High carrier transport based on perovskite quantum dots in perovskite matrix

Yongge Yang, Yusheng Li, Chao Ding, Shuzi Hayase, Qing Shen*

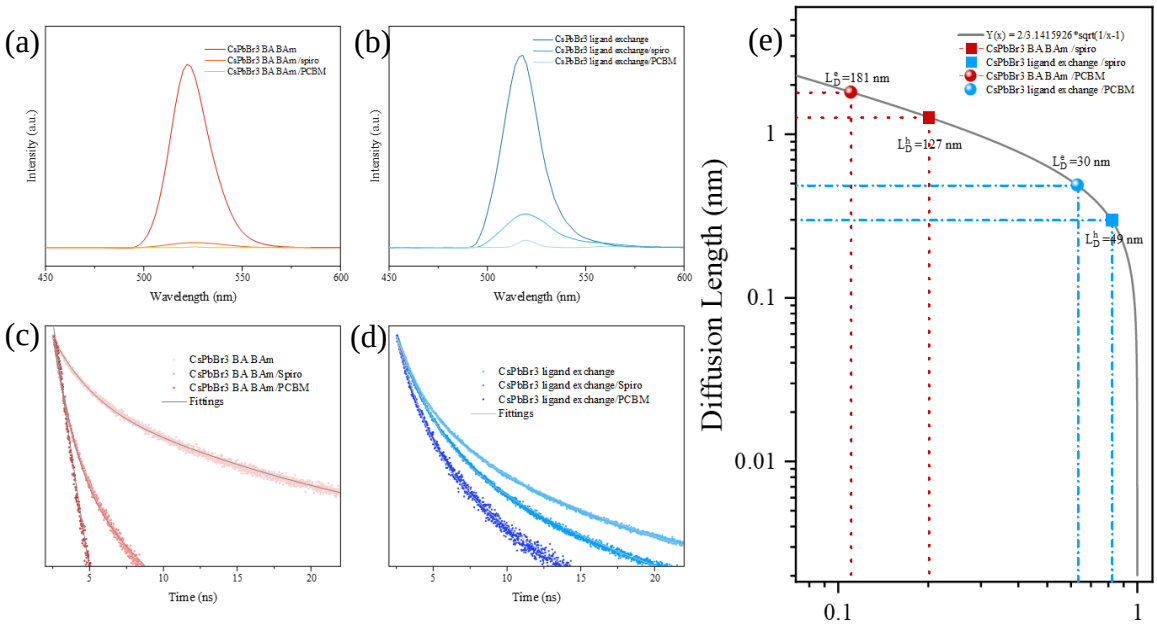
Faculty of Informatics and Engineering, The University of Electro- Communications, 1-5-1 Chofugaoka, Chofu, Tokyo 182-8585, Japan.

yangyungke@gmail.com

Abstract

Metal halide perovskite quantum dots (PQDs) have attracted a lot of attention due to their tunable direct band gap absorption and excellent emission properties in optoelectronic devices such as solar cells (SCs)[1]. However, due to the presence of surface-insulating ligands, achieving high carrier transport in the active layer of the above-mentioned optoelectronic device is still difficult and cumbersome[2]. Here, we report a direct synthesis PQDs quasi-ink with capped by conductive ligands, which exhibits enhanced coupling induced by quantum dot fusion. Moreover, In situ formation of a type-II heterostructure of PQDs in perovskite matrix with enhanced carrier separation and transport. Finally, the prepared films exhibit higher carrier transport capabilities (μ_e=1.40cm^{2}V^{-1}S^{-1},μ_h=0.68cm^{2}V^{-1}S^{-1}) relative to conventional ligand exchange-treated quantum dot films (μ_e=0.15cm^{2}V^{-1}S^{-1},μ_h=0.06cm^{2}V^{-1}S^{-1}).

Results and Discussions



The steady-state fluorescence and TRPL of quantum dot films capped with conductive t ligands exhibit weaker fluorescence and shorter lifetime due to high carrier transport, Its carrier diffusion distance obtained by fitting are L_D^e=181 nm, L_D^h=127 nm, In contrast, the ligand exchange-treated quantum dot films are L_D^e=49 nm, L_D^h=30 nm[3].

References

[1] Zhu, Z., Zhu, C., Yang, L. et al. Nat. Mater. 21, 1042–1049 (2022).

[2] Zhang X, Huang H, Jin L, et al. Angewandte Chemie International Edition, 2022.

[3] Liu Y, Li Z, Xu J, et al. Journal of the American Chemical Society, 2022, 144(9): 4009-4016.