Electronic Supplementary Material (ESI) for Materials Advances.

Supporting Information

Formamide Iodide: A new cation additive for inhibiting δ-phase formation of formamidinium lead iodide perovskite

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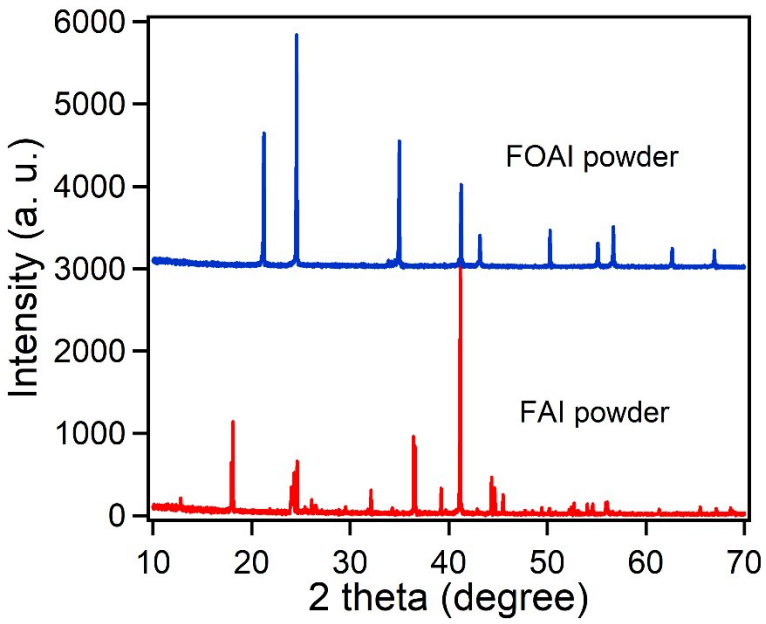

Figure S1 Powder XRD patterns of formamide iodide (FoAI) and formamidinium iodide (FAI).

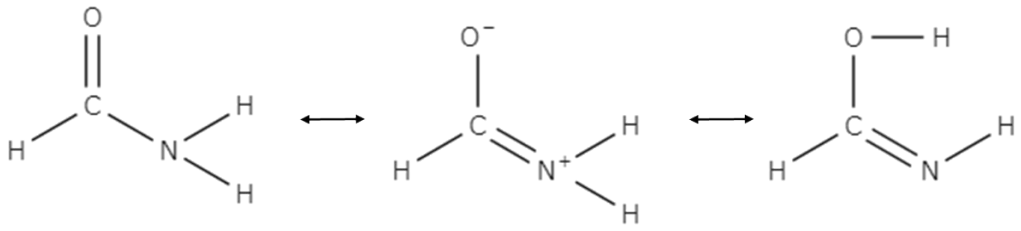

Figure S2 Resonance structures of formamide.

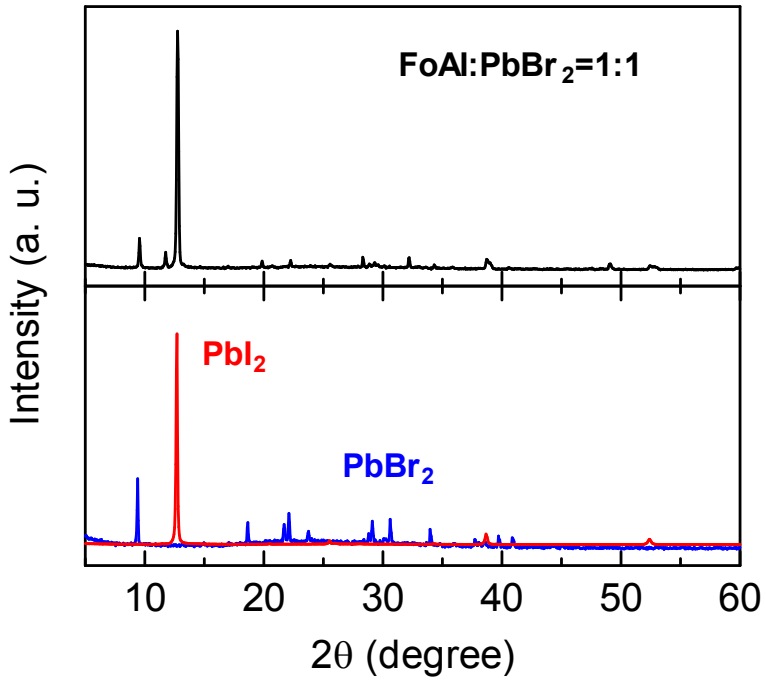

Figure S3 XRD patterns of PbI_2, $PbBr_2$ films and a film prepared from a precursor solution including $PbBr_2$ and formamide iodide (FoAI) with the molar ratio of 1:1.

