

Supplementary Information

**Two-dimension additive diethylammonium iodide promoting crystal growth for  
efficient and stable perovskite solar cells**

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Figure S1. Top view of SEM images of perovskite films (a) with 10% PEAI content, (b) with 10% BAI content. This figure shows that the films doped with PEAI or BAI present small grains less than 100 nm, and even smaller than the MAPbI<sub>3</sub> film. The results indicate PEAI or DAI could not induce the crystal grain growth of 3D film.

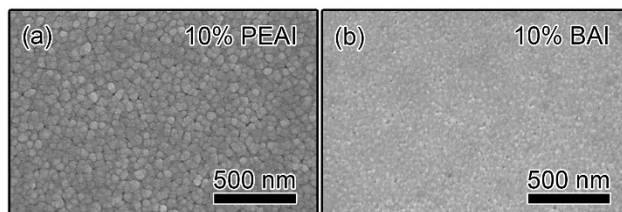


Figure S2. XRD patterns of the perovskite films without and with 7%, 10% and 15% DA contents. The inset is the XRD pattern of DA<sub>2</sub>PbI<sub>4</sub>. Compared with the XRD patterns of 2D perovskite DA<sub>2</sub>PbI<sub>4</sub> films, the peaks around 7.5° in the XRD patterns of DA mixed films mainly belong to DA<sub>2</sub>PbI<sub>4</sub>.

