Supporting Information

Low-temperature solution-processed SnO$_2$ electron transport layer modified by oxygen plasma for planar perovskite solar cells

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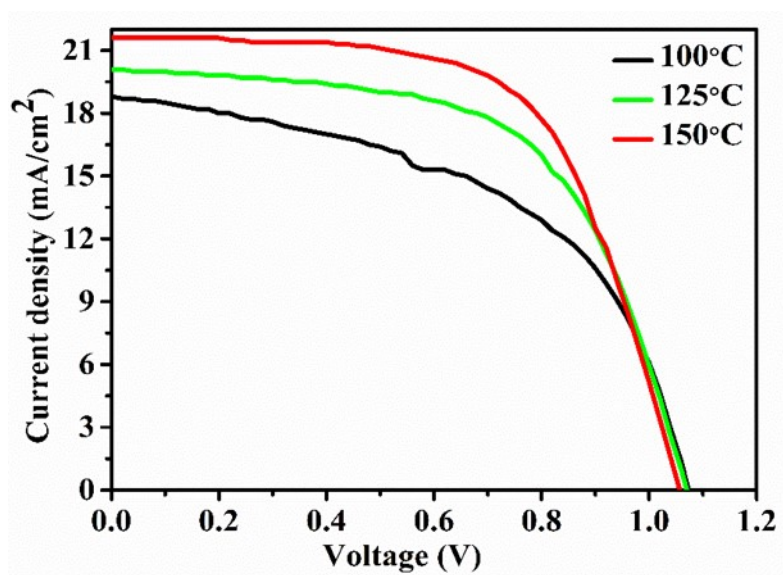
Figure S1. *J-V* characteristics of PSCs based on