

**Polymer interface engineering enabling high-performance perovskite solar cells
with improved fill factor over 82%**

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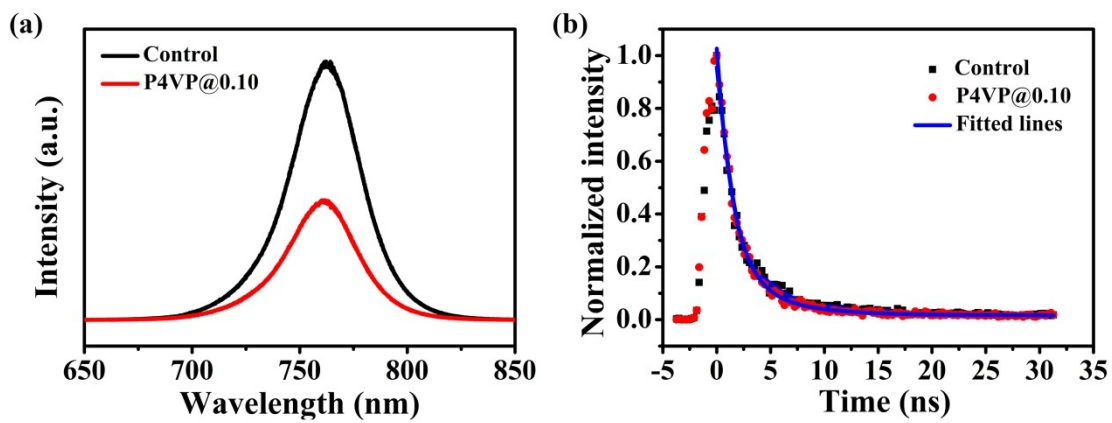


Fig. S1 (a) Photoluminescence (PL) spectra and (b) time-resolved photoluminescence (TRPL) spectra of perovskite films with PCBM capping layer.

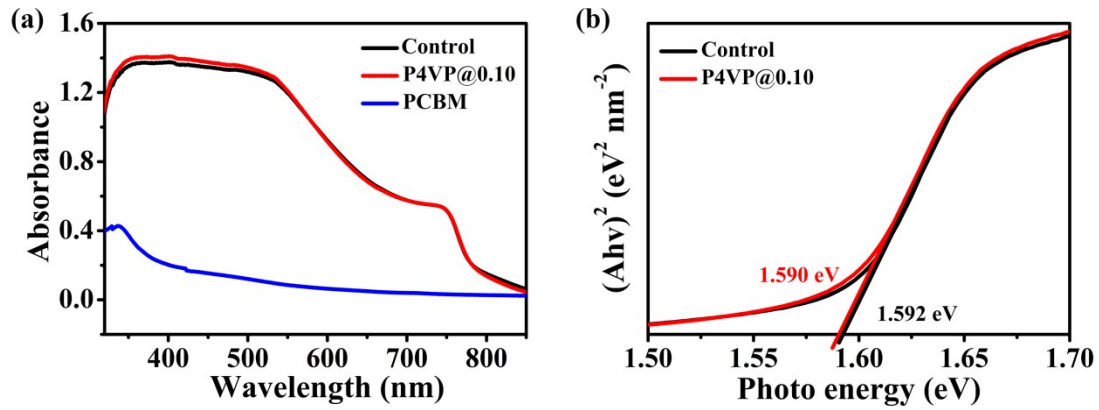


Fig. S2 (a) UV-vis absorption spectra and (b) Tauc plots of the control perovskite film, P4VP modified perovskite film, and electron-transporting layer (PCBM) (Inset in Fig. S2b).

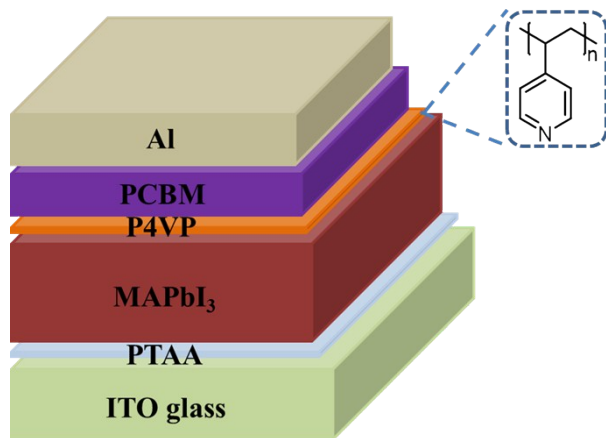


Fig. S3 Device structure of MAPbI₃ based perovskite solar cells.

