

A Contact Study in Hole Conductor Free Perovskite Solar Cells with Low Temperature Processed Carbon Electrodes

Supporting information

J. Li,^{1,2} J. X. Yao,² X. Y. Liao,^{2,3} R. L. Yu,² H.R. Xia,^{1,2} W. T. Sun,^{2,3*} and L. M. Peng^{1,2*}

¹ Academy for Advanced Interdisciplinary Studies, Peking University, Beijing 100871, China

² Key Laboratory for the Physics and Chemistry of Nanodevices and Department of electronics, Peking University, Beijing 100871, China

³ School of Software and Microelectronics, Peking University, Beijing 100871, China

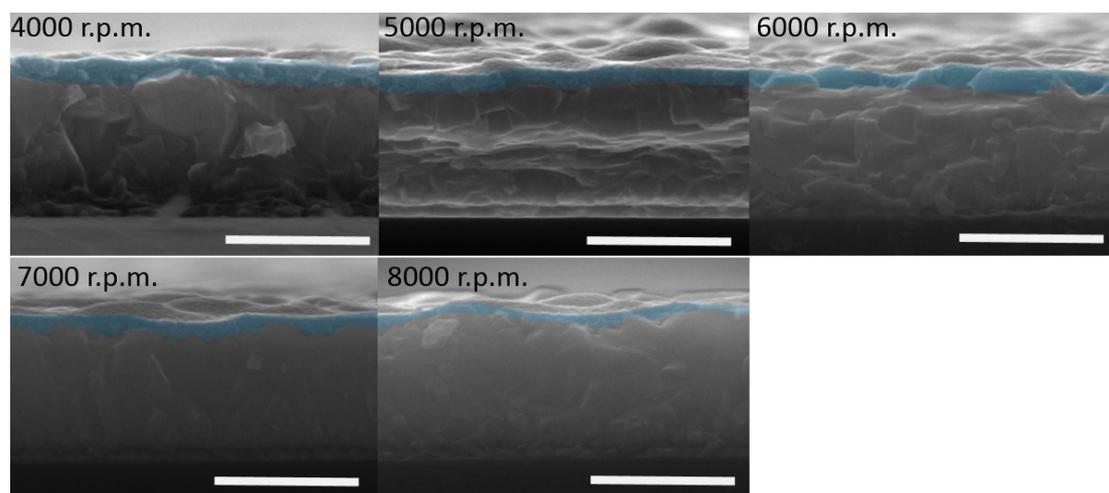


Fig. S1. Cross-sectional SEM images of TiO₂ compact layer (Scale bar: 500 nm)

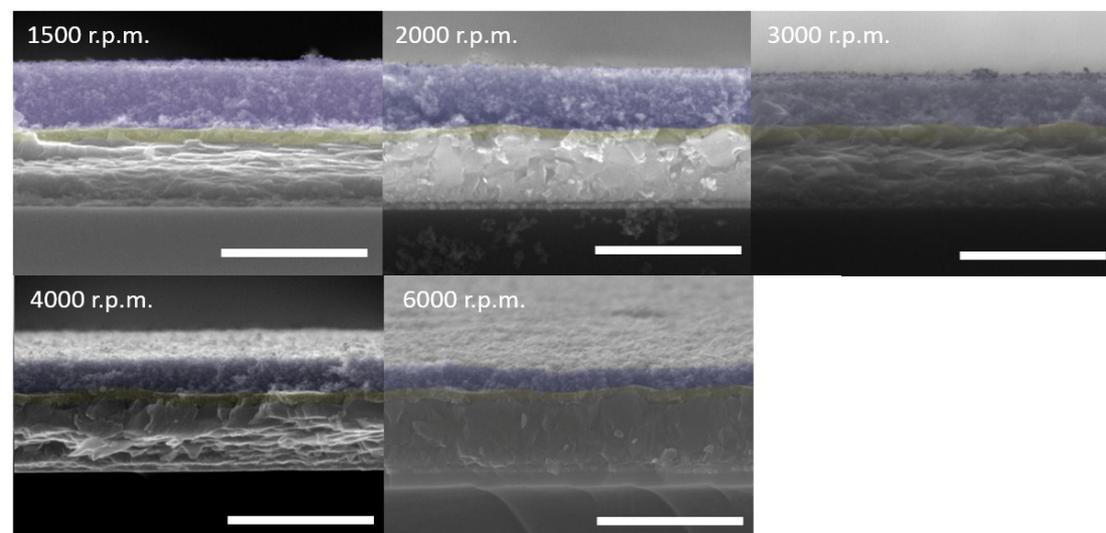


Fig. S2. Cross-sectional SEM images of TiO₂ mesoporous layer (Scale bar: 1 μm)

