Supporting Information

Low-pressure Accessible Gas-quenching for Absolute Methylammonium-free Perovskite Solar Cells

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Figures

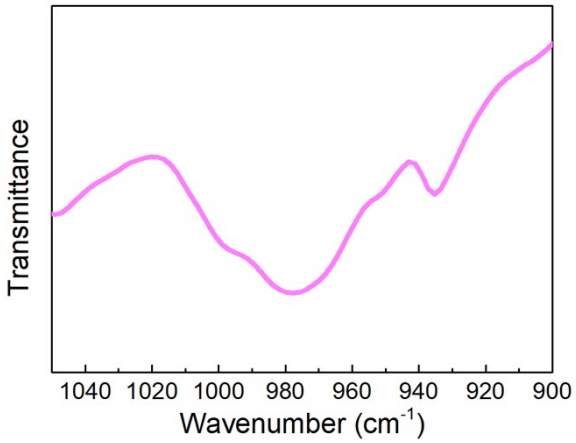


Fig. S1. The FTIR spectra of the 1 hour aged intermediate film with gas-quenching.

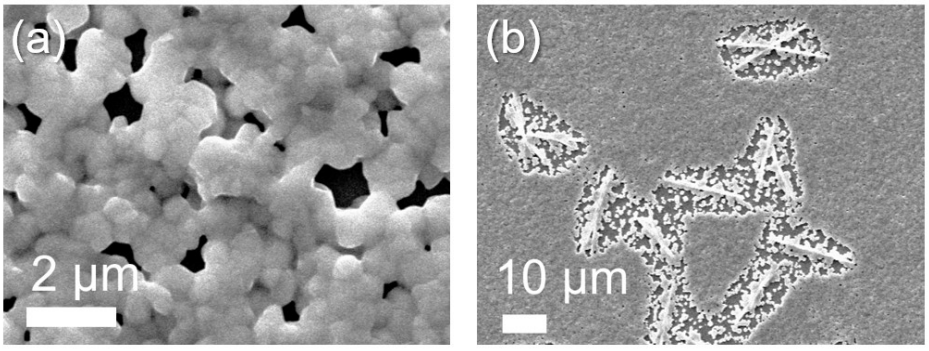


Fig. S2. (a) SEM topography of the $FA_{0.9}Cs_{0.1}PbI_3$ film prepared without gas-quenching. (b) SEM topography of gas-quenched the $FA_{0.9}Cs_{0.1}PbI_3$ film with annealing of 1 hour delayed.

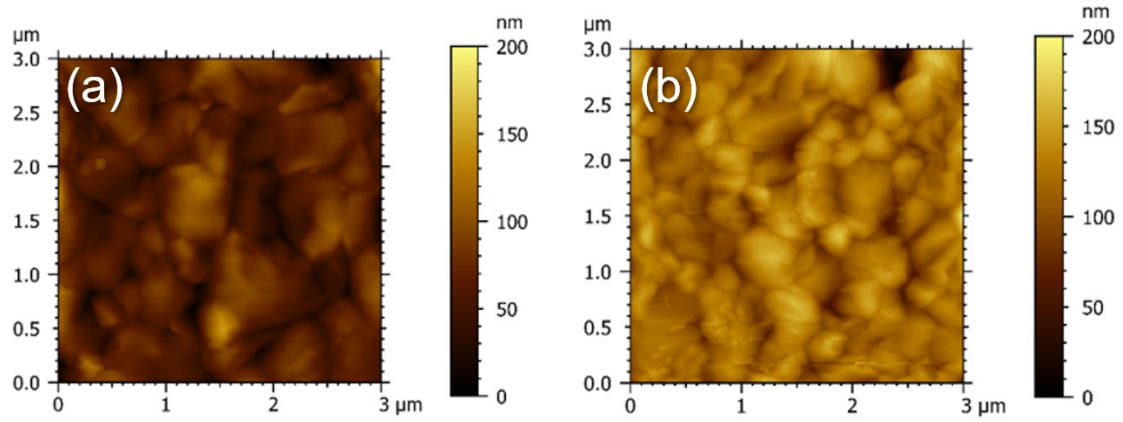


Fig. S3. AFM topography of gas-quenched the $FA_{0.9}Cs_{0.1}PbI_3$ film with (a) TMSO and (b) DMSO.

