

Supporting information

Thin Film (< 200 nm) Perovskite Solar Cell with 18% Efficiency

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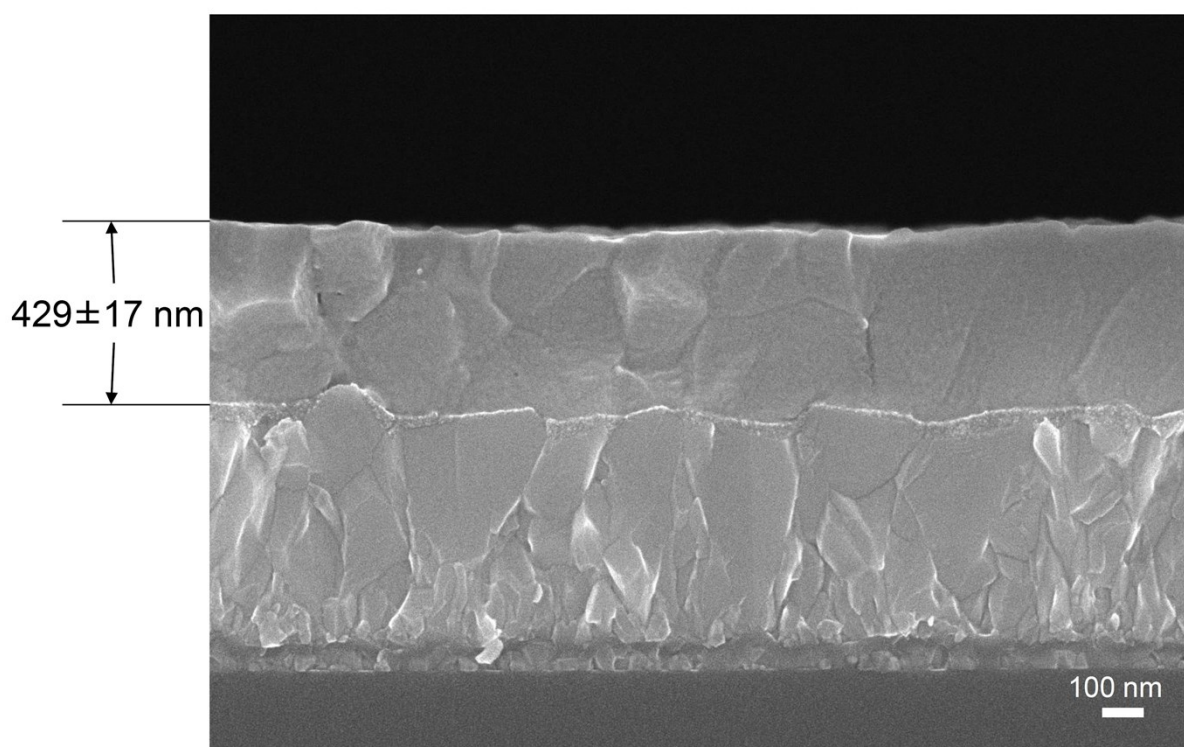


Figure S1. Cross-sectional SEM images of a pre-annealed MAPbI₃ film used for stamping.

