

Supplementary information

Improved Current Density of Inverted Perovskite Solar Cells via Hole Transport Layer Doping

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Table S1 Measured transmittance values of the devices.

Device	Input Power (W/m ²)	Output Power (W/m ²)	Transmittance (%)
Glass / ITO	1000	827	82.7
Glass / ITO / Control PTAA	1000	815	81.5
Glass / ITO / Doped PTAA	1000	799	79.9

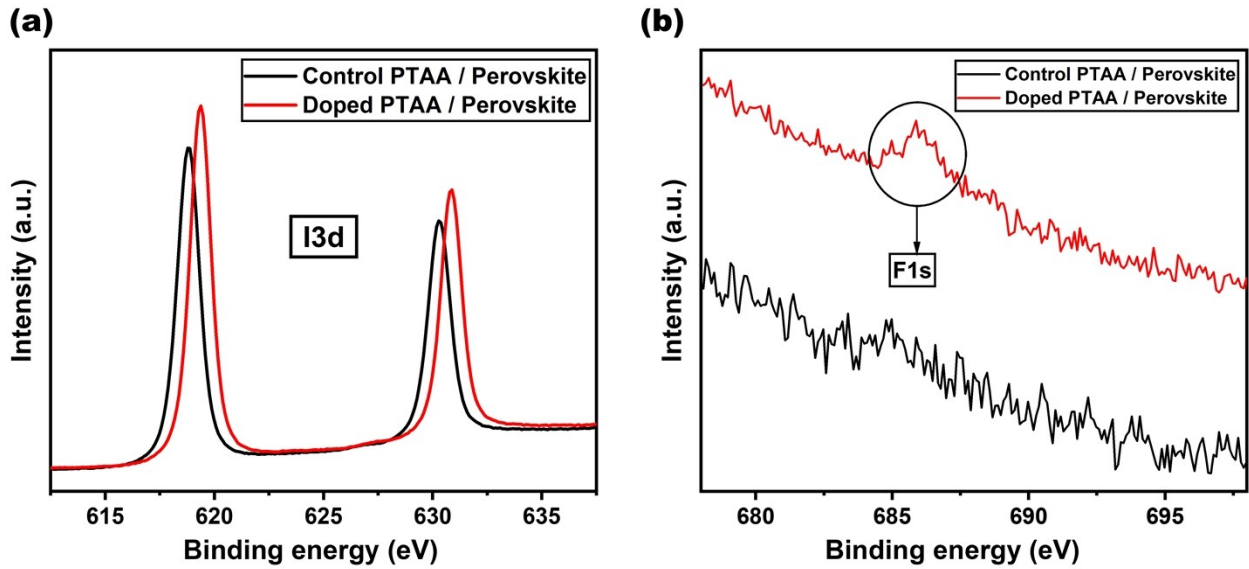


Fig. S1 XPS analysis of (a) I 3d and (b) F 1s orbitals of perovskite films on control and doped PTAA.

