

Supporting Information

Buried interface modification by multifunctional ionic liquid for triple-cation perovskite solar cells made in a fully-ambient air

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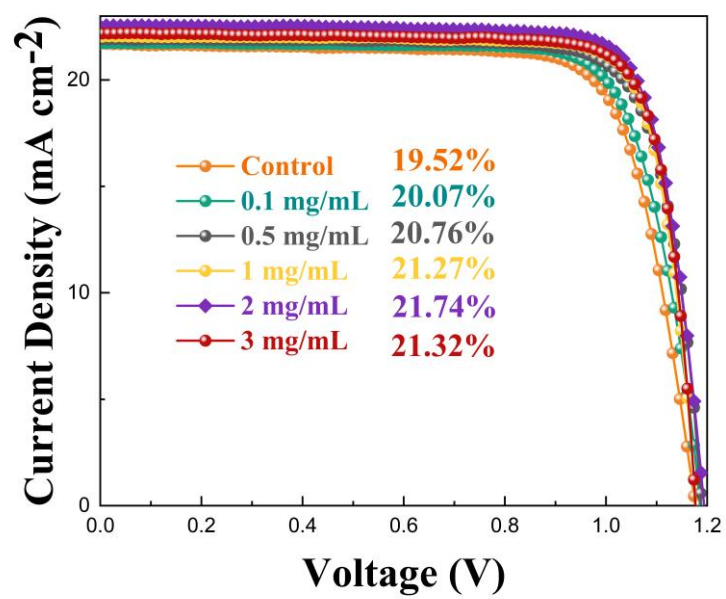


Figure S1. The champion PCE for devices with different BMIMPF₆ concentrations of 0.1, 0.5, 1, 2, and 3 mg/mL.

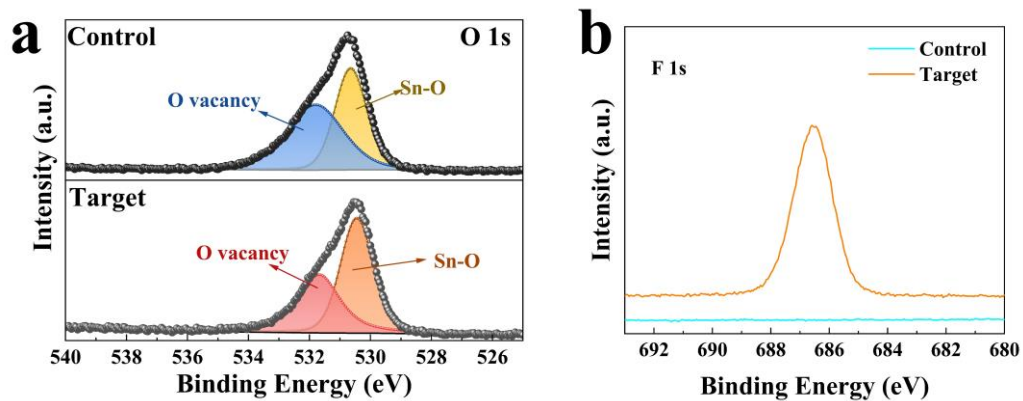


Figure S2. a) XPS of O 1s core-level spectra; b) XPS of F 1s core-level spectra.

