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Supporting information

High quality perovskite thin films induced by crystal seeds with lead monoxide interfacial engineering

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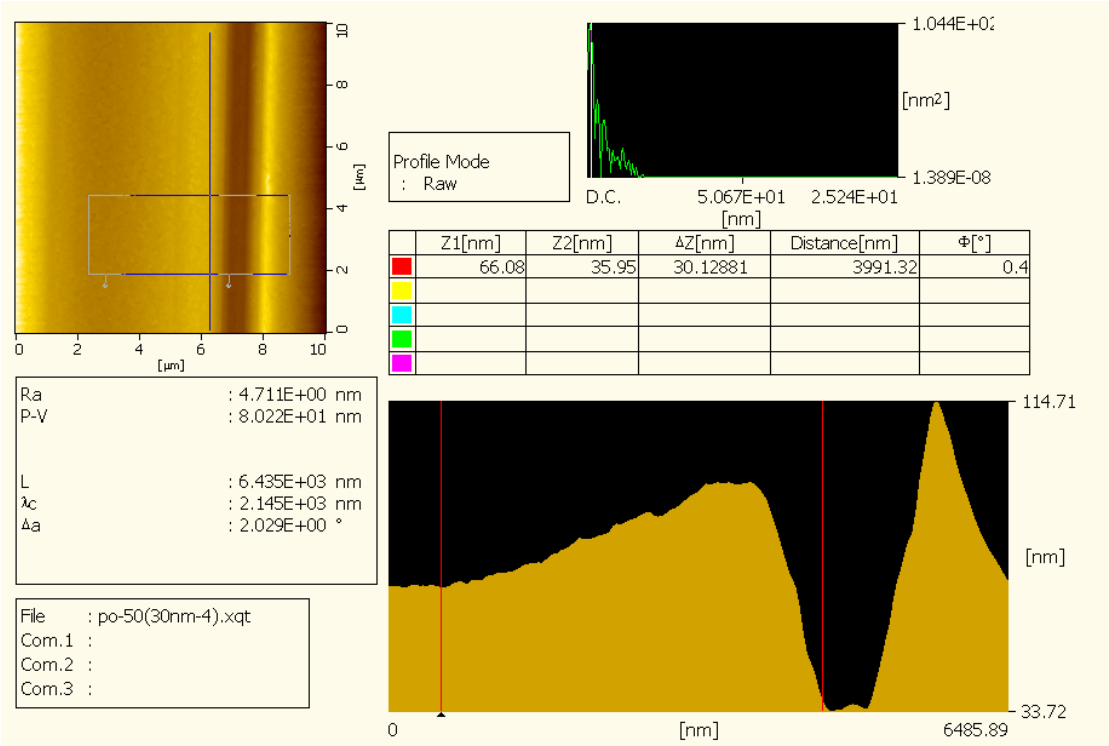

Fig. S1 The AFM results of the thickness of the PO-50 films.

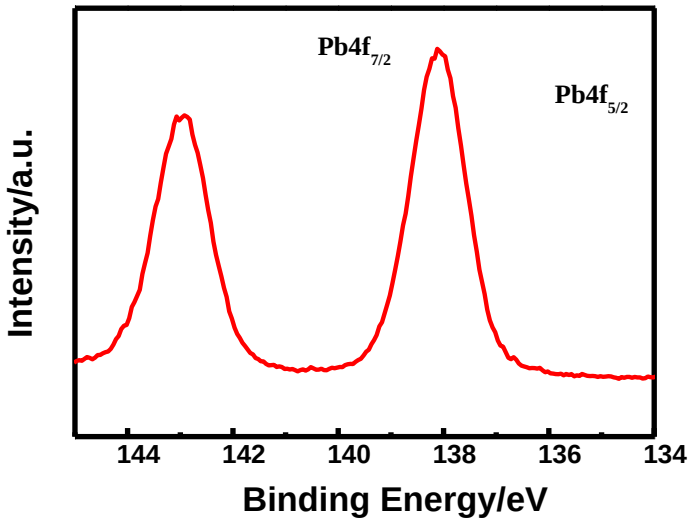

Fig. S2 The high resolution Pb $4f_{7/2}$ and Pb $4f_{5/2}$ XPS spectra of PO-50 film on c-TiO_2.