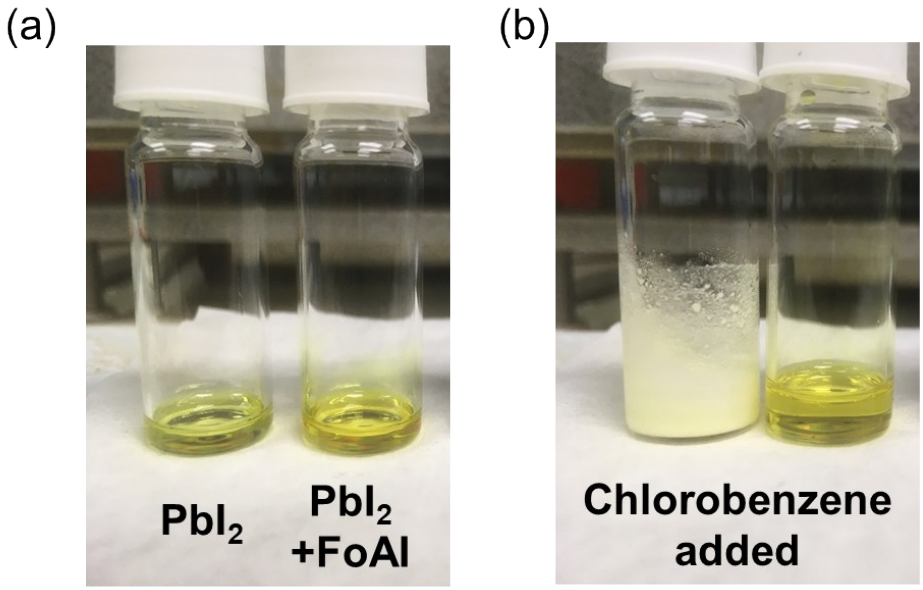

Figure S4 Photographs of PbI_2 and PbI_2 + FoAI solution (a) before and (b) after adding chlorobenzene.

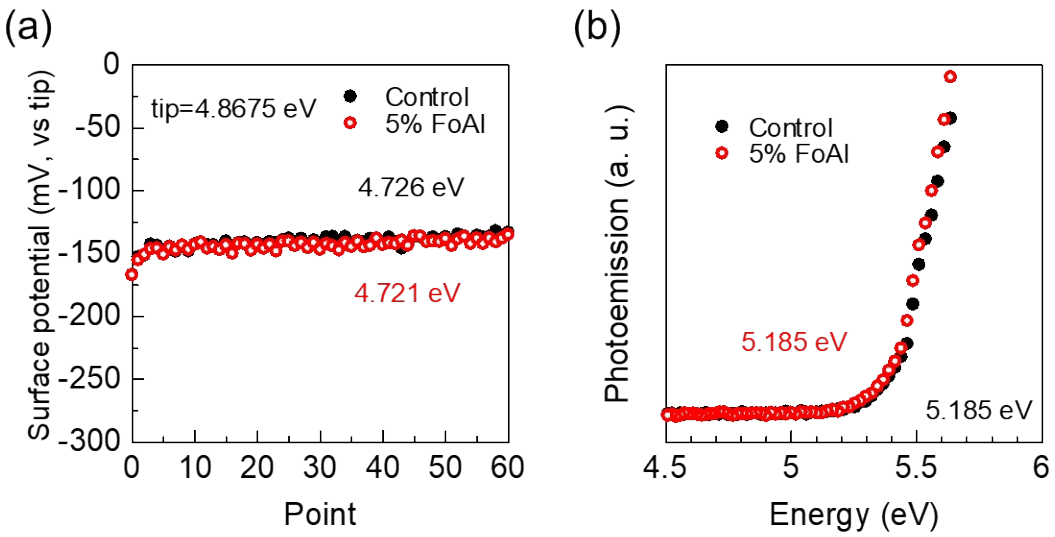

Figure S5 (a) Surface potential of $FAPbI_3$ films with and without FoAI additive. Values in the graph are work function of both films. (b) Photoemission spectra of $FAPbI_3$ films with and without FoAI additive. Values in the graph are ionization potential of both films.

