Appendix A. Electronic Supplementary Material

Multifunctional buried interface modification for efficient and stable SnO_2-based perovskite solar cells

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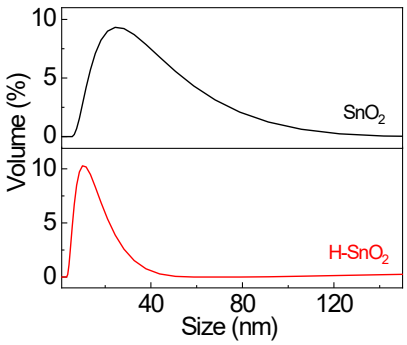

Fig. S1. DLS measurements of the dispersion of pristine SnO_2 and H-SnO_2.

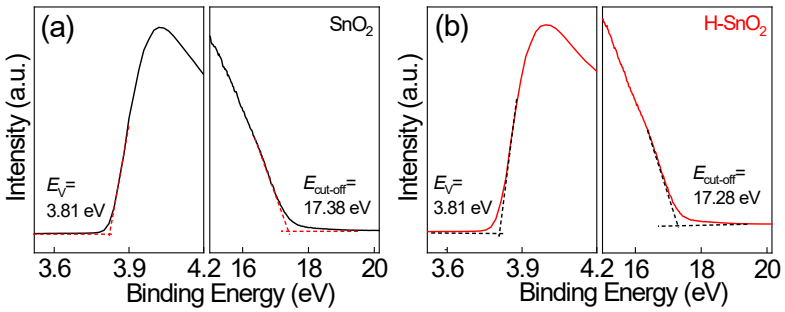

Fig. S2. The UPS spectra of (a) pristine SnO_2 and (b) H-SnO_2 film, where the secondary electron cutoff and the Fermi edge are focused.

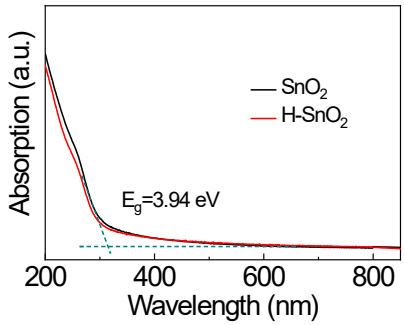

Fig. S3. The UV-vis absorption spectra of the pristine SnO_2 and H-SnO_2 film, from which the bandgap of the samples is estimated to be 3.94 eV.

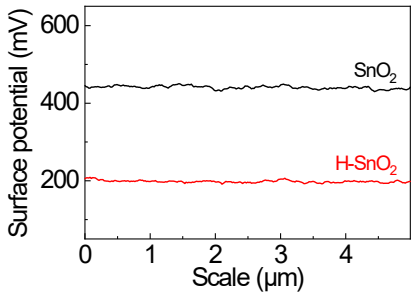

Fig. S4. The surface potential profiles of the pristine SnO_2 and H-SnO_2 films taken at the positions marked by white line in the KPFM images (Fig. 1e and 1f).

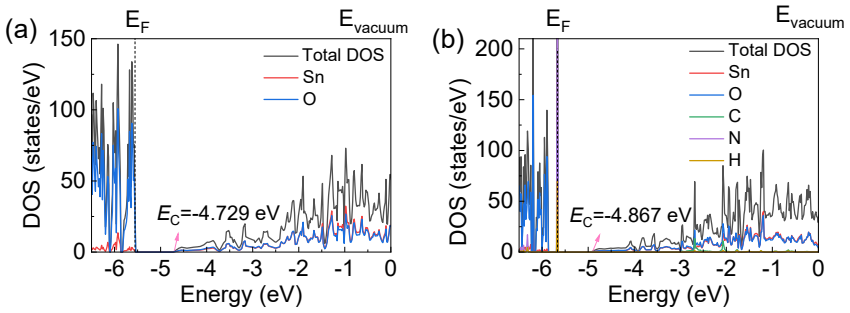

Fig. S5. Electronic DOS of (a) SnO_2, (b) H-SnO_2.

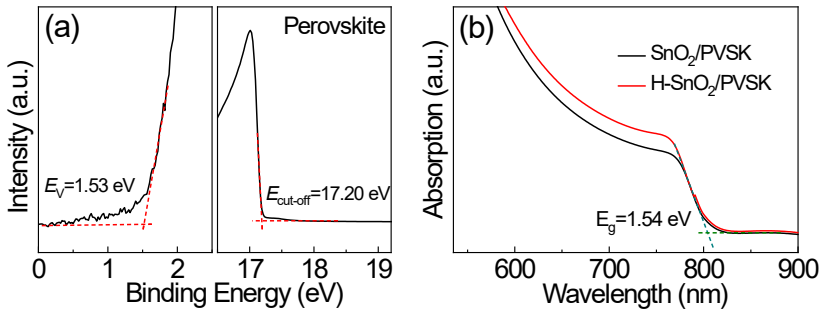

Fig. S6. (a) The UPS spectra of perovskite film, (b) UV-vis absorption spectra of the perovskite films deposited on SnO_2 ETLs.

