Supporting Information

Energy Level Modulation of TiO_2 Using Amino Trimethylene Phosphonic Acid for Efficient Perovskite Solar Cells with Average V_{OC} of 1.19 V

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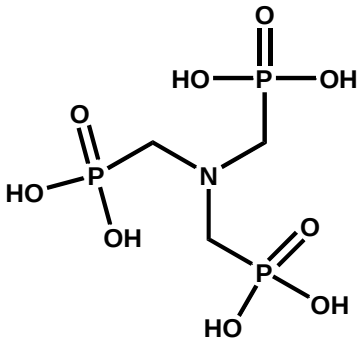

Figure S1. Chemical structure of ATMP.

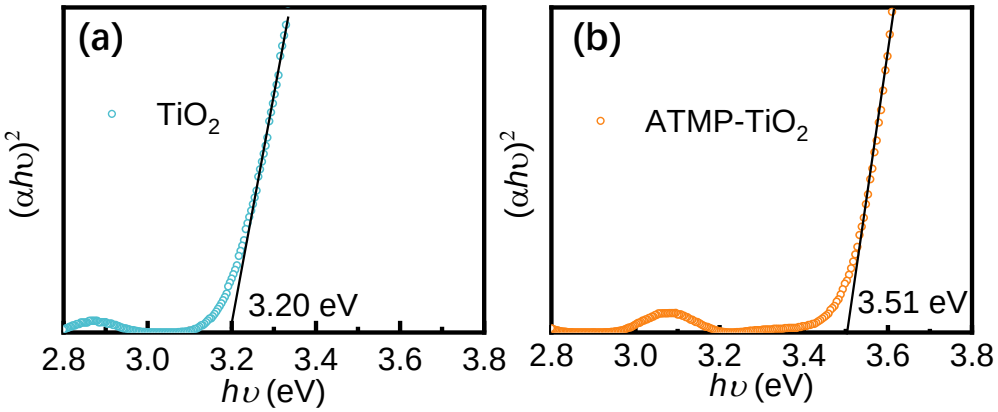

Figure S2. Tauc plots for (a) TiO_2 and (b) ATMP-TiO_2 films.

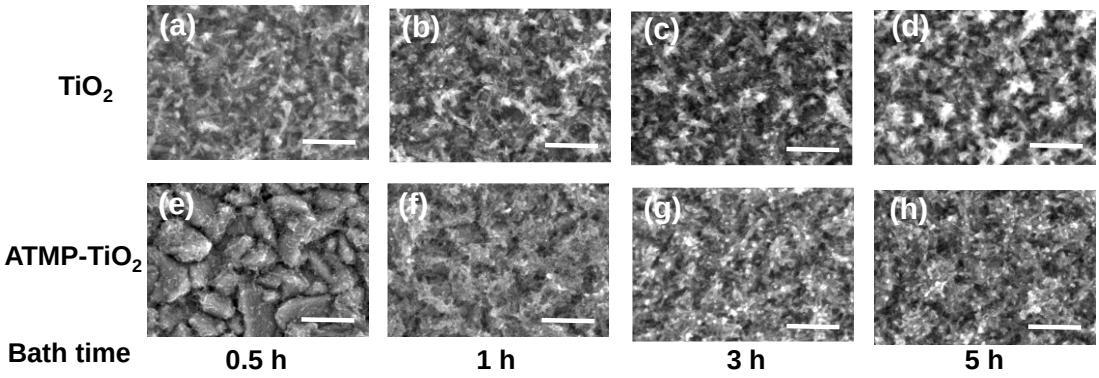

Figure S3. SEM images of TiO_2 films (a-d) and ATMP-TiO_2 films (e-h) with different chemical bath times. Scale bars represent 300 nm.