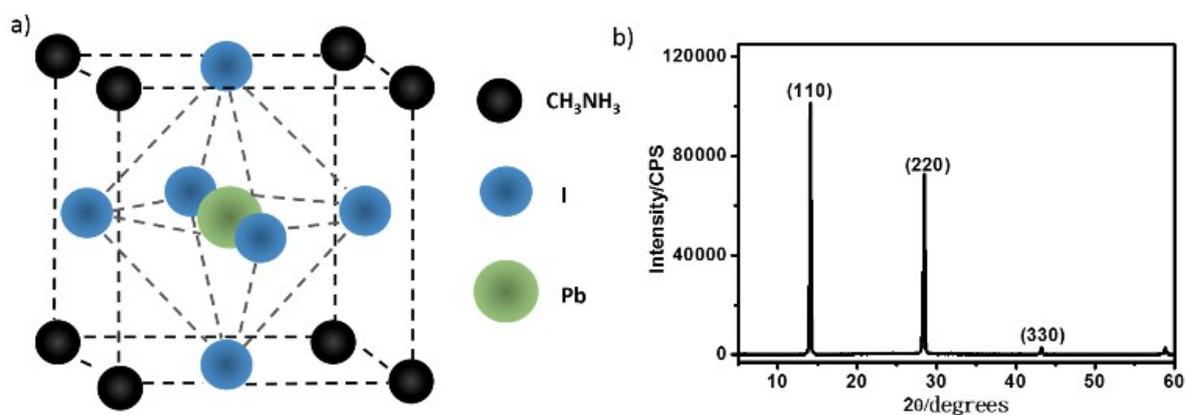


Fig. S3. a) Schematic crystal structure of perovskite ABX_3 ($A=CH_3NH_3$, $B=Pb$, $x= I$), b) XRD pattern of the perovskite.

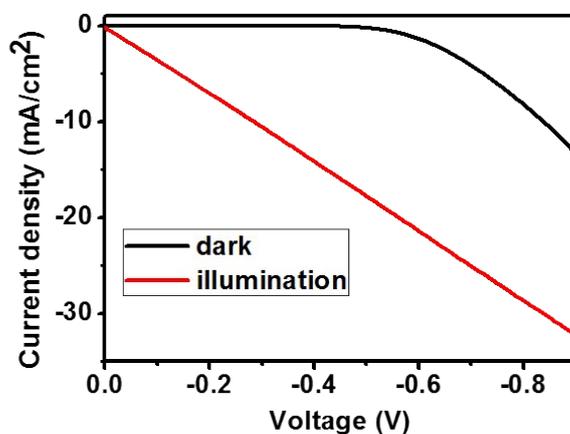


Fig. S4. J-V curves of a device with carbon on pure TiO_2 in dark and under illumination

Hysteresis effects: The hysteresis effects of the devices were also discussed by measuring J-V curves with different scan directions and scan rates (Fig. S5). The photovoltaic parameters are shown in Table S1 and Table S2. The device obtained efficiency of 10.0% by backward direction scanning and 6.9% by forward direction scanning. Though J-V curves were quite different with different scanning direction, they varied slightly with different scanning rates. The efficiency were 10.4% and 10.1% with the scanning rates of 100 mV/s and 50 mV/s, respectively.

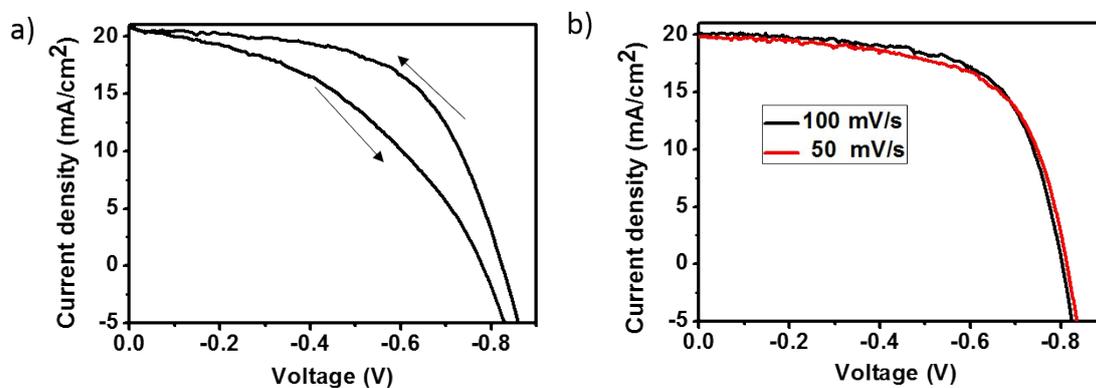


Fig. S5. J-V curves of a device a) with different scan directions, b) with different scan rates

Table S1. Photovoltaic parameters of a device with different J-V scanning directions.

