Electronic Supporting Information

Monolayer-like Hybrid Halide Perovskite Films Prepared by Additive Engineering without Antisolvent for Solar Cells

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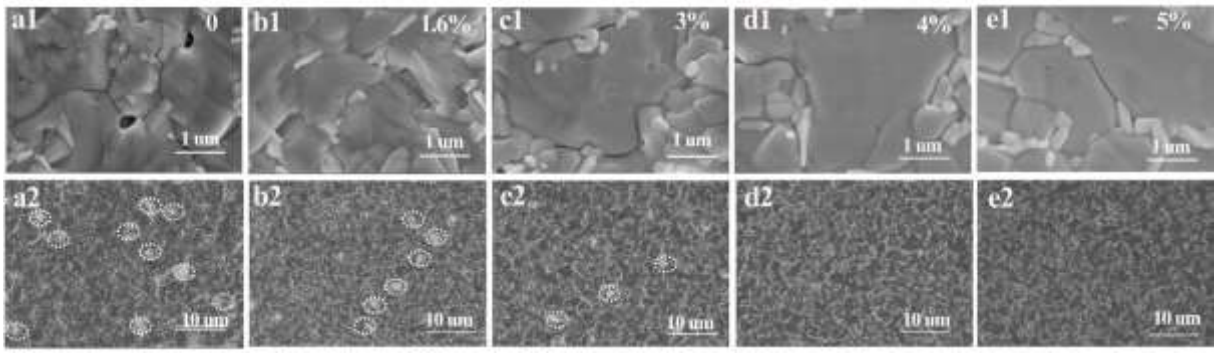

Fig. S1. (a-e) Top-view SEM images of perovskite films with different content of MAAc deposited on FTO substrate. White ellipse represents holes； Small white crystals indicate PbI_2.

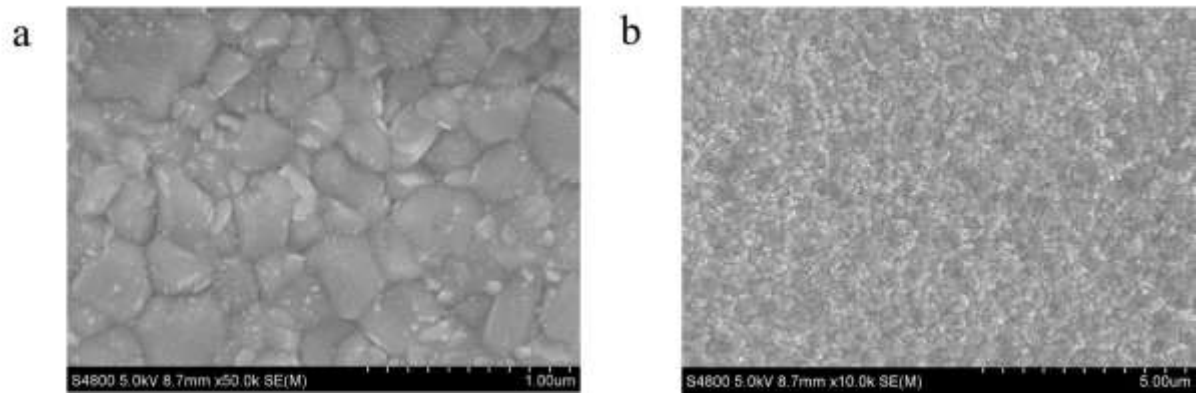

Fig. S2. Top-view SEM images of perovskite films prepared by 4 % MAAc additive by antisolvent-free process. The wet film was annealed at 100 °C for 5mins.

