Improved $CH_3NH_3PbI_3$ Perovskite Morphology for Highly Efficient Solar Cells via Air-Assisted Flowing in the Two-Step Spin Coating Method.

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Introduction

To date, there have been a multitude of reports on different methods to fabricate organic-inorganic metal halide perovskite films for high-efficiency solar cells. Here, planar heterojunction (PHJ) $CH_3NH_3PbI_3$ perovskite solar cells have been prepared via two-step spin coating method.[1)] The uniformity of the perovskite light absorbing layer was elevated by using air-assisted flowing (AAF) during spin coating.[2)] The photovoltaic performances of films prepared with AAF (w/ AAF) and without AAF (w/o AAF) were compared. Perovskite solar cells (PSCs) constructed w/o AAF showed power conversion efficiency (PCE) of 8.67% while higher PCE of 13.28% was obtained from a w/ AAF based perovskite solar cell, mainly due to higher photovoltaic parameters.

Results and Discussion

PSCs with a planar architecture of FTO glass/compact-TiO_2/$CH_3NH_3PbI_3$/spiro-OMeTAD/Au was fabricated. Fig. 1 presents the schematic procedure of AAF in the two-step spin coating process for preparing PbI_2 and $CH_3NH_3PbI_3$ films. The current density-voltage (*J-V*) curves of forward and reverse scan for our best-performanced solar cells are shown in Fig. 2 a. All the photovoltaic parameters of w/ AAF solar cells are superior to those of w/o AAF solar cell. The short-circuit density (*Jsc*), open-circuit voltage (*Voc*), fill factor (FF), and power conversion efficiency (PCE) of 17.91 mA/cm^2, 0.864 V, 0.56, and 8.67% are obtained from w/o AAF solar cell, while higher values of 21.52 mA/cm^2, 0.98V, 0.63, and 13.28% have been achieved from the w/ AAF ones.

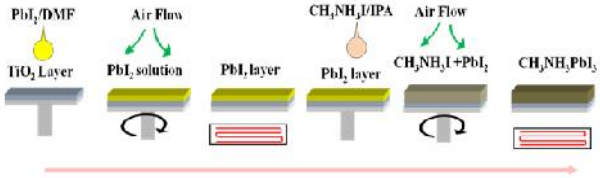

Fig. 1 Schematic illustration of AAF in the two-step spin coating method

The values reported here are for the forward potential scan from short circuit to open circuit with 50 ms delay measurement time. Hysteresis were observed for both cells' *J-V* characterization but not so pronounced. The IPCE spectra of both devices show wide photoresponse from 350 nm to 800 nm (Fig. 2 b), with a maximum value close to ~80% for the w/ AAF solar cell. The integrated *Jsc* from IPCE curves for w/o AAF (17.07 mA/cm^2) and w/ AAF (21.32 mA/cm^2) solar cells are found to be consistent with the experimentally measured *Jsc* under simulated AM 1.5 illumination of 100 mW cm^{-2}.

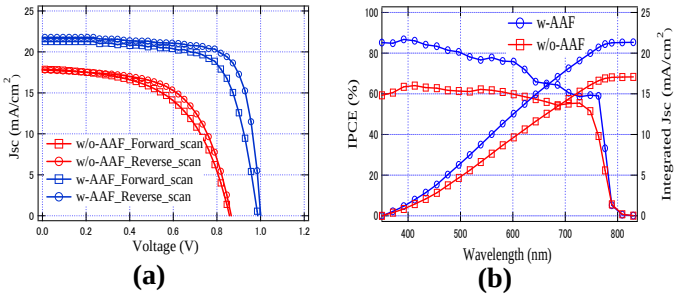

Fig. 2 (a) *J-V* curves for w/ AAF and w/o AAF perovskite solar cells. (b) IPCE spectra and integrated *Jsc* curves for w/ AAF and w/o AAF Perovskite solar cells

Reference: (1) J.-H. Im, I.-H. Jang, N. Pellet, et. al., Nature nanotechnology **9** (2014). (2) F. Huang, Y. Dkhissi, W. Huang, et. al., Nano Energy **10** (2014).