

ペロブスカイト量子ドットの光物性と光励起キャリアダイナミクス および光電変換デバイスへの応用

Photophysical Property and Photoexcited Carrier Dynamics of Perovskite Quantum Dots as well as their Application to Optoelectronic Devices

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Perovskite quantum dots (PQDs) as a new type of colloidal nanocrystals (NCs) have gained significant attention for both fundamental research and applications of optoelectronic devices owing to their appealing optoelectronic properties and excellent chemical processability. For their wide range of potential applications, synthesizing colloidal PQDs with high crystal quality and stability is of crucial importance. However, like most common QD systems, those reported PQDs still suffer from a certain density of trapping defects, giving rise to detrimental non-radiative recombination centers and thus quenching luminescence. In recent years, we have succeeded in synthesis of phase stable and less defect PQDs, including Pb-based QDs, Sn-Pb alloyed QDs and Sn-based QDs, as well as Pb-free double PQDs [1-10]. We have demonstrated that a high photoluminescence quantum yield (PL QY) of close to 100% can be obtained in the Pb-based PQDs and double PQDs, signifying the achievement of ignorable less trapping defects in these PQDs [1-10]. Ultrafast kinetic analysis with time-resolved transient absorption spectroscopy evidences the negligible electron or hole trapping pathways in our PQDs, which explains such a high quantum efficiency. In addition, photoexcited hot and cold carrier dynamics as well as charge extraction were systematically investigated [4,10]. Very recently, through metal doping and Sn (IV) control [5-8], we found that Sn(IV)-induced defects and distortions could be reduced greatly in Sn and Sn-Pb PQDs. As a result, stable Sn and Sn-Pb PQDs with ultra long carrier lifetimes (>180 ns) were realized. In addition, we have achieved efficient near-infrared emission from highly defective Sn-Pb perovskite QDs with substantially improved PL QY from ~0.3% to 35% [8]. LED devices based on double PQDs have also been prepared. Our findings provide new insights into the materials design strategies for improved optoelectronic properties of PQDs [5-10]. In this talk, our research progress on the synthesis, photophysical properties and photoexcited carrier dynamics of PQDs as well as their applications to optoelectronic devices will be presented.

References

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