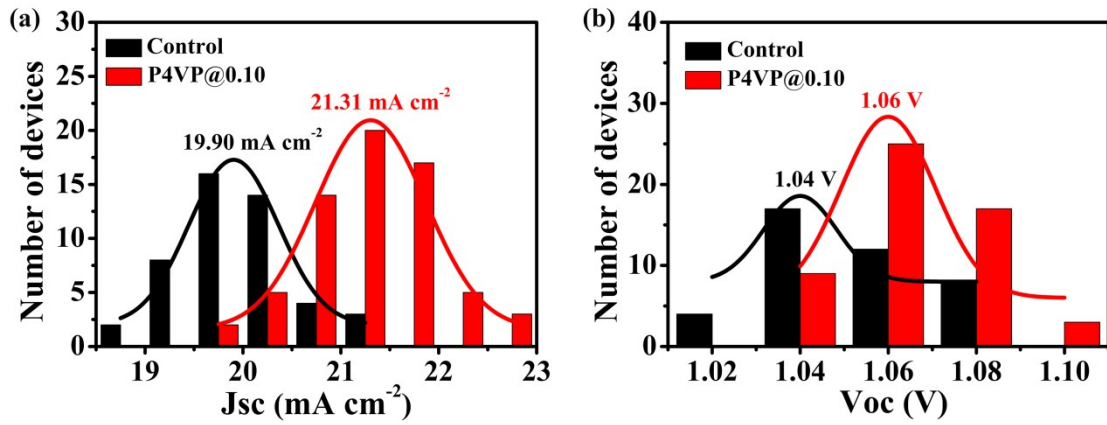


Fig. S4 Histogram of short current density (J_{sc}) and open-circuit voltage (V_{oc}) for the control and P4VP modified samples. All the black/red lines were obtained by fitting the histograms using Gaussian function.

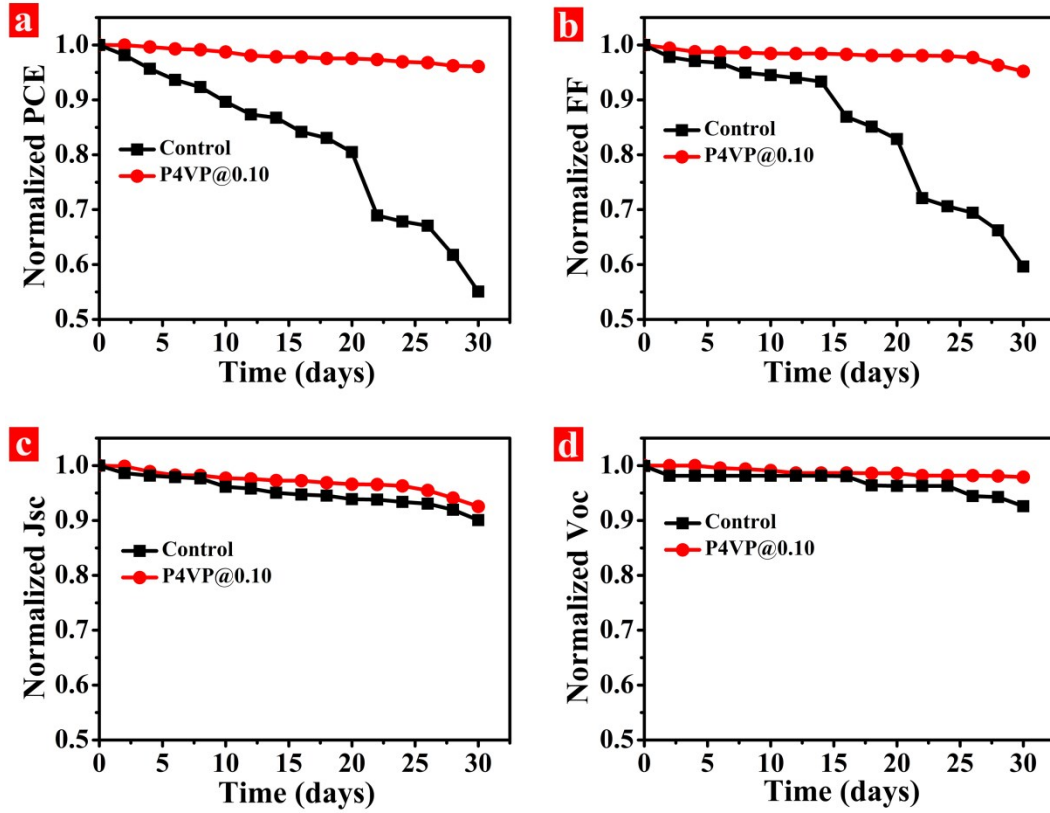


Fig. S5 Stability evaluation of the control and optimal devices, which were stored in nitrogen atmosphere for 30 days.

Table S1 Fitting parameters for time-resolved photoluminescence (TRPL) spectra obtained by illuminating glass/MAPbI₃ and glass/MAPbI₃/P4VP@0.10.

	τ_1 (ns)	Frac. τ_1 (%)	τ_2 (ns)	Frac. τ_2 (%)	Lifetime (ns)
Control	4.40	58.50	25.47	41.50	13.14
P4VP@0.10	4.74	52.38	42.41	47.62	22.67

Table S2 Fitting parameters for TRPL spectra obtained by illuminating glass/MAPbI₃/PCBM and glass/MAPbI₃/P4VP@0.10/PCBM.

	τ_1 (ns)	Frac. τ_1 (%)	τ_2 (ns)	Frac. τ_2 (%)	Lifetime (ns)
Control	1.35	72.35	5.28	27.65	2.44
P4VP@0.10	1.51	80.92	4.95	19.08	2.17