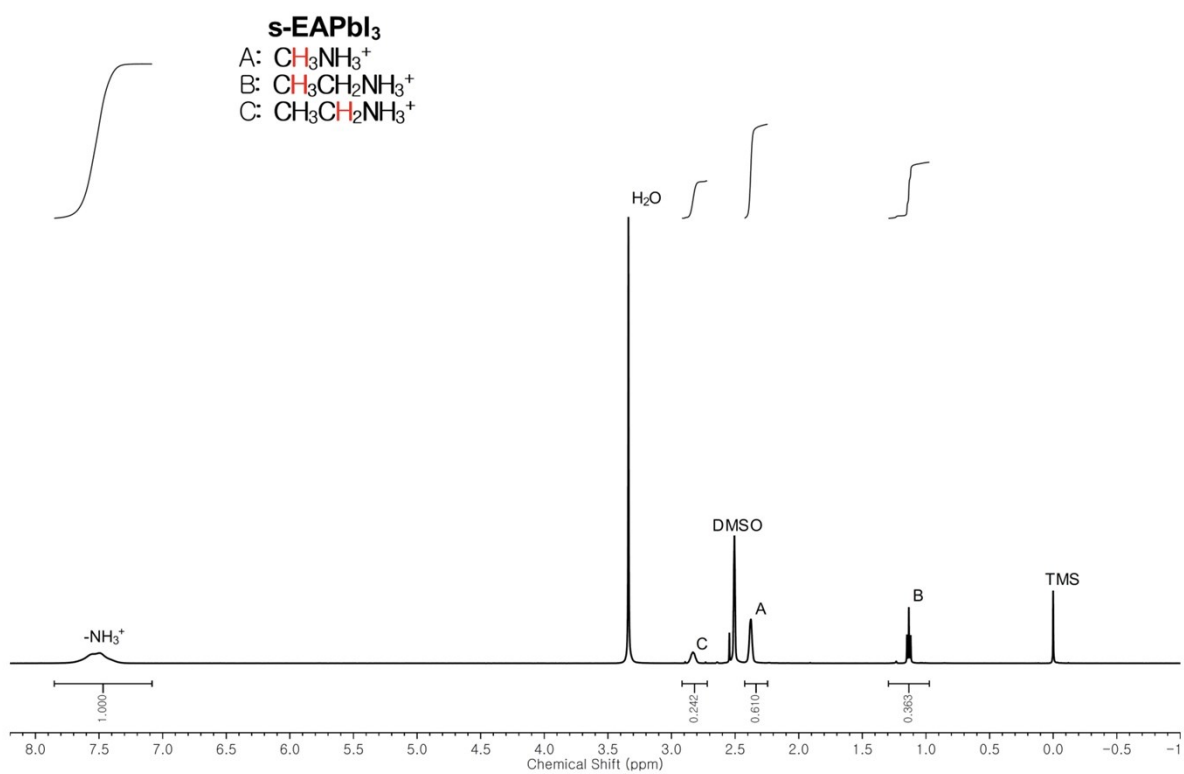


Figure S2. ¹H NMR for the stamped EAPbI₃ (s-EAPbI₃) film.