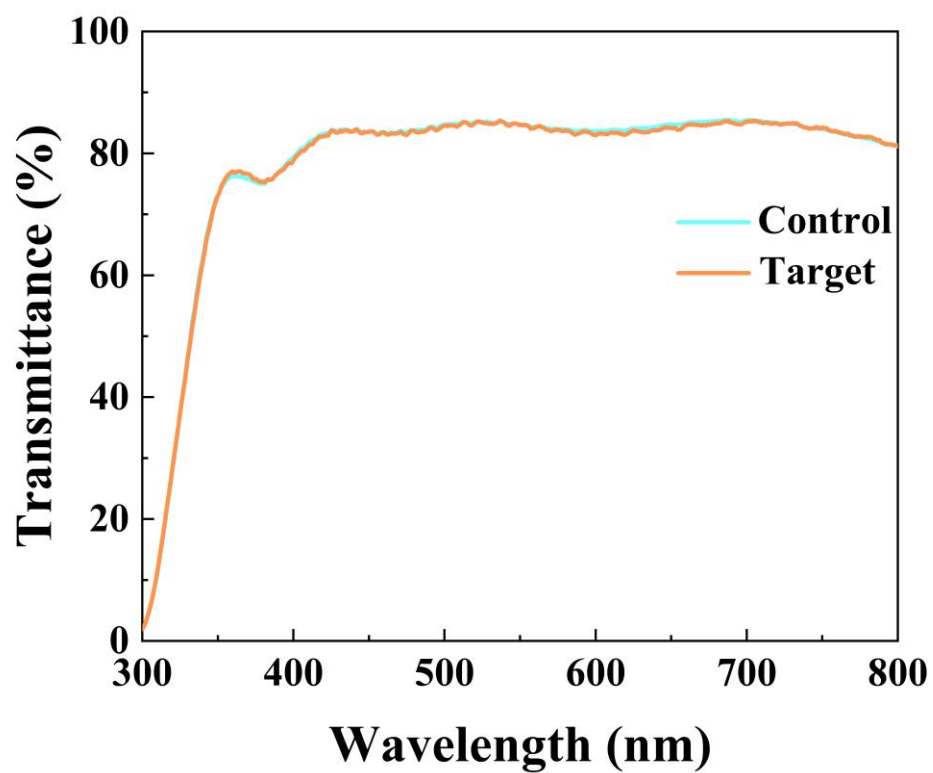


Figure S3. The light transmission of control and target SnO₂ films.

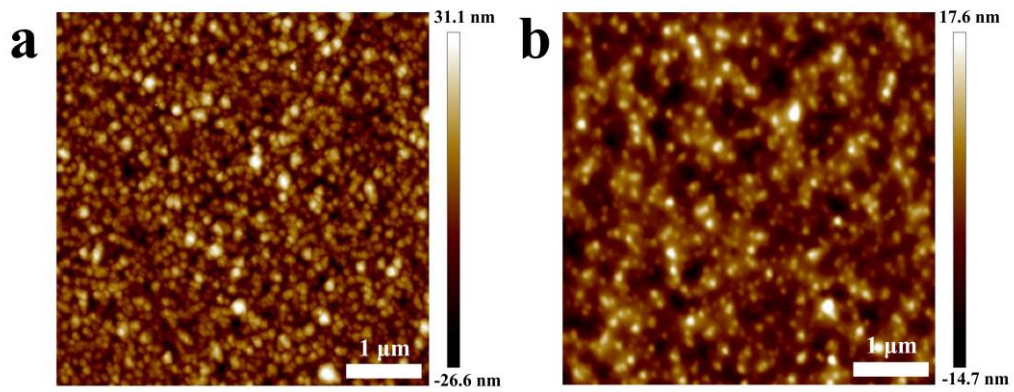


Figure S4. a) AFM image of control SnO₂ film; b) AFM image of control SnO₂ film with BMIMPF₆.

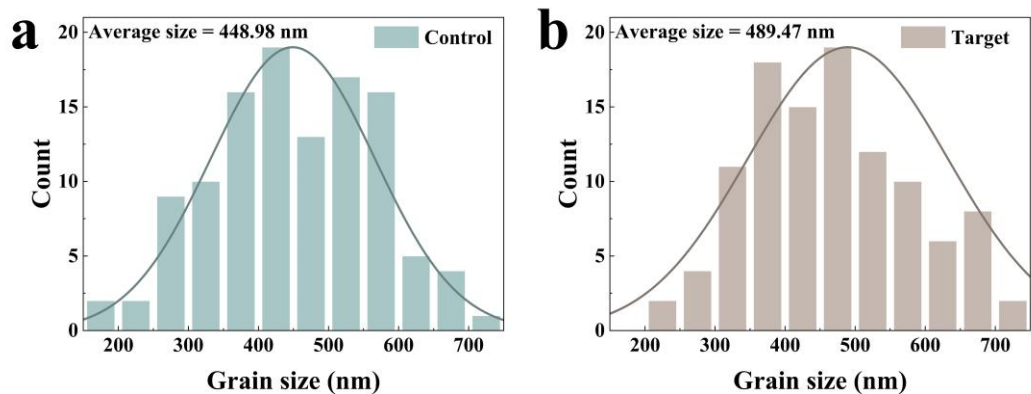


Figure S5. The distribution of grain size for a) control and b) target perovskite films.

