

Title: Perovskite materials in X-ray detection and imaging: recent progress, challenges, and future prospects

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Abstract: Perovskite materials have attracted significant attention as innovative and efficient X-ray detectors owing to their unique properties compared to traditional X-ray detectors. Herein, chronologically, we present an in-depth analysis of X-ray detection technologies employing organic–inorganic hybrids (OIHs), all-inorganic and lead-free perovskite material-based single crystals (SCs), thin/thick films and wafers. Particularly, this review systematically scrutinizes the advancement of the diverse synthesis methods, structural modifications, and device architectures exploited to enhance the radiation sensing performance. In addition, a critical analysis of the crucial factors affecting the performance of the devices is also provided. Our findings revealed that the improvement from single crystallization techniques dominated the film and wafer growth techniques. The probable reason for this is that SC-based devices display a lower trap density, higher resistivity, large carrier mobility and lifetime compared to film- and wafer-based devices. Ultimately, devices with SCs showed outstanding sensitivity and the lowest detectable dose rate (LDDR). These results are superior to some traditional X-ray detectors such as amorphous selenium and CZT. In addition, the limited performance of film-based devices is attributed to the defect formation in the bulk film, surfaces, and grain boundaries. However, wafer-based devices showed the worst performance because of the formation of voids, which impede the movement of charge carriers. We also observed that by performing structural modification, various research groups achieved high-performance devices together with stability. Finally, by fusing the findings from diverse research works, we provide a valuable resource for researchers in the field of X-ray detection, imaging and materials science. Ultimately, this review will serve as a roadmap for directing the difficulties associated with perovskite materials in X-ray detection and imaging, proposing insights into the recent status, challenges, and promising directions for future research. cancer early, leading to a more precise diagnosis and course of treatment for this fatal condition.

Keywords: Perovskite materials, X-ray detectors, Organic–inorganic hybrid perovskites (OIHs), All-inorganic perovskites, Lead-free perovskites, Single crystals (SCs)

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