

Supplementary Information

Using low-temperature carbon electrode for preparing hole-conductor-free perovskite heterojunction solar cells under high relative humidity

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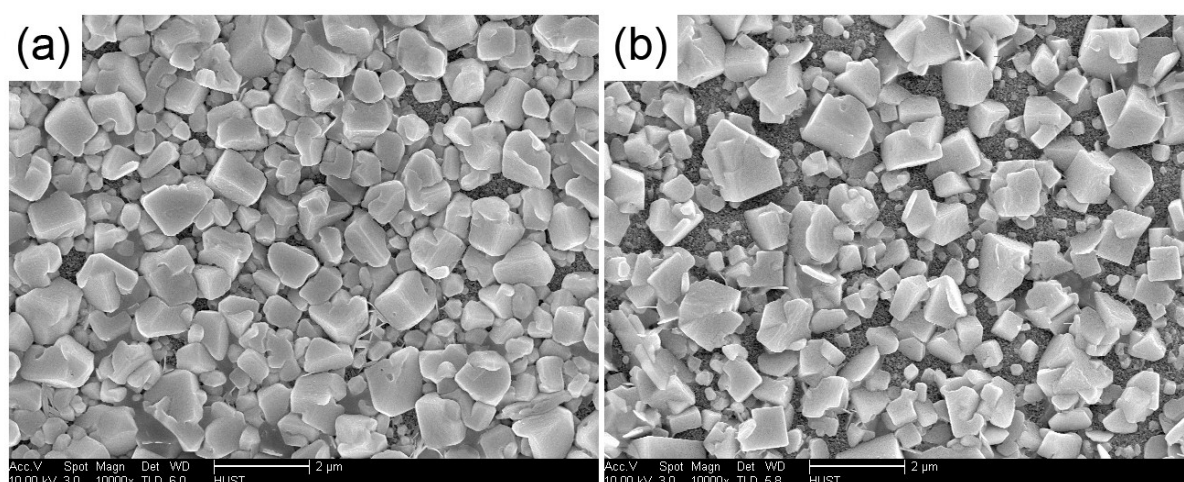


Fig. S1 Plane-view SEM images of $\text{CH}_3\text{NH}_3\text{PbI}_3$ formed by two-step method at substrate temperature of (a) 50 °C, (b) room temperature (without pre-heating).

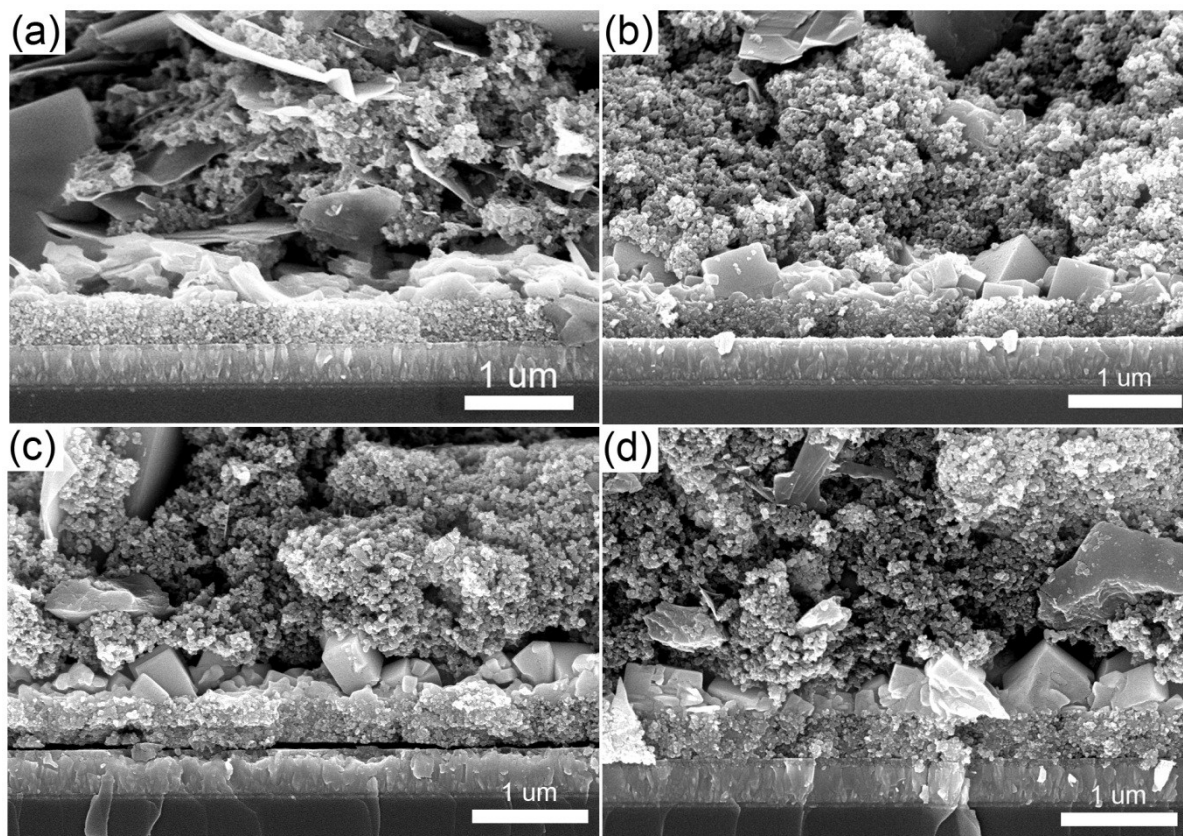


Fig. S2 Cross-sectional SEM images of the HTM-free perovskite heterojunction solar cell prepared by carbon film (a) A, (b) B, (c) C and (d) D.

Table S1 The photovoltaic parameters of HTM-free CH₃NH₃PbI₃/TiO₂ heterojunction solar cell within a 2000 h long-term stability test period.

Time (h)	V_{OC} (V)	J_{SC} (mA cm ⁻²)	FF	PCE (%)
0	0.87	16.8	0.425	6.21
50	0.88	17	0.423	6.33
100	0.87	17.8	0.426	6.597
150	0.86	18.1	0.422	6.57
200	0.86	18	0.430	6.66
250	0.84	17.8	0.452	6.76
300	0.85	18.1	0.425	6.54
400	0.84	17.2	0.470	6.8
500	0.85	17.9	0.420	6.39
600	0.84	16.9	0.450	6.41
1100	0.83	16.5	0.470	6.46
1200	0.85	16.8	0.424	6.06
1300	0.83	16.2	0.460	6.22
1400	0.82	16.3	0.444	5.94
1600	0.83	14.9	0.463	5.73
1700	0.83	13.9	0.430	4.96
1800	0.81	12.8	0.380	3.97
2000	0.83	10.2	0.440	3.72