

Supplementary Information

Consolidating Pb-X Framework via
Multifunctional Passivation of Fluorinated
Zwitterion for Efficient and Stable Perovskite
Solar Cells

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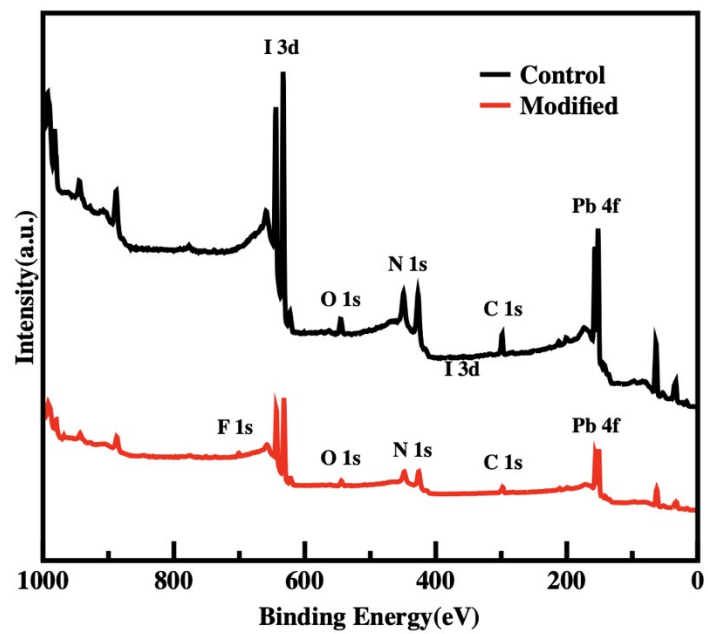


Figure S1. XPS measurement result of pure perovskite film and perovskite/ D-PFPAA films.