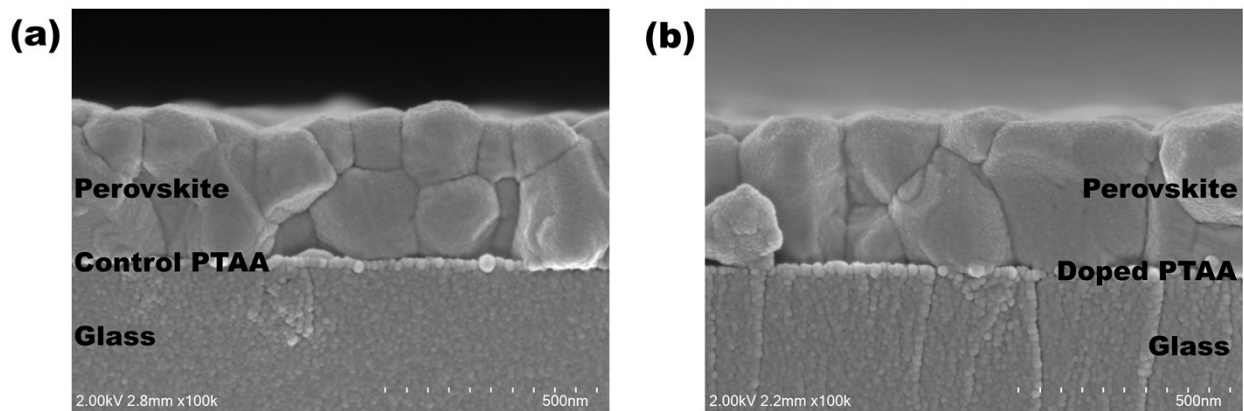


Fig. S2 Cross sectional SEM images of (a) glass/control PTAA/perovskite and (b) glass/doped PTAA/perovskite films.

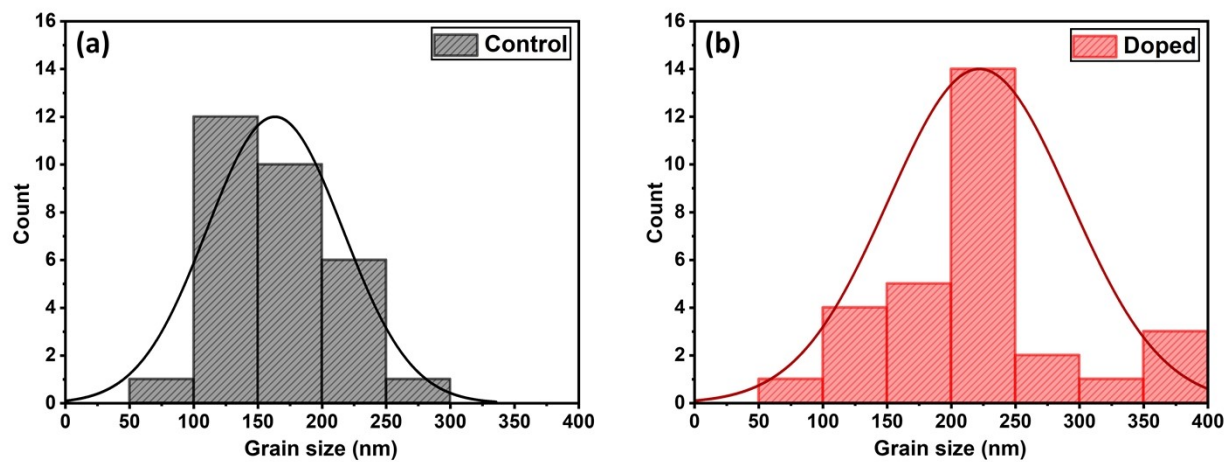


Fig. S3 Grain size distribution of perovskite layer coated on (a) Control PTAA and (b) 5.0 wt% T35FP-doped PTAA