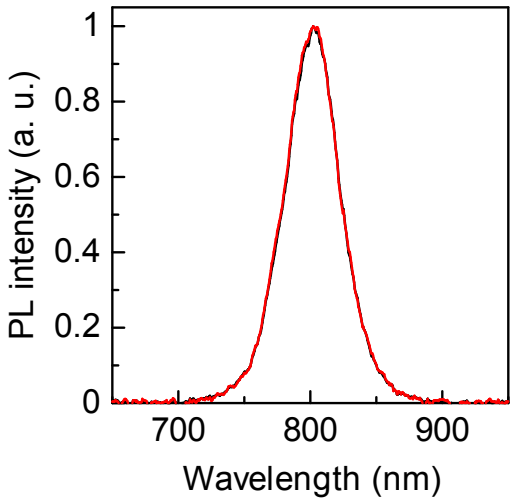

Figure S6 PL spectra of pure $FAPbI_3$ and FoAI added $FAPbI_3$ films. The black and red lines represent PL spectra of pure and FoAI added $FAPbI_3$ films, respectively.

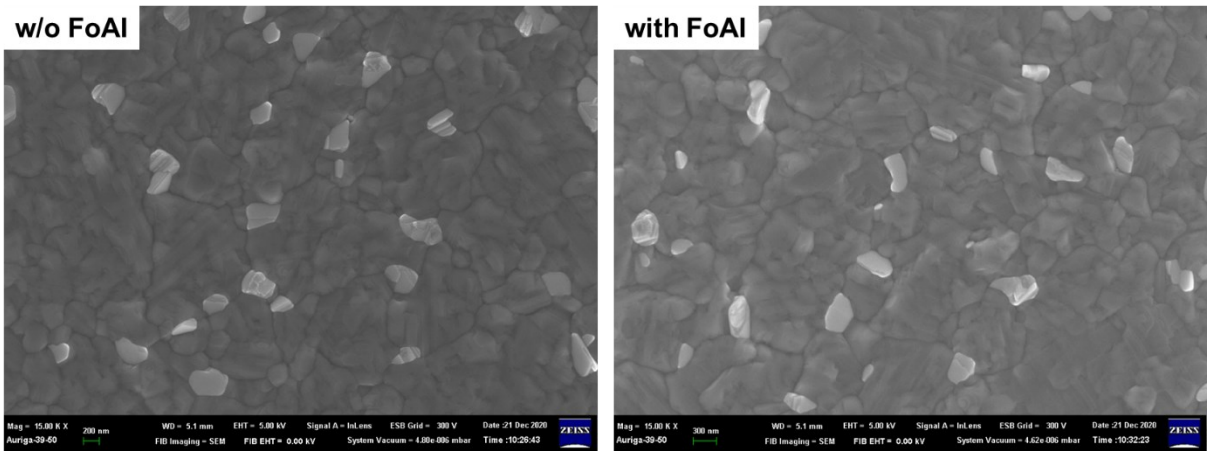

Figure S7 SEM images of pure $FAPbI_3$ and FoAI added $FAPbI_3$ films.

