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Supporting Information

Additives for Pb defect passivation and FA immobilization:

towards efficient and stable perovskite solar cells

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Figure S1. TGA curves EMTC at a heating rate of 10 °C under N₂ protection.



Figure S2. EDS analysis of perovskite thin films after EMTC treatment.



Figure S3. DSC results of control and EMTC-doped perovskite.



Figure S4. Step profilometry analysis of control and EMTC-doped perovskite films.



Figure S5. UV-vis spectra of perovskite thin films without/with EMTC.



Figure S6. Tauc plot of perovskite thin films without/with EMTC.

Table S1. Fitted parameters from TRPL spectra for control and EMTC-dopedperovskite films.

Device	τ_1 (ns)	f_1 (%)	τ_2 (ns)	$f_{2}(%)$	τ_{ave} (ns)
control	15.3	7.0	783.3	93.0	729.5
w EMTC	57.9	3.2	1327.1	96.8	1286.5

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EMTC		$V_{\rm OC}({ m V})$	$J_{\rm SC}$ (mA cm ⁻²)	FF (%)	PCE (%)
0 wt‰	best	1.05	24.94	83.1	21.68
	average	1.04 ± 0.01	24.67±0.39	83.0±1.3	21.20±0.34
0.5 wt‰	best	1.07	25.28	83.9±0.7	22.69
	average	1.07 ± 0.01	25.18±0.21	82.8	22.47±0.16
1.0 wt‰	best	1.09	25.36	84.2	23.27
	average	1.08 ± 0.01	25.32±0.12	83.9±0.5	23.04±0.13
1.5 wt‰	best	1.10	25.33	84.6	23.57
	average	1.10 ± 0.01	25.26±0.12	84.1±0.6	23.33±0.11
2.0 wt‰	best	1.09	25.33	84.6	23.36
	average	1.09±0.01	25.23±0.20	84.1±0.6	23.24±0.10

Table S2. Photovoltaic parameters of Pero-SCs doped with different concentrations of EMTC.



Figure S7. Statistical results for 35 Pero-SCs prepared via different methods: (a) PCE, (b) V_{OC} , (c) J_{SC} , and (d) FF.



Figure S8. *J*–*V* curves for holy only devices without/with the EMTC.



Figure S9. TPC of Pero-SCs without/with an EMTC.

Table S3. Fitted parameters from the ACIS of the Pero-SCs.

Device	$\mathrm{R}_{\mathrm{s}}\left(\Omega ight)$	$R_{tr}\left(\Omega ight)$	C _{tr} (F)
control	27.9	225.4	1.2×10 ⁻⁸
w EMTC	28.3	62.2	3.2×10 ⁻⁸



Figure S10. XRD patterns of (a) control and (b) EMTC-doped perovskite films after 20 days of aging in ambient air with 30-40% relative humidity.



Figure S11. Water contact angle analysis of (a) control and (b) EMTC-doped perovskite films.