose of ionizing radiation. Hence, RPL can be applied to dosimetry. Demand for accurate identification of dose distribution is increasing with the advancement of radiation therapy. Dosimeters composed of inorganic materials have conventionally been used. However, since their radiation absorption properties differ significantly from those of biological tissues, discrepancies may arise between the measured and actual dose distributions during the therapy. Given this background, we aimed to develop RPL dosimeters composed of organic materials with radiation absorption properties equivalent to those of biological tissues.

In this study, we developed organic RPL dosimeters based on polymethyl methacrylate (PMMA) containing fluorescein, 2,5-diphenyloxazole (DPO), and photobase generators (WPBG-018 and WPBG-300). The increase in the fluorescence intensity of fluorescein was caused by its deprotonation by bases, which are generated from the photobase generators upon ultraviolet excitation emitted from X-ray-irradiated DPO. The fluorescence intensity at 533 nm increased linearly with dose up to 100 Gy, which indicates the RPL behavior of these materials. The fluorescence intensity also increased under excitation-light irradiation Even after compensating for this contribution, the increase due to X-ray exposure was evident. The observed RPL demonstrates that X-ray-induced ultraviolet emission from DPO can effectively excite photobase generators. This mechanism provides a new pathway for tissue-equivalent dosimetry based on organic materials.

Near-Infrared Emission Properties of Transition Metal-doped Lithium Tantalate Single Crystal for Radiation Detection

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Abstract

Radiation detectors are used for various applications. These radiation detectors are loaded into scintillators. Scintillators are one of the phosphors which immediately convert ionizing radiation into a lot of low-energy photons and are used converting with photodetectors. Then, their emission wavelengths need to match with sensitivities of photodetectors. Near-infrared (NIR) light emitting scintillators have recently been studied more intensively with the spread of InGaAs-based photodetectors. NIR light emitting scintillators are expected for monitoring applications for nuclear reactors because there is little overlap with the wavelength of Cherenkov light. In this research, we focused on LiTaO3 as a host material due to a high effective atomic number, and a high density for radiation detection. According to the previous reports, Cr-doped LiTaO3 showed photoluminescence at around 950 nm. Thus, this material has a potential for the NIR light emitting scintillator. Then, we grew the 0.5 % Cr-doped LiTaO3 single crystal using the floating zone method and investigated its NIR scintillation properties.

Speaker CV

Toshiaki Kunikata received his M.S. degree from the Nara Institute of Science and Technology (NAIST), Japan, and is currently pursuing his Ph.D. degree at NAIST. He has been selected as a JSPS Research Fellow (DC).

Near-infrared photoluminescence and scintillation properties of Er-doped SrLu2O4 single crystals

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Noriaki Kawaguchi1 and Takayuki Yanagida1

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Abstract

A combination of photodetectors that can detect near-infrared (NIR) photons and NIR-emitting scintillators (NIR scintillators) is expected to be applied in high-dose field monitoring. Although a detection sensitivity of 0.1 mGy/h with good linearity is required in reactor monitoring, the lowest detection limit of NIR scintillators developed to date is 0.5 mGy/h when using an InGaAs photodiode. Achieving a lower detection limit requires improving scintillation intensity. The scintillation intensity depends on scintillation light yield and the stopping power of the material. The present study employs SrLu2O4 single crystal as an NIR scintillator host to achieve the target value (0.1 mGy/h). Doping Er3+, which is an NIR luminescence center, into the host material showed the potential for a detection limit of 0.26 mGy/h while maintaining good linearity. Therefore, Er:SrLu2O4 is expected to surpass the performance of NIR scintillators developed to date.

Speaker CV

Yusuke Endo is a doctoral student at Nara Institute of Science and Technology (NAIST), where he focuses on the research and development of single-crystal scintillators. He earned his master’s and bachelor's degrees from NAIST and Kobe College of Technology in March 2025 and March 2023, respectively.

Ratiometric Fluorescence Optical Fiber Enabling In-situ and Real-time Temperature Monitoring

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Abstract

Thermal evolution is essential for improving the performance and monitoring the status of Li-ion batteries (LIBs). However, it is a challenge to design efficient and facile sensing materials for the detection of the in situ temperature of a working LIB. Herein, a ratiometric fluorescence optical fiber is developed and real-time temperature monitoring is performed with a measurement accuracy of 0.12 °C, and the feasibility based on this polymer optical fiber composed of NaLaTi2O6:Yb/Er phosphors is verified in a pouch-type battery. During the charging and discharging cycles, the in situ temperature is instantaneously conveyed, revealing the internal situation of LIBs. This article further dwells on the thermal characteristics in constant current (CC)/constant voltage charging and CC discharging processes at different C-rates and the battery failure when operated at low temperatures (0 °C). This work demonstrates an innovative strategy for operando solitary temperature monitoring conducted by ratiometric fluorescence optical fiber.

Speaker CV

Yuzhen Wang received her Ph.D. in Condensed Physics from the Renmin University of China, CHN. She conducted postdoctoral research at South China University of Technology in 2022. Since 2025, she has been an Associate Professor of Physics at South China University of Technology, CHN. Her research interest is on the luminescent composite materials for sensing applications.

Biomimetic Overflow Interfacial Materials

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Abstract

Overflow, also known as the "teapot effect", is a classic dynamic overflow phenomenon discovered in the middle of the 20th century. Limited by the development of observation methods and control technologies, research in this field has stagnated for a long time. Many plants leaves in nature can use their curvature structure to control overflow behavior. For example, pitcher plants in tropical rainforests use their peristome structures to direct water transport, and the trees in the tropical rainforest use their drip-tip to drain water. Inspired by these natural phenomena, we proposed using the bionic wettabilities and curvature structures to control the overflow behavior and realized the use of the surface superhydrophobicity to suppress overflow completely, and the use of the surface superhydrophilicity to promote the overflow behavior completely. Based on the size matching principle, we built a series of interface materials with multi-level and multi-curvature structures and proposed new Gaussian curvature-controlled liquid separation and edge curvature-controlled liquid directional transport mechanisms. The proposed method can be used in high-efficiency atomization, drip-irrigation, and high-efficiency pesticide spraying.

Keywords: Superwettability interface; Overflow; Biomimetic materials

Speaker CV

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