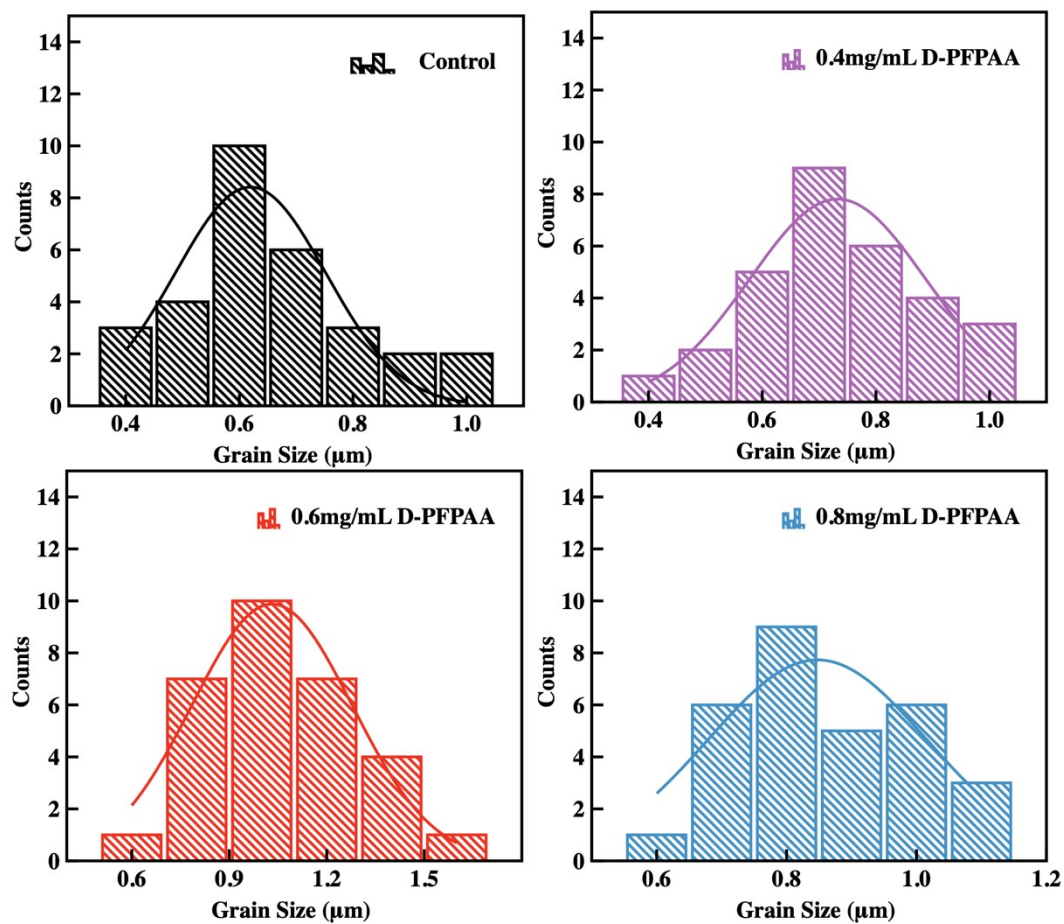


Figure S2. The histogram of the grain size distribution obtained from the SEM for the control and D-PFPAA modified perovskite films.

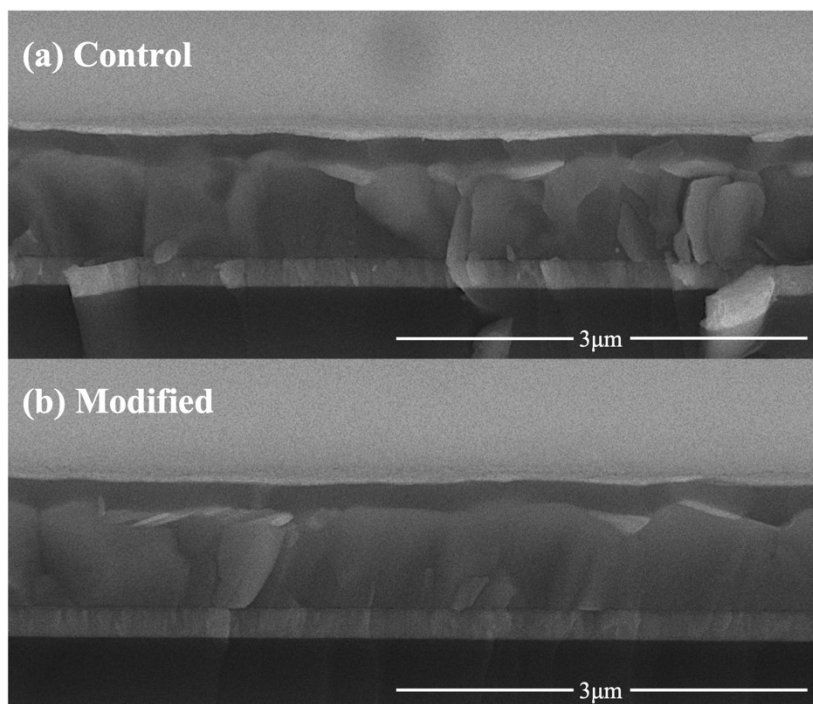


Figure S3. Cross-sectional SEM image of control and D-PFPAA modified device.

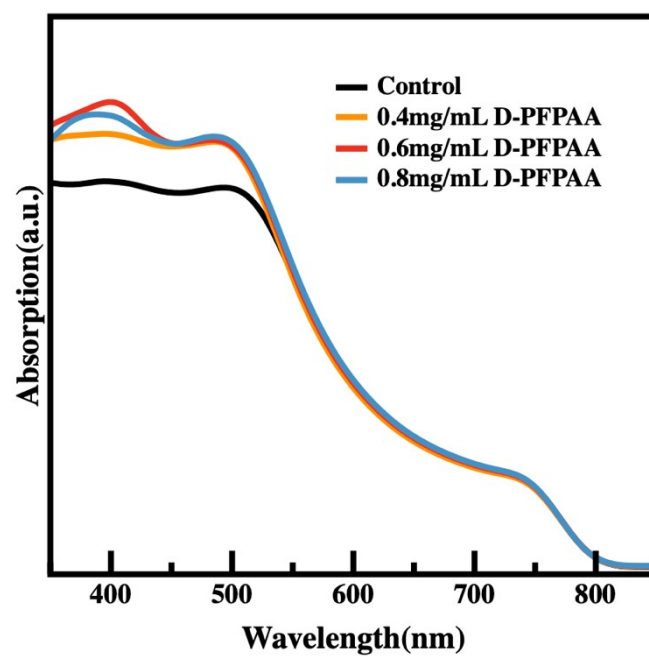


Figure S4. The UV-vis spectra of pure perovskite film and perovskite/ D-PFPAA films.

