Supporting information:

Facile preparation of smooth perovskite films for efficient meso/planar hybrid structured solid-state solar cells

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Experimental section

Device fabrication:

Fluorine-doped tin oxide (FTO) coated glass (Opvtech) was cut into 15 mm × 20 mm pieces and cleaned with soap water, acetone and 2-propanol sequentially. The TiO_2 compact layer was prepared by spin-coating using a titanium isopropoxide solution and annealed at 500 ^{0}C for 30 min. The TiO_2 mesoporous layer was then spin-coated using a diluted commercial TiO_2 paste (Dyesol, 18NR-T) followed by an annealing process at 500 ^{0}C for 30 min.

The perovskite precursor solution was prepared by dissolving 369 mg of PbI_2 (Sigma-Aldrich), 73 mg of $PbBr_2$ (Sigma-Aldrich), 153 mg of CH_3NH_3I (Dyesol), 27 mg of CH_3NH_3Br (Dyesol) in 1ml N,N-Dimethylformamide (anhydrous, Sigma-Aldrich). Applying excess amount of methylammonium halide is aimed at providing sufficient source of cations in compensating the loss in reacting with moisture in ambient air. For perovskite deposition, 30 μl of precursor solution was dispensed onto the mesoporous electrode film. The excess solution was removed by directly absorbing the solution by a tissue paper. The film was then blow-dried by compressed air for 10s. The gas outlet was point to the surface with an angle of 45^0. And the flow speed at the sample surface was kept at 25±2 m/s which is tested by a wind speed meter (Dwyer). During gas blowing precursor quickly crystalized and formed a dark brown perovskite film. The film was further annealed at 100 ^{0}C for 10 min on a hotplate. Pristine P3HT (15 mg/ml, MW 54000-75000, Sigma-Aldrich without further purification)

was dissolved in 1,2-dichlorobenzene (Sigma-Aldrich) and spin-coated at 2000 rpm. Finally, the device was completed by deposition of 60 nm thick Au layer with an electron-beam evaporator at 10^{-6} torr. The cell active area was 0.06 cm^2.

Characterizations:

X-ray diffraction (XRD) data was obtained from a Bruker Advanced X-ray diffractometer (40 kV and 30 mA) with Cu Kα radiation. The cross-sectional morphology were recorded using a scanning electron microscope (7100, JEOL). UV-Vis absorption spectra of the resulting films were measured by a spectrophotometer (V-650, Jasco).

The photocurrent density-voltage (*J-V*) curve measurements were performed by employing an AM1.5 solar simulator (91160_1000, Oriel) equipped with a 300 W xenon light source (6258, Newport). The light intensity of the solar simulator was measured by using a thermal power meter (1918-c, Newport) with a detector (818P-040-25) and adjusted by a standard silicon solar cell. *J-V* curves were obtained by applying an external bias to the cell and measurements were recorded by a Keithley model 2420 digital source meter. The voltage step and delay time of photocurrent were 10 mV and 10 ms, respectively. The incident photon-to-current conversion efficiency (IPCE) was recorded on a Newport 1918-c power meter under the irradiation of a 300 W xenon light tower (66902, Newport) with an Oriel Cornerstone^T 260 ¼ m monochromator (74125, Oriel) in DC mode