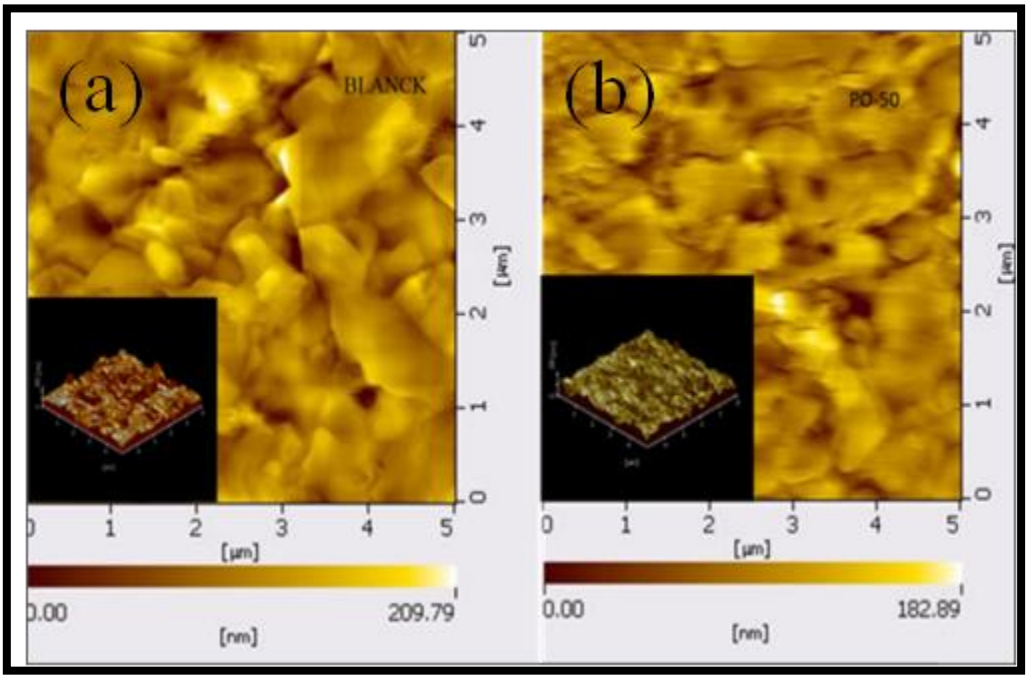

Fig. S3 Atomic force microscopy (AFM) images (inset: 3D surface topographical images) of perovskite film a) without and b) with PO-50 modification layer.

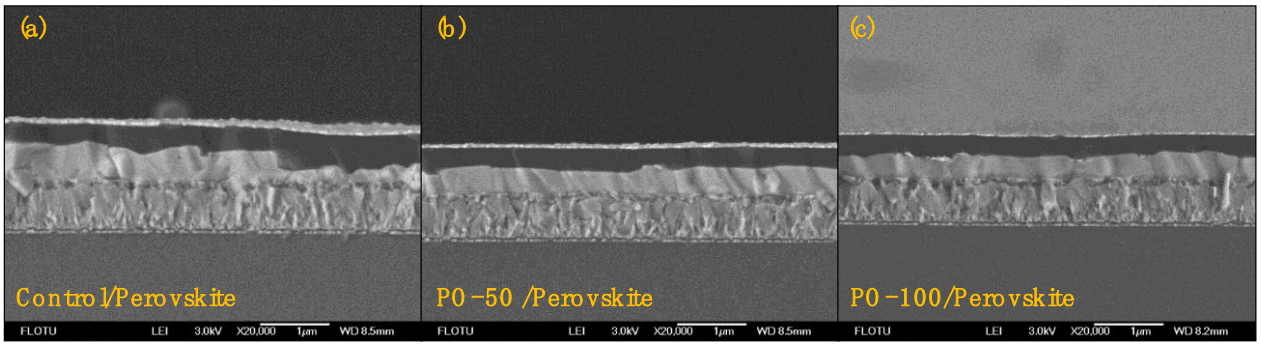

Fig. S4 Side viewed SEM images of the perovskite thin films prepared with different modifier concentrations.

