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Supporting information

Modifying SnO_2 with Ammonium Polyacrylate to Enhance the Performance of Perovskite Solar Cells

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Measurements

Atom force microscope (AFM) and the top view of scanning electron microscope (SEM) were used to obtained the surface morphology of perovskite layer. The phases of ITO glass and CsMAFA perovskite layers were recorded by X-ray diffraction (Nalytical, Netherlands). Surface element and valence states of SnO_2 and modified SnO_2 were analysed by X-ray photoelectron spectroscope (Thermo Fisher Scientific, USA). The energy band structure of SnO_2 and modified SnO_2 was analysed by ultraviolet photoelectron spectroscope (Thermo Fisher Scientific, USA). Transmittances of different kind of ETL was recorded by UV–vis-NIR spectrophotometer (Perkinelmer, USA). Absorption spectra of ITO/ SnO_2/perovskite were recorded by UV–vis-NIR spectropho-tometer (Perkinelmer, USA). The photovoltaic performance of PSCs was recorded by photocurrent density–voltage (*J-V*) curves using a Keithley 2450 source meter (Tektronix, USA). The incident light from a solar simulator (Beijing Perfectlight Technology, China) was calibrated to one-sun illumination (AM 1. 5G, 100 mW cm^{-2}) by a standard single-crystal silicon solar cell. Electrochemical impedance spectroscopy (EIS) of PSCs were recorded by an IM6 electrochemical workstation (Shanghai Chenhua Device Company, China). The symmetrical devices of ITO/SnO_2/perovskite/spiro-OMeTAD/Au were fabricated and characterized by a Keithley 2450 source meter (Tektronix, USA) for the space-charge-limited current (SCLC) analysis. The symmetrical devices of ITO/SnO_2/perovskite/spiro-OMeTAD/Au were fabricated and characterized by monochromatic incident photon-to-electron conversion efficiency (Beijing China Education Au-light, China).

Fig. S1. Schematic device architecture of PSCs studied.

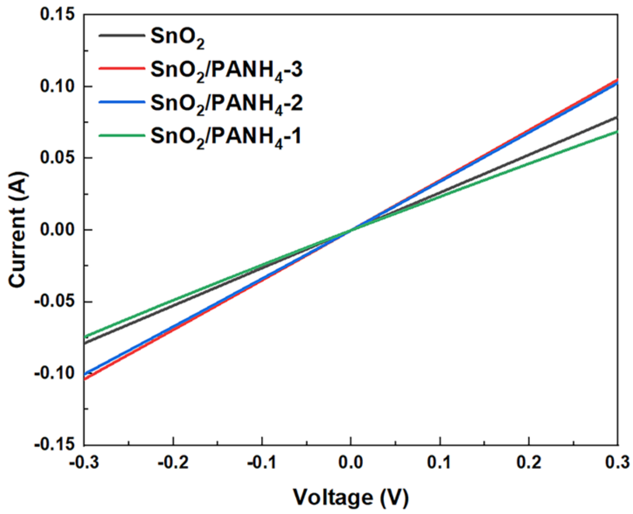

Fig. S2. Dark *I*−*V* measurement of SnO_2, SnO_2/$PANH_4$-1, SnO_2/$PANH_4$-2 and SnO_2/$PANH_4$-3.

