Luminescent hybrid halide material for scintillation and latent fingerprint development

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Eco-friendly, lead-free organic-inorganic manganese halides (OIMnHs) have emerged as promising materials for optoelectronic applications due to their excellent optical performance and versatile solution-based processability [1,2]. In this study, we report the synthesis of a novel zero-dimensional OIMnH, (EtPPh3)2MnBr4 (where EtPPh3 stands for 2-bromoethyltriphenylphosphonium), in single crystal form under ambient conditions using a modified slow evaporation method. Additionally, we have developed a rapid and straightforward strategy for the direct synthesis of powder (DSP) of (EtPPh3)2MnBr4.

Both single crystals and powder forms exhibit intense green emission under UV light irradiation, demonstrating high photoluminescence (PL) quantum yields and excellent color purity. A flexible polymer film synthesized from the DSP showcases exceptional X-ray scintillation properties, with a high light yield of 116,203.8 photons/MeV and a spatial resolution of 5 lp/mm, enabling high-resolution X-ray imaging with a minimal afterglow of 25 milliseconds.

Besides X-rays, we also assessed the scintillation properties of the DSP film using alpha and beta ionizing radiations. Given the excellent PL properties of our materials, we successfully demonstrated highly efficient, sensitive, and background-free latent fingerprint detection using the DSP. This method reveals level 1-3 features such as core, delta, island, bifurcation, dot, and sweat pores, with good contrast between ridges and furrows on various surfaces including glass, plastic, and ceramics. The developed fingerprints remain clear for up to 35 days, which is vital for documentation purposes. Moreover, we have been able to create fingerprints that are 90 days old, even when stored under normal conditions.

Our work highlights an easy synthesis method and the potential of our material for use as an X-ray scintillator and in the development of latent fingerprints in forensic science applications.

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