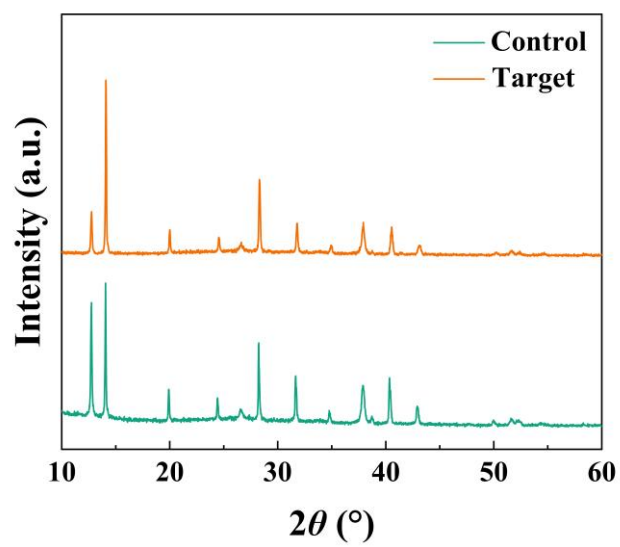


Figure S6. The XRD pattern for a) control and b) target perovskite films.

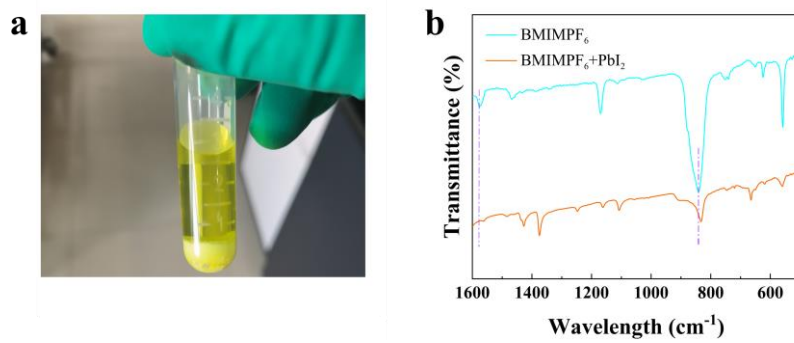


Figure S7. a) The photograph of white powder. b) The FTIR of BMIMPF₆ with or without PbI₂.

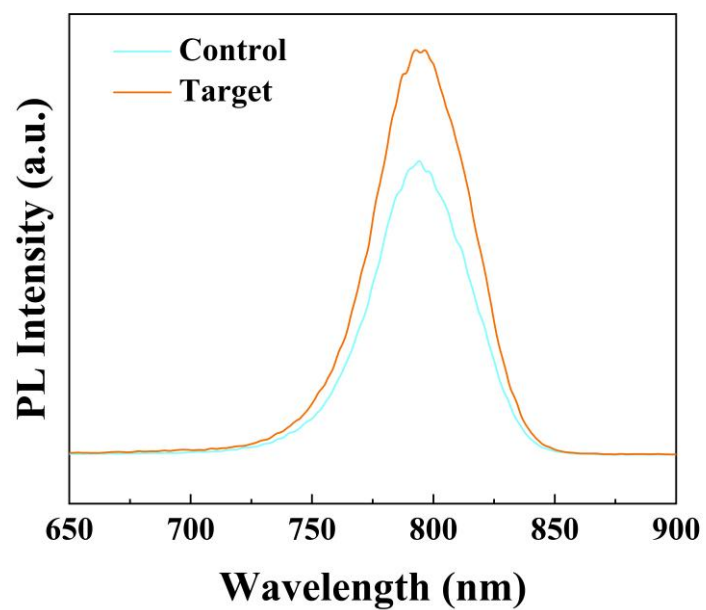


Figure S8. The PL spectra for control and target perovskite films which the excitation light is incident from the glass side.

