Supplementary Information

Low-Bandgap Mixed Tin-Lead Iodide Perovskite with Large Grains for High Performance Solar Cells

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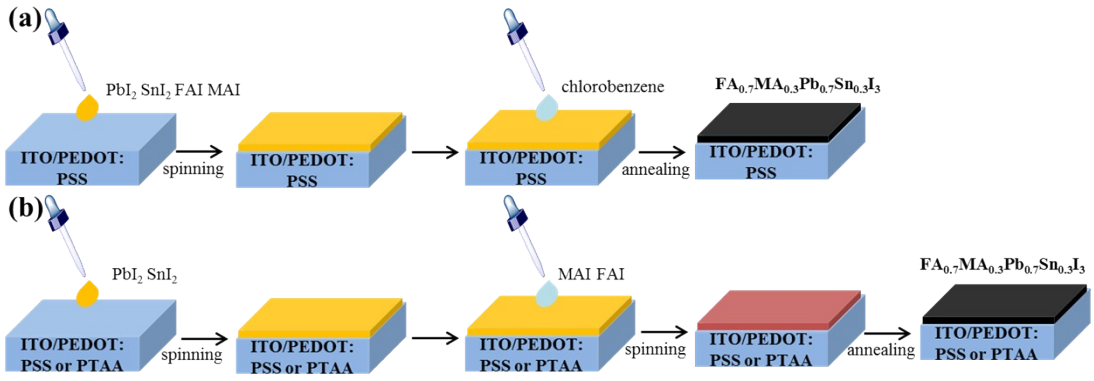

Figure S1. Schematic of the processing of the perovskite films with one-step (a) and two-step (b) method on different substrates.

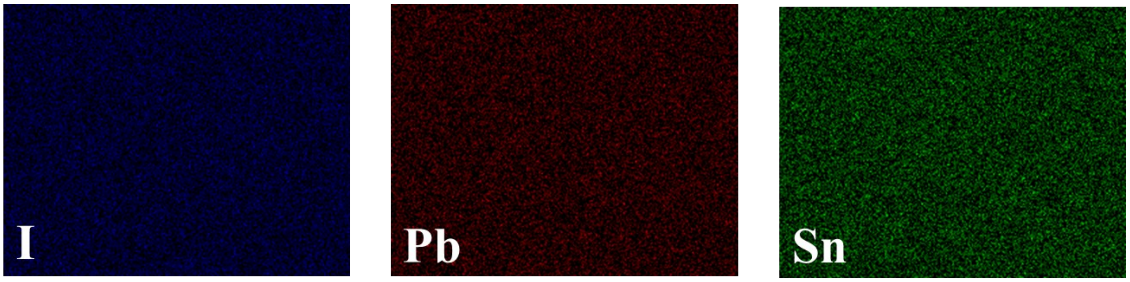

Figure S2. Energy-dispersive X-ray spectroscopy (EDS) elemental mappings of I, Pb and Sn elements in the $FA_{0.7}MA_{0.3}Sn_{0.3}Pb_{0.7}I_3$ perovskite film fabricated by two-step processing method on PTAA.

Table S1. Performance comparison of low-bandgap perovskite solar cells.

PVSK	HTL	V_{OC} [V]	J_{SC} [mA cm^{-2}]	FF	PCE [%]	Refs.
$FA_{0.75}Cs_{0.25}Sn_{0.5}Pb_{0.5}I_3$	PEDOT:PSS	0.74	26.7	0.71	14.1	1
$MASn_{0.25}Pb_{0.75}I_3$	TiO2	0.728	15.82	0.64	7.37	2
$MASn_{0.15}Pb_{0.85}X$	PEDOT:PSS	0.77	19.5	0.67	10.1	3
$MASn_{0.25}Pb_{0.75}I_3$	PEDOT:PSS	0.82	22.44	0.78	14.35	4
$MASn_{0.5}Pb_{0.5}I_3$	PEDOT:PSS	0.75	26.3	0.688	13.6	5
$(FASnI_3)_{0.6}(MAPbI_3)_{0.4}$	PEDOT:PSS	0.853	28.5	72.5	17.6	6
$MA_{0.3}FA_{0.7}Sn_{0.3}Pb_{0.7}I_3$	PTAA	0.782	23.6	0.737	13.6	This work

Hole Mobility Test

The charge carrier mobilities of different perovskite films were measured using the space-charge-limited current (SCLC) method. Hole-only devices were fabricated in a structure of ITO/HTL / $FA_{0.7}MA_{0.3}Sn_{0.3}Pb_{0.7}I_3/MoO_3$/Al.