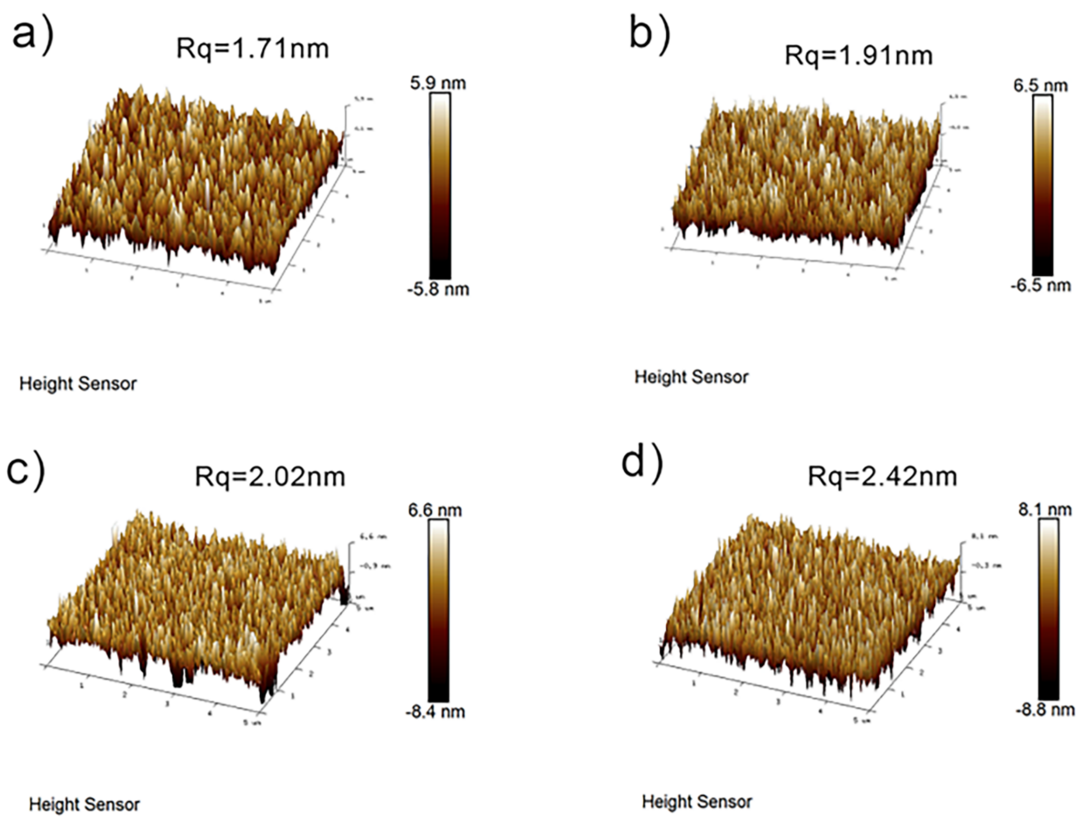

Fig. S3. AFM images of different substrates: (a) SnO_2, (b) $SnO_2/PANH_4$-3, (c) $SnO_2/PANH_4$-2, (d) $SnO_2/PANH_4$-1.