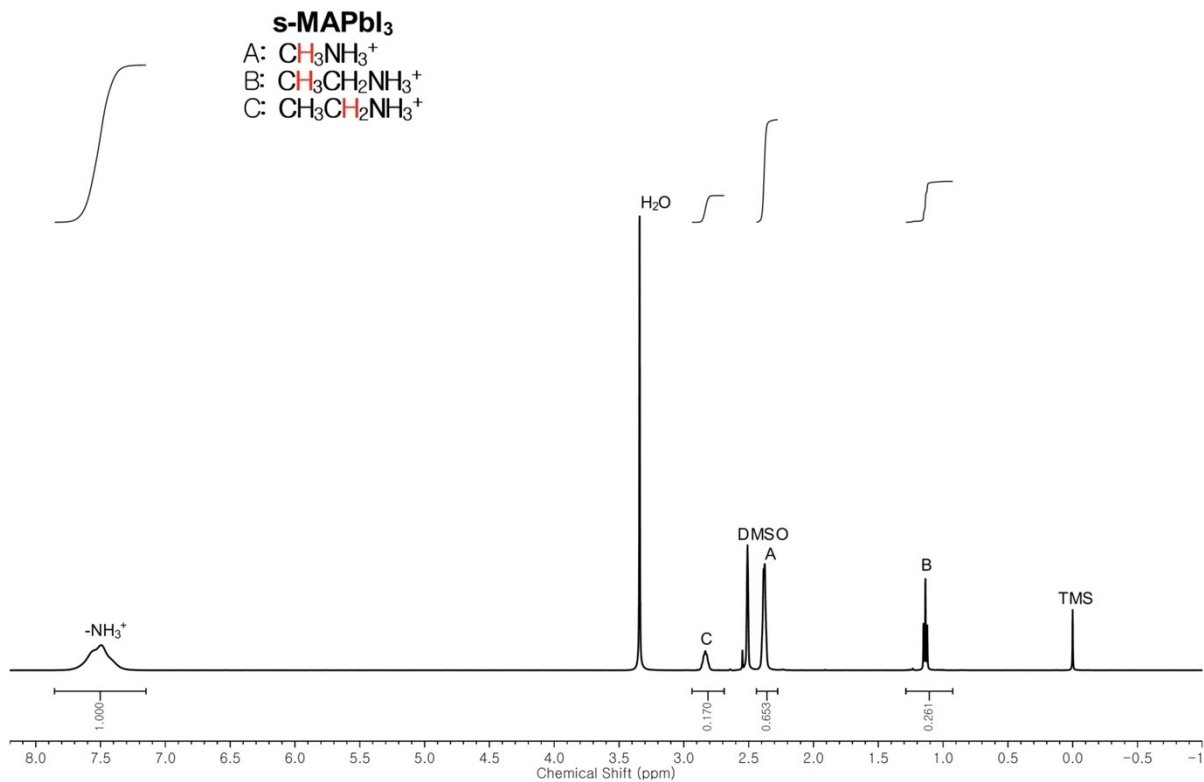


Figure S3. ¹H NMR for the stamped MAPbI₃ (s-MAPbI₃) film.

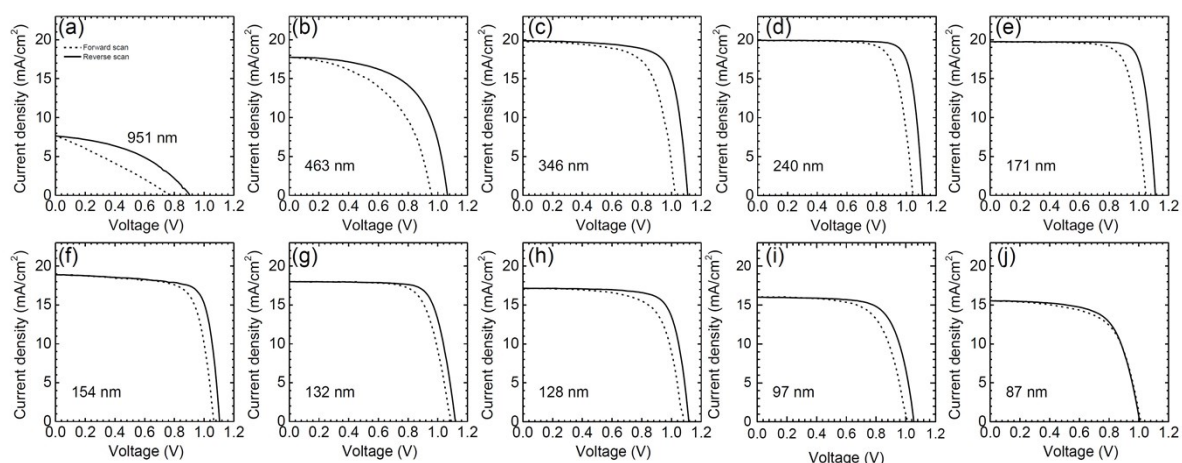


Figure S4. (a)-(j) J-V curves of PSCs employing the s-EAPbI₃ films with different thickness. The device structure was glass/FTO/SnO₂/s-EAPbI₃/spiro-MeOTAD/Au. The curves were measured under the simulated one sun illumination at scan rate of 130 mV/s. The solid line and dashed line represent J-V curves measured by reverse scan (RS) and forward scan (FS), respectively.

