Process optimization to enhance the stability of vapor-deposited metal halide perovskite thin films

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Defects such as vacancies and grain boundaries in metal halide-based perovskites (MHPs) can lead to the diffusion or desorption of cations/anions, which degrade the crystallinity and lower the performance of the devices. Therefore, the stability enhancement of the perovskite crystal structure is essential. Here, we present an optimized surface stabilization process of the MHP thin films prepared from the vapor deposition method. First, methylammonium lead iodide ($MAPbI_3$) thin films were grown via two steps of PbI_2 deposition and perovskite conversion process. The as-grown $MAPbI_3$ thin films were then treated with phenethylammonium iodide (PEAI) vapor, a surface passivating agent. The introduction period and time were controlled such that the PEAI was simultaneously evaporated with methylammonium iodide (MAI) or independently introduced onto the $MAPbI_3$ films. Combined analyses confirms that the post-introduction of PEAI for 2 min show the most enhanced structural stability and integrity. Our results offer an important insight into the process optimization for the stability enhancement of vapor-deposited perovskite thin films.