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| **Science and Technology for Novel & High-Performance Materials** |
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| **Research background:** The goal of ouralliance is to investigate synthetic control of excited states, physical-chemical properties and applications of colloidal quantum dots (QDs). Colloidal quantum dots (QDs) are a uniqueclass of fluorescent materials with quantum confinement effects. Owning to their outstanding optical properties, such as broad-band absorption, narrow and tunable emission, high photoluminescence quantum yield and high photo-chemical stability, QDs have great potential in the fields of biomedical imaging, photoelectric devices,etc.Their optical and electrical properties can be continuously tuned by sizesand compositions. Besides, compared with the conjugated organic/polymer light-emitting materials and fluorescent protein, QDs have superior advantage such as thermal, optical, and chemical stability, small excited state relaxation energy, long photoluminescence life and high color purity.Compared with the phosphor and other inorganic solid luminescence materials, they have other advantages including superior color purity, flexible synthetic chemistry and solution processability. Therefore, QDs are expected to beunderstandingmaterials for light-emitting diode andother applications.We focus on the excited states of QDs, aiming to establish an international leading research alliance in the field of quantum dots. We focus onthe basic scientific problems-the excited states of QDs with scopes on synthesis chemistry,ligand chemistry, spectroscopy and applications. |
| **Main research topics and progress:**（1）Synthetic control of excited states of QDs. We plan to study a range of defect-related specific traps on the basis of perfect and controllable excited states of QD system. We aim to obtain the picture of traps on the excited states of QDs. We will systemically investigate interfacial chemistry of excited states of QDs. In addition, the synthesis of III-V QDs will be developed. (2)Spectroscopy of excited states of QDs. Currently excited states spectroscopy involves ultrafast spectroscopy, single molecular spectroscopy, and the combination of both. In terms of single molecule spectroscopy, we will develop both single molecule spectroscopy in solution and apply the existing technologies. We are interested in the technology that can be used to control the synthesis of excited state, including high flux ultrafast spectroscopy and ultrafast/ultrasensitive spectroscopy. We have demonstrated that picosecond-nanosecond luminescence spectroscopy is suitable for the synthetic control of high flux monitoring. We plan to improve the time resolution of the photoluminescence spectrum to femtosecond and picosecond range to obtain information of the ultra-fast hot carrier state.(3)The functional assembly structure of QDs. In this projectwe plan to combine "function" with "structure". We focus on several subjects including complex and precise control on catalytic structures andthe bionic structures. The influence of assemble process on excited states of QDs properties will be systematically studied using optimized assemble structure. (4) The optoelectronic applications of QDs. Relying on basic research (synthetic control of excited states, excited states spectroscopy) and the functional structure assembly of QDs, the optoelectronic application of QDs including QLED, QD catalysis and QD photovoltaic devices will be realized eventually. |
| **Member and college:****Department of Chemistry**PENG Xiaogang，FANG Qun，HUANG Feihe，FAN Jie，Simon Lukas Duttwyler，WANG Linjun，WANG Peng，WU Chuande，SU Bin，ZHU Haiming，KONG Xueqian**College of Optical Science and Engineering**TONG Liming，FANG Wei  |
| **Representative achievements:**[Xing Lin#, Xingliang Dai#, Chaodan Pu#, Yunzhou Deng, Yuan Niu, Limin Tong, Wei Fang\*, Yizheng Jin\*, and Xiaogang Peng\*. Near-optimal-Antibunching, Electrically-driven, and Room-temperature Single-photon Sources Based on Colloidal Quantum Dots. Nature Communications. 2017, 8, 1132.](https://www.nature.com/articles/s41467-017-01379-6)Breakthroughs have been made on several subjects of fundamental research. Here,Peng,Jin and Fang’s groups report an electrically driven single-photon source based on colloidal QDs.Tong’s group observed that QDs strongly coupled with optical cavity.Based on the earlier platform of the optoelectronic materials and devices, Profs. WANG Peng Wang and ZHU Haiming are responsible for the construction of ultrafast spectroscopy platform. Prof.WANG Linjun is responsible for the construction of material calculation and simulation platform. Profs. FANG Qun and TANG Ruikangare in charge of the construction of biological microscopic research platform. These platforms have been fully developed.The scientific achievements of the alliance have been transferredto the industry by Zhejiang University-Najingtechjoint laboratory. We have successfully fabricated4-inch full-color AMQLED with 100 ppiresolution.In addition, we launched a special issue on Advanced Materials, a top journal in materials science, to celebrate the 120th anniversary of Zhejiang University. This special issue contains 12 reviews, 5 progress reports and 1 communication. The authors are from the Department of Chemistry, the School of Materials Science and Engineering, the Department of Polymer Science and Engineering, the College of Chemical and Biological Engineering, the College of Optical Science and Engineering, and the College of Pharmaceutical Sciences.  |