Compositional engineering of 2D perovskites via Cd substitution and its impact on optical and scintillation properties

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Two-dimensional (2D) Ruddlesden–Popper hybrid perovskites have emerged as promising candidates for next-generation scintillators due to their strong excitonic effects and tunable emission properties [1]. In this work, we investigate the impact of Cd^{2+} substitution on the optical and scintillation behavior of $(BA)_2PbBr_4$ single crystals. High-quality pristine and Cd-alloyed $(BA)_2Pb_{0.6}Cd_{0.4}Br_4$ crystals were synthesized via slow solution evaporation and systematically characterized. Structural analysis confirms successful incorporation of Cd into the lattice while preserving the layered framework, accompanied by lattice distortion and bandgap reduction. Optical measurements reveal the emergence of a secondary emission band at 431 nm in the Cd-alloyed crystal. Time-resolved photoluminescence indicates modified recombination dynamics. Under X-ray excitation, temperature-dependent radioluminescence exhibits altered negative thermal quenching behavior and a higher activation energy for thermal quenching, indicating improved resistance to nonradiative losses [2]. Scintillation measurements under γ-ray excitation demonstrate a ~20% increase in light yield, reaching 11,000 photons/MeV, along with a significantly faster decay time (21.7 ns) compared to the pristine crystal. These results highlight Cd alloying as an effective strategy for engineering emission dynamics and enhancing timing performance in low-dimensional perovskite scintillators, offering potential for fast radiation detection and imaging applications.

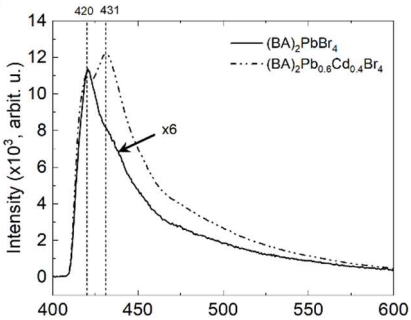

Fig. 1. Steady-state PL, where the intensity of $(BA)_2PbBr_4$ was scaled by a factor of 6 to facilitate comparison with the Cd-alloyed sample.

[1] Mao L. et al. (2018) JACS, 141, 1171.
[2] Shibata H. (1998) JJAP, 37, 550.

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