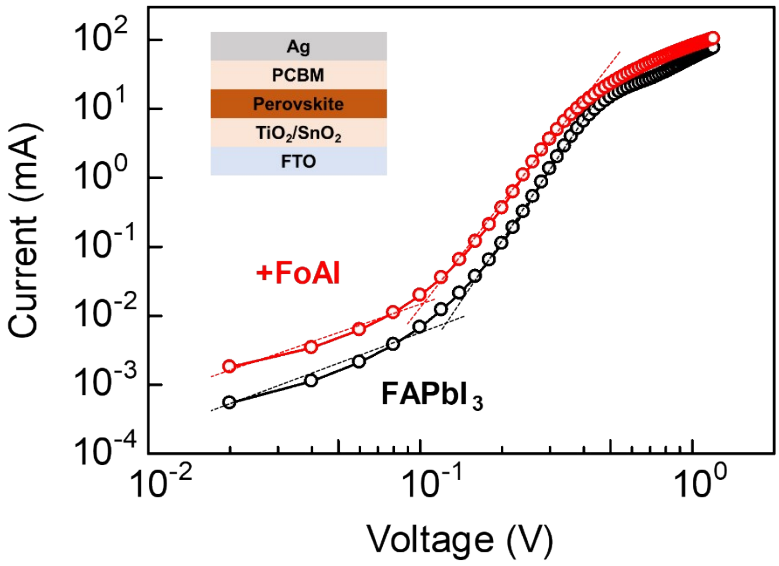

Figure S8 Dark *I-V* curves of electron-only devices employing pure and FoAI added $FAPbI_3$ films.

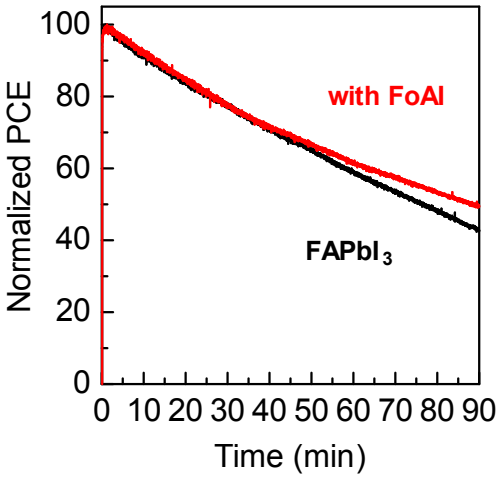

Figure S9 Stability of $FAPbI_3$ perovskite solar cells kept at maximum power point under 1 sun irradiation without encapsulation.

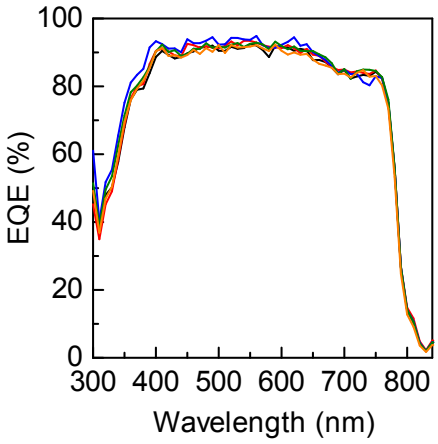

Figure S10 EQE spectra of FoAI added triple-cation perovskite solar cells. The black, red, blue, green, and orange lines represent 0, 0.625, 1.25, 2.5 and 5 mol% FoAI added samples, respectively.