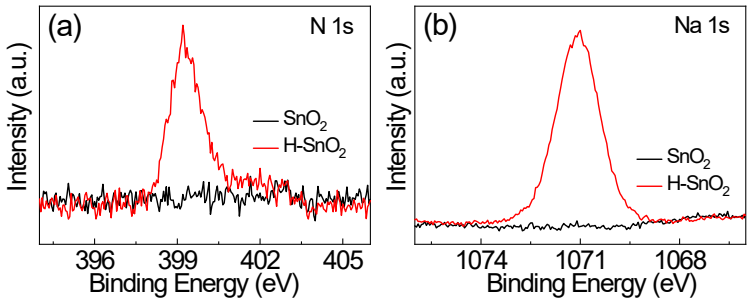

Fig. S7. XPS core-level spectra of (a) N 1s and (b) Na 1s for SnO_2 and H-SnO_2 film.

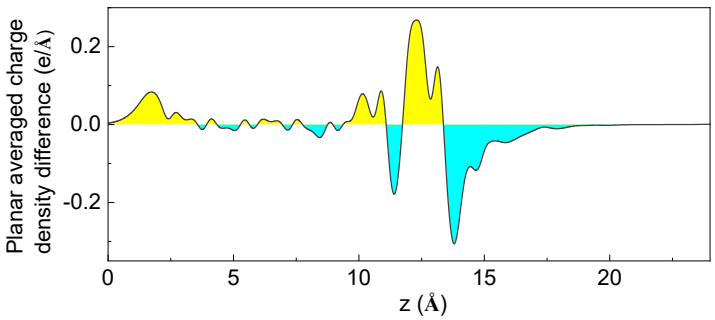

Fig. S8. Plane-averaged charge density difference of SnO_2/HEDTA interface, the cyan and yellow regions correspond to the charge depletion and accumulation regions, respectively.

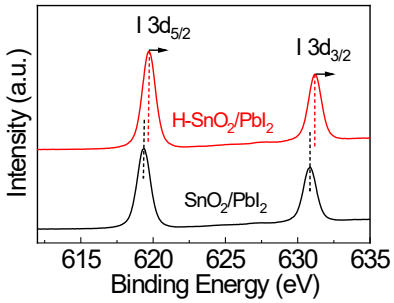

Fig. S9. I 3d core-level spectra for the PbI_2 films coated on SnO_2 and H-SnO_2 ETLs.

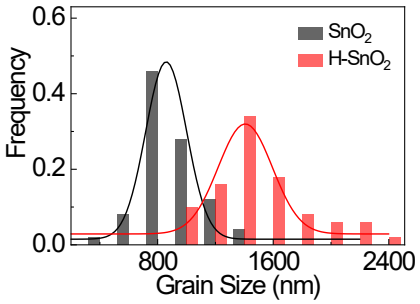

Fig. S10. The grain size distribution diagram of perovskite films coated on SnO_2 and H-SnO_2 ETLs.

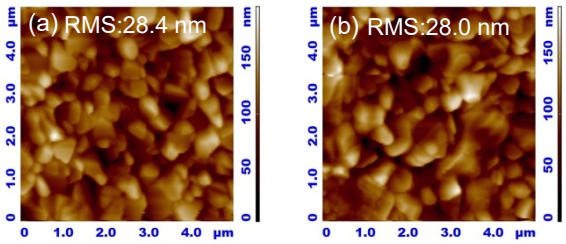

Fig. S11. AFM images of perovskite films deposited on (a) SnO_2 and (b) H-SnO_2, the scan area is 5×5 μm^2.

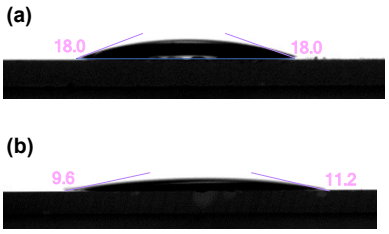

Fig. S12. Contact angle measurements of DMF on (a) SnO_2 and (b) H-SnO_2 film.

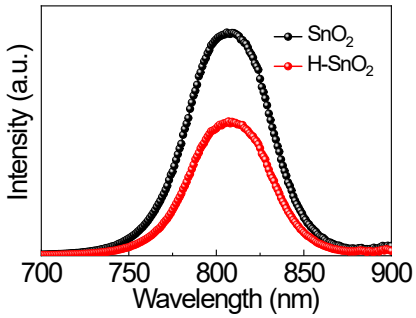

Fig. S13. Steady-state PL spectra of the perovskite films deposited on the SnO_2 and H-SnO_2 substrates.