Scan direction	J_{sc} (mA/cm ²)	V_{oc} (V)	FF	η (%)
backward	20.8	0.820	0.586	10.0
forward	20.8	0.780	0.425	6.9

Table S2. Photovoltaic parameters of a device with different J-V scanning rates.

Scan rates	J_{sc} (mA/cm ²)	V_{oc} (V)	FF	η (%)
100 mV/s	20.1	0.803	0.644	10.4
50 mV/s	19.8	0.815	0.626	10.1

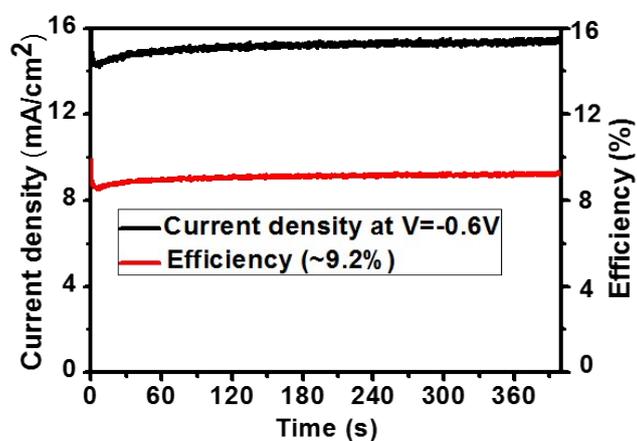


Fig. S6. The stabilized output of current density and photoelectrical efficiency of a device at voltage of -0.6V.

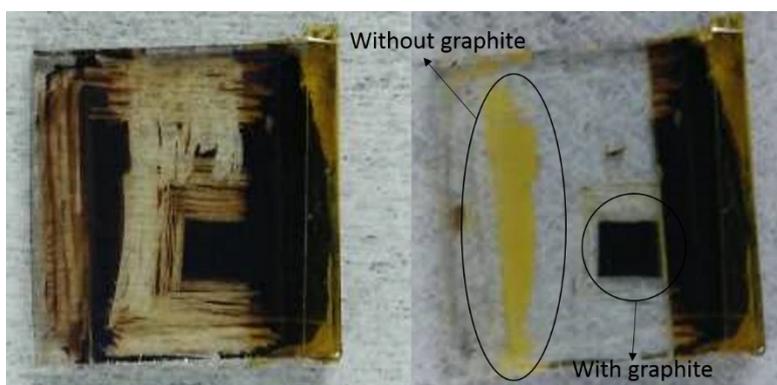


Fig. S7. Photographs of a device before and after immersing in water for 1 minutes.

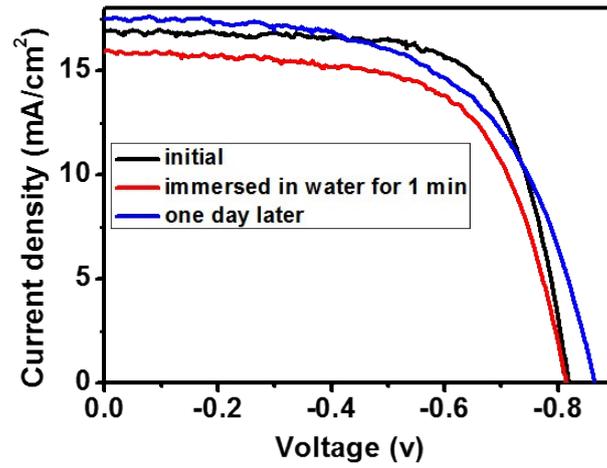


Fig. S8. J-V curves of devices before and after immersing in water for 1 minutes and after 1 day in ambient atmosphere.

Table S3. Photovoltaic parameters of a device before and after immersing in water for 1 minutes and after 1 day in ambient atmosphere.

Samples	$J_{sc}(\text{mA}/\text{cm}^2)$	$V_{oc}(V)$	FF	$\eta(\%)$
initial	16.9	0.818	0.703	9.72
1 min in water	15.9	0.814	0.642	8.31
1 day later	17.5	0.864	0.591	8.93