Control of the Excitons and Photoluminescence of Self-Assembled Lead Halide Perovskite Quantum Dots by Mechanical Force

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Lead halide perovskites show excellent optical and electronic properties. The emission color and photoluminescence (PL) lifetime of perovskites nanomaterials can be tuned by the size, structures, and aggregated states.[1)] Assembly- or aggregation-assisted emission of perovskites are expected to develop switchable optical devices. However, the effects of an external stimulus on the structure or the optical properties of the assemblies remains unexplored. We investigate optical properties of self-assembled formamidinium lead bromide ($FAPbBr_3$) perovskite quantum dots (PQDs) under an applied mechanical force.

$FAPbBr_3$ PQDs are prepared by the ligand-assisted reprecipitation method. The as-synthesized sample was diluted with toluene or reprecipitated using acetone/hexane mixtures to promote the self-assembling of the PQDs. Although the PL of a PQD solution in toluene was blue-emitting, with time after synthesis, two additional redshifted emission peaks appeared (Figure a). The reprecipitated sample also showed green emission and longer PL lifetime than the blue emitting PQD solution. The PQDs showed 2D self-assembly (Figure b) assisted by the hydrophobic ligands. The large nanocrystals (>100 nm) are obtained from a reprecipitated sample (Figure b). Interestingly, the red-shifted emission and long PL lifetime reverse by a mechanical force on the nanocrystal films (Figure c). We discuss the mechanically changing excitons and PL of self-assembled $FAPbBr_3$ PQDs.

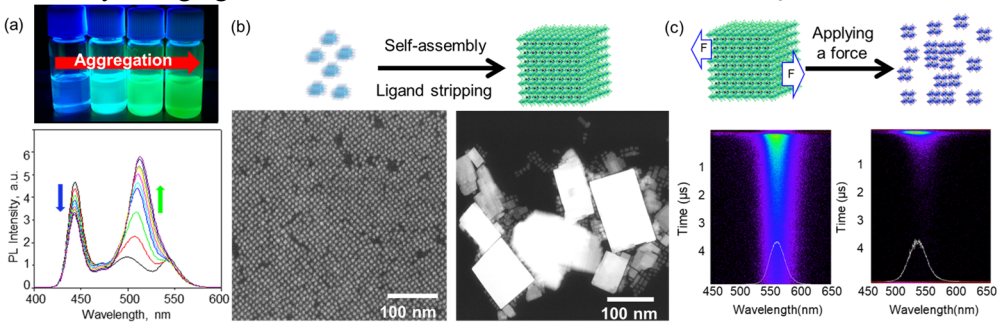

Figure (a) The photograph and PL spectra of $FAPbBr_3$ PQD solutions, (b) a scheme and STEM images of the PQDs and the fused nanocrystals of PQDs, and (c) a scheme and streak-camera images of a nanocrystal film before and after mechanical deformation.

1) M. C. Weidman, *et al.*, *Chem. Mater.* **2017**, *29*, 5019.