LTP-SnO$_2$ annealed at various temperatures ranging from 100°C to 150°C.
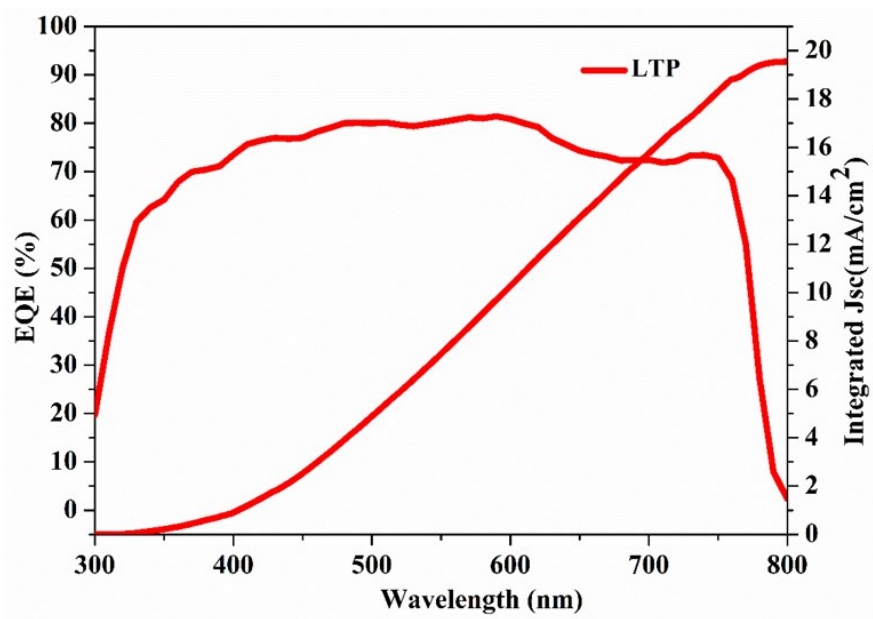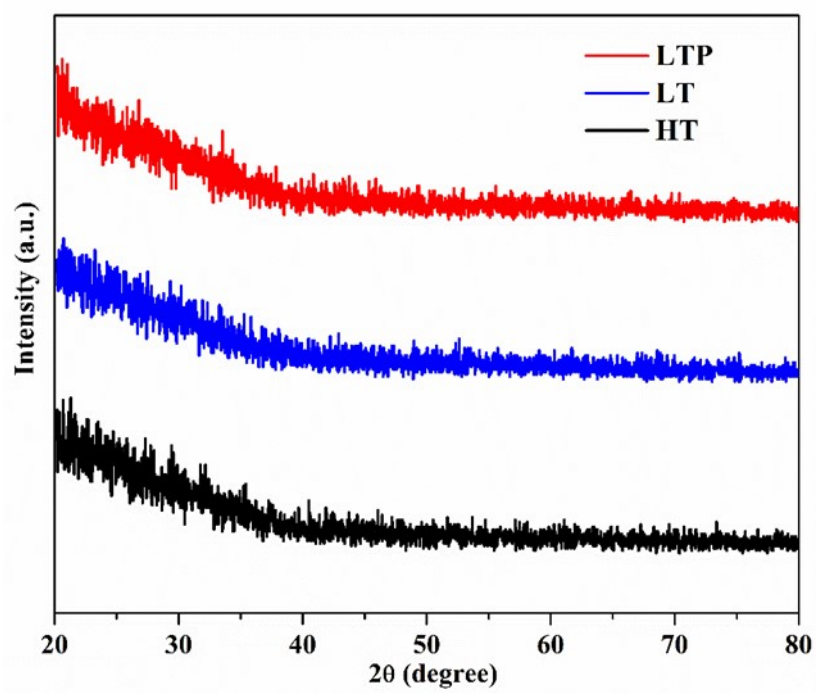
Figure S2. EQE spectra of LTP-PSCs and integrated J_{sc}.
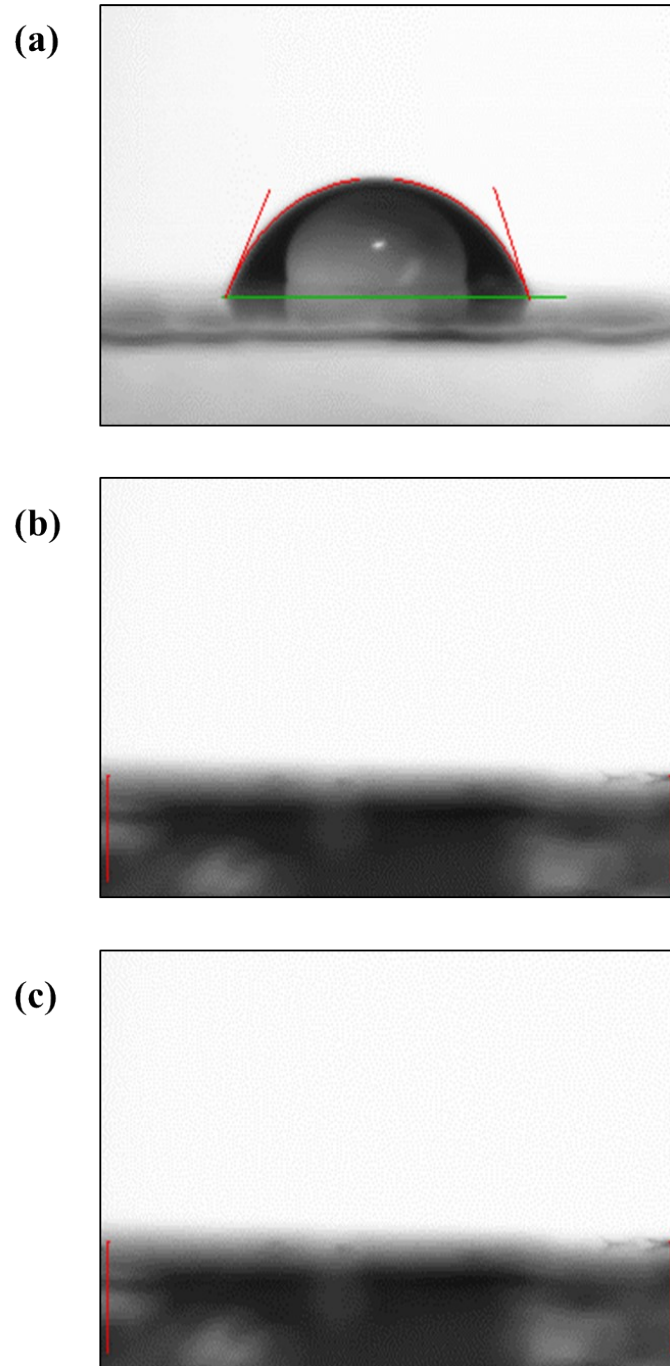
Figure S3. XRD pattern of HT-, LT-, and LTP-SnO$_2$.