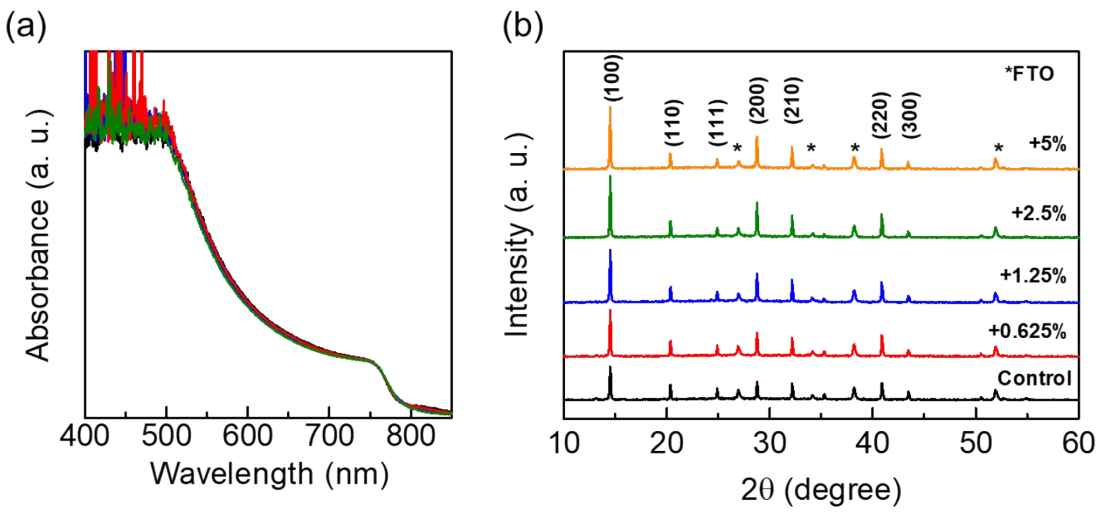

Figure S11 Absorbance spectra and (b) XRD patterns of FoAI added triple-cation perovskite films. The black, red, blue, green and orange line represent 0, 0.625, 1.25, 2.5 and 5 mol% FoAI added films.

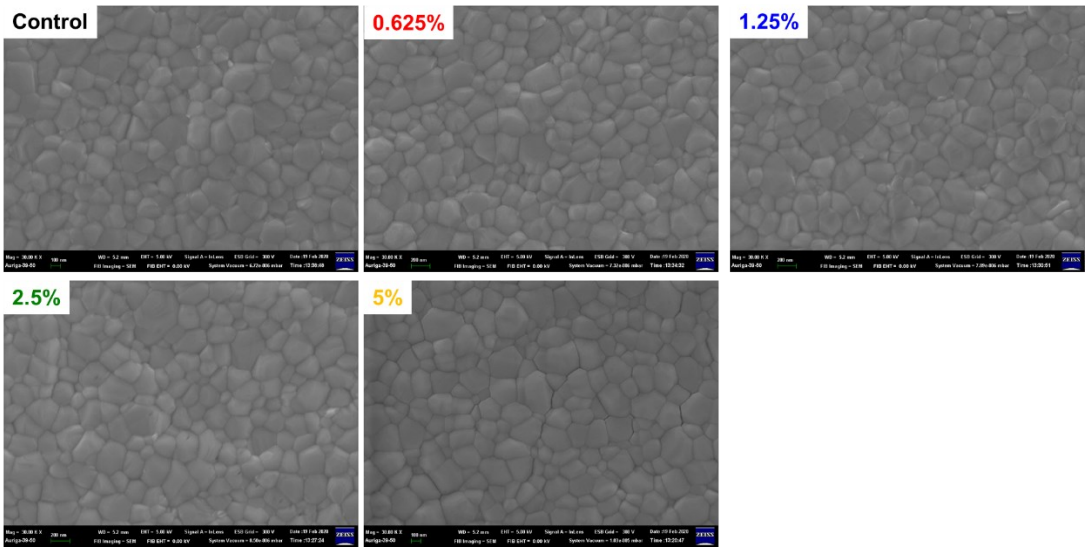

Figure S12 SEM images of FoAI added triple-cation perovskite films.

