Bright Circularly Polarized Photoluminescence in Chiral Layered Hybrid Lead-halide Perovskites

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Abstract— Hybrid semiconductor materials are predicted to lock chirality into place and encode asymmetry into their electronic states, while the softness of their crystal lattice accommodates lattice strain and maintains high crystal quality with the low defect densities necessary for high luminescence yields. The realization of chiral bulk emitters with bright circularly-polarized luminescence from such materials is desired for the design of chiroptical photonic and opto-spintronic applications. Here, we report the fabrication of novel chiral layered hybrid lead-halide perovskites with high photoluminescence quantum efficiencies and large degrees of circularly polarized photoluminescence at room temperature. Using state-of-the-art transient chiroptical spectroscopy, we rationalize the excellent photoluminescence yields from suppression of non-radiative loss channels and very high rates of radiative recombination. We further find that photo-excitations sustain polarization lifetimes that exceed the timescales of radiative decays, which rationalize the high degrees of polarized luminescence. We postulate that the superior optoelectronic properties of the layered hybrid perovskites arise from their special tolerance to crystal structure chirality, which we carefully designed by cation engineering. We demonstrate that our materials can be used in electroluminescent devices and polarized-light detectors. Our findings pave the way towards high-performance solution-processed photonic systems for chiroptical applications and chiral-spintronic logic at room temperature.