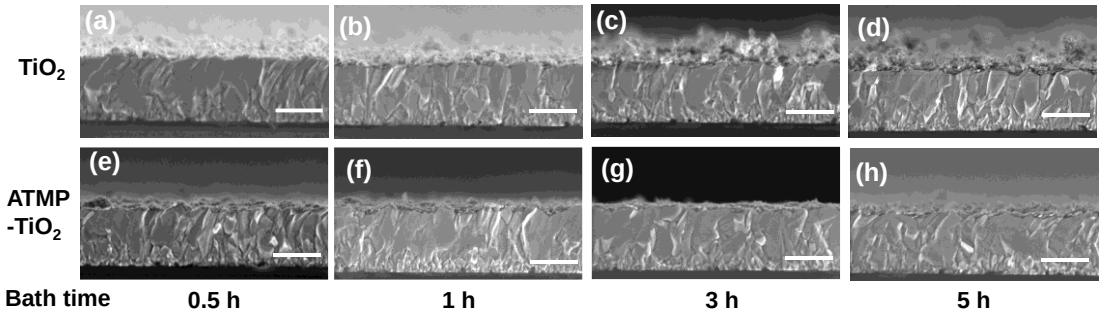

Figure S4. Cross-sectional SEM images of (a-d) TiO_2 and (e-h) ATMP-TiO_2 films with different chemical bath times. Scale bars represent 500 nm.

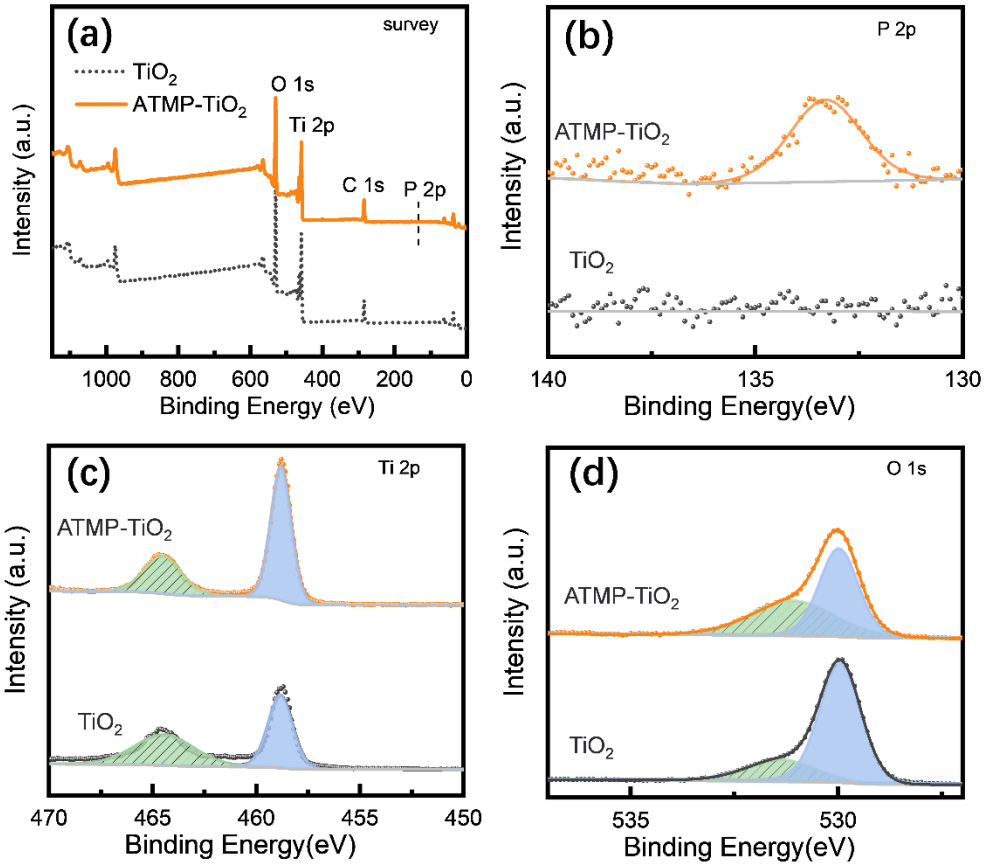

Figure S5. XPS spectra of TiO_2 and ATMP-TiO_2 films. (a) Full survey spectra, (b) high-resolution P 2p spectra (c) high-resolution Ti 2p spectra and (d) high-resolution O 1s spectra.