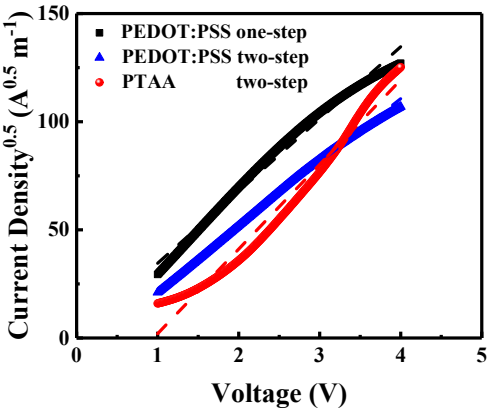

Figure S3. $J^{0.5}$-V curves of hole-only devices with a architecture of ITO/HTL / $FA_{0.7}MA_{0.3}Sn_{0.3}Pb_{0.7}I_3/MoO_3$/Al.

Table S2. Summarized hole mobilities of different perovskite films (each 8 counts) processed with various methods on different substrates.

Processing Method	HTL	μ_h [$\times 10^{-4}$ cm^2 (Vs)$^{-1}$]
one-step	PEDOT:PSS	3.77±0.15
two-step	PEDOT:PSS	2.87±0.11

two-step	PTAA	5.17±0.17

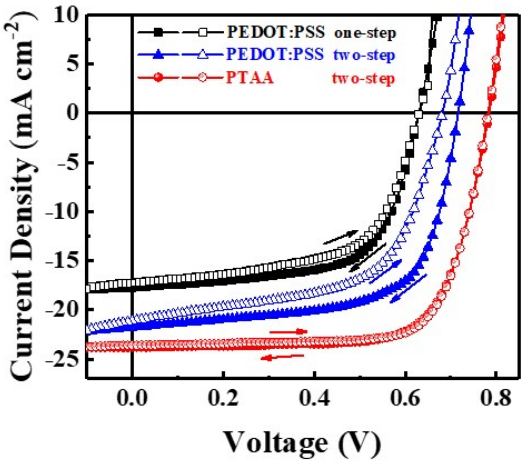

Figure S4. Forward and reverse J-V curves of devices based on perovskite films processed with various methods on different substrates.

Table S3. Performance of the best devices based on perovskite films processed with various methods on different substrates.

HTL			V_{OC}[V]	J_{SC}[mA cm^{-2}]	FF	PCE[%]
one-step	PEDOT:PSS	Forward	0.63	17.7	0.64	7.1
		Reverse	0.62	17.2	0.61	6.5
two-step	PEDOT:PSS	Forward	0.72	19.0	0.72	9.7
		Reverse	0.68	18.4	0.65	8.1
two-step	PTAA	Forward	0.78	23.8	0.72	13.4
		Reverse	0.78	23.6	0.74	13.6

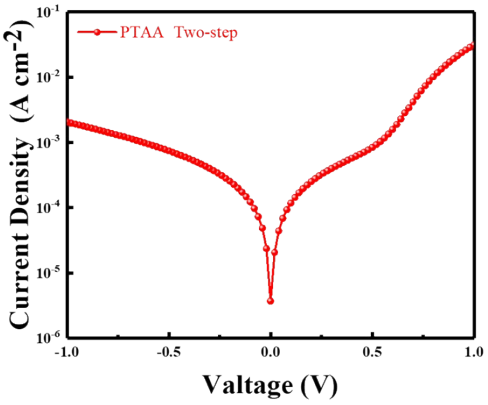

Figure S5. The dark *J–V* curve for the best PVSC based on perovskite film with two-step on PTAA.

References

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