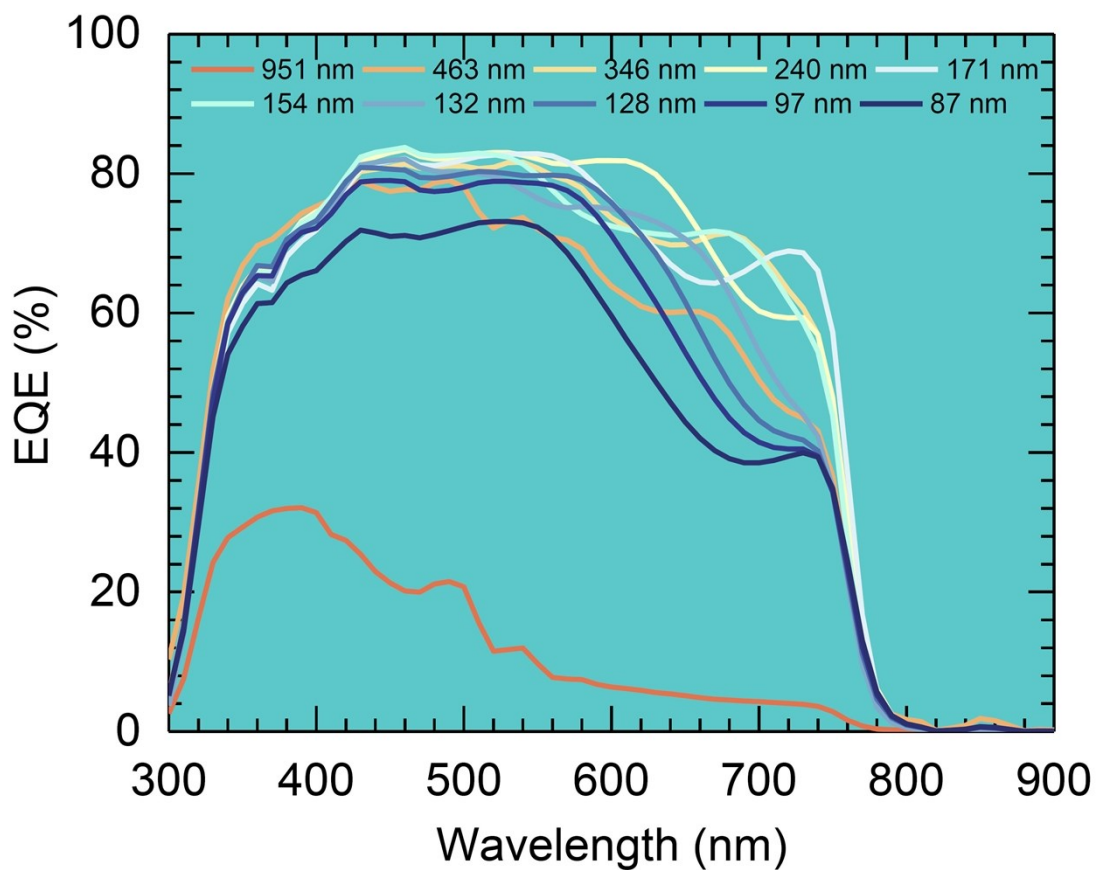


Figure S5. External quantum efficiency (EQE) as a function of wavelength for the PSCs employing s-EAPbI₃ with different thickness.