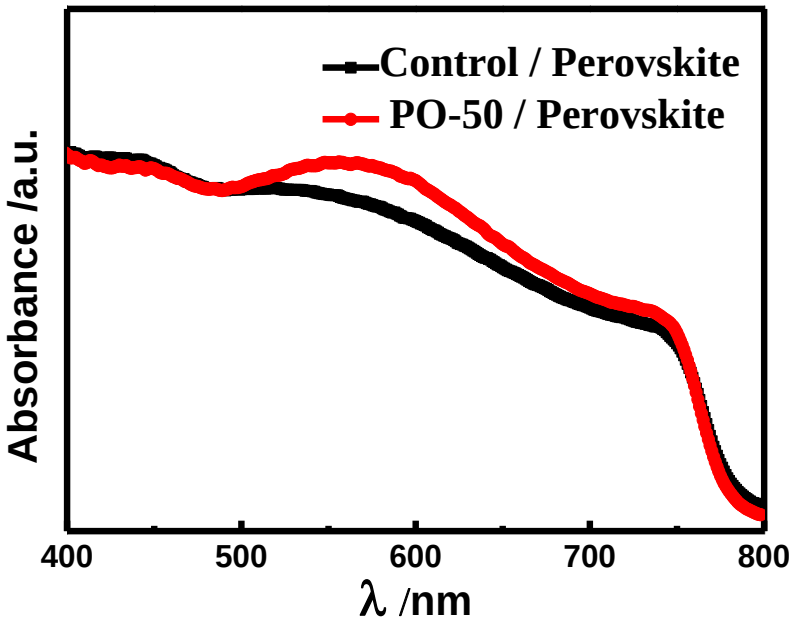

Fig. S5 UV-vis absorption of the perovskite film with and without PO-50 modification layer.

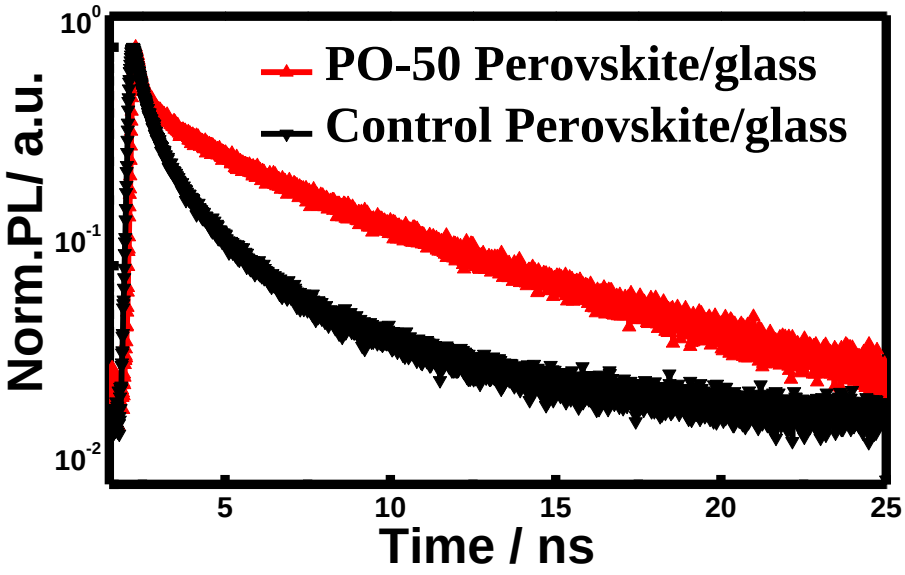

Fig. S6 Time resolved photoluminescence decay spectra of perovskite films on glass (corresponding toTable.1) with and without PO-50 modification.

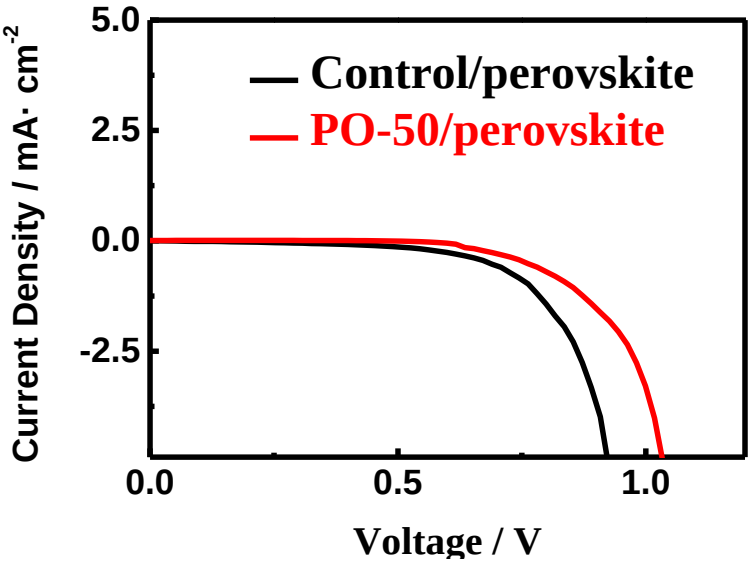

Fig. S7 Dark current of perovskite devices with and without PO-50 modification.