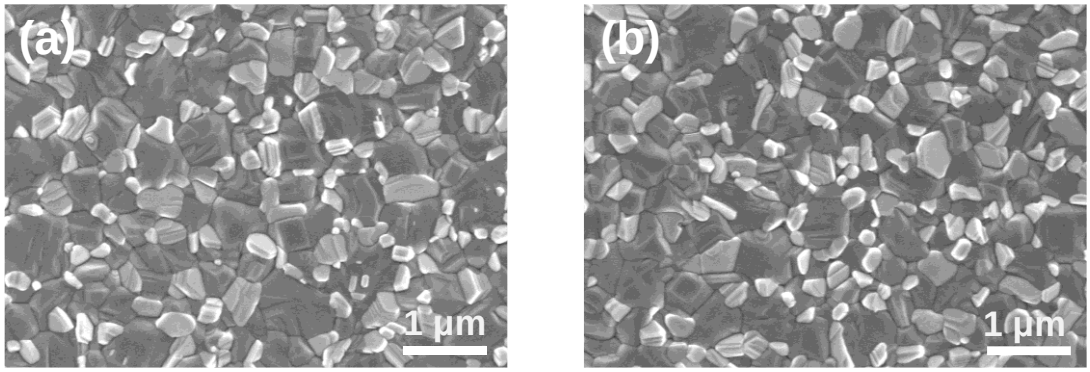

Figure S6. Top SEM images of perovskite films deposited on (a) TiO_2 film and (b) ATMP-TiO_2 film.

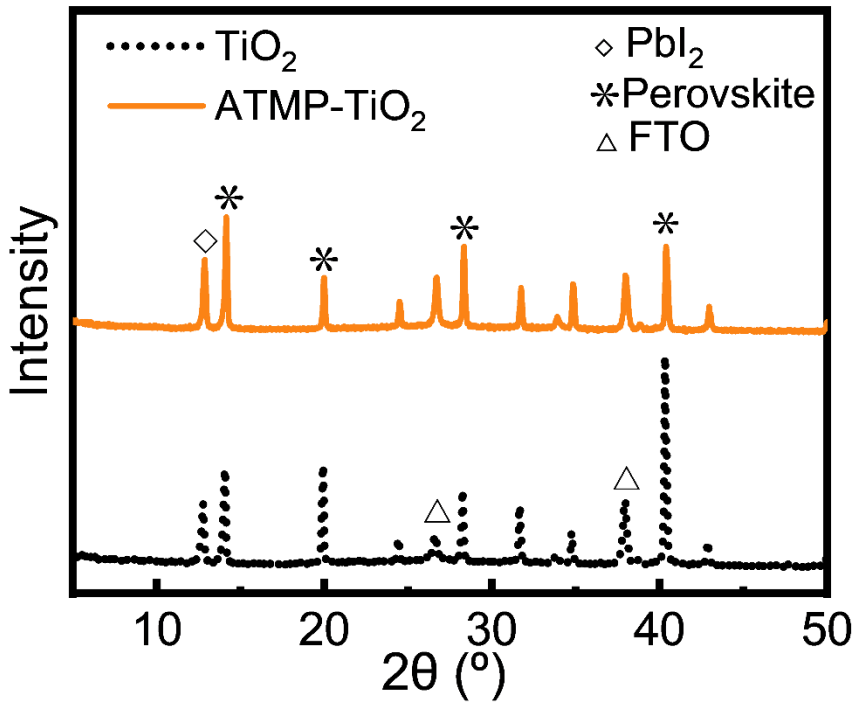

Figure S7. XRD patterns for perovskite films deposited on TiO_2 film and ATMP-TiO_2 film.

Table S1. TRPL parameters of PSCs based on TiO_2 and ATMP-TiO_2.

ETL	τ_1 (μs)	A_1	τ_2 (μs)	A_2	τ_{Avg} (μs)
TiO_2	0.22	0.29	1.06	0.68	0.99
ATMP-TiO_2	0.17	0.31	1.51	0.68	1.44

Table S2. EIS parameters of PSCs based on TiO_2 film and ATMP-TiO_2 film.

ETL	R_s (Ω)	CPE-T	CPE-P	R_{rec} (Ω)
TiO_2	12.06	5.05×10^{-8}	0.919	948
ATMP-TiO_2	9.94	3.01×10^{-8}	0.943	3022