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Optimisation-Deposition and Conversion of Lead Halide Thin Films to 2D Metal Halide Perovskite Thin Films via Low-Pressure CVD

Two-dimensional (2D) metal halide perovskite (MHP) thin films were synthesised by the conversion of lead halide thin films to 2D MHP thin films using a two-step low-pressure chemical vapour deposition (LPCVD) method. The first step involved the deposition of lead halide thin films (i.e., PbI₂, PbBr_{0.6}I_{1.4}, PbBr_{1.1}I_{0.9}, PbBr_{1.5}I_{0.5}, and PbBr₂) on glass/FTO/TiO₂ substrates via LPCVD, the second step exposed the as prepared lead halide thin films to phenethyl-ammonium iodide (PEAI) vapour during the conversion process. The conversion process was investigated at two different temperatures (170 ℃ and 190 ℃) using phenethyl-ammonium (PEA⁺) as the cation. The structural and optical properties of the converted thin films were characterised using X-ray diffraction (XRD), ultraviolet-visible (UV-Vis) spectroscopy, and photoluminescence (PL) spectroscopy. The results show that the conversion process is influenced by bromine (Br) ions in the precursor lead halide thin films, which enhances the conversion process. However, the converted thin films do not fully convert to 2D MHPs, as evidenced by lead iodide (PbI₂) diffraction peaks in the XRD patterns. The optical properties of the converted thin films show a blueshift in the absorption and PL peaks as the Br content increases, indicating the formation of 2D MHPs with a stoichiometry of (PEA)₂PbBr_xI_{4-x} (0 ≤ x < 1). The results suggest that the conversion temperature of 170 ℃ is more suitable for obtaining high-quality 2D MHP thin films due to the lower defect density, and the presence of Br ions enhances the conversion. The findings provide insights into the conversion process and the potential applications of 2D MHP thin films in optoelectronic devices.

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