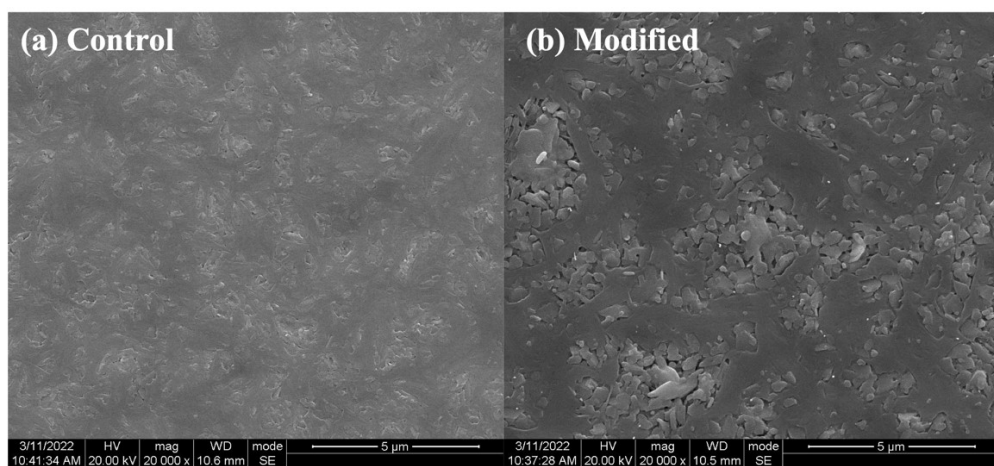


Figure S5. Top-view SEM images of the PbI_2 film: (a) control, (b) D-PFPAA modified.

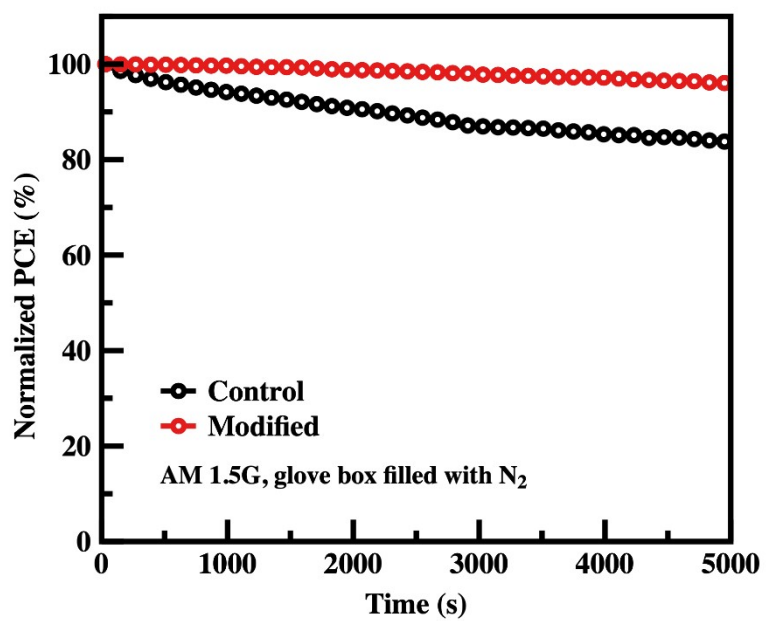


Figure S6. steady-state power output at the maximum power point (0.94 V for the control device and 0.99 V for the D-PFPAA-modified device).

