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Characterisation of Perovskite Thin Films using Single Source Vacuum Deposition (SSVD) for Ionising Radiation Application

Metal halide perovskite thin-films are among the promising class of materials with significant potential for large-area radiation detectors. While solution-based processing is common, it presents challenges in achieving uniform, thick films. This study explores single-source vacuum deposition (SSVD) as an alternative and simplified method by utilising a single precursor to enhance control over film composition and uniformity of lead halide perovskite films. Using an in-house deposition system, formamidinium lead bromide (FAPbBr3) films were deposited on glass substrates at varying deposition rates. The results from thin films were systematically characterised to evaluate their structural, compositional, optical, and radiation response properties. Film thickness and roughness were measured with a profilometer and morphology and composition were analysed using Scanning Electron Microscopy (SEM) and Energy-Dispersive X-ray Spectroscopy (EDS). Additionally, the optical properties were assessed using photoluminescence (PL) and the X-ray response was evaluated through radioluminescence (RL) measurements. The study successfully produced films with a maximum thickness of 6.6 ± 0.5 µm and an average roughness of 1.2 ± 0.1 µm. SEM analysis revealed grain sizes from 0.3 µm to 3 µm, dependent on deposition conditions. EDS and PL analyses confirmed the successful deposition of the FAPbBr3 perovskite phase. The films demonstrated a linear response to radiation, with a notable limit of detection (LoD) of 100 nGy/s, showing potential for radiation detection applications. This work enhances the understanding of the SSVD process for perovskite thin films and motivates further exploration towards a scalable, high-quality radiation detector for nuclear security and medical radiation field.

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