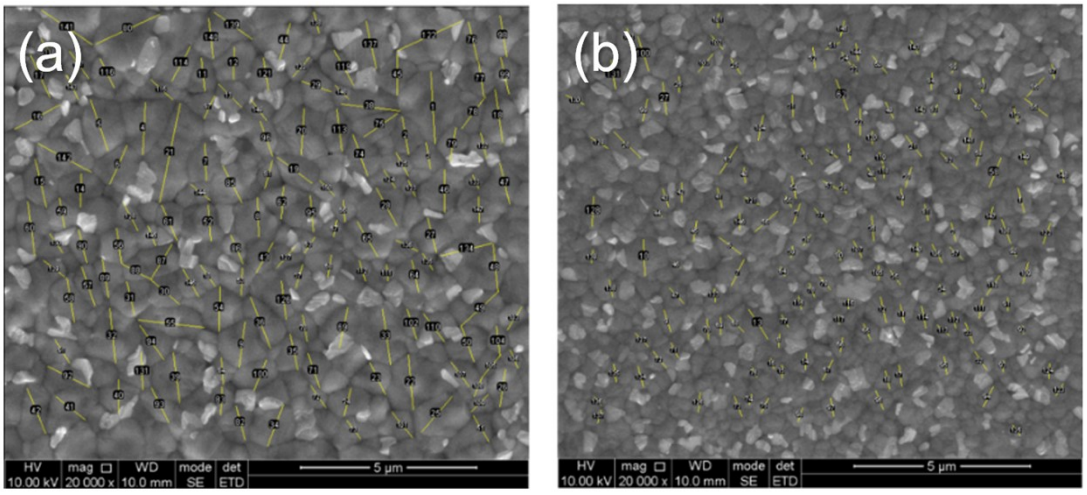


Fig. S4. SEM images for grain-size analysis of gas-quenched the $FA_{0.9}Cs_{0.1}PbI_3$ film with (a) TMSO and (b) DMSO.

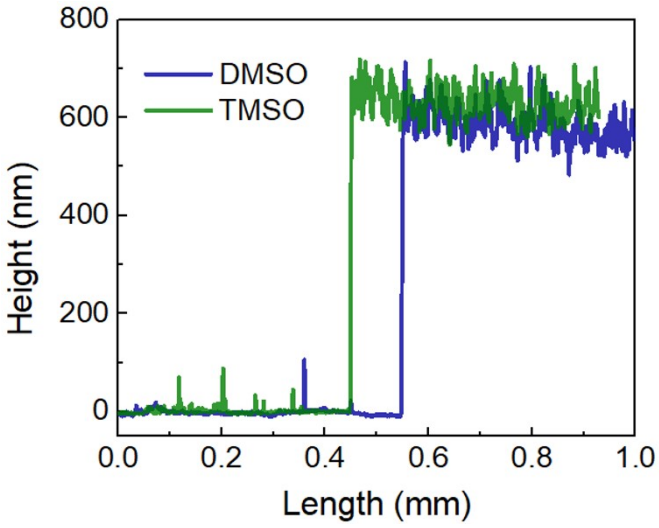
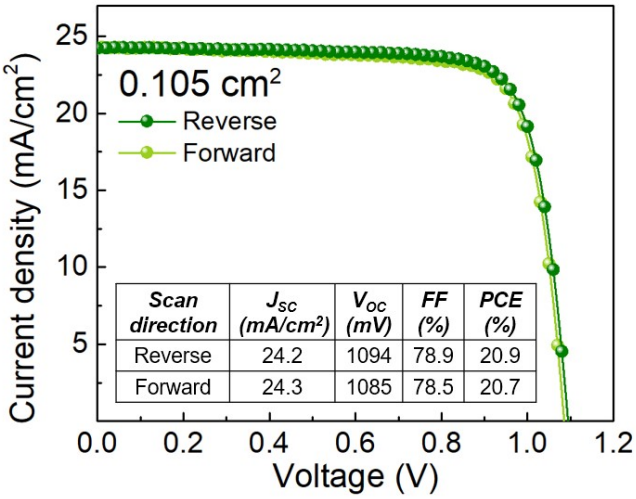


Fig. S5. Thickness profile of perovskite films prepared with DMSO and TMSO.



Scan direction	J_{sc} (mA/cm²)	V_{OC} (mV)	FF (%)	PCE (%)
Reverse	24.2	1094	78.9	20.9
Forward	24.3	1085	78.5	20.7

Fig. S6. Bidirectional J-V curves of the TMSO device with highest V_{OC}.

