Aggregation-Induced Tunable Emission from Perovskite Quantum Dots

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Keywords: Halide Perovskites; Self-assembly; Quantum Dots; Photoluminescence

Halide perovskites (ABX_3) show extraordinary optoelectronic properties. Aggregation-induced emission (AIE) of halide perovskite nanocrystals (PNCs) is promising for their applications to switchable photonic devices such as luminescence sensors and probes. However, efficient energy transfer and photon recycling by repeated self-absorption and reemission in closely-packed perovskite crystallites often result in low photoluminescence (PL) quantum yield (QY), and limit the AIE-based applications of these materials. Therefore, it is important to preserve the brightness of individual PNCs in aggregates and achieve an aggregation-induced enhanced emission (AIEE) intensity.

Formamidinium lead bromide ($FAPbBr_3$) PNCs are synthesized by the ligand-assisted reprecipitation method where $PbBr_2$ and FABr are the precursors and oleic acid and octylammonium bromide are the ligands. To understand the kinetics of assembly formation, we allow $FAPbBr_3$ PNCs to self-assemble in the solution phase and monitor the temporal PL change by recording the emission spectra at an interval of 2 min (Figure 1a). With time, the intensity of the blue emission (ca. 440 nm) is decreased and correspondingly, the intensity of the green emission (ca. 500 nm) is increased with a gradual redshift in the PL spectral maximum, suggesting an aggregation-induced tunable emission behavior. To understand the dynamics of carrier recombination in the PNCs and their aggregates, we record the PL decay profiles of these samples, which are shown in Fig 1b. While the blue emission from the isolated PNCs is associated with short PL lifetime of 2.6 ns, the PL lifetime is increased to 83 ns in the green-emitting aggregates. The red-shifted emission with the long PL lifetime is attributed to the diffusion of excitons among the aggregated nanocrystals.

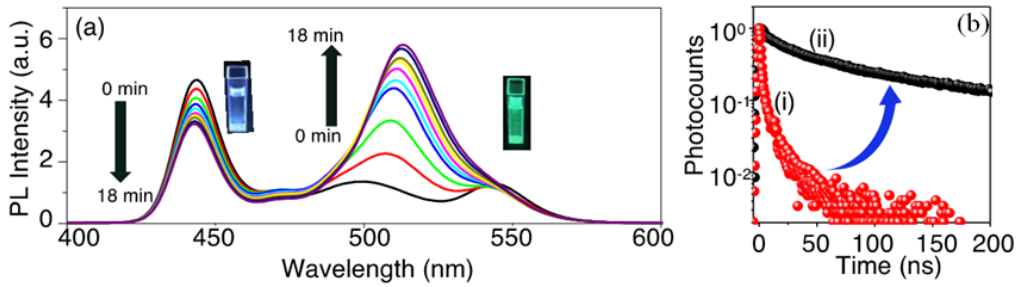

Figure 1. (a) PL spectra of $FAPbBr_3$ PNCs in toluene recorded at an interval of 2 min. Insets: the photographs of the respective colloidal solutions under the UV light. (b) PL decay profiles of (i) isolated and (ii) self-assembled PNCs.