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Supplementary Information

The effect of permanent electric dipoles on the stability and photoelectric properties of $MAPbI_3$

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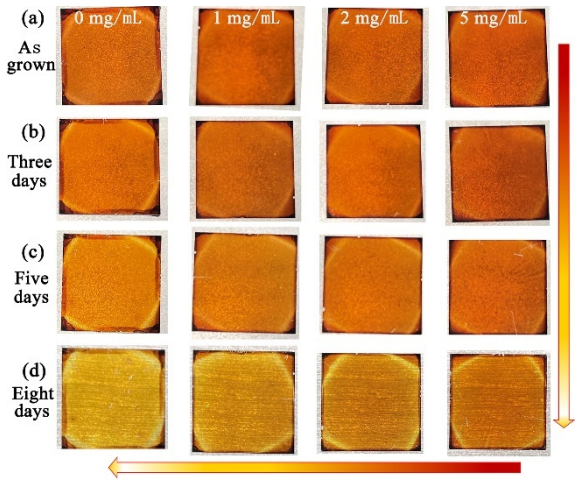

Fig. S1 Time-dependent color changes of the $MAPbI_3$ films with different P(VDF-TrFE) concentrations, measured in the atmosphere.

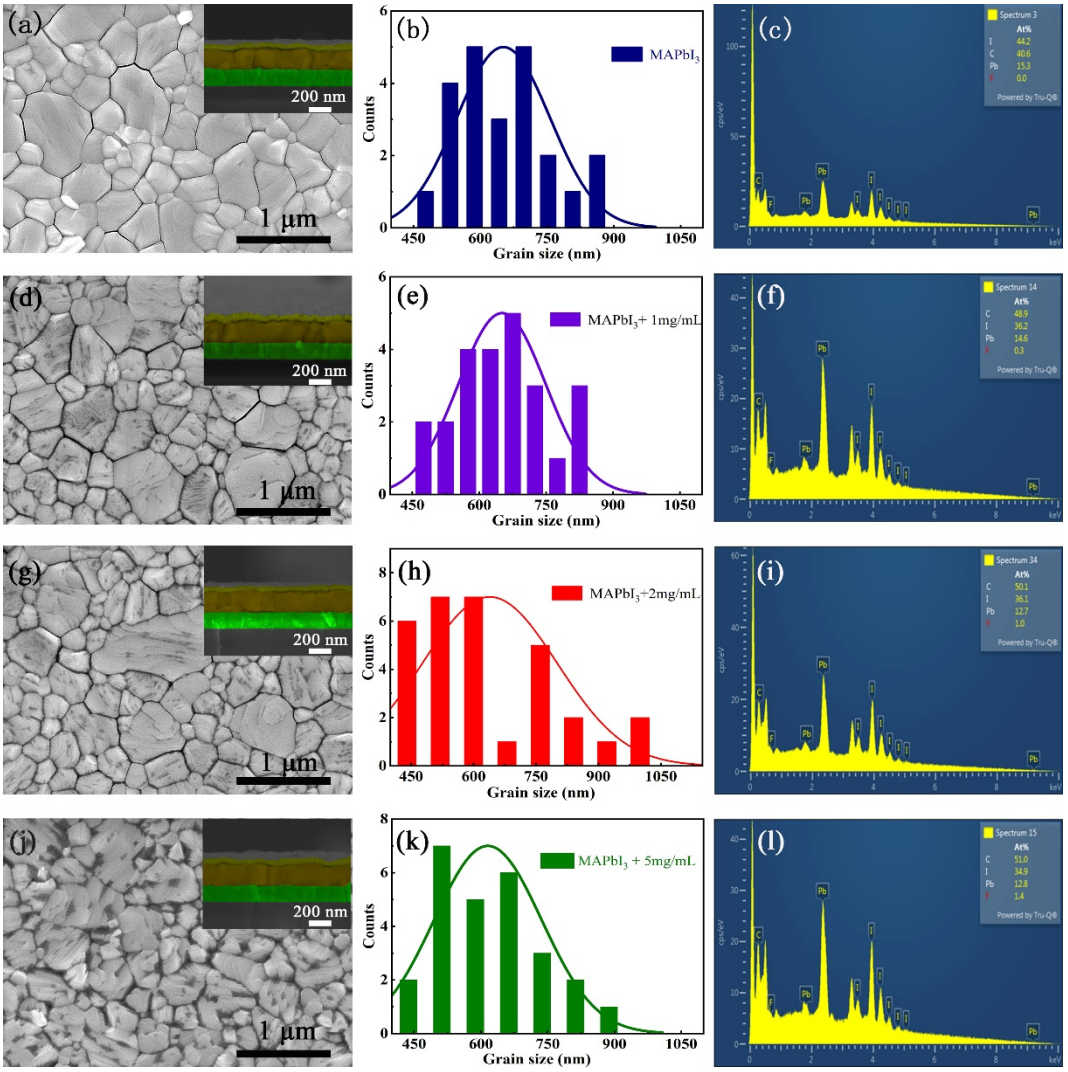

Fig. S2 Top-view and cross-sectional (Inset) SEM images, distributions of grain

size, and EDS analysis of the $MAPbI_3$ films, with the P(VDF-TrFE) concentration of 0 mg/mL (a-c), 1 mg/mL (d-f), 2 mg/mL (g-i), and 5 mg/mL (j-l), respectively.