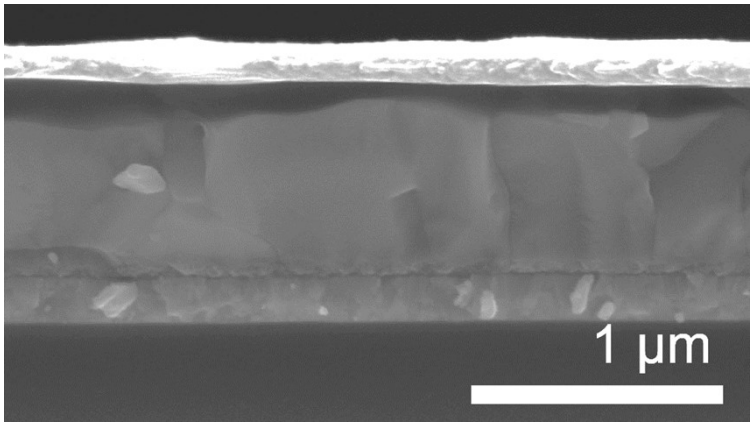


Fig. S7. Cross-sectional SEM image of ITO/SnO_2/$FA_{0.9}Cs_{0.1}PbI_3$/spiro-OMeTAD/Ag device

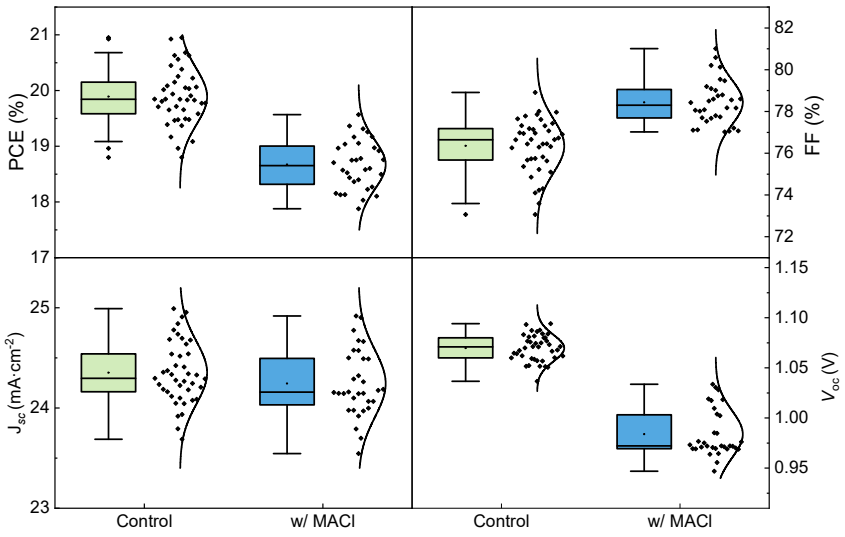


Fig. S8. Statistical photovoltaic parameters of PSCs prepared with and without MACl (0.2M added in precursor).

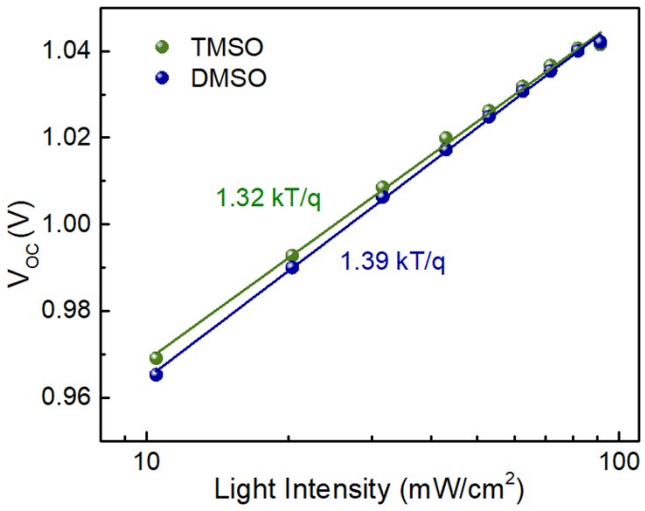


Fig. S9. V_{OC} versus light intensity curves for the PSCs process with TMSO and DMSO