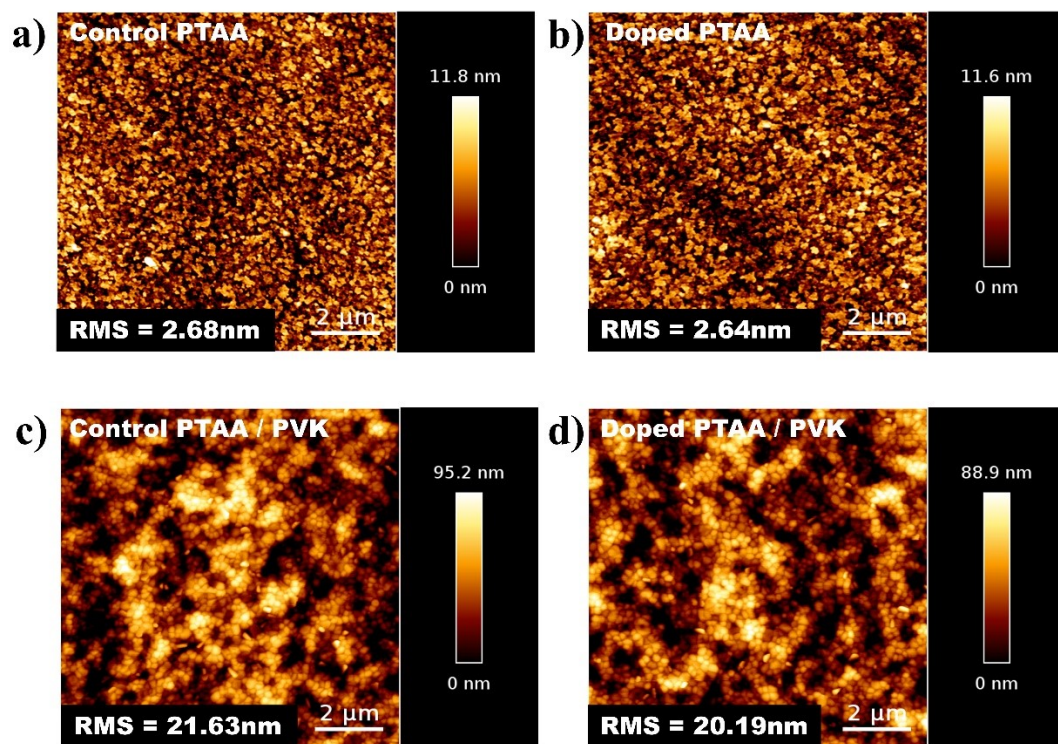


Fig. S4 AFM images of (a) Control PTAA, (b) 5.0 wt% T35FP-doped PTAA, (c) Control PTAA/Perovskite (PVK) and (d) 5.0 wt% T35FP-doped PTAA/PVK films.

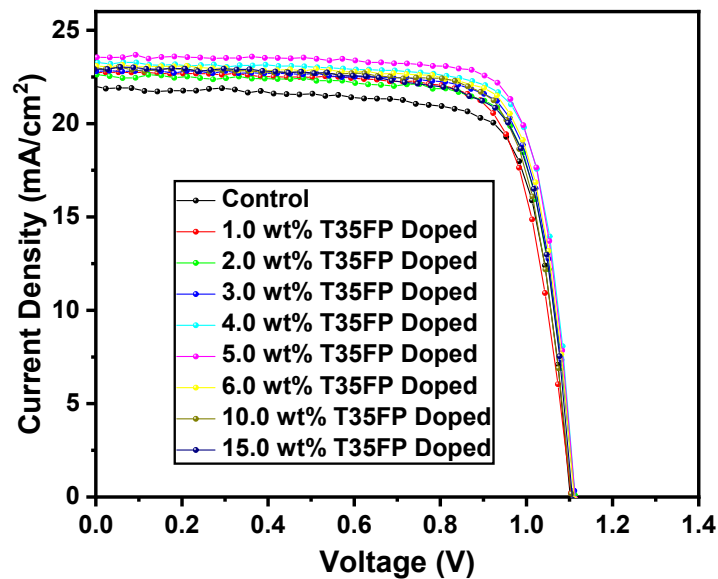


Fig. S5 J-V curves of champion devices fabricated with various PTAA T35FP doping weight percentages.

Table S2 Photovoltaic parameters of champion devices fabricated with various PTAA T35FP doping weight percentages.