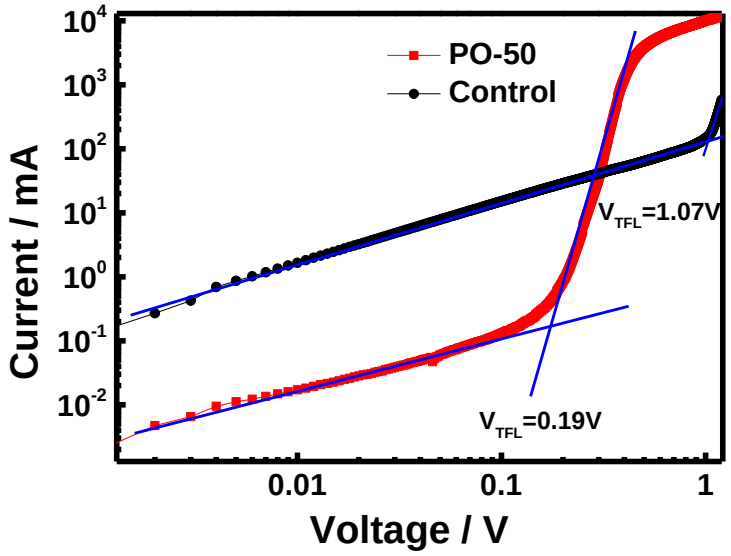

Fig. S8 The SCLC curves of the modified and control devices.

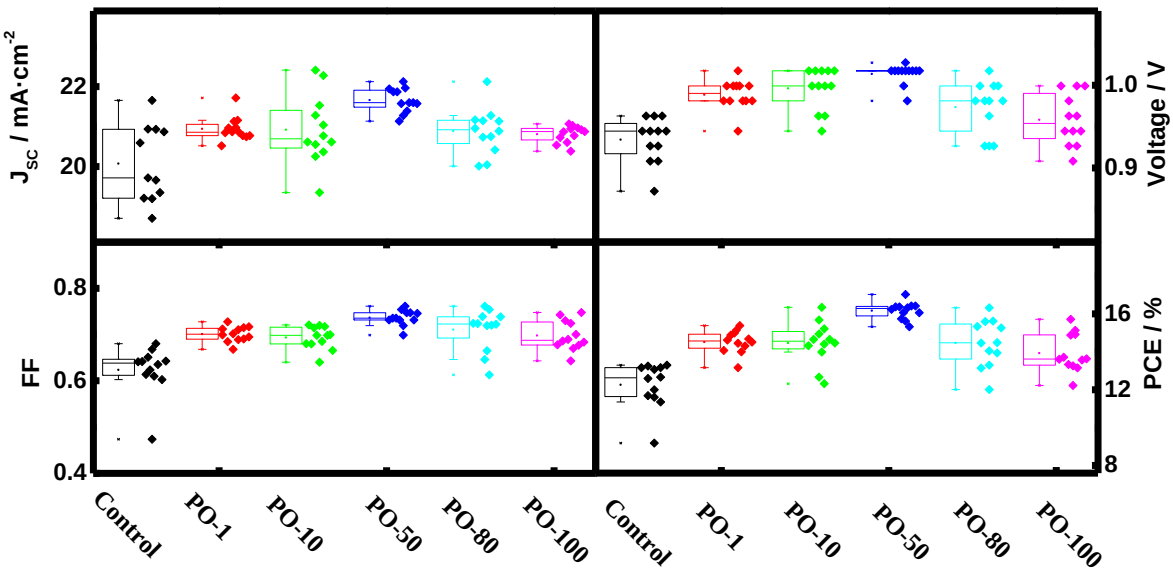

Fig. S9 Performance summary of the planner perovskite solar cells fabricated with different modifier concentrations under simulated AM 1.5G sunlight of 100 mW·cm^{-2} illumination irradiance.

