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The synergistic effect of H₂O and DMF towards stable and 20% efficiency inverted perovskite solar cells

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High quality thick 500 nm CH₃NH₃PbI₃ perovskite absorber with the horizontal grain size up to 3 μm and the lateral size equal to the film thickness was prepared by the synergistic effect of H₂O additive and DMF vapor treatment. The inverted (p-i-n) cell based on this high-quality thick perovskite film achieves a high power conversion efficiency of 20.1%. The cell shows no current hysteresis and stable in the inert and ambient atmospheres. H₂O helps MAI to penetrate into the thick PbI₂ to form thick film with pure MAPbI₃ phase and produce bigger gains by slow down the perovskite crystallization rate. It can also cooperate with DMF to control the dissolving of perovskite grains during DMF vapor post treatment. As a result, large multi-crystalline perovskite grains without observable hole and crease are formed when DMF and H₂O were removed in the following heating. The synergistic effect of H₂O and DMF was evidenced by SEM images and GIWXR patterns taken simultaneously. This synergistic strategy for preparing high-quality, thick perovskite film was extended to fabricate large-area MAPbI₃ film for the mini-module with the active area of 11.25 cm² to realize the efficiency of more than 15%.

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