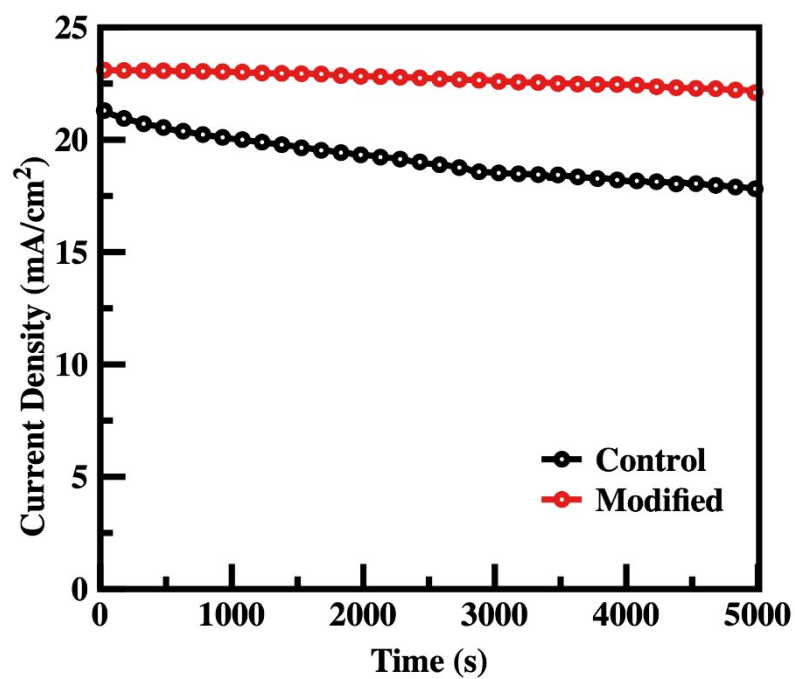


Figure S7. The photocurrent stability of the control device and modified device measured at the maximum power point.

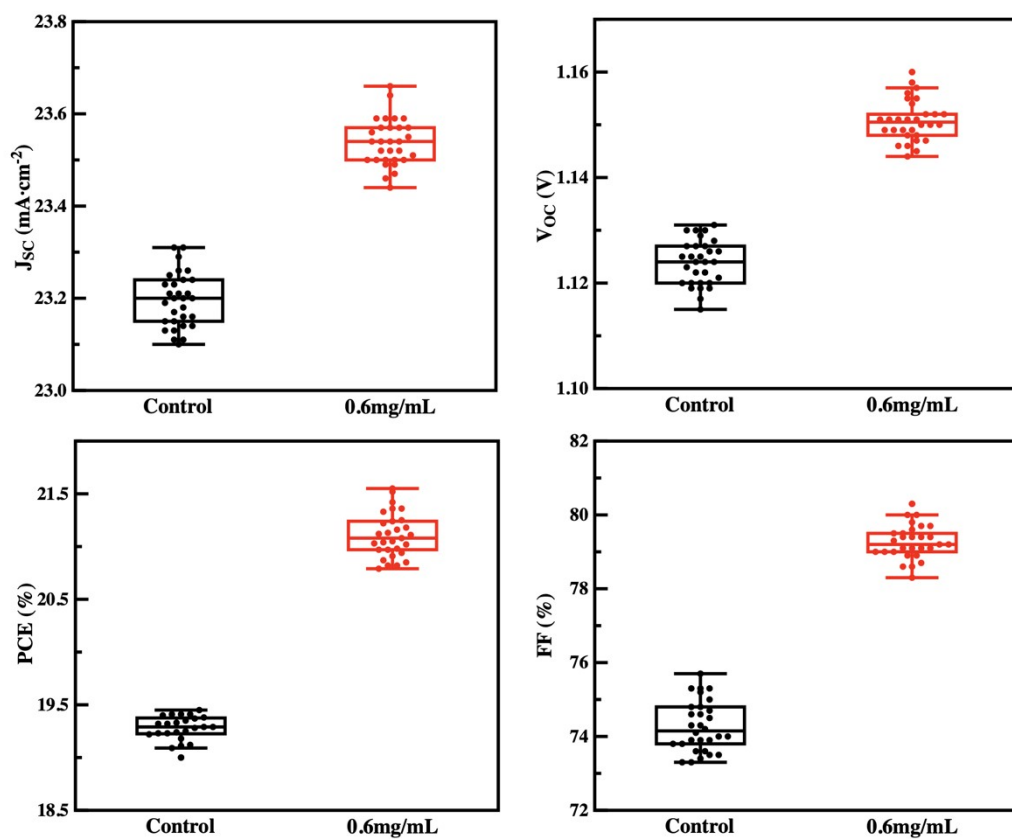


Figure S8. Statistical distribution of photovoltaic parameters of 30 perovskite devices for control and different concentrations of D-PFPAA modified.