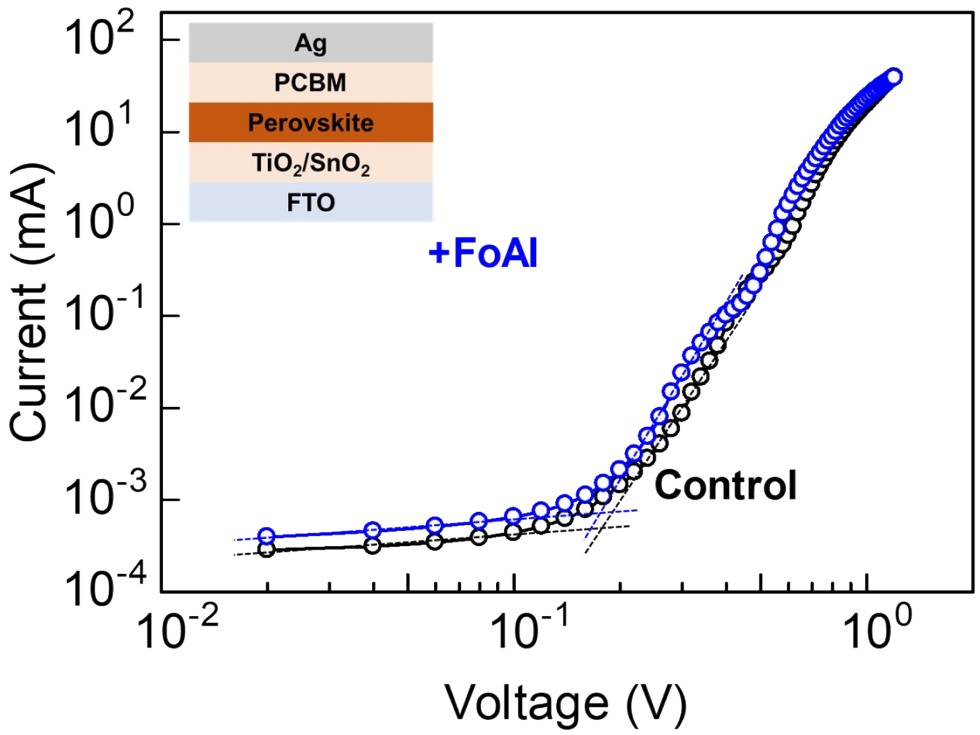

Figure S13 Dark *I-V* curves of electron-only devices employing pure and FoAI added triple cation perovskite films.

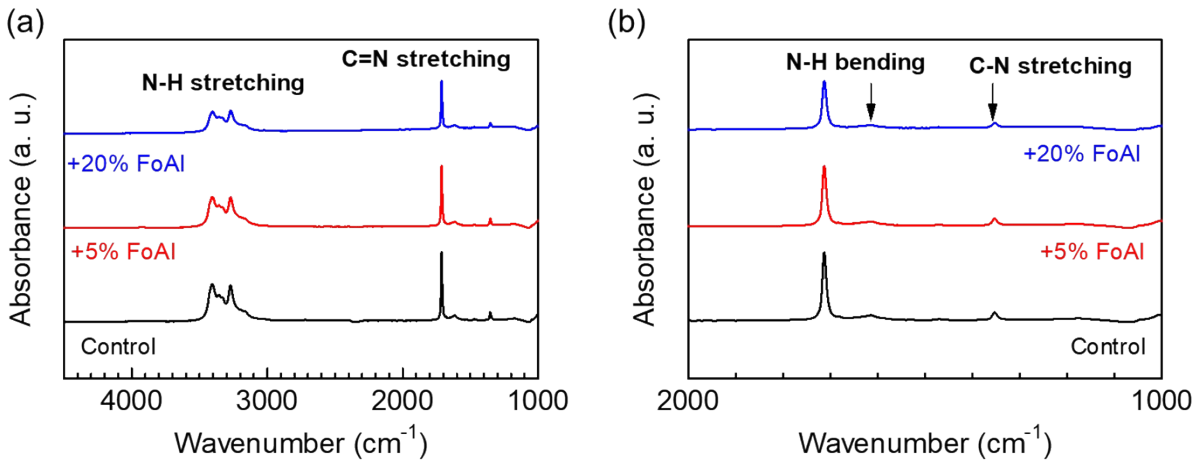

Figure S14 FT-IR spectra of FoAI added triple-cation perovskite films. (a) from 4500 cm^{-1} to 1000 cm^{-1} and (b) from 2000 cm^{-1} to 1000 cm^{-1}.