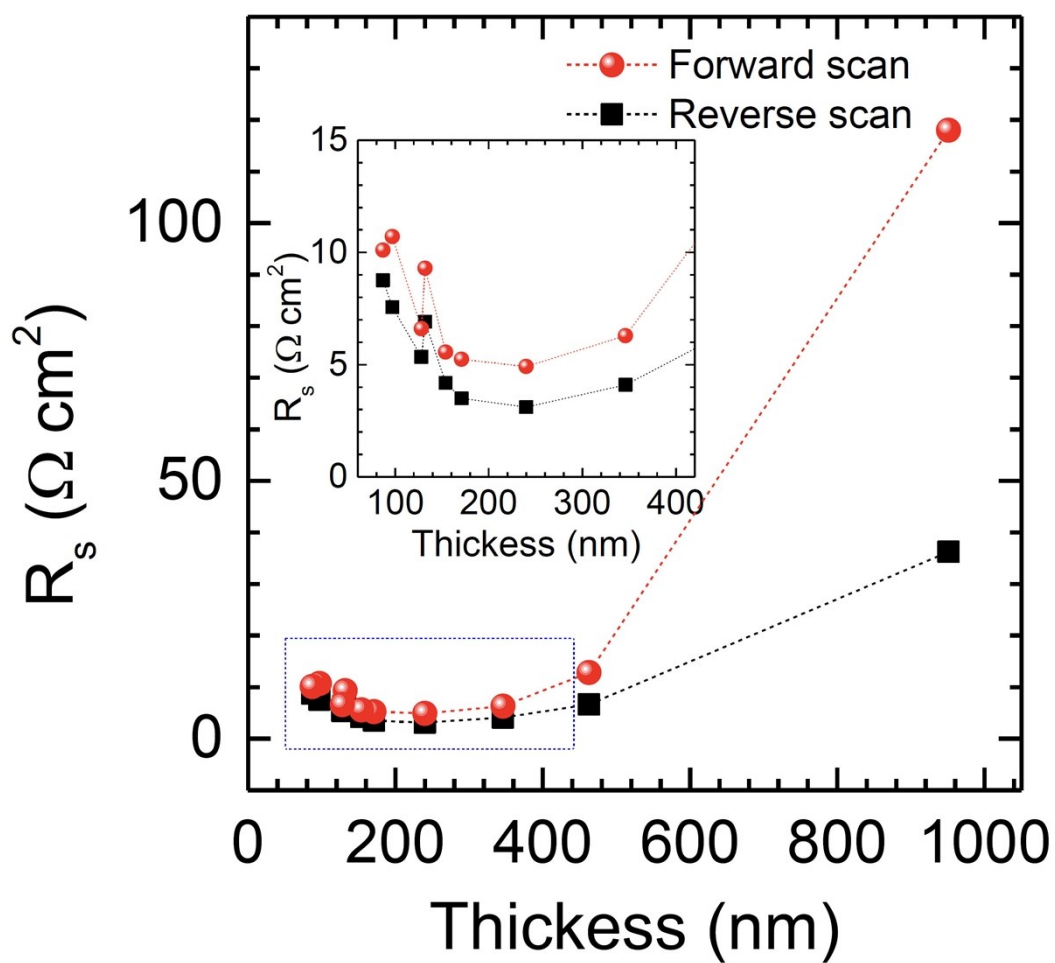


Figure S6. Series resistance (R_s) of PSCs employing the $s\text{-EAPbI}_3$ films with different thickness. Insert is the enlarged R_s for the 50 nm - 400 nm thickness. R_s was estimated from the champion J-V curves shown in Figure S4 by calculating the slope at V_{oc} .

