

Supplementary Information

High efficiency planar Sn-Pb binary perovskite solar cells: Controlled growth of large grains via one-step solution fabrication process

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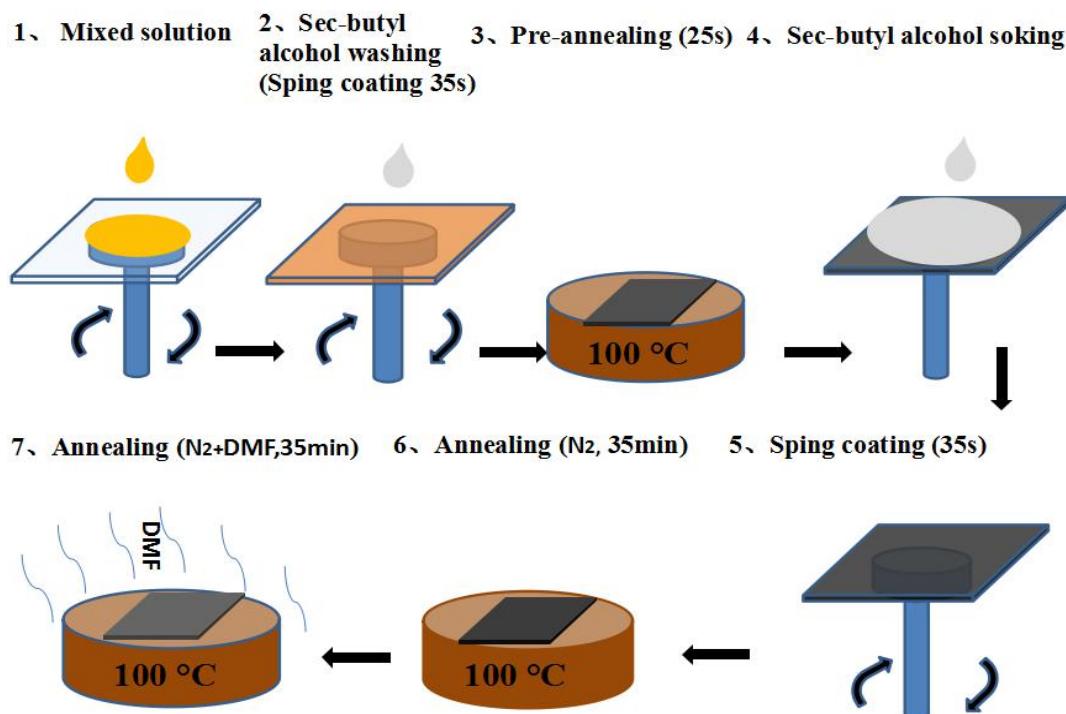


Figure S1 Schematic illustration of the fabrication procedure of $MASn_xPb_{(1-x)}I_3$ perovskite films

Table S1 The results of the cell parameters averaged from the measurements for more than 10 $\text{MASn}_x\text{Pb}_{1-x}\text{I}_3$ PSCs with different Sn contents in the Sn-Pb binary perovskite layer, e.g., $x = 0, 0.15, 0.25, 0.35$ and 1

Sample	V_{oc} (V)	J_{sc} (mA/cm 2)	FF (%)	PCE (%)	Maximum PCE (%)
$\text{CH}_3\text{NH}_3\text{PbI}_3$	0.91 ± 0.00	16.71 ± 0.90	0.52 ± 0.04	7.93 ± 0.48	8.49
$\text{CH}_3\text{NH}_3\text{Sn}_{0.15}\text{Pb}_{0.85}\text{I}_3$	0.67 ± 0.02	18.40 ± 1.89	0.53 ± 0.03	6.51 ± 0.52	7.39
$\text{CH}_3\text{NH}_3\text{Sn}_{0.25}\text{Pb}_{0.75}\text{I}_3$	0.80 ± 0.01	21.03 ± 0.43	0.67 ± 0.02	11.24 ± 0.39	11.63
$\text{CH}_3\text{NH}_3\text{Sn}_{0.35}\text{Pb}_{0.65}\text{I}_3$	0.75 ± 0.02	21.03 ± 1.72	0.60 ± 0.02	9.37 ± 0.46	10.05
$\text{CH}_3\text{NH}_3\text{SnI}_3$	0.06 ± 0.05	0.02 ± 0.03	0.28 ± 0.08	0.00 ± 0.00	0.00