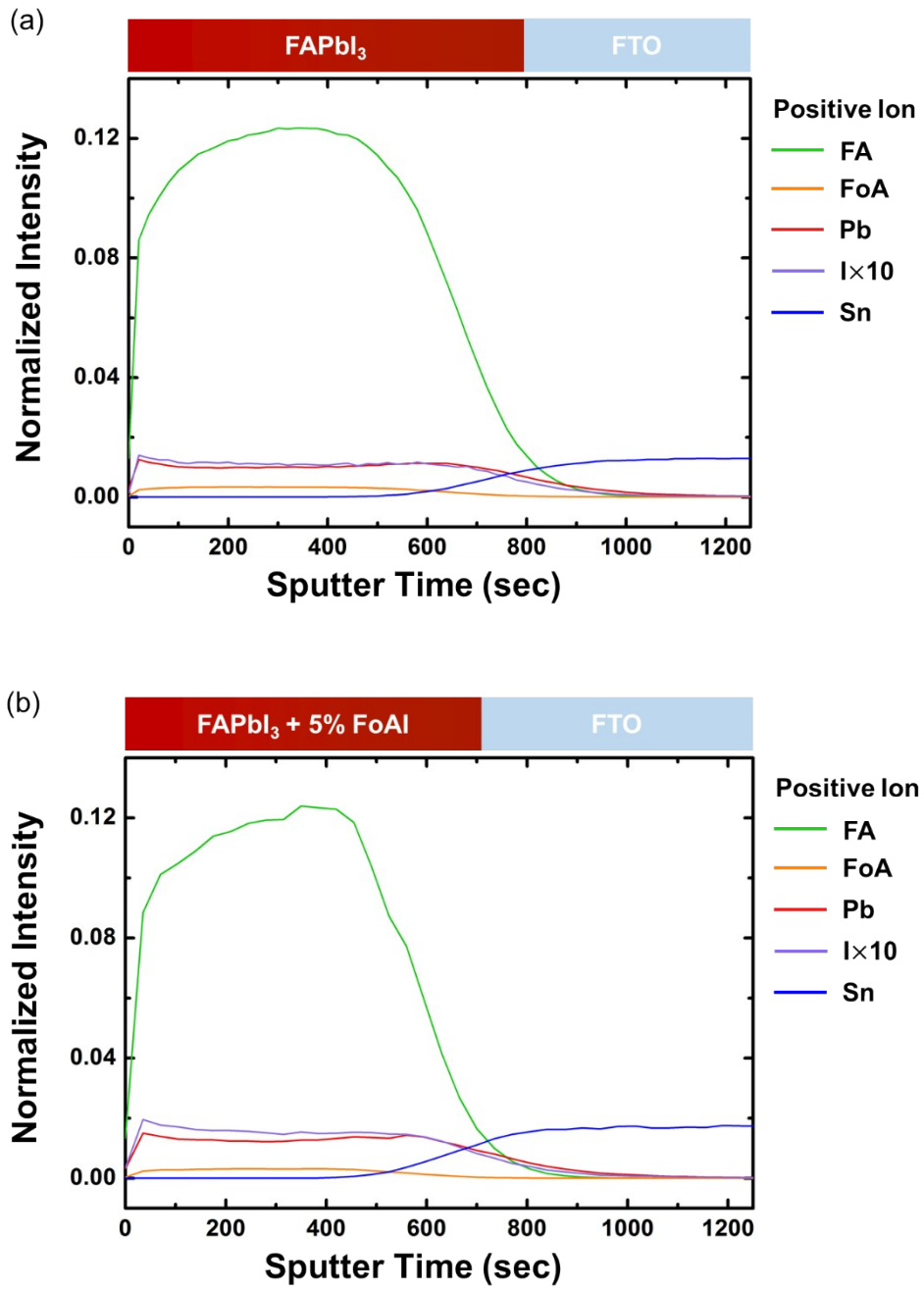

Figure S15 ToF-SIMS profile (positive ion) of (a) pure $FAPbI_3$ and (b) FoAI added $FAPbI_3$ films.