Figures

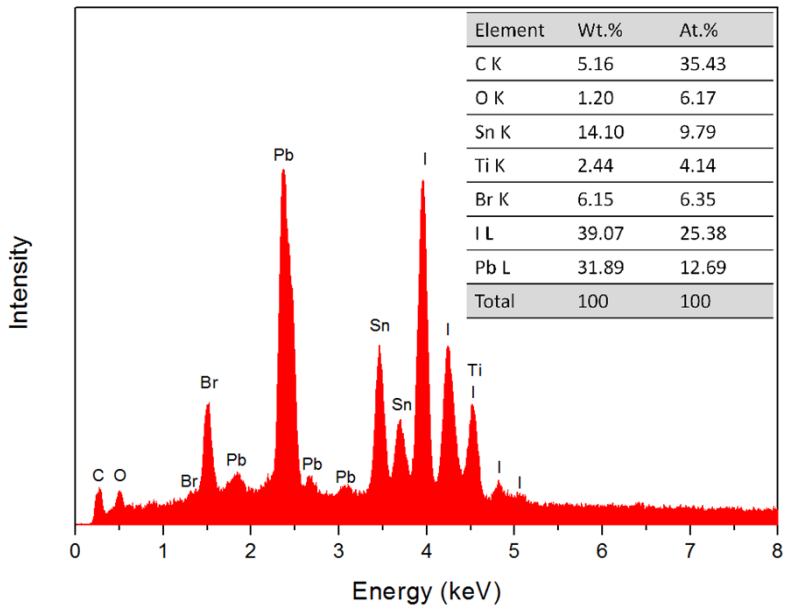

Fig. S1. EDS spectrum for the $CH_3NH_3PbI_{2.4}Br_{0.6}$ perovskite film on TiO_2 coated FTO substrate.

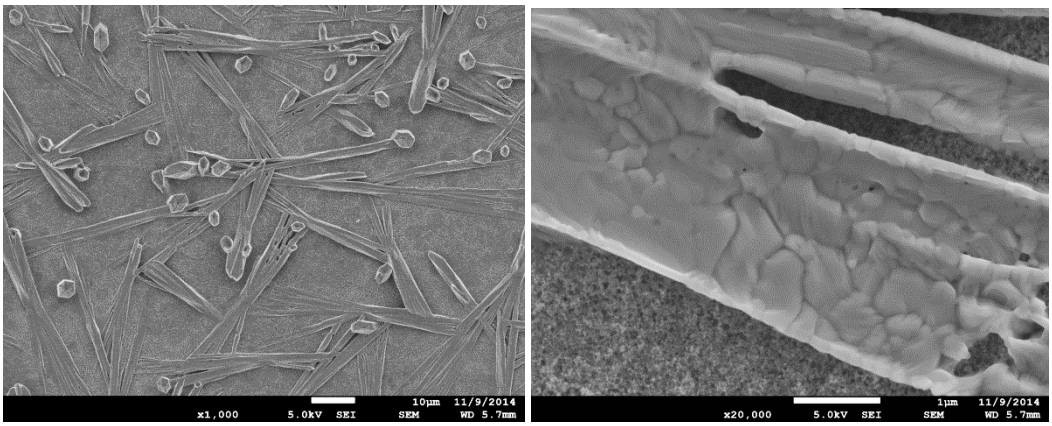

Fig. S2. SEM surface mophorlogy the the spin-coated film. Left: low megnification; Right: High megnification.

