Co-assembly of Shape Anisotropic Lead Halide Perovskite Nanocrystals into Functional Binary Superlattices

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Over the last few decades, the development of new approaches in colloidal chemistry enabled the synthesis of various colloidal nanocrystals in the monodisperse form. This, in turn, opened a new avenue for extensive research and application possibilities of novel nanomaterials. To this end, nanocrystal self-assembly holds great promise for creating metamaterials with tunable functionalities which originate not only from ensemble-average properties but also from diverse synergistic and collective effects, including conductivity enhancement, exchange coupling effects as well as collective light emission–superfluorescence [1]. The last was recently exhibited on the lead halide perovskite nanocrystal superlattices [2]. Such peculiar optical properties, together with a high degree of monodispersity, size tunability, and shape anisotropy of perovskite nanocrystals, stimulated research in exploring multicomponent superlattices, wherein perovskite nanocubes are combined with non-emissive nanocrystal spacers [3]. Thus, a whole plethora of superlattice types has become accessible, encompassing the superlattices comprised of perovskite nanocubes and spherical, truncated cuboid, or disc-shaped nanocrystals [4]. Not only were the perovskite superlattices obtained as films on the flat substrates including at the liquid-air interface, but also as spherically confined 3-dimensional supraparticles. Apart from superlattice type and morphology diversification, we managed to vary the superlattice composition by employing mixed halide and hybrid organic-inorganic perovskite nanocrystals [5]. A particular interest lies in studying superlattices containing a few light emitter types, wherein promising collective phenomena are expected to emerge.

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