Structural diversity in superfluorescent multicomponent nanocrystal superlattices comprising lead halide perovskite nanocrystals

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Self-assembly of colloidal nanocrystals into long-range ordered superlattices is a versatile platform for materials engineering, wherein the functionalities of the mesostructures may result not only from the combination and enhancement of size-dependent properties of constituent building blocks but also from synergistic effects and emergent interactions between neighboring nanocrystals. The assembly of steric-stabilized colloidal nanocrystals coated with hydrocarbon ligand chains relies on relatively weak (van der Waals, dipole–dipole, magnetic, Coulombic) interactions with the considerable role of entropic contributions, with the nanocrystal shape anisotropy often being the decisive factor determining self-organization into diverse structures. Cesium lead halide perovskites, being synthetically available as uniform, monodisperse nanocrystals and owing to their outstanding properties (high oscillator strength of bright triplet excitons, slow dephasing, minimal inhomogeneous broadening of emission lines), are promising building blocks for creating functional superlattices exhibiting collective luminescence phenomena, namely superfluorescence. We present a broad structural diversity in binary and ternary, long-range ordered superlattices obtained by shape-directed co-assembly of highly luminescent $CsPbBr_3$ nanocrystals with the spherical and shape-anisotropic building blocks. We also demonstrate the effect of superlattice structure on the emergence of collective optical properties.

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