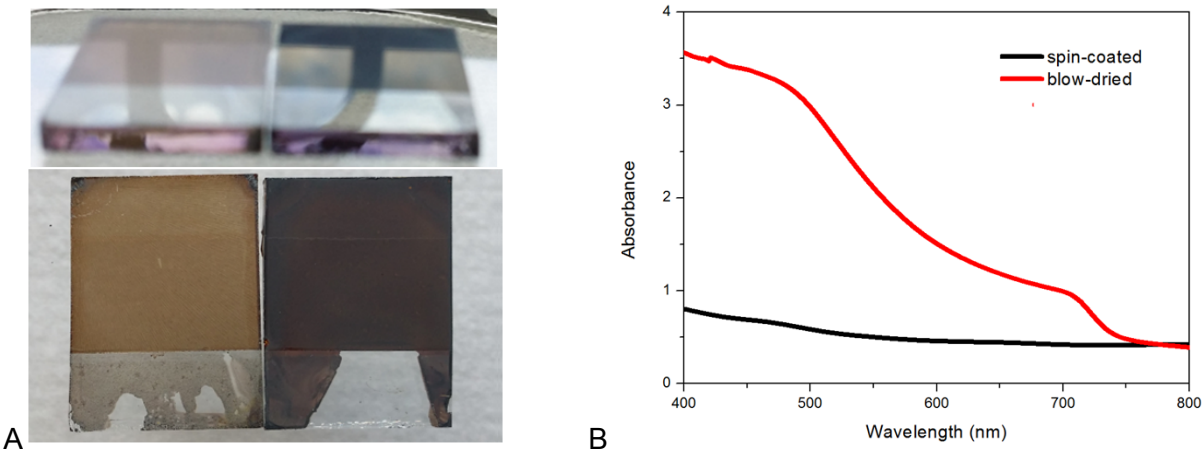

Fig. S3. Images (A) and light absorbance spectra (B) of the film samples prepared by spin-coating (left) and blow drying (right).

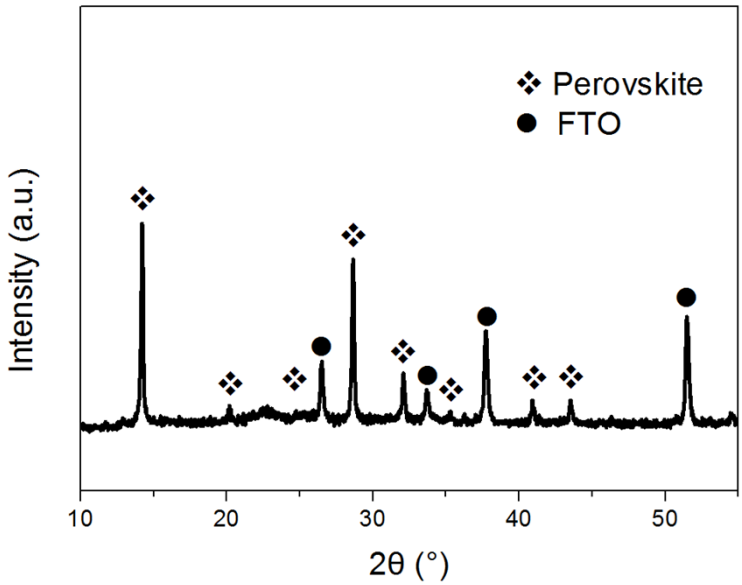

Fig. S4. XRD pattern of the blow-dried $CH_3NH_3PbI_{2.4}Br_{0.6}$ film deposited on mesoporous-TiO_2 coated FTO glass substrates without annealing.

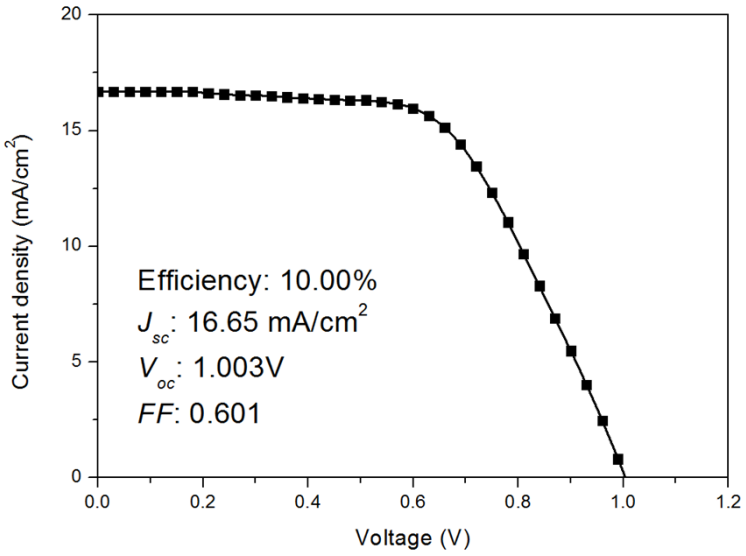

Fig. S5. I-V curve of the device with an open circuit voltage over 1V.