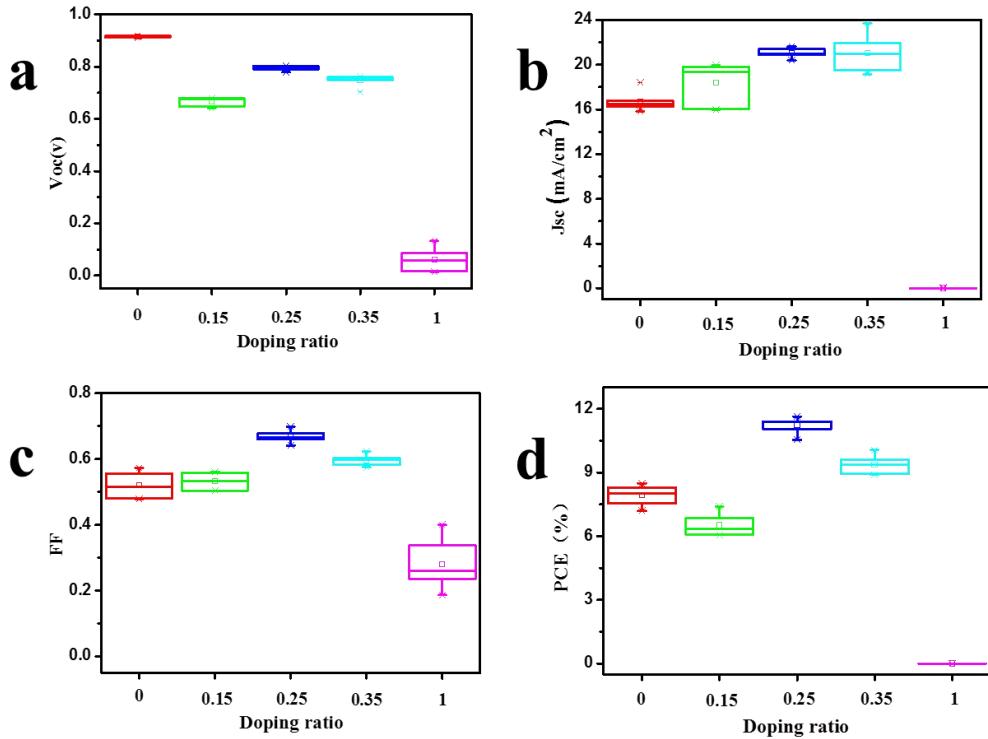


Figure S2 Average V_{oc} (a), J_{sc} (b), FF (c) and PCE (d) of $\text{MASn}_x\text{Pb}_{1-x}\text{I}_3$ -based cells with different Sn contents in the $\text{MASn}_x\text{Pb}_{1-x}\text{I}_3$ layer, e.g., $x = 0, 0.15, 0.25, 0.35$ and 1