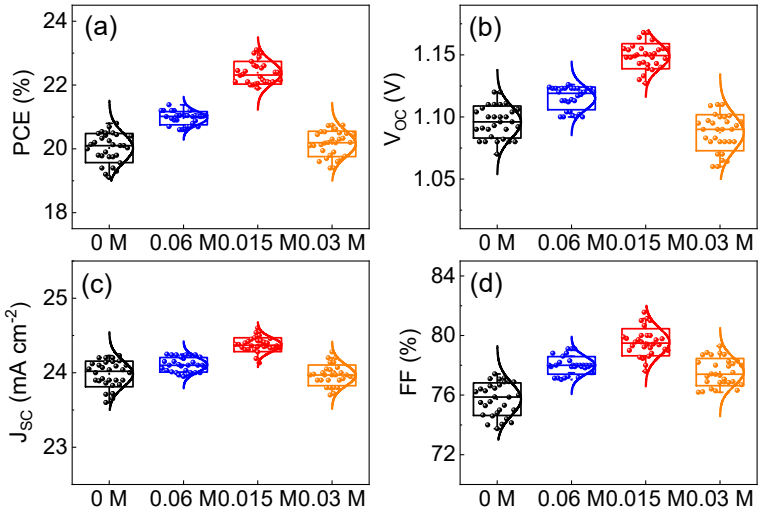

Fig. S14. Statistic diagram of (a) PCE, (b) V_{OC}, (c) J_{SC} and (d) FF for the PSCs based on SnO_2 ETL with different concentration of HEDTA-3Na. The statistical data were collected from 30 cells for each concentration.

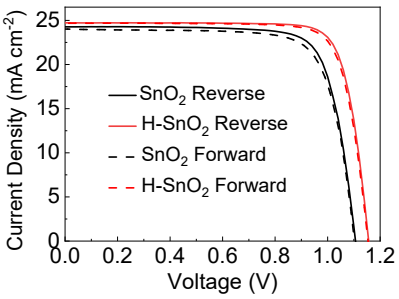

Fig. S15. *J-V* curves measured by the reverse scan and forward scan of the PSCs based on pristine SnO_2 and H-SnO_2 ETLs, the photovoltaic parameters are listed in Table S2.

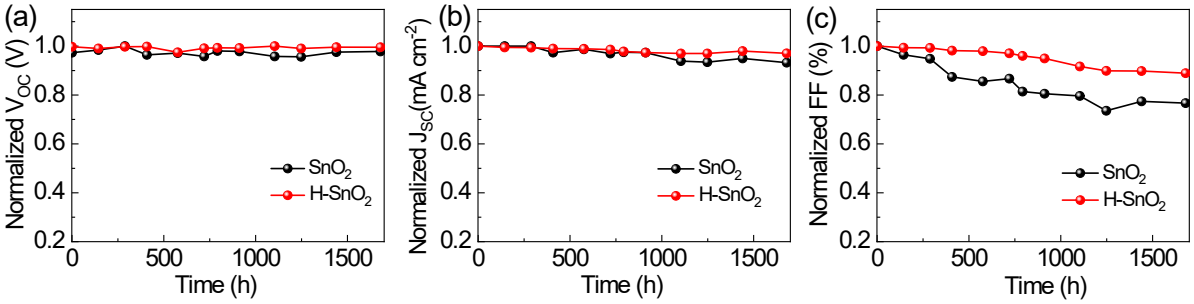

Fig. S16. Long-term stability of (a) V_{OC}, (b) J_{SC} and (c) FF (unencapsulated devices) for the PSCs with SnO_2 and H-SnO_2 ETLs.

Table S1. The TRPL spectra parameters of perovskite based on SnO_2 and H-SnO_2 ETLs.

Samples	A_1 (%)	τ_1 (ns)	A_2 (%)	τ_2 (ns)	τ_{ave} (ns)
SnO_2	85.6	79.2	14.4	383	215.5
H-SnO_2	85.2	46.8	14.8	183.3	101.8

Table S2. Photovoltaic parameters for PSCs made with SnO_2 or H-SnO_2 under reverse and forward scan directions.

Samples	Scan direction	V_{OC} (V)	J_{SC} (mA cm^{-2})	FF (%)	PCE (%)	HI
SnO_2	Reverse	1.106	24.26	77.57	20.82	0.032
	Forward	1.102	24.01	76.13	20.16	
H-SnO_2	Reverse	1.156	24.72	80.86	23.11	0.014
	Forward	1.154	24.67	80.02	22.78	

Table S3. EIS parameters of devices based on SnO_2 and H-SnO_2 ETLs.

Sample	R_{tr} (Ω)	R_{rec} (Ω)
SnO_2	580.6	3172
H-SnO_2	317.2	6021