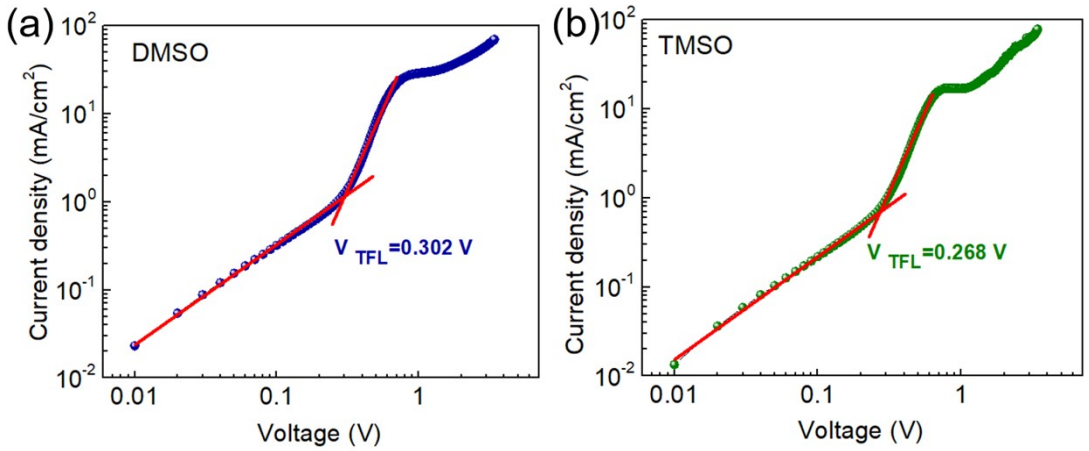


Fig. S10. J-V characteristics of the (a) DMSO sample and (b) TMSO sample from the SCLC measurements of the device structured with ITO/PEDOT:PSS/perovskite/spiro-OMeTAD/Ag (V_{TFL}, trap-filled limited voltage).

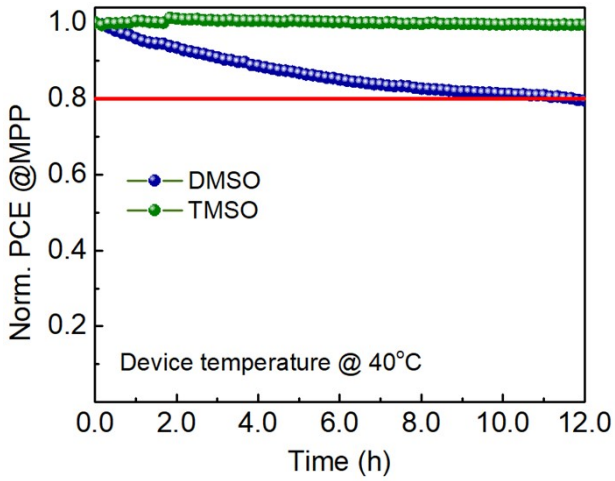


Fig. S11. MPP tracking (in N_2) of unencapsulated device prepared with TMSO and DMSO

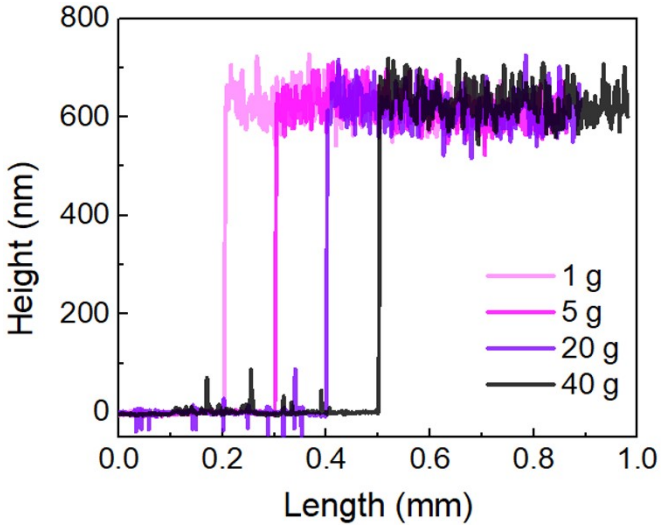


Fig. S12. Thickness profile of perovskite films prepared under different gas-pressure

