Supporting Information

Steering the crystallization of perovskites for high performance solar cells in ambient air

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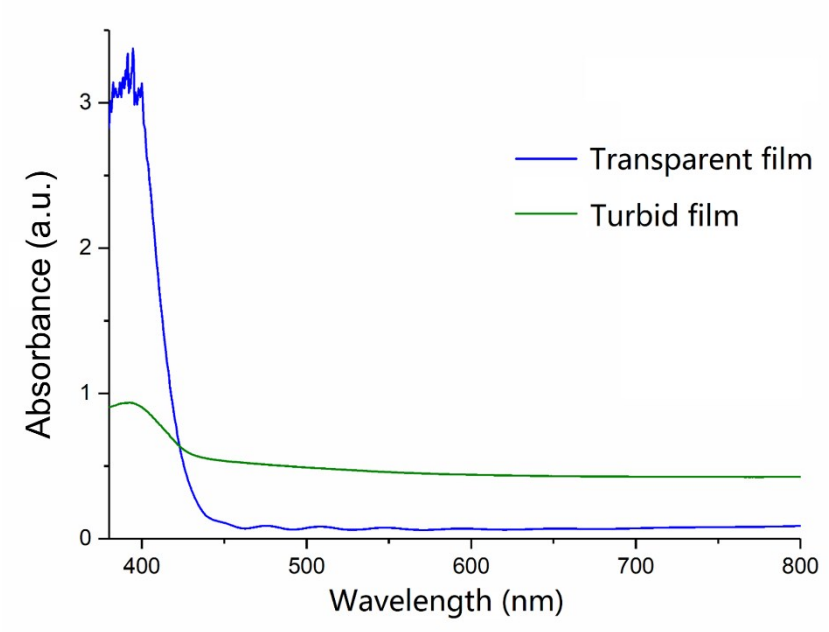
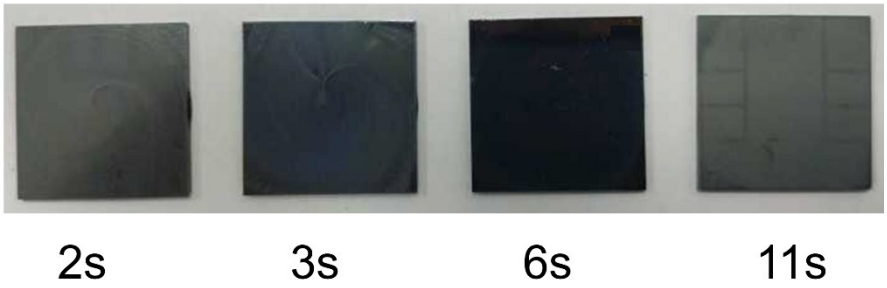
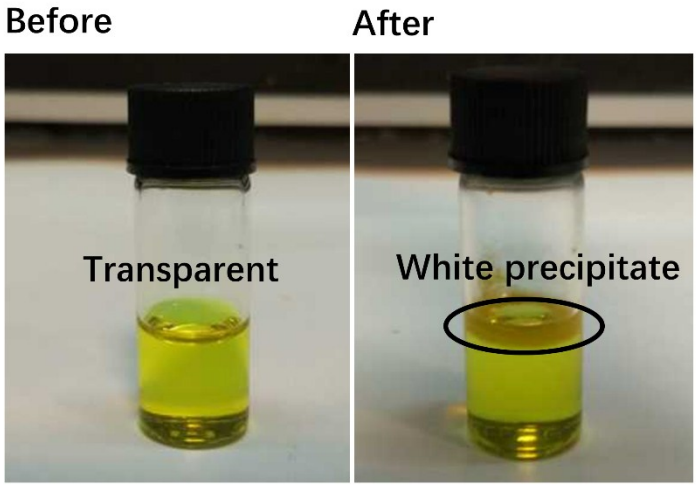