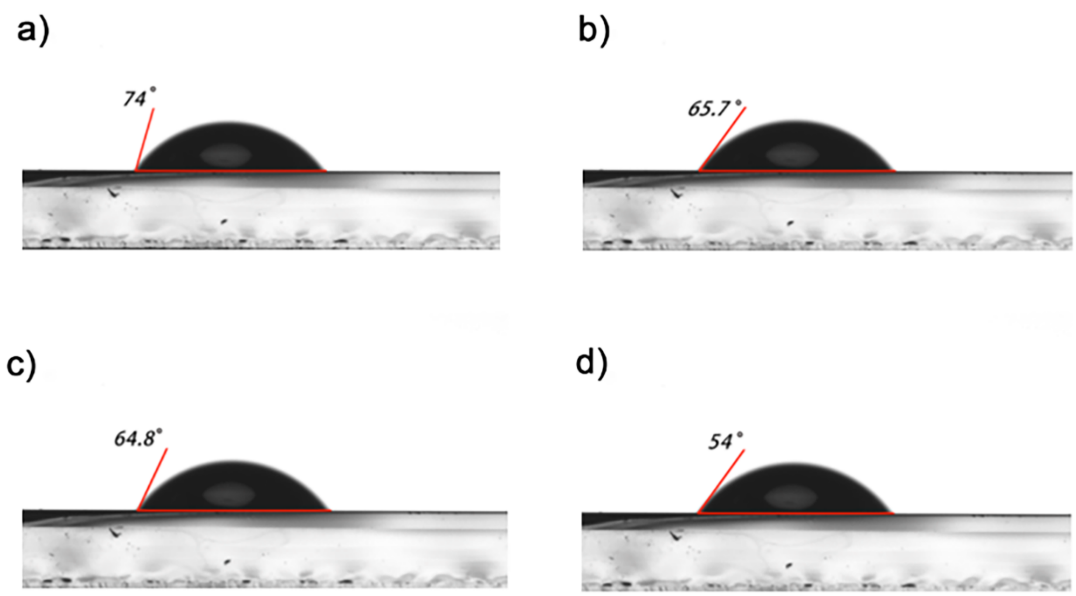

Fig. S4. Contact angle of water droplets on different substrates: (a) SnO_2, (b) $SnO_2/PANH_4$-3, (c) $SnO_2/PANH_4$-2, (d) $SnO_2/PANH_4$-1.

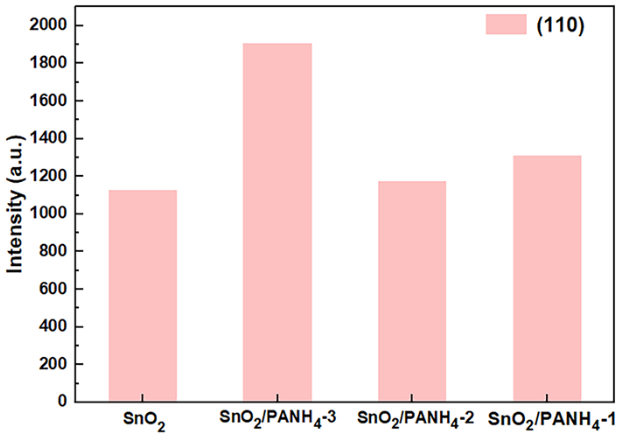

Fig. S5. (110) peak strength of perovskite. (SnO_2, $SnO_2/PANH_4$-1, $SnO_2/PANH_4$-2 and $SnO_2/PANH_4$-3)

