<u>Supporting information</u>

Eco-friendly Antisolvent Enabled Inverted $MAPbI_3$ Perovskite Solar Cells with Fill Factors over 84%

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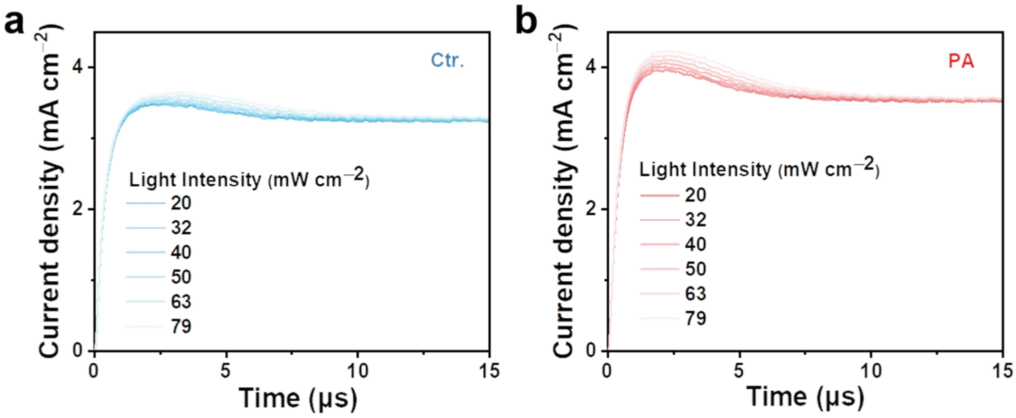

Fig. S1. Photo-CELIV transients recorded at various light intensity for the control (a) and PA-treated single carrier devices.

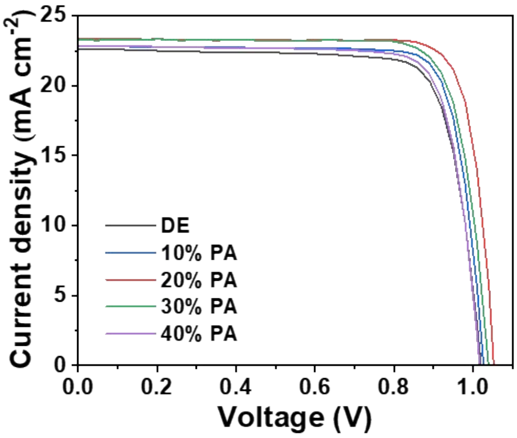

Fig. S2. *J-V* curve of the devices with different antisolvents (DE: PA = 1:0, 1:0.1, 1:0.2, 1:0.3 and 1:0.4, respectively).

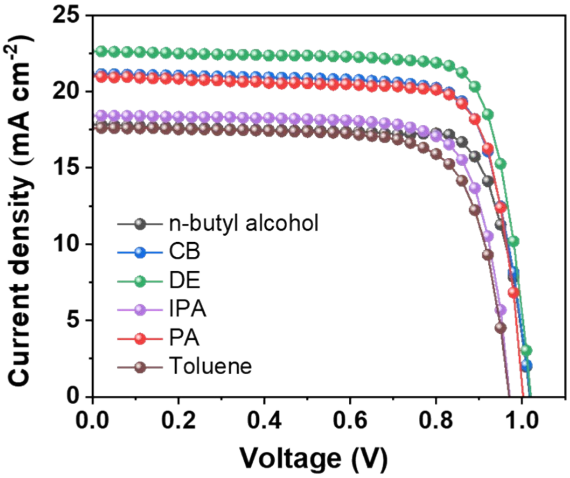

Fig. S3. *J-V* curves of PSCs with different antisolvents.

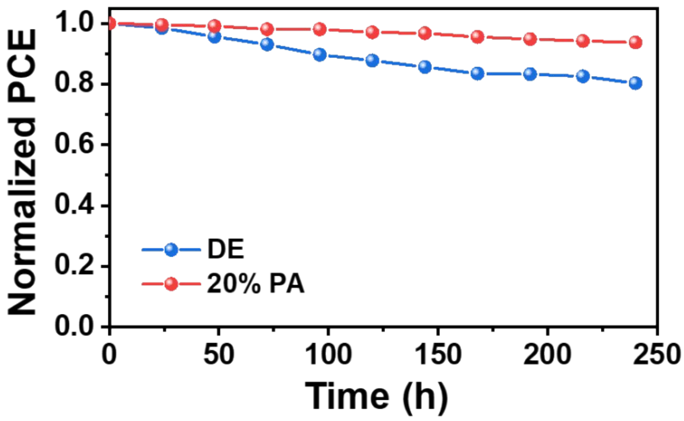

Fig. S4. Stability tests of unencapsulated devices with DE and 20% PA-treated PSCs (stored in ambient condition at 25℃, 30% relatively humidity).

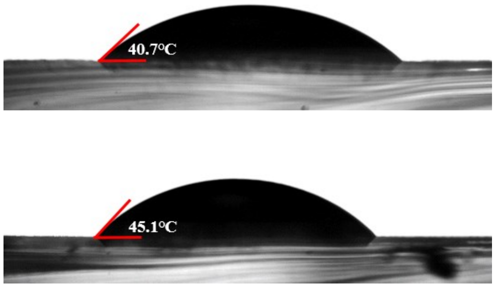

Fig. S5. Contact angles of DE and 20% PA-treated perovskite films.