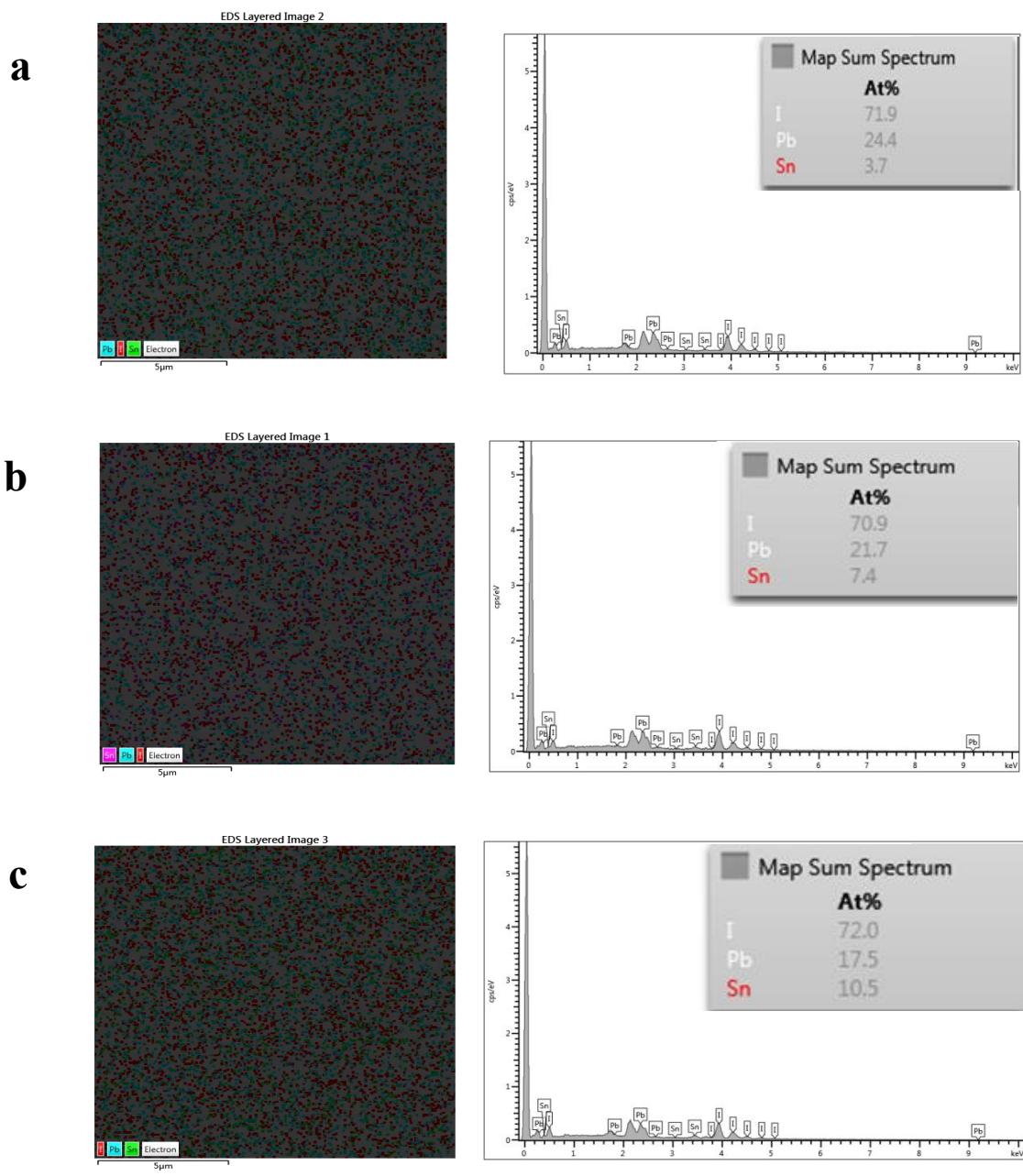


Figure S3 EDS elemental mapping of different $\text{MASn}_x\text{Pb}_{1-x}\text{I}_3$ films having different Sn contents, e.g., $x = 0.15$ (a), 0.25 (b), and 0.35 (c)