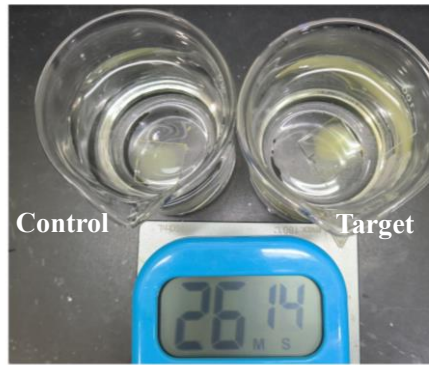


Figure S9. The photograph of perovskite in DI water.

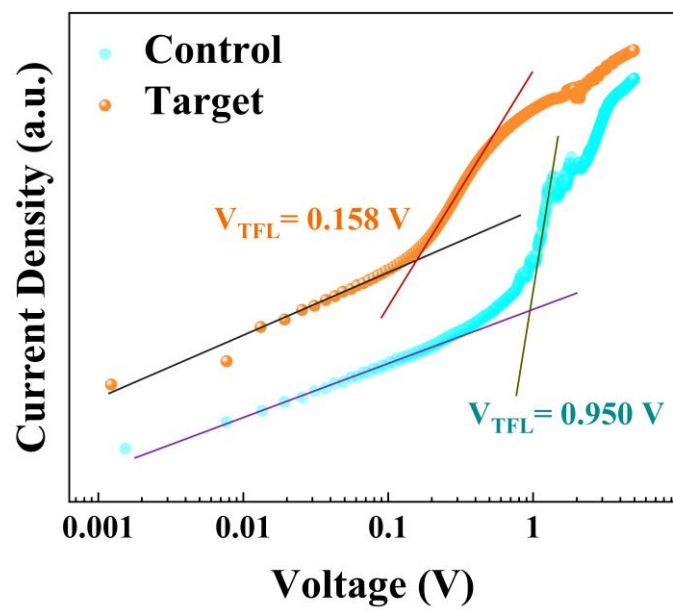


Figure S10. The SCLC measurement of the corresponding for electron-only devices.

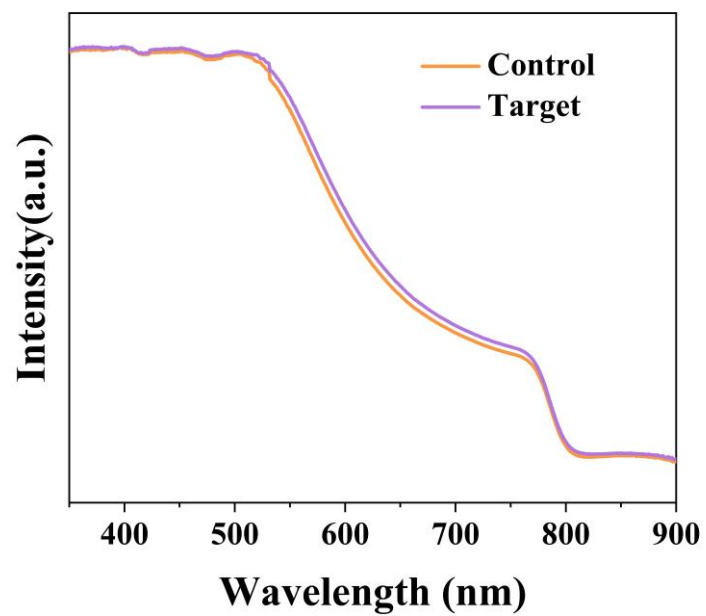


Figure S11. The UV-Vis spectra for the corresponding perovskite films.

