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Self-formed Two-dimensional Perovskite Films for 2D Perovskite Solar Cells

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Perovskite solar cells have become a popular field of research since 2009.[1] Traditional perovskite solar cells use three-dimensional (3D) perovskite materials as the light absorber. Power conversion efficiency exceeding 22% has been achieved so far.[2] However, the stability of the 3D perovskite structure remains a challenge for future industrial commercialization. Recently, 2D perovskite materials have attracting more research interest due to their advanced stability.[3] All of the reported works use a hot-casting method to prepare 2D perovskite films via unscalable spin coating, which cannot be applied to large scale fabrication. The maximum power conversion efficiency of 2D perovskite solar cells is still low (<14%), so new methods need to be developed to improve the performance of 2D perovskite solar cells. Here, we report a simple self-formation method to prepare 2D perovskite films without using spin coater or other coating equipment. The properties of the 2D perovskite films were investigated by absorbance mapping, absorption spectra, X-ray diffraction, atomic force microscopy, and cross-section scanning electron microscopy. The self-formed 2D perovskite films are highly oriented, smooth, and uniform. Solar cell devices were then made by using the self-formed 2D perovskite as the light absorber. The best cell gave a V_{oc} of 1.14 V, a J_{sc} of 18.76 mA/cm^2, a FF of 69.48%, and a PCE of 14.86% by forward scan (**Table 1**). A PCE of 14.78% was obtained by reverse scan, which is one of the highest for 2D perovskite solar cells. The PCE of the cell didn't decrease after being stored in glove box for 160 days, suggesting good stability. Slot-die coating and roll-to-roll (R2R) processing for the preparation of 2D perovskite films were also investigated. Perovskite solar cells made by slot-die and R2R coated 2D perovskite films showed PCEs of 12.47% and 7.99%, respectively.

Table 1. Performance data for perovskite solar cells under forward and reverse scan.

Scan direction	V_{oc} [V]	J_{sc} [mA/cm^2]	FF [%]	PCE [%]
Forward	1.14	-18.76	69.48	14.86
Reverse	1.14	-18.78	69.03	14.78

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