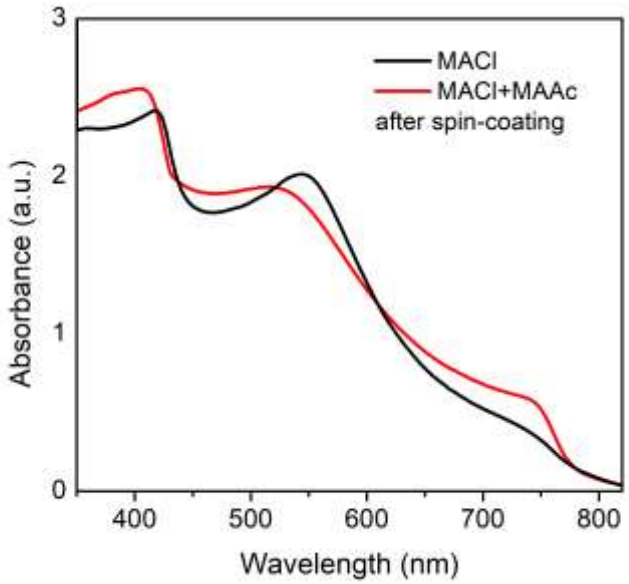

Fig. S3. Absorption spectra of the wet perovskite films prepared by MACl (black) and MACl-MAAc (red) based perovskite precursor directly after spin coating.

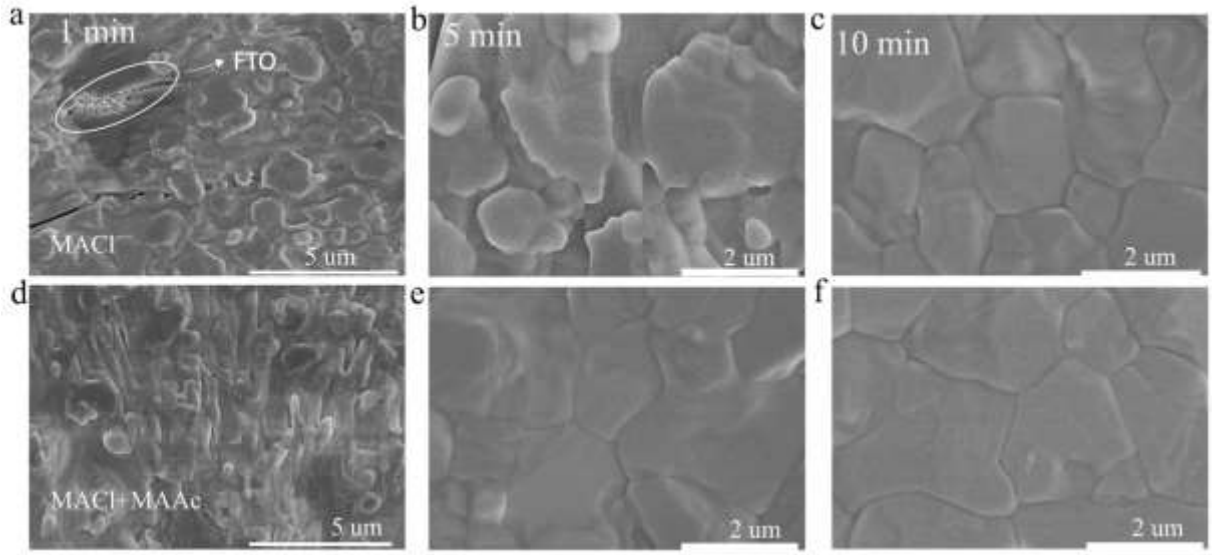

Fig. S4. SEM images of perovskite intermediate phase film with additive of MACl (a-c) and MACl-MAAc-based (d-f), the perovskite films were dried at 60 °C for 1 min (a, d), and at 100 °C for 5 min (b, e) and 10 min (c, f).