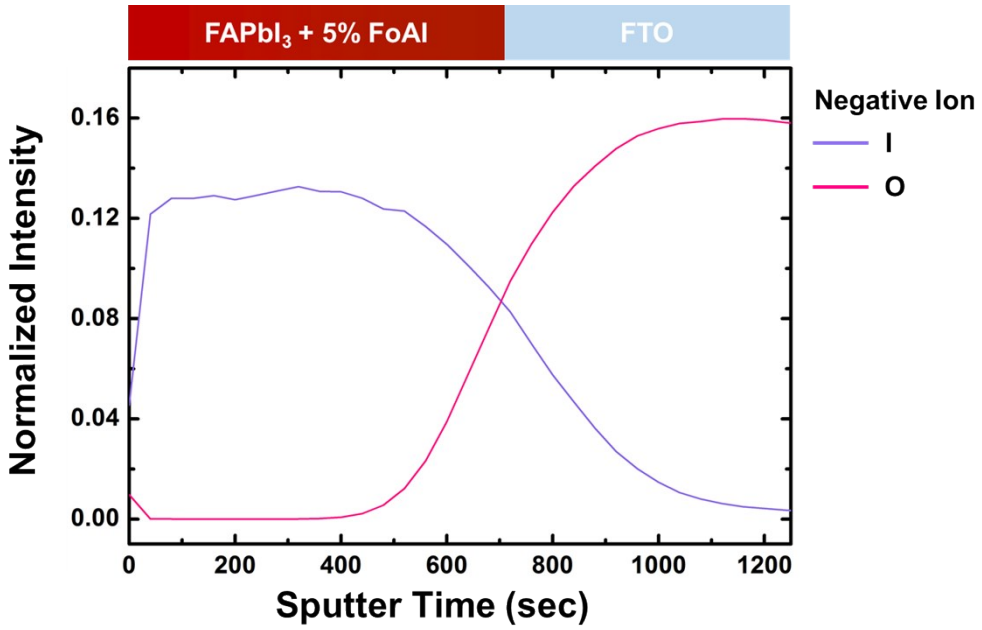

Figure S16 ToF-SIMS profile (negative ion) of FoAI added $FAPbI_3$ films.

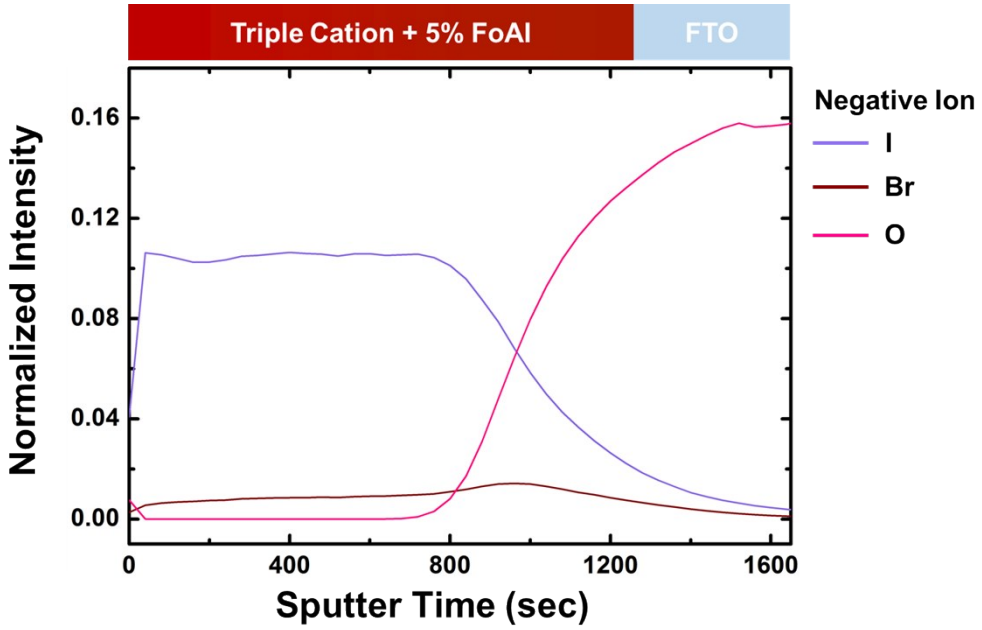

Figure S17 ToF-SIMS profile (negative ion) of 5% FoAI added triple cation perovskite films.

Table S1 The peak positions and assumed bonding in the FT-IR spectrum of formamidinium iodide (FAI).

Wavenumber (cm^{-1})	Signal
3400-3000	N-H stretching
2800	C-H stretching
1700	C=N stretching
1600	N-H bending
1400-1200	C-N stretching

Table S2 The peak positions and assumed bonding in the FT-IR spectrum of formamide iodide (FoAI).

Wavenumber (cm^{-1})	Signal
3300-2900	N-H stretching
2800	C-H stretching
1400	C-N stretching
	C-OH bending

Table S3 Hysteresis index of $FAPbI_3$ PSCs

Sample	Hysteresis index (%)
Pure $FAPbI_3$	6.16±1.67
FoAI added	4.34±1.06

Table S4 Hysteresis index of triple cation PSCs

FoAI concentration (mol%)	Hysteresis index (%)
0	3.94±0.57
0.625	3.81±0.87
1.25	4.23±0.62
2.5	4.28±0.69
5	5.78±0.37