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Nanostructured Mixed-Dimensional Lead Bromide Perovskite Films with Preferential Crystal Orientation Investigated with Advanced Scattering Techniques

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Organometal halide perovskite materials have attracted tremendous interests in optoelectronic applications due to their intrinsic dielectric properties. To further boost these materials in to large scale application, a deep understanding of morphology-property correlation in perovskite films is essential. Particularly, it is challenging to thoroughly determine the complex film morphology. In the present work, lead bromide perovskite films composing of a mixture of three-dimensional (3D) and two-dimensional (2D) perovskite crystals are prepared using a succinctly solution-processed route. The film morphologies are quantitatively characterized by grazing incidence small angle/wide angle x-ray and neutron scattering (GISAXS/GIWAXS and GISANS). The findings reveal that the resulting optoelectronic property closely interrelates with the tailored film nanostructures. A compact film morphology associated with an anisotropic preferential crystal orientation, as well as efficient energy transfer between 2D perovskite platelets and 3D perovskite bulk crystals secure a comparable low amplified spontaneous emission (ASE) threshold of 17.8 uJ/cm2. This result renders the potential of realizing these materials for optical gain media in the future.

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