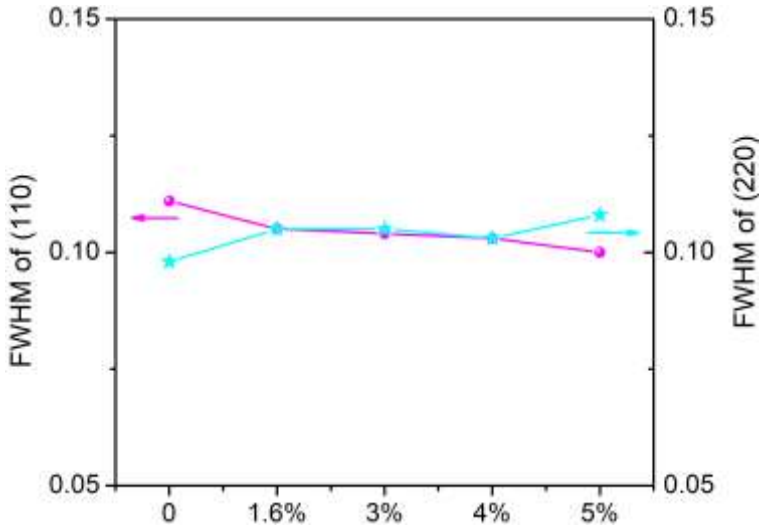

Fig. S5. XRD diffraction intensity and FWHM of the (110) and (220) plane of the perovskite films prepared using 0.5 M MACl and different MAAc content;

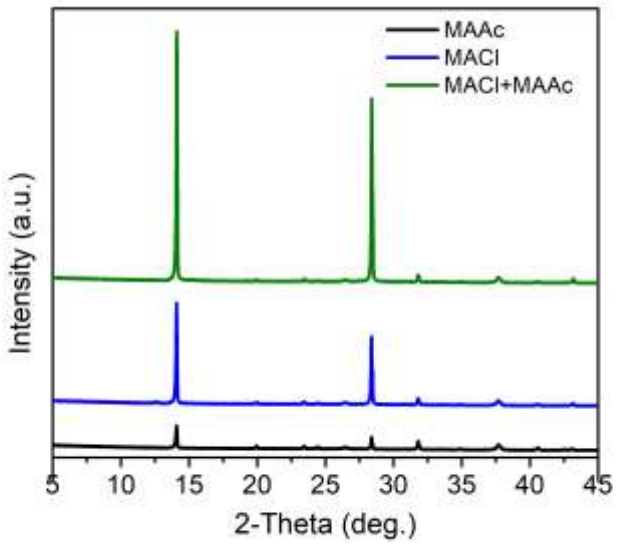

Fig. S6. XRD patterns of the perovskite films prepared by antisolvent-free process using 4 % MAAc additive (black); 0.5 M MACl (blue); coordination of 0.5 M MACl and 4 % MAAc (olive).

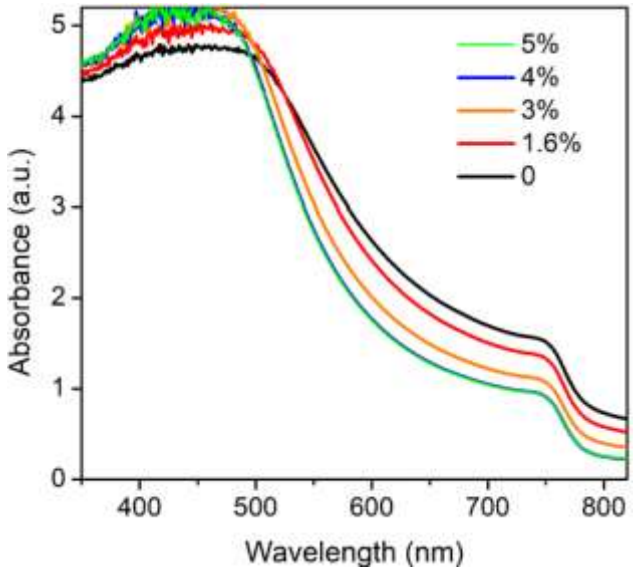

Fig. S7. UV-Vis of perovskite films prepared by antisolvent-free process using 0.5 M MACl and different MAAc contents.