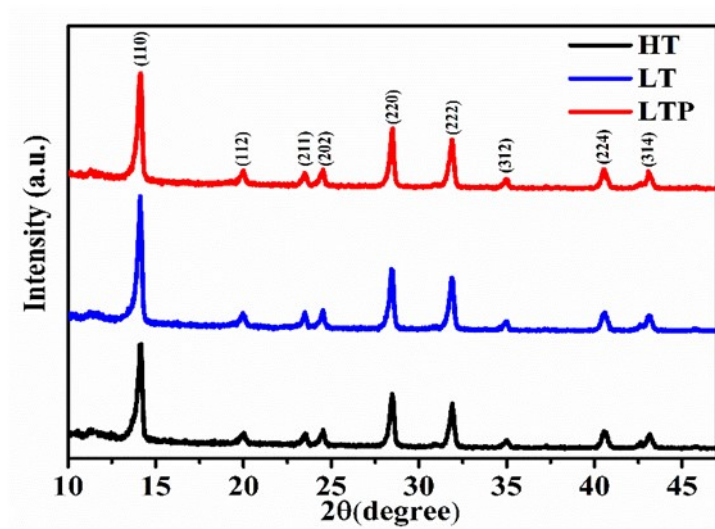**Figure S4. Measured contact angle of water droplets on (a) LT-, (b) LTP- , and (c) HT-SnO$_2$.**

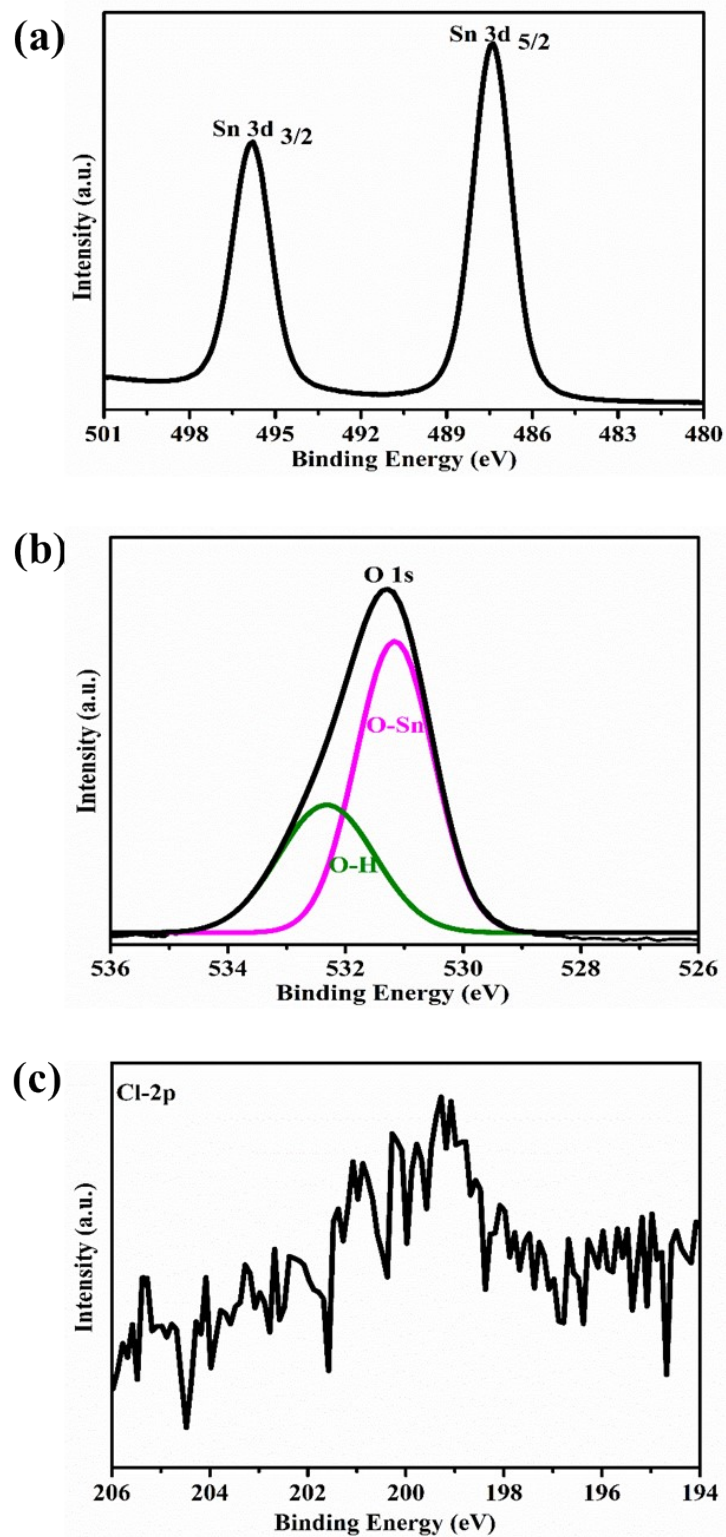**Figure S5. XRD pattern of MAPbI₃ layers deposited on HT-, LT-, and LTP-SnO₂.**