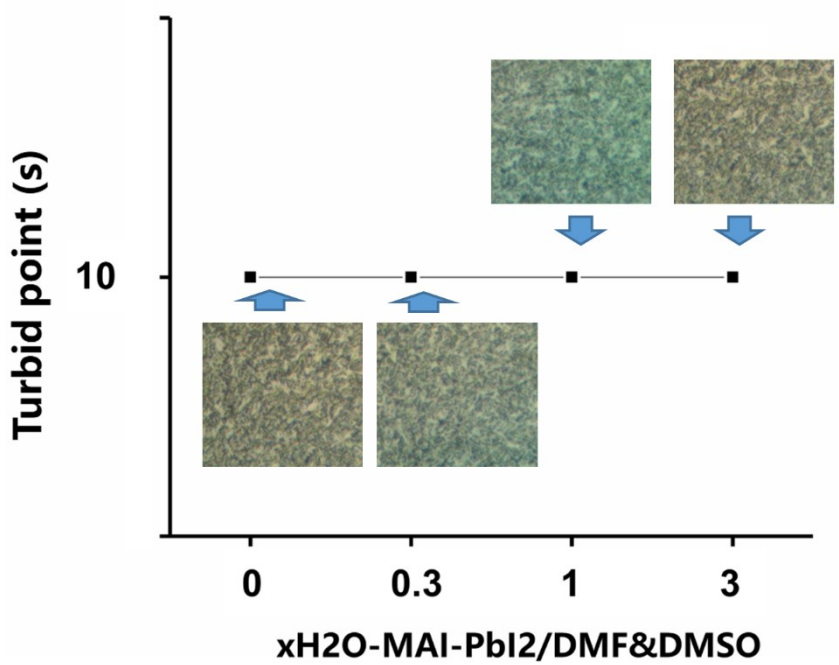
Supplementary Figure 1. UV-vis absorption characterization. UV-vis absorption spectra of transparent and turbid $MAPbI_3$ precursor films prepared in ambient air.



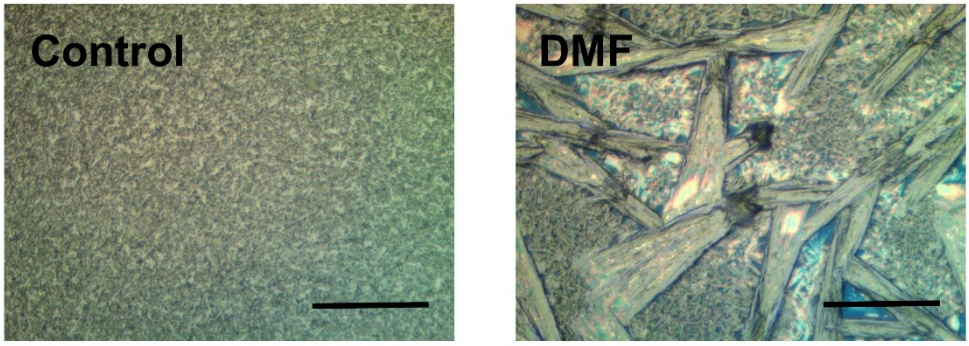
Supplementary Figure 2. Perovskite films photograghs. $MAPbI_3$ films prepared using antisolvent method inside the glovebox as antisolvent dropped at different time (2s, 3s, 6s and 11s) after spin-coating starts. Turbid point is at around 9s.



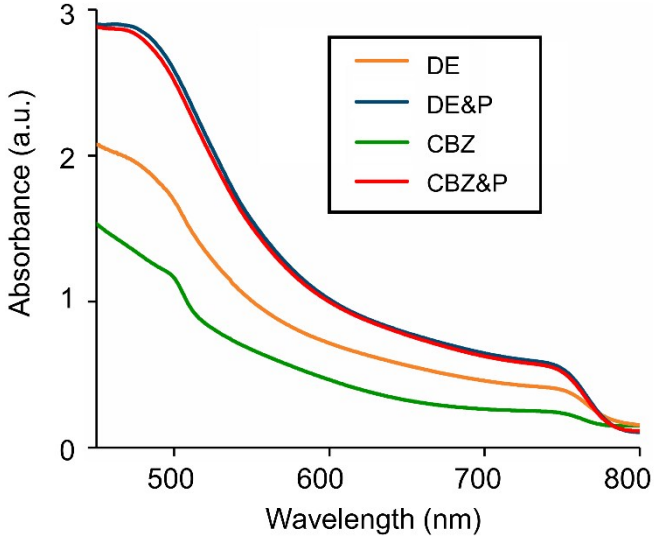
Supplementary Figure 3. Appearance change of perovskite precursor solutions. Appearance of perovskite solution (2 mL) before and after the addition of deionized water (~20 uL).



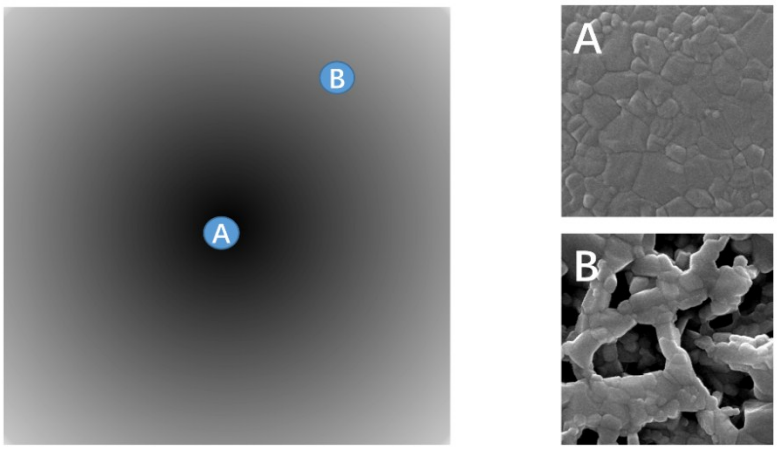
Supplementary Figure 4. The influence of addition H_2O on SCIC. Turbid poin and morphology of perovskite films prepared from precursor solutions (equal molar of MAI and PbI_2 in a mixed solvent of DMF and DMSO) with addition of xH_2O (x=0.3, 1 and 3, molar ratio to MAI).