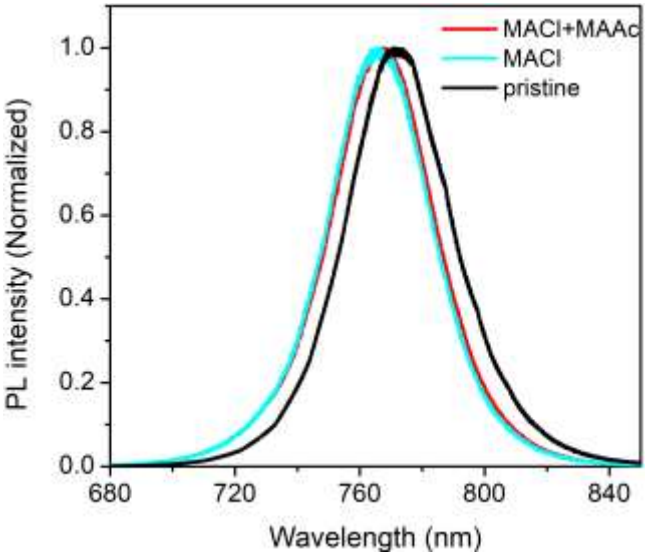

Fig. S8.the steady-state PL spectra for pristine perovskite film, MACl additive film and MACl+MAAc additive film.

Table S1. Parameters of PL-decay for MACl-MAAc and MACl-based perovskite films

	f_1	τ_1(ns)	f_2	T_2(ns)	T_{ave}(ns)
MACl	3.312	5.722	96.688	45.96	45.788
MACl/ MAAc	0.404	2.487	99.596	50.462	50.452

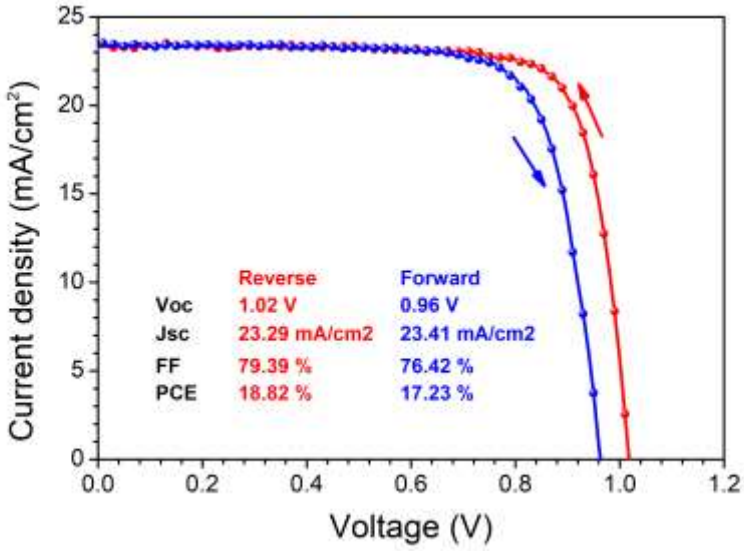

Fig. S9. J-V curves of the PSCs with a different scanning direction, using a 10 mV/s scanning rate. The structure of devices: FTO/TiO_2 /Perovskite/PCBM /Ag.

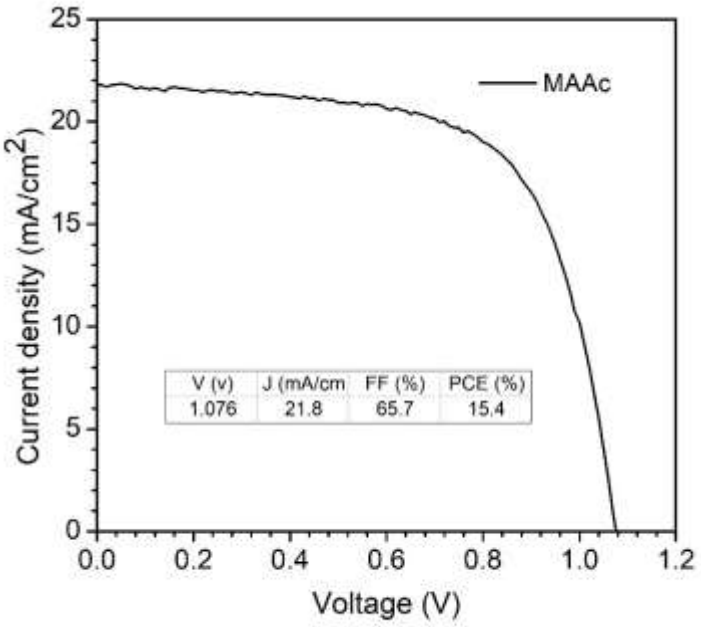

Fig. S10. J-V curve of PSC fabricated by using solely the MAAc additive. (Insert: parameters of PSC).