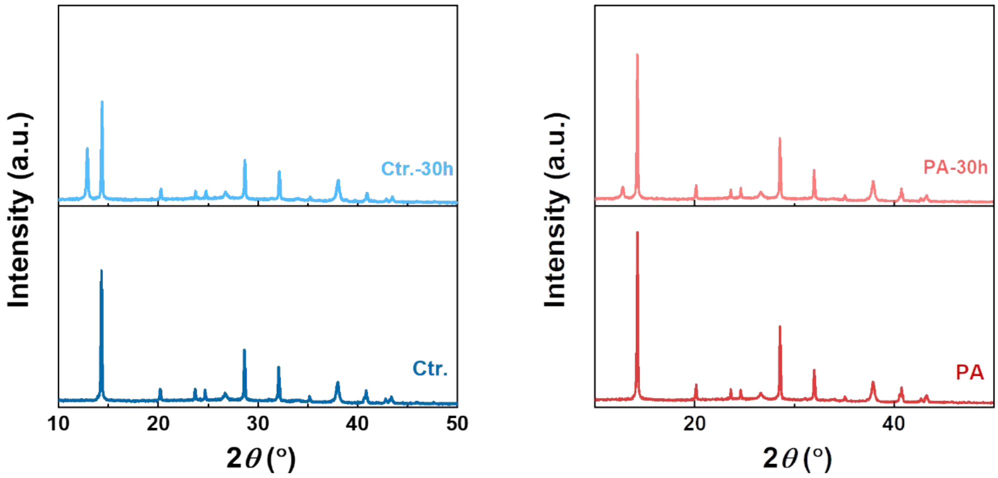

Fig. S6. XRD stability tests of unencapsulated devices with DE and PA-treated PSCs (stored at 50-60% relative humidity and 100 ℃).

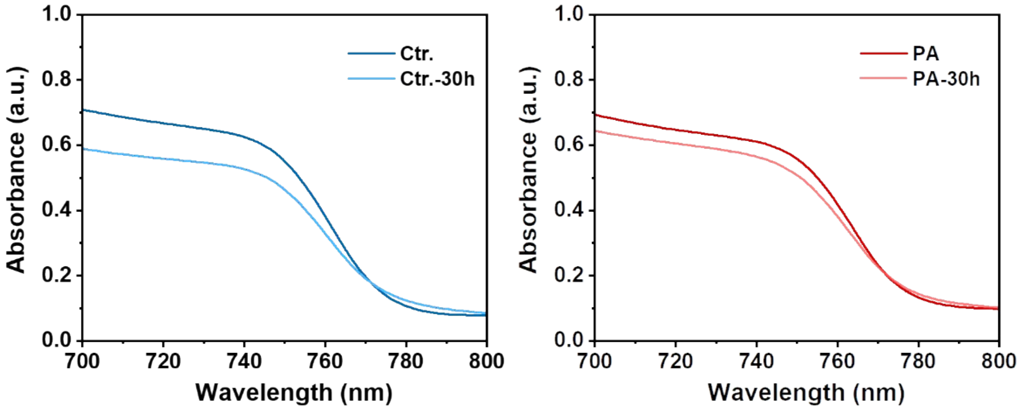

Fig. S7. UV stability tests of unencapsulated devices with DE and PA-treated PSCs (stored at 50-60% relative humidity and 100 ℃).

Table S1. The environmental and healthy impact of different antisolvents[1]. (The higher the score, the greener it is.)

Antisolvent	Environmental impact	Healthy impact
DE	5	5
PA	7	8
TOL	3	4
Anisole	6	7
EA	8	8
isopropyl acetate	7	7
IPA	9	8
PE	2	2

Table S2. The detailed parameters of photo-CELIV current transients for devices with different antisolvents.

Antisolvent	A (100 V ms^{-1})	t_{max} (μs)	Δj (mA cm^{-2})	j_0 (mA cm^{-2})	d (nm)
Ctr.	100	2.703	2.541	1.046	420
PA	100	2.186	3.276	1.049	420

Table S3. Photovoltaic parameters for the champion PSCs with different antisolvents ratios.

Antisolvent	Voc (V)	Jsc (mA cm^{-2})	FF (%)	PCE (%)
Ctr.	1.02	22.64	79.13	18.28
10% PA	1.03	22.86	81.89	19.23
20% PA	1.05	23.20	84.49	20.61
30% PA	1.04	23.30	81.37	19.63
40% PA	1.02	22.88	80.19	18.65

Table S4. The detailed performance data of PSCs with different antisolvents.

Antisolvent	V_{oc} (V)	J_{sc} (mA cm^{-2})	FF (%)	PCE (%)
CB	1.02	21.17	77.25	16.65
DE	1.02	22.64	79.13	18.28
IPA	0.97	18.42	76.75	13.75
PA	1.00	21.06	78.26	16.52
Toluene	0.97	17.62	74.49	12.73
n-butyl alcohol	1.02	17.85	78.82	14.35

Table S5. Representative inverted $MAPbI_3$ PSCs with high fill factors.

Method	Antisolvent	V_{oc} (V)	J_{sc} (mA cm^{-2})	FF (%)	PCE (%)	Refs
Antisovent	EA	1.08	22.00	79.90	18.98	2
Single crystal	-	1.14	21.93	81.00	21.93	3
Antisovent	Toluene	1.13	22.19	81.29	20.46	4
Antisovent	CB	1.10	23.38	81.87	21.11	5
Thin monocrystal	-	1.08	22.60	82.50	20.10	6
Antisovent	CB	1.13	23.10	83.81	21.88	7
Blade coating	-	1.10	22.60	86.30	21.50	8
Antisovent	PA	1.05	23.20	84.49	20.61	This work

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