

## Structure and Optical Properties of Halide Perovskite-Supercrystals Formed from Nanocrystals using Bidentate Ligands

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Lead halide perovskites show excellent optical and electronic properties such as high photoluminescence (PL) quantum yields, size- and halide-dependent tunable bandgaps, and excellent charge carrier transport properties.<sup>1</sup> Perovskite supercrystals (PSCs), one type of nanocrystal (PNC) assembly, show different optical properties from isolated PNCs and PNC films. However, a correlation between the structures and optical properties of isolated PNCs, PNC films, and PSCs is yet to be identified. We report the structure and optical properties of PSCs formed from PNCs using bidentate ligands.

CsPbBr<sub>3</sub> PNCs are prepared by the hot injection method with oleic acid and hexadecyl amine ligands. PNC films are prepared by drop casting of PNC colloidal solution. PSCs are prepared by a ligand exchange with bidentate ligand eicosanedioic acid. The scanning electron microscope (SEM) image of the PSC shows well-ordered PNCs (Figure a). Conversely, partially assembled and fused PNCs were observed in the SEM image of the PNC film (Figure b). Figure c and d show PL spectra and PL decay curves of the PNC colloidal solution, the PSC, and the PNC film. The PNC colloidal solution (the isolated PNCs) showed a short PL wavelength (511 nm) and PL lifetime (4.9 ns) due to moderately confined excitons. The PNC films show a large PL redshift ( $\Delta\lambda = 23$  nm) and long PL lifetime (178 ns) due to their reabsorption, strong dielectric screening, and trapping-detrapping. Compared to the isolated PNCs or the PNC film, the PL redshift is smaller ( $\Delta\lambda = 7$  nm) for the PSC. The PL lifetime of the PSC (5.6 ns) is comparable to the isolated PNCs and much shorter than the PNC film. We discuss the structure and exciton recombination process in isolated PNCs, PNC films, and PSCs.

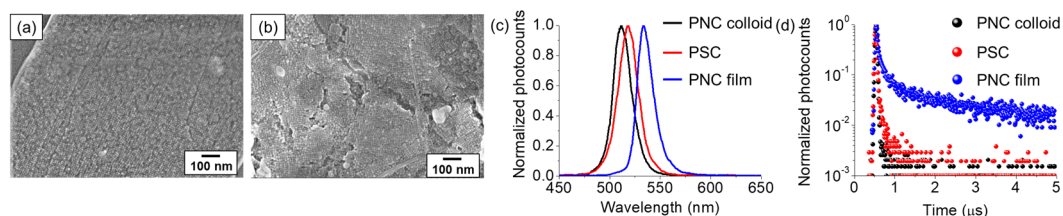


Figure. SEM images of (a) a PSC and (b) a PNC film (scale bar: 100 nm). (c) PL spectra and (d) PL decay curves of a PNC colloidal solution, a PNC film, and a PSC.

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