

Greener Humidity-Assisted Fabrication of High-Efficiency Perovskite Solar Cells

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Abstract: Antisolvent-assisted crystallization, though widely adopted for high-efficiency perovskite solar cells, is highly sensitive to dripping time and solvent volume, making it difficult to reproduce and unsuitable for scalable manufacturing [1]. In addition, it typically relies on toxic antisolvents such as chlorobenzene, toluene and diethyl ether. Here, we demonstrate an antisolvent-free fabrication strategy that deliberately utilizes ambient humidity to regulate nucleation and crystal growth of the perovskite active layer. Moderate ambient moisture with relative humidity of 54% is exploited to mediate intermediate phase formation, enabling uniform grain growth and compact film morphology without the need for hazardous antisolvent dripping. Structural characterization confirms enhanced crystallinity and phase stability. Devices fabricated under optimized humidity conditions exhibit improved photovoltaic performance. This work highlights that ambient humidity, when properly managed, can serve as a green and scalable crystallization tool [2], providing a reproducible and eco-friendly route toward high-performance perovskite solar cells.

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