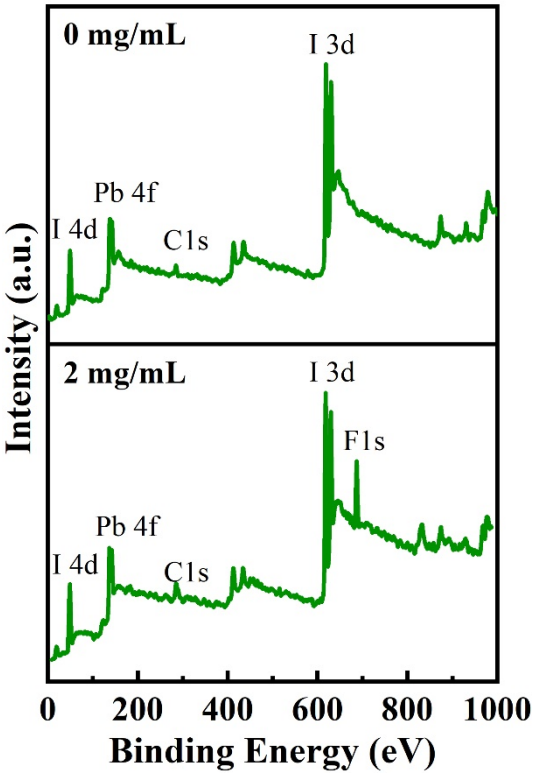

Fig. S3 XPS spectra of the pure $MAPbI_3$ and 2 mg/mL P(VDF-TrFE) added $MAPbI_3$ films

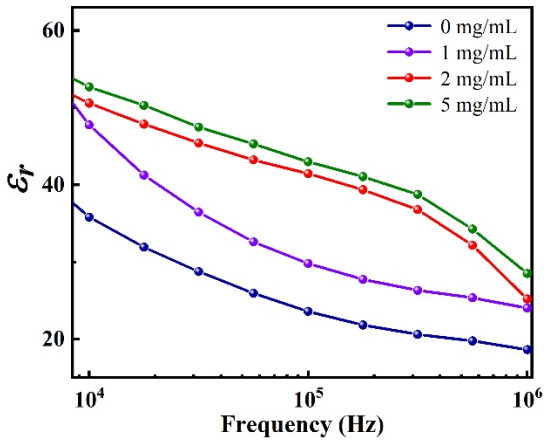

Fig.S4 Frequent-dependent dielectric constant of the different $MAPbI_3$ films added by 0, 1, 2, and 5 mg/mL P(VDF-TrFE) respectively.

P(VDF-TrFE) Amount (mg/mL)	ε_r @10 KHz	N_{trap} (cm^{-3}) @10 KHz	Mobility ($cm^2V^{-1}s^{-1}$) @10 KHz	ε_r @1 MHz	N_{trap} (cm^{-3}) @1 MHz	Mobility ($cm^2V^{-1}s^{-1}$) @1 MHz
0	37	1.53×10^{17}	3.25×10^{-2}	20	8.25×10^{16}	6.01×10^{-2}
1	46	1.48×10^{17}	4.08×10^{-2}	24	7.70×10^{16}	7.82×10^{-2}
2	50	1.31×10^{17}	6.68×10^{-2}	26	6.83×10^{16}	1.28×10^{-1}
5	52	1.76×10^{17}	3.61×10^{-2}	28	9.45×10^{16}	6.71×10^{-2}

Table1. The dielectric constant, defect density, and carrier mobility of the $MAPbI_3$ films with different amounts of P(VDF-TrFE) at 10 KHz and 1 MHz, respectively.

P(VDF-TrFF) Amount (mg/ml)	V_{TFL} (V) Classic	Defect density ($\times10^{17}$ cm^{-3}) Classic	Mobility ($\times10^{-2}$ $cm^2V^{-1}s^{-1}$) Classic	V_2 (V) New	Defect density ($\times10^{17}$ cm^{-3}) New	Mobility ($\times10^{-2}$ $cm^2V^{-1}s^{-1}$) New
0	1.49	1.53	3.25	1.78	1.82	3.25
1	1.16	1.48	4.08	1.28	1.63	4.08
2	0.95	1.31	6.68	1.02	1.41	6.68
5	1.22	1.76	3.61	1.25	1.80	3.61

Table 2. The comparison of trap density and carrier mobility, by using the V_{TFL} obtained with the classic SCLC and new method respectively. The dielectric constant measured at 10 kHz was used.