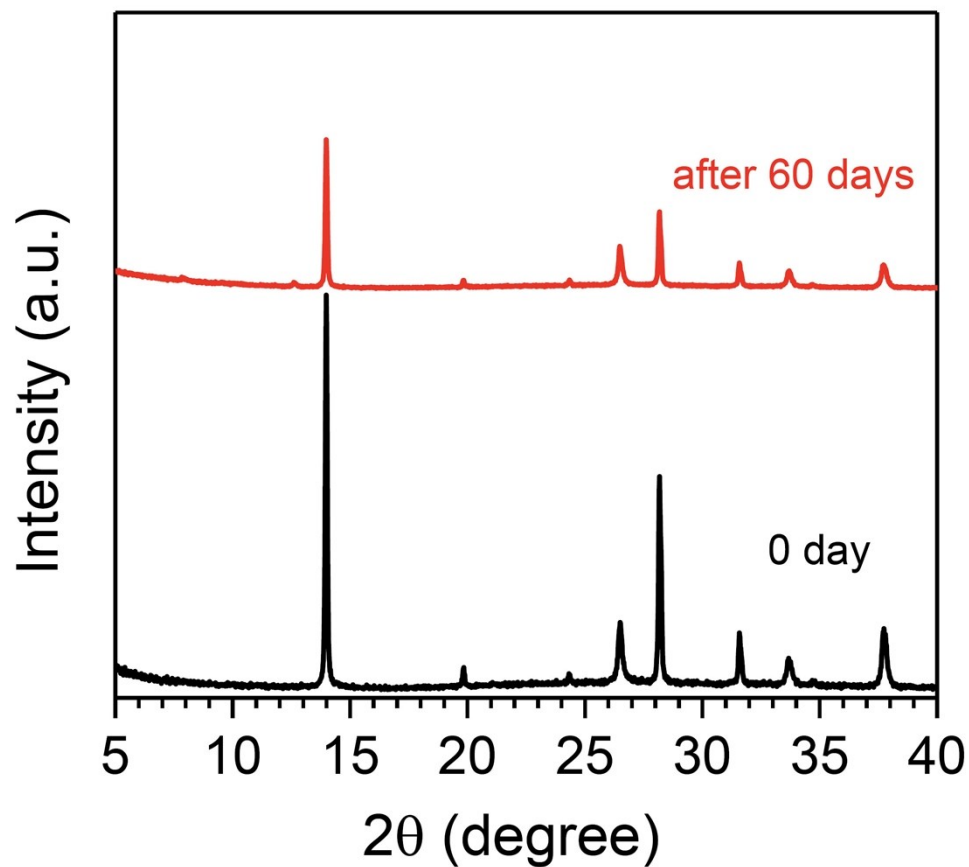


Figure S7. XRD of the 171 nm-thick s-EAPbI₃ film without (0 day) and with 60-day aging. The film was stored in the ambient temperature with the relative humidity of 20%-30%.

Table S1. Photovoltaic parameter of champion PSCs employing the s-EAPbI₃ films with different thickness. The device structure was glass/FTO/SnO₂/s-EAPbI₃/spiro-MeOTAD/Au. J-V curves were measure at reverse scan and forward scan at scan rate of 130 mV/s under simulated one sun illumination.

Thickness	direction	J _{sc} (mA/cm ²)	V _{oc} (V)	FF	PCE (%)	R _s (Ω cm ²)
951 nm	Reverse	7.639	0.903	0.426	2.94	36.25
	Forward	7.675	0.801	0.268	1.65	118
463 nm	Reverse	17.75	1.07	0.599	11.4	6.65
	Forward	17.77	0.963	0.501	8.57	12.8
346 nm	Reverse	19.87	1.11	0.746	16.5	4.10
	Forward	19.78	1.03	0.683	13.9	6.29
240 nm	Reverse	19.91	1.11	0.817	18.1	3.11
	Forward	19.91	1.04	0.761	15.8	4.92
171 nm	Reverse	19.75	1.11	0.821	18.0	3.50
	Forward	19.72	1.05	0.762	15.8	5.24
154 nm	Reverse	18.88	1.10	0.768	15.9	4.19
	Forward	18.88	1.07	0.731	14.8	5.56
132 nm	Reverse	18.00	1.12	0.758	15.3	6.91
	Forward	18.00	1.09	0.717	14.1	9.29
128 nm	Reverse	17.16	1.12	0.760	14.6	5.35
	Forward	17.14	1.08	0.688	12.7	6.60
97 nm	Reverse	16.05	1.05	0.709	11.9	7.56
	Forward	16.01	1.01	0.657	10.6	10.7
87 nm	Reverse	15.54	1.01	0.658	10.3	8.76
	Forward	15.54	1.01	0.632	9.92	10.1