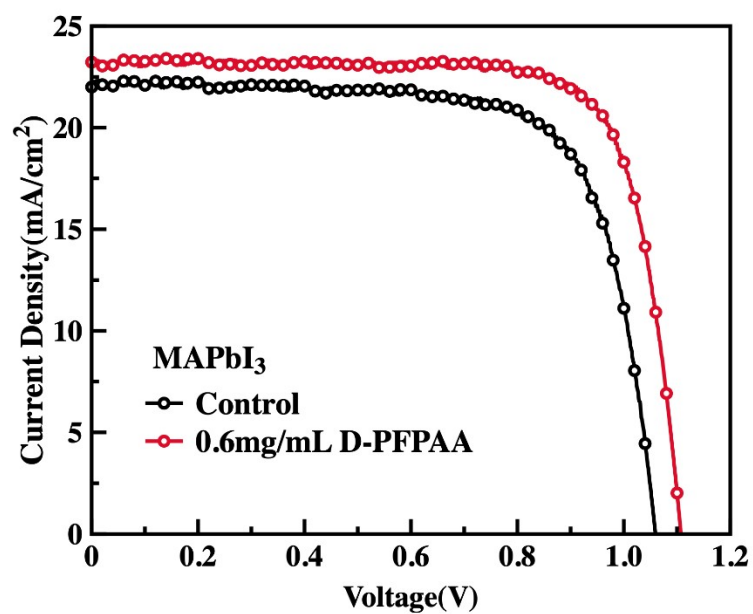


Figure S9. J - V curves of MAPbI₃ PSCs modified with optimal concentration of D-PFPAA (0.6 mg/mL) and the control MAPbI₃ PSCs.

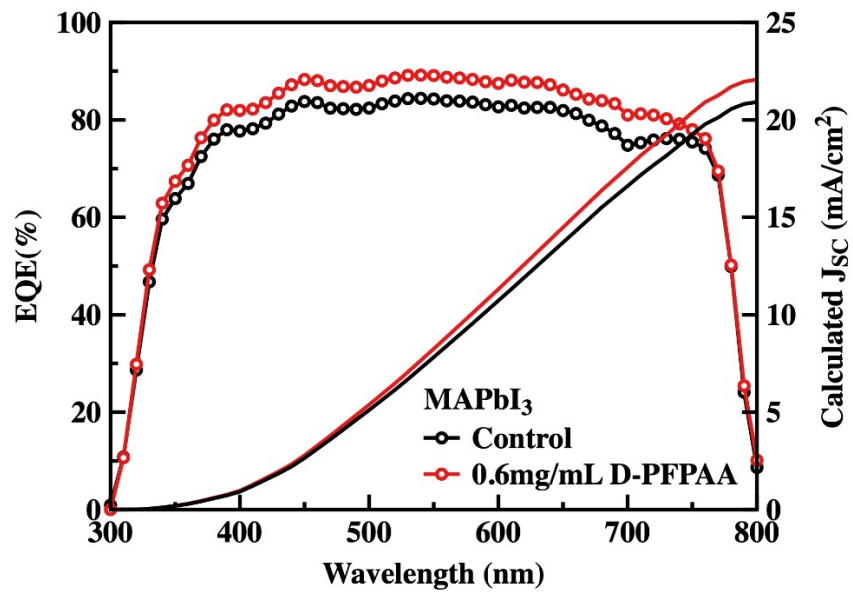


Figure S10. EQE and the corresponding integrated J_{sc} of control and modified MAPbI₃ devices.

Table S1. Fitting parameters for the TRPL spectra.

Sample	τ_{ave} (ns)	τ_1 (ns)	A_1 (%)	τ_2 (ns)	A_2 (%)
CsFAMA/ETL	603.15	5.22	44.46	607.26	55.54
D-PFPAA·CsFAMA/ETL	256.18	5.97	60.29	264.75	39.71

Table S2. Photovoltaic parameters of control and modified MAPbI₃ devices. (Measured under simulated AM 1.5G solar irradiance at 100 mW/cm²).

Device	V_{oc}	J_{sc}	FF	PCE
Control	1.060	22.00	73.90%	17.23%
0.6mg/mL	1.106	22.92	78.1%	19.80%