T35FP doping	V_{oc} (V)	J_{sc} (mA/cm²)	FF (%)	PCE (%)
0 wt%	1.101	21.99	76.36	18.50
1.0 wt%	1.104	22.72	75.61	18.97
2.0 wt%	1.112	22.61	77.32	19.45
3.0 wt%	1.112	22.80	77.89	19.76
4.0 wt%	1.112	23.27	78.27	20.27
5.0 wt%	1.112	23.55	78.96	20.69
6.0wt%	1.110	23.08	78.13	20.02
10.0 wt%	1.104	22.98	77.26	19.62
15.0 wt%	1.106	22.90	76.26	19.32

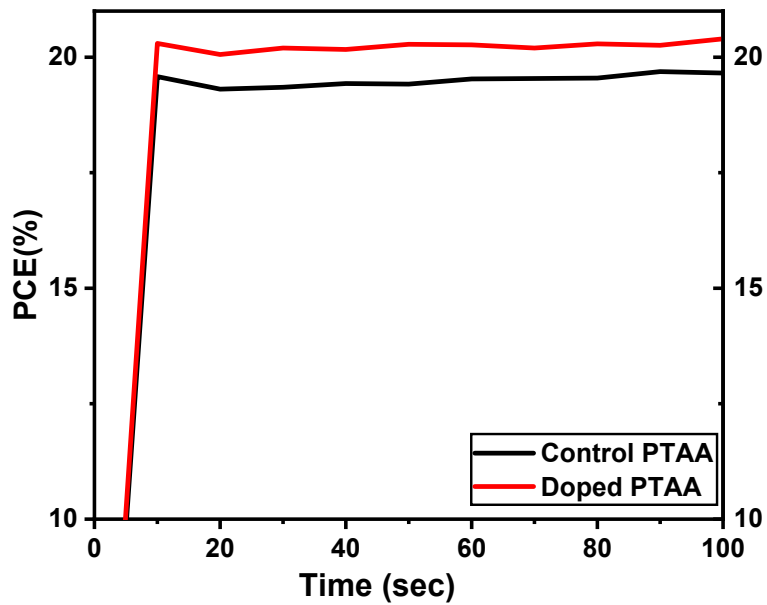


Fig. S6 Steady state PCE of PSCs for 100 seconds with and without T35FP dopant.

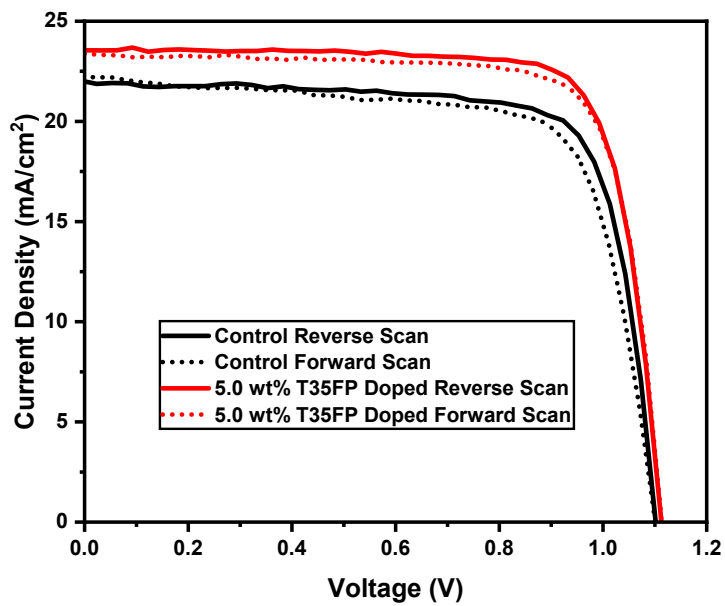


Fig. S7 J-V curves of the PSCs with different scan directions.

Table S3 Hysteresis index for the devices made with control and doped PTAA layers

Scan direction	V_{oc} (V)	J_{sc} (mA/cm ²)	FF (%)	PCE (%)	HI
Control reverse	1.101	21.99	76.36	18.50	0.042
Control Forward	1.100	22.24	72.44	17.73	
5.0 wt% T35FP Doped Reverse	1.112	23.55	78.96	20.69	0.020
5.0 wt% T35FP Doped Forward	1.113	23.36	77.95	20.27	

