Towards Highly Efficient and Stable Wide-Bandgap Perovskite Solar Cells

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Mixed iodide-bromide organolead perovskites with a bandgap of 1.70-1.80 eV have great potential to boost the efficiency of current silicon solar cells by forming a perovskite-silicon tandem structure. Yet, the stability of the perovskites under various application conditions, and in particular combined light and heat stress, hasn't been well studied. Here we used $FA_{0.15}Cs_{0.85}Pb(I_{0.73}Br_{0.27})_3$, with an optical bandgap of ~1.72eV, as a model system to investigate the thermal-photostability of wide bandgap mixed halide perovskites. We found that the concerted effect of heat and light can induce both phase segregation and decomposition in a pristine perovskite film. On the other hand, through a post-deposition film treatment with benzylamine (BA) molecules, the highly defective regions (e.g. film surface and grain boundaries) of the film can be well passivated, thus preventing the progression of decomposition or phase segregation in the film. Besides the stability improvement, the BA-modified perovskite solar cells also exhibited excellent photovoltaic performance, with the champion device reaching a power conversion efficiency of 18.1%, a stabilized power output efficiency of 17.1% and a V_{oc} of 1.24V. By combining a stable perovskite layer with all-inorganic charge-transporting layers, we have achieved excellent long-term ambient stability of perovskite solar cells. The devices exhibit no degradation in efficiency after being exposed to ambient air (humidity level: 50~60%) for 4 months without encapsulation.