Table S1. The PL lifetimes of the perovskite films with or without BMIMPF₆

Sample	A₁	τ₁ (ns)	A₂	τ₂ (ns)	A₁/(A₁+A₂) (%)	τ_{avg} (ns)
Control	0.2635	38.61	0.6669	166.99	28.3%	121.54
Target	0.3993	15.37	0.5512	75.43	42.0%	47.71

Table S2. The J - V parameters for control and target PSCs.

	V_{oc} [V]	J_{sc} [mA cm ⁻²]	FF	PCE [%]	HI
Target-R	1.194	22.55	80.72	21.74	0.047
Target-F	1.181	22.49	78.04	20.72	
Control-R	1.177	21.69	76.50	19.52	0.073
Control-F	1.160	21.43	72.83	18.10	

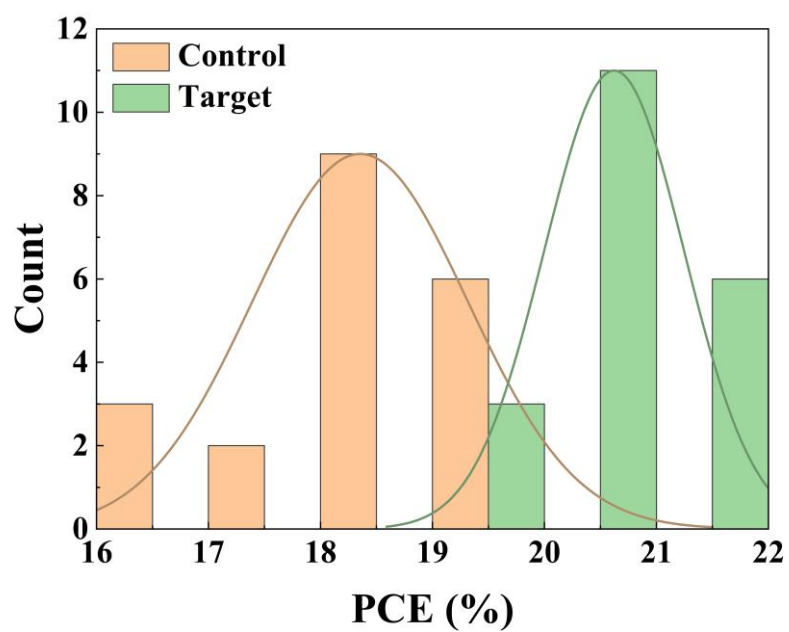


Figure S12. The PCE distribution for 20 devices.

Table S3. The statistical analysis of PCE (%) for control and target PSCs.

Device	Control	Target
1	19.52	21.74
2	19.37	20.85
3	16.61	20.00
4	18.55	19.65
5	19.02	20.15
6	19.24	20.48
7	18.88	19.46
8	16.77	20.89
9	19.06	21.25
10	18.57	20.42
11	18.89	20.71
12	17.14	20.44
13	18.62	20.66
14	18.50	20.14
15	16.32	19.76
16	18.09	21.00
17	18.53	21.39
18	17.55	20.89
19	18.64	21.22
20	19.19	21.34
Average	18.35 ± 0.94%	20.62 ± 0.61%