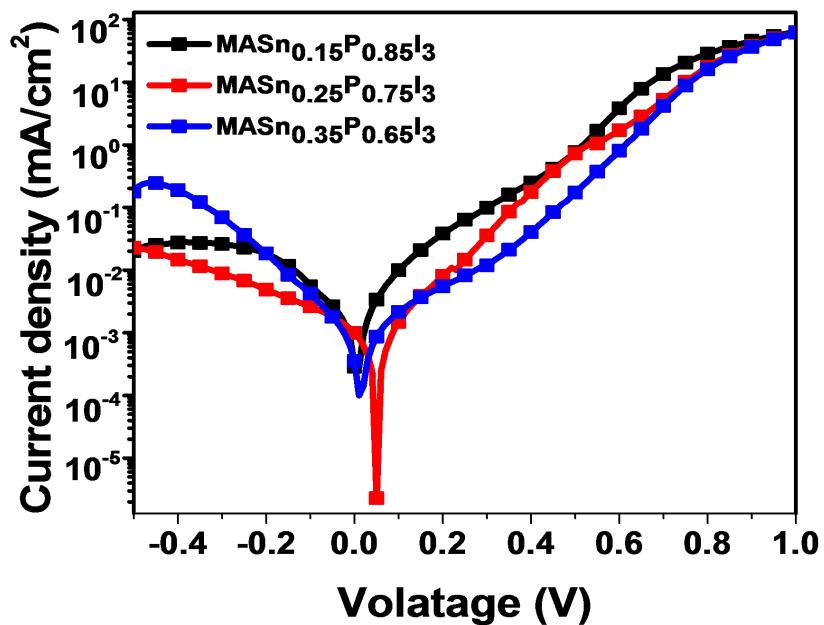


Figure S4 Log-linear plots of dark current density-voltage characteristics measured for the Sn-Pb binary PSCs having different Sn Contents in the $\text{MASn}_x\text{Pb}_{1-x}\text{I}_3$ layers, with.g., $x = 0.15, 0.25$, and 0.35 .

Table S2 The statistical photovoltaic parameters averaged from measurements for more than 10 $\text{MASn}_x\text{Pb}_{1-x}\text{I}_3$ PSCs fabricated with different solvent annealing

$\text{CH}_3\text{NH}_3\text{Sn}_{0.25}\text{Pb}_{0.75}\text{I}_3$	V_{oc} (V)	J_{sc} (mA/cm ²)	FF (%)	PCE (%)	Maximum PCE (%)
N_2 (DMF)	0.80 ± 0.01	21.03 ± 0.43	0.67 ± 0.02	11.24 ± 0.39	11.63
N_2 (out of DMF)	0.73 ± 0.03	19.83 ± 0.68	0.56 ± 0.01	8.14 ± 0.34	8.56
Air (DMF)	0.65 ± 0.05	1.67 ± 0.38	0.45 ± 0.09	0.37 ± 0.22	0.64