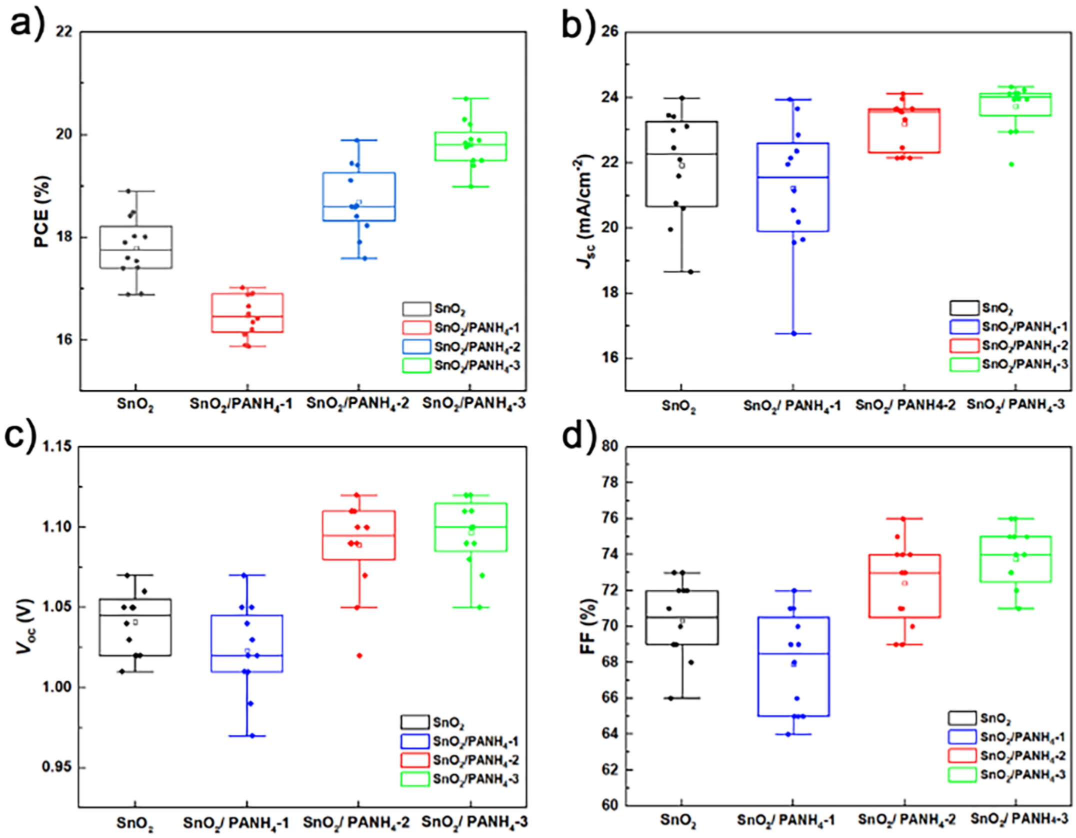

Fig. S6. Statistic output parameters of PSCs deposited on SnO_2, $SnO_2/PANH_4$-1, $SnO_2/PANH_4$-2 and $SnO_2/PANH_4$-3 : (a) PCE, (b) J_{sc}, (c) V_{oc} and (d) FF.

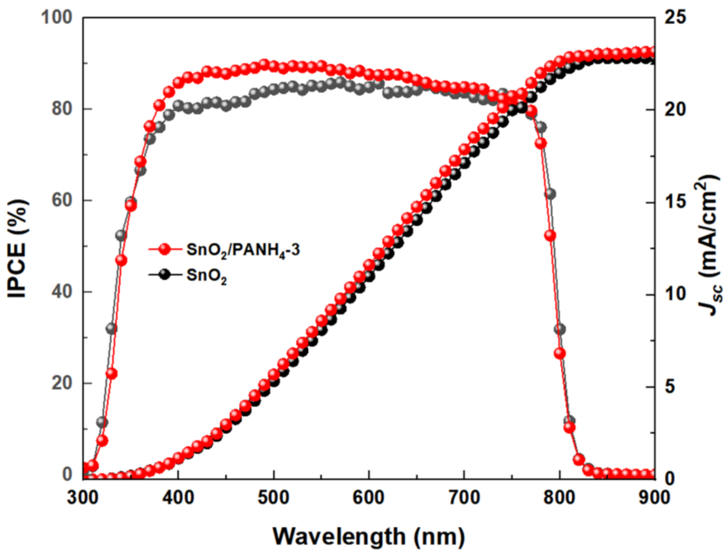

Fig. S7. IPCE spectra of device based on SnO_2 and $SnO_2/PANH_4$-3.

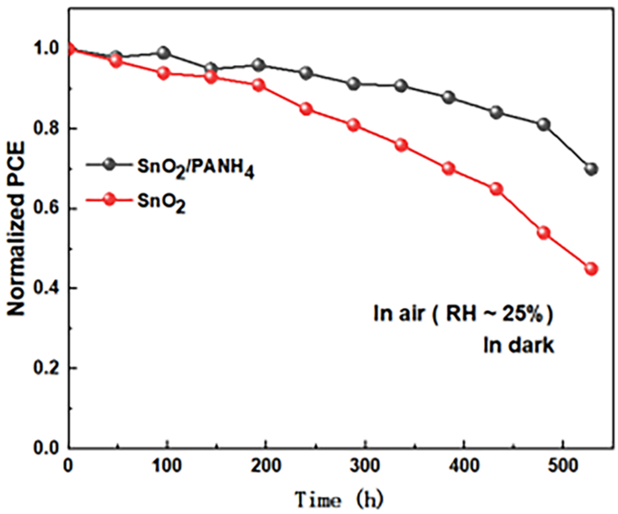

Fig. S8. Changing of PCEs for the devices made using SnO_2 and $SnO_2/PANH_4$.