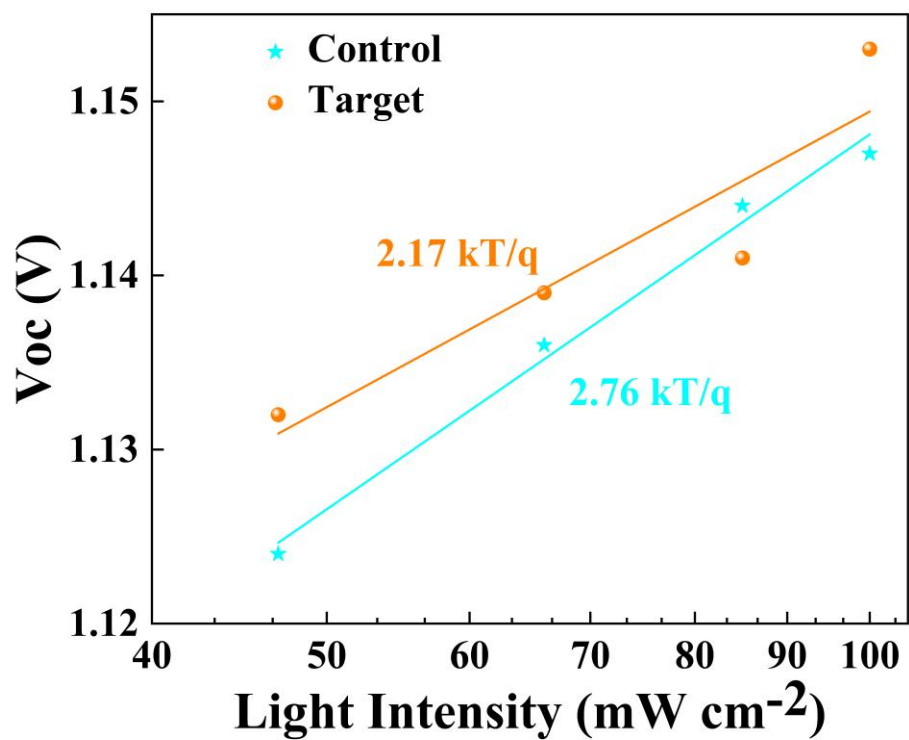


Figure S13. The V_{OC} versus light intensity for the corresponding device.

Table S4. The EIS parameters for control and target PSCs.

Device	R_s	R_{CT}
Control	25.32	88.61
Taregt	25.60	18.89

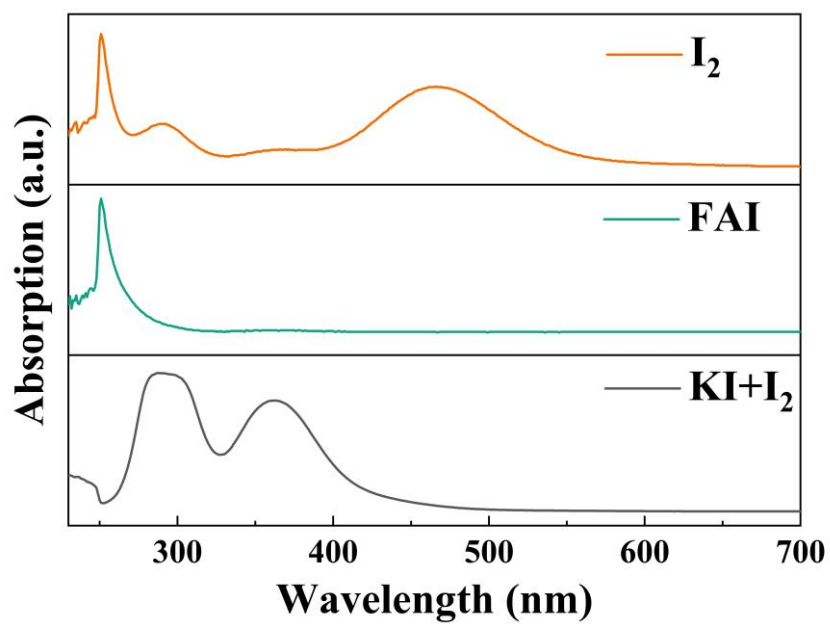


Figure S14. The light absorption of I₂, FAI, and KI+I₂.

Table S5. The normalized performance of PSCs kept in air.

(room temperature, $\approx 25\%$ RH)

Time (h)	Normalized PCE of control device	Normalized PCE of target device
0	1	1
1464	0.909	0.927
3528	0.616	0.775
4128	0.369	0.670

Table S6. The normalized performance of PSCs kept at 85 °C.

(ambient conditions, $\approx 25\%$ RH)

Time (h)	Normalized PCE of control device	Normalized PCE of target device
0	1	1
12	0.8879	1.0226
24	0.6637	0.9537
36	0.4433	0.7352