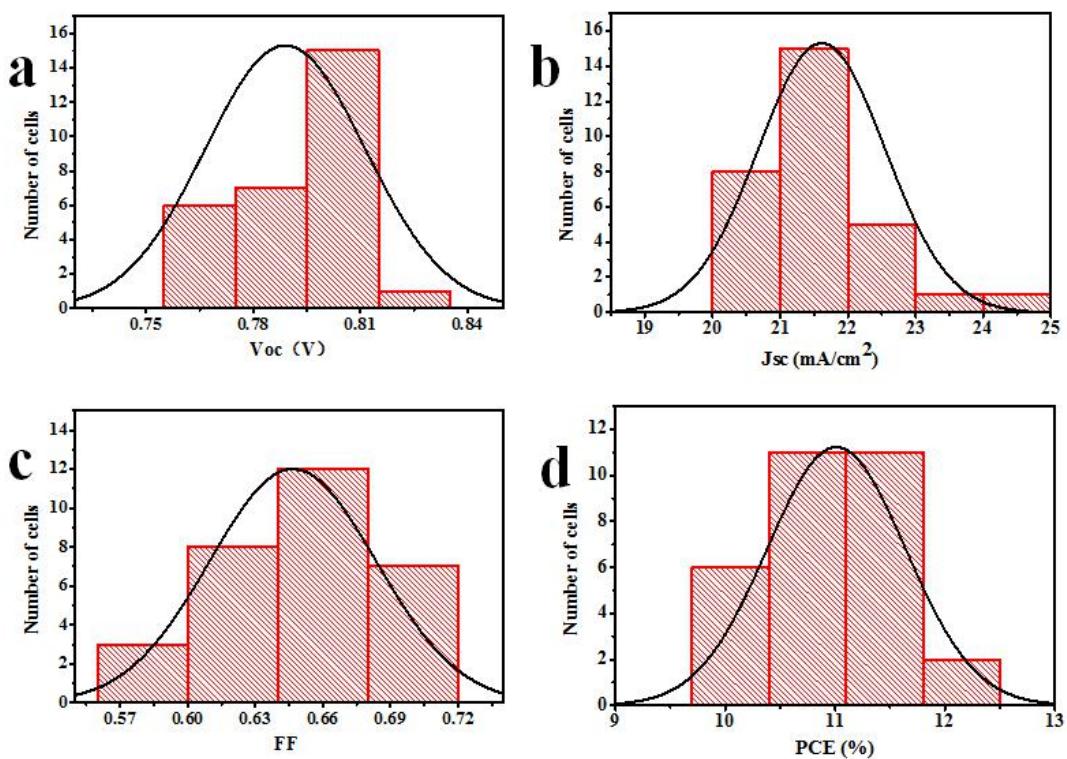


Figure S5 Histograms of J_{sc} , V_{oc} , FF, and PCE of 30 $\text{MASn}_{0.25}\text{Pb}_{0.75}\text{I}_3$ -based PSCs

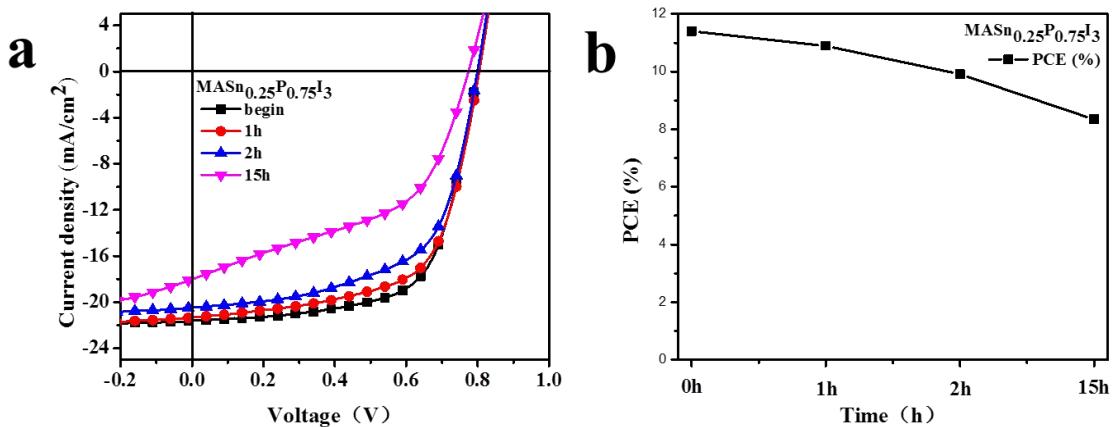


Figure S6 Evolution of J-V characteristics (a) and PCE (b) of $\text{MASn}_{0.25}\text{Pb}_{0.75}\text{I}_3$ -based PSCs as a function of the storage time under atmospheric environment

Table S3 The evolution of cell parameters obtained for $\text{MASn}_{0.25}\text{Pb}_{0.75}\text{I}_3$ PSCs with different storage periods under atmospheric environment

storage time	V_{oc} (V)	J_{sc} (mA/cm²)	FF (%)	PCE (%)
0h	0.80	21.61	0.66	11.41
1h	0.80	21.31	0.64	10.89
2h	0.80	20.48	0.61	9.91
15h	0.77	18.01	0.49	8.35