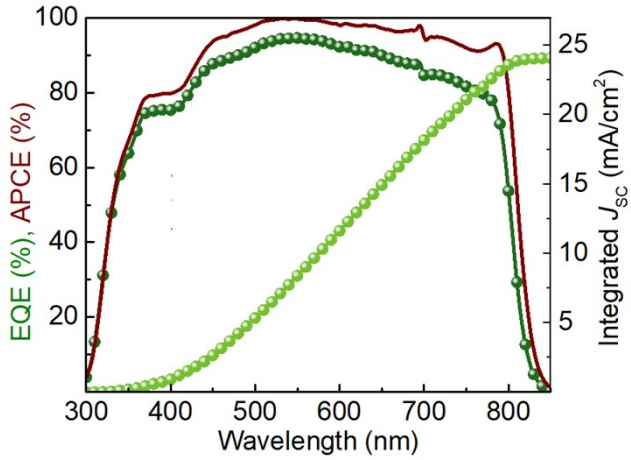


Fig. S13. EQE and APCE spectrum of the gas-quenched device fabricated with TMSO.

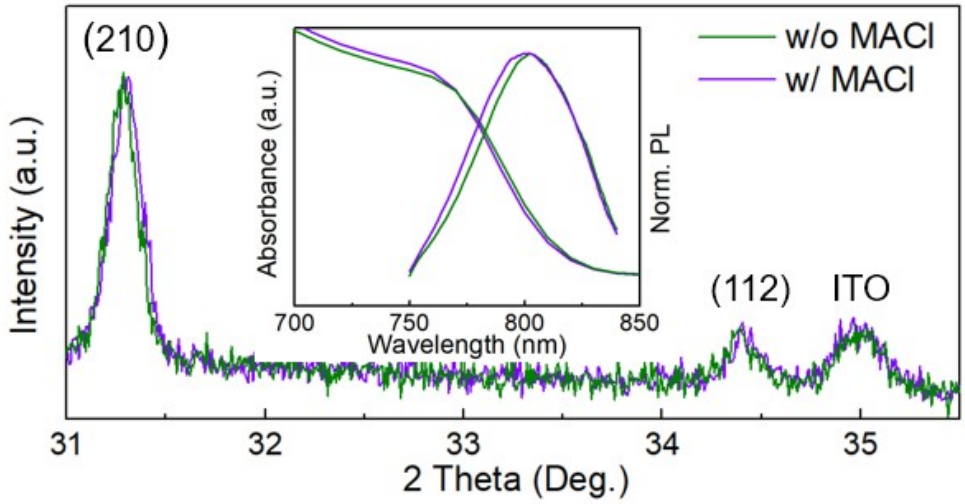


Fig. S14. XRD patterns of the $FA_{0.9}Cs_{0.1}PbI_3$ films with and without the additive of MACl; inset: Light absorption spectra and steady-state PL spectra of the samples.

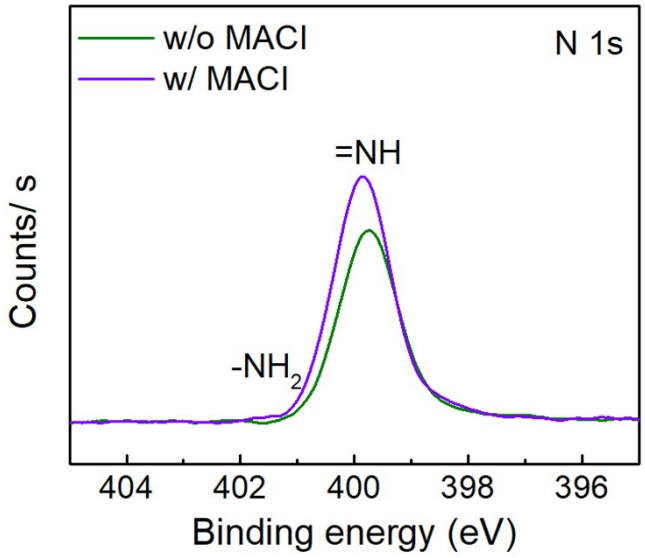


Fig. S15. N 1s XPS spectra of the $FA_{0.9}Cs_{0.1}PbI_3$ films with and without the additive of MACl

Tables

Table S1 Full width at half maxima (FWHM) of the XRD peaks in Fig. 3a

Peaks	DMSO-sample	TMSO-sample
(001)	0.243	0.152
(111)	0.339	0.289
(002)	0.302	0.175
(012)	0.358	0.214