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Metal Halide Perovskite X-rays Detectors Based on Pressed Polycrystalline Wafers

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Metal halide perovskite is a new semiconductor family with great potential in various applications such as X/γ-ray detectors, solar cells, light emission diodes, and lasers. Especially inorganic metal halide perovskites, such as e.g. CsPbI₃ or CsPbBr₃ feature high atomic numbers (Z_{Cs} = 55, Z_{Pb} = 82, Z_{Br} = 35, and Z_I = 53), an adjustable energy band gap (1.5–3.5 eV), high resistivity (10⁷–10¹² Ωcm), and a large carrier mobility-lifetime product (10^{−5}–10^{−2} cm²/V). These superior characteristics promise perovskite crystals with large radiation attenuation and improved charge collection efficiency, combined with a facile preparation and lower costs. However, the research progress of metal halide perovskite-based X/γ-ray detectors in terms of photoelectric performance and device application is still far behind those of PSCs and LEDs. The development of tailored growth and fabrication methods for radiation detectors and the evaluation of their performance is an important scientific and engineering objective. Among other methods, dry mechanochemical ball-milling synthesis has recently emerged as a very convenient and reliable method to obtain high quality perovskites.
In this work, we study structural, electrical, and spectrometric properties of X/γ-ray detectors based on CsPbI₃, CsPbBr₃, and Cs₂AgBiBr₆ pressed polycrystalline metal halide perovskite wafers produced from dry mechanochemical ball-milling synthesized powder. Ohmic devices were fabricated to correlate grain size with wafer resistivity, and Schottky diodes were fabricated to reduce dark current. Finally, their X-ray detection performance is studied and correlated to the observed microstructure, resistivity, and device architecture. These results provide guidance for further investigations on pressed mechano-synthesized inorganic perovskite crystal as very promising X/γ-rays radiation detection materials.

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