One-Dimensional Single Crystals of Lead Bromide Organic- Inorganic Hybrid Perovskites: Structure and Optical Properties

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Lead halides hybrid perovskites have recently emerged as a highly promising class of functional materials for a variety of applications such as photovoltaic cells, LEDs, and light absorption sensors because of their excellent properties including strong absorption coefficient and long carrier lifetime [1]. The exceptional structural tunability enables these materials to possess three- (3D), two- (2D), and one- (1D) dimensional structures at the molecular level. Remarkable progress has been reported in the field of lead halide hybrid perovskites in recent years, focusing mainly on the preparation and application of materials with 3D structures. There are, however, some disadvantages in 3D perovskites for applications: instability in air and difficulties in structural modifications. In 2014, Smith et al. reported the thin film solar cell application of a 2D lead- halide perovskites light absorber with enhanced moisture stability [2]. Among various 2D and 1D lead halide perovskites, we have found that 1D lead bromide perovskites show air stability. They are expected to show high and fast optical nonlinear effects owing to the enhanced electron density of states and electron-phonon interaction. Here we report the synthesis of novel 1D lead bromide perovskites and structural dependence on their optical properties. We prepared 1D lead bromide perovskites with three different structures (triple-chain, face, and side shared) by controlling the growth condition and selecting aromatic compounds for organic layers. Figure 1 shows photoluminescence spectra at 5 K for the 1D crystals. The peaks energy and spectra width depend on the structures of the crystals. Side-shared and face shared and triple –chain 1D crystals showed yellow, green, and white luminescence, respectively. Especially, we observed extremely broadband white light photoluminescence for triple-chain lead bromide perovskite crystals with much larger Stokes shift than that of previous report on core-shell wires crystals [3].

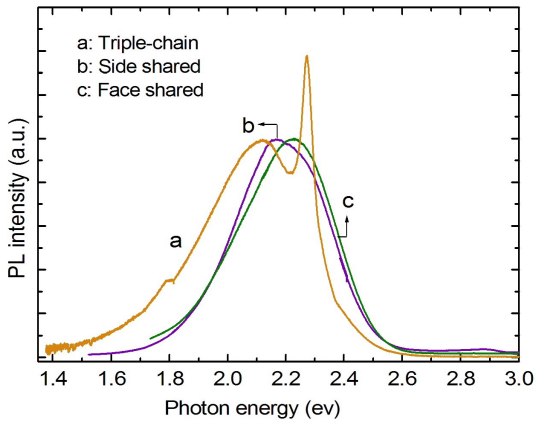

Fig. 1. Photoluminescence spectra of 1D lead bromides perovskites for three different structures, excited at 3.87 eV, intensities normalized.

[1] Y. Liu et al. Adv. Sci. 2018, 5, 1700471.
[2] I.C. Smith et al. Angew. Chem., Int. Ed. 2014, 53, 11232.
[3] Z. Yuan et al. Nat. Commun., 2017, 8, 14051.