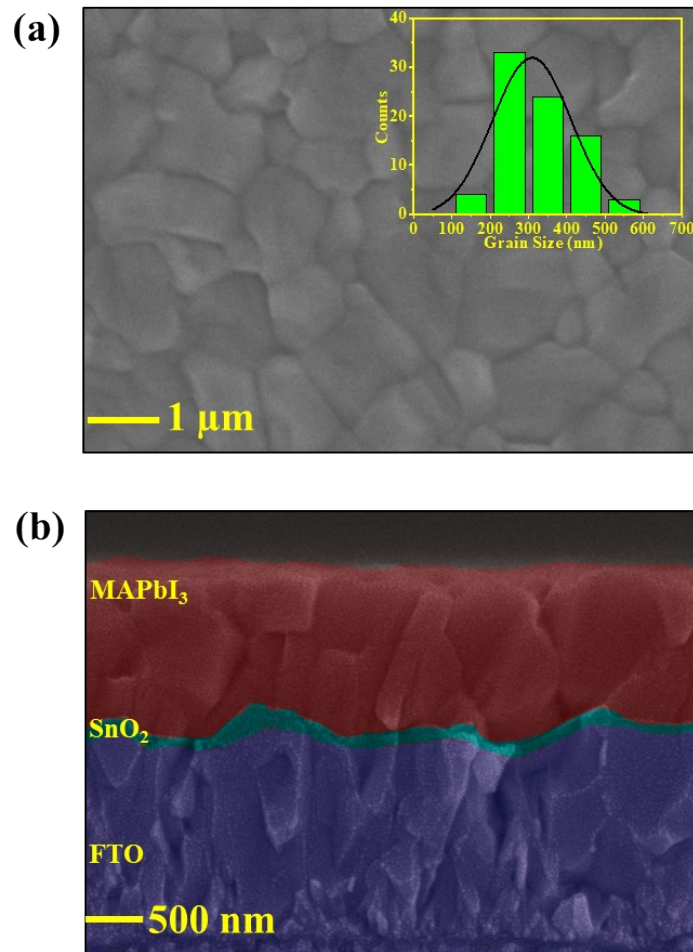**Figure S6. XPS spectra of (a) Sn 3d (b) O 1s and (c) Cl 2p from HT-SnO$_2$.**