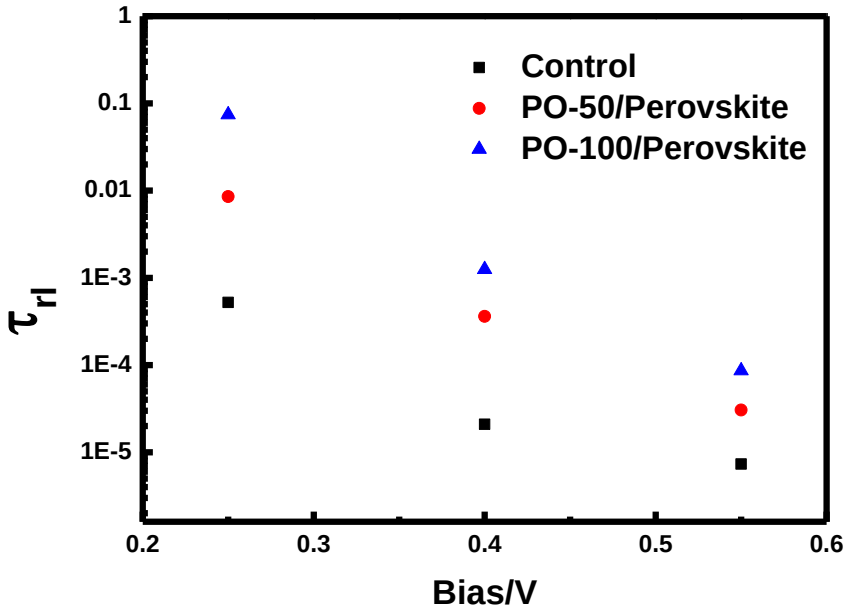

Fig. S10 The recombination lifetime of devices with different thicknesses of PbO.

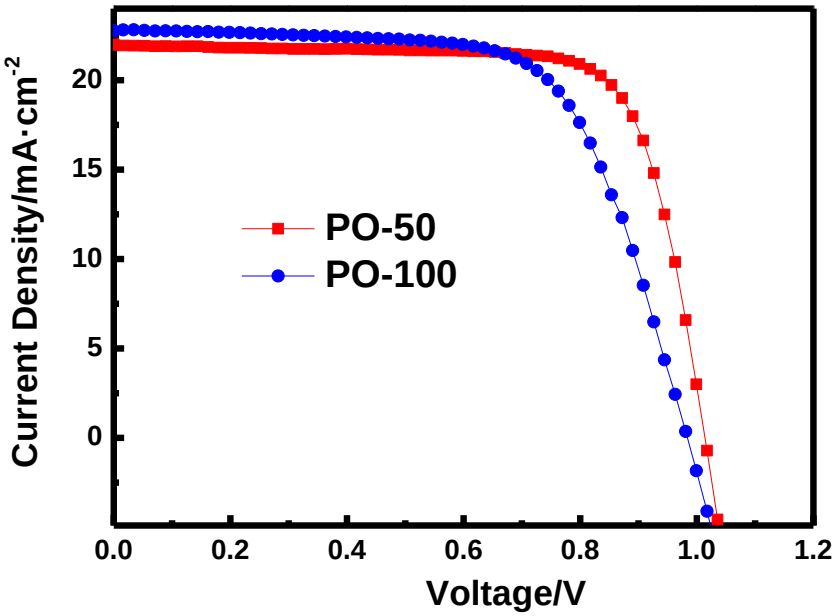

Fig. S11 The J-V curves of the PO-50 and PO-100 devices.

Table S1 Fitting parameters for the TRPL measurements shown in Fig. 5 and Fig.S4.

Samples	A_1	τ_1/ns	A_2	τ_2/ns	<τ>/ns
Control Perovskite /Glass	0.435	0.652	0.565	6.27	5.87
PO-50 Perovskite / Glass	0.896	2.82	1.35	10.6	16.9
Control Perovskite/ c-TiO_2	0.259	0.418	0.0864	2.71	0.326
PO-50 Perovskite / c-TiO_2	0.0262	0.285	0.0664	1.57	0.111

The TRPL decay is fitted by a biexponential function:

$$I(t)= A_1 \exp(-t/\tau_1) + A_2 \exp(-t/\tau_2) + y0$$

where τ_1 and τ_2 denotes the decay time of fast and slow decay; A_1 (A_2) represents the amplitude of the fast-decay (slow-decay) component; $\langle\tau\rangle$ denotes the average decay time.

Table S2. Parameters of the solar cells

	J_{SC} [mA·cm^{-2}]	V_{OC} [V]	FF	PCE [%]
Control	19.64±0.8	0.93±0.4	0.67±0.3	12.28±1.2
PbO-(2nm)	18.69±0.7	0.82±0.3	0.63±0.3	9.69±1.1
PbO-(20nm)	17.0±1	0.88±0.4	0.67±0.6	10.19±1.3
PbO-(60nm)	14.08±0.9	0.78±0.3	0.53±0.5	5.87±0.8
PbO-(120nm)	4.38±0.7	0.70±0.4	0.53±0.3	1.65±0.8