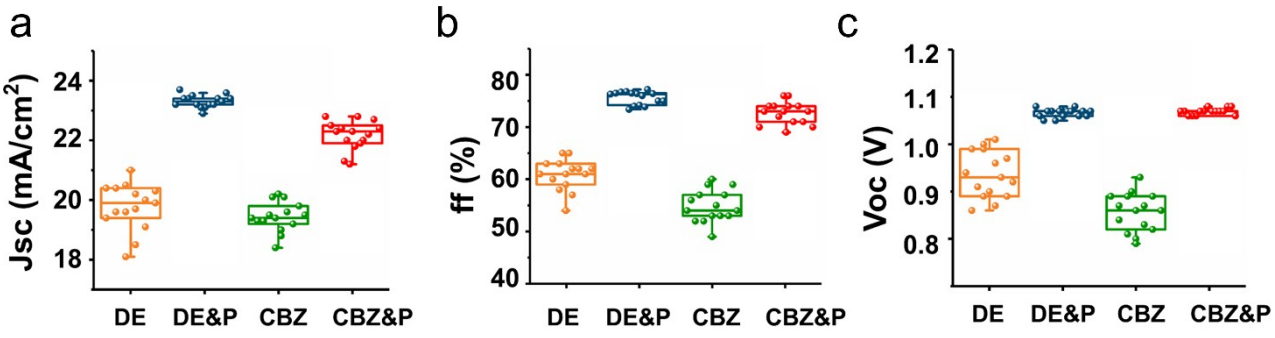
Supplementary Figure 5. The influence of DMF atmosphere on SCIC. Morphology of perovskite films obtained by spin-coating with or without (control) DMF atmosphere introduced to the spin-coater chamber.



Supplementary Figure 6. UV-vis absorption characterization. UV-vis absorption spectra of $MAPbI_3$ films prepared using antisolvent method with and without preheating. "P" denotes preheating.



Supplementary Figure 7. Perovskite films morphology. Appearance schematic and SEM images of $MAPbI_3$ films prepared by antisolvent method with preheating using CBZ as antisolvent under 90% RH humid atmosphere. It is shown that the middle area is pinhole free, while the morphology becomes mesoporous near the edge.



Supplementary Figure 8. Photovoltaic performance of solar cells. (**a**) J_{sc}, (**b**) FF, and (**c**) V_{oc} of PSCs with $MAPbI_3$ films prepared by antisolvent method with or without preheating using either DE (90% RH) or CBZ (70% RH) as the antisovlent.

Supplementary Table 1. Summary of cell parameters. Photovoltaic performance of PSCs fabricated at 0%, 50%, 70% RH atmosphere (~25 ℃) using antisolvent method with preheating (70 ℃). The antisolvent is DE or CBZ. For each case, the statistical data is obtained from 15 cells.

	RH (~25℃)	J_{sc} (mA cm^{-2})	V_{oc} (V)	FF	PCE (%)
DE	0%	22.4±0.8	1.06±0.02	0.72±0.02	17.3±0.7
	50%	22.6±0.5	1.07±0.03	0.72±0.03	17.8±0.5
	70%	22.8±0.5	1.07±0.03	0.74±0.02	18.4±0.6
CBZ	0%	21.4±0.8	1.06±0.02	0.72±0.02	16.3 ±0.5
	50%	21.5±0.7	1.06±0.02	0.73±0.03	16.8±0.4
	70%	21.4±0.6	1.07±0.02	0.74±0.02	17.0±0.6

Supplementary Table 2. Summary of cell parameters. Photovoltaic performance of PSCs fabricated at 90% RH atmosphere (~25 ℃) using antisolvent method with or without preheating (70 ℃). The antisolvent was DE or CBZ. For each case, the statistical data was obtained from 15 cells.

	Preheating	J_{sc} (mA cm^{-2})	V_{oc} (V)	FF	PCE (%)
DE	Without	19.8±1.6	0.93±0.08	0.60±0.08	11.2±0.7
	with	23.2±0.6	1.07±0.02	0.75±0.02	18.7±0.7
CBZ	Without	19.4±0.9	0.86±0.07	0.55±0.07	9.2 ±0.5
	with	22.1±1.0	1.07±0.02	0.72±0.03	17.1 ±0.5