Figure S7. (a) Top view SEM images and grain size distribution histograms (inset) of MAPbI$_3$ deposited on HT-SnO$_2$. (b) Corresponding cross sectional SEM images of MAPbI$_3$ deposited on HT--SnO$_2$.
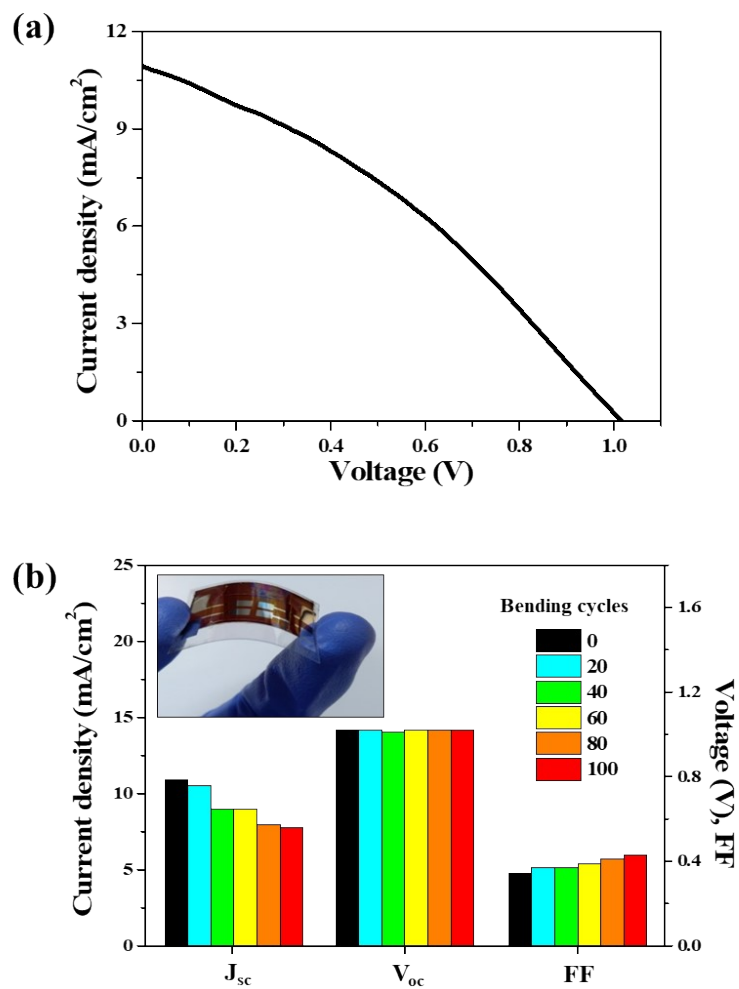
Figure S8. (a) *J-V* **graph for flexible PSC based on LTP-SnO₂ ETL and (b) bending cycle test results.**

Table S1. Averaged photovoltaic performance parameters of PSCs obtained from 20 cells.

Device	J_{sc} (mA/cm^2)	V_{oc} (V)	Fill factor	Efficiency (%)
HT-SnO$_2$	21.25±0.5	1.02±0.05	0.61±0.04	13.25±1.0
LT-SnO$_2$	19.04±1.0	0.29±0.06	0.33±0.02	1.82±0.43
LTP-SnO$_2$	21.16±0.8	1.06±0.02	0.63±0.05	14.16±0.82

Table S2. Device parameters of PSC at different temperatures using oxygen plasma treatment.

Device	J_{sc} (mA/cm^2)	V_{oc} (V)	Fill factor	Efficiency (%)
100°C	18.83	1.07	0.51	10.30
125°C	20.14	1.07	0.60	12.86
150°C	21.61	1.06	0.62	14.30

Table S3. The parameters of TRPL spectra.

Device	A1(%)	τ_1 (ns)	A2(%)	τ_2 (ns)	A3(%)	τ_3 (ns)	τ_{Avg} (ns)
HT-SnO$_2$	46	2.84	53	11.5	1	134	18
LT-SnO$_2$	40	2.48	59	11.5	1	138	18
LTP-SnO$_2$	49	2.28	50	7.24	1	121	15

Table S4. EIS fitted parameters.

Device	R_S (Ω)	R_{rec} (Ω)
HT-SnO$_2$	25.43	1961
LT-SnO$_2$	30.95	19.37
LTP-SnO$_2$	19.69	3669