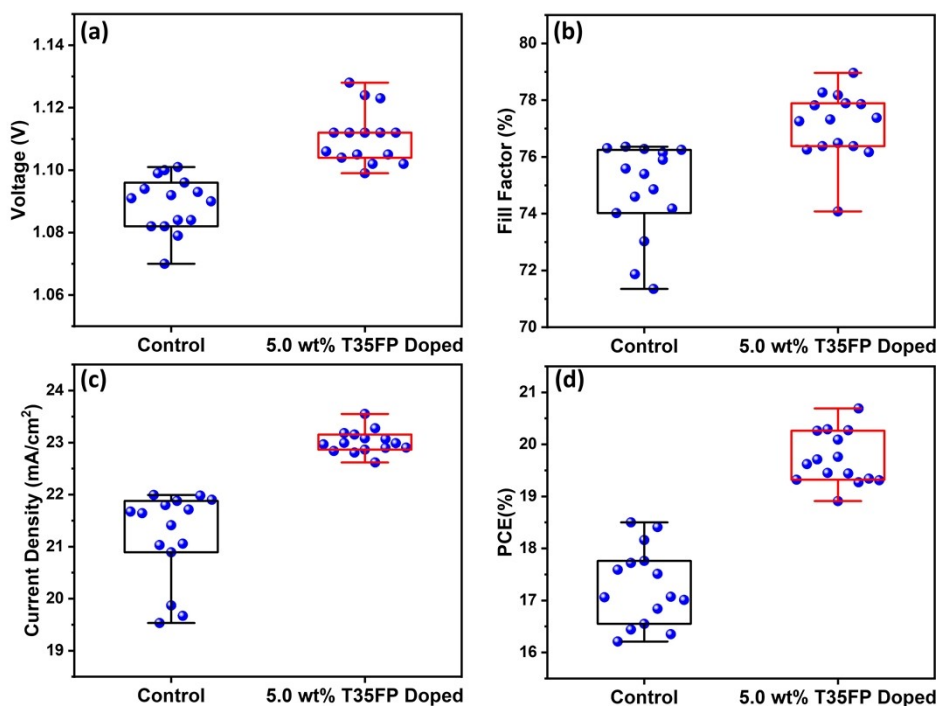


Fig. S8 Statistical distribution of photovoltaic characteristics (a) V_{oc} , (b) FF (c) J_{sc} and (d) PCE for the 15 PSCs.

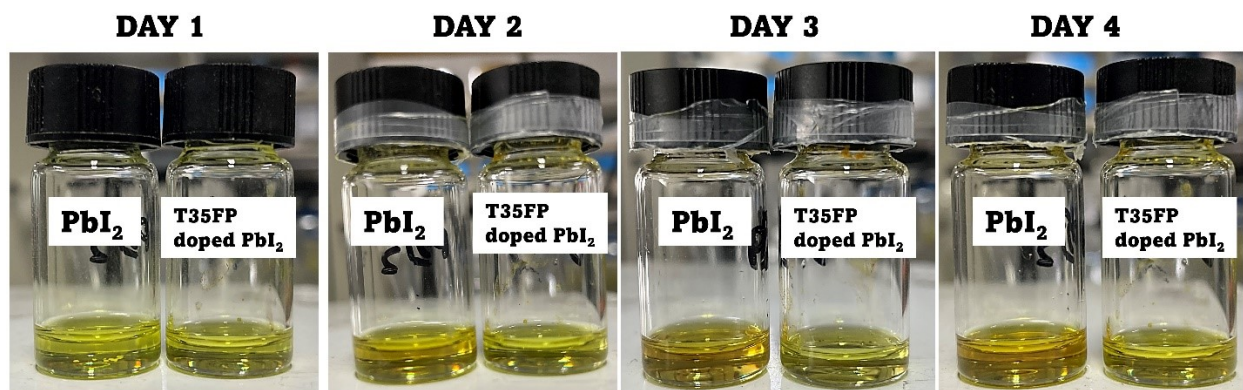


Fig. S9 Images of PbI_2 (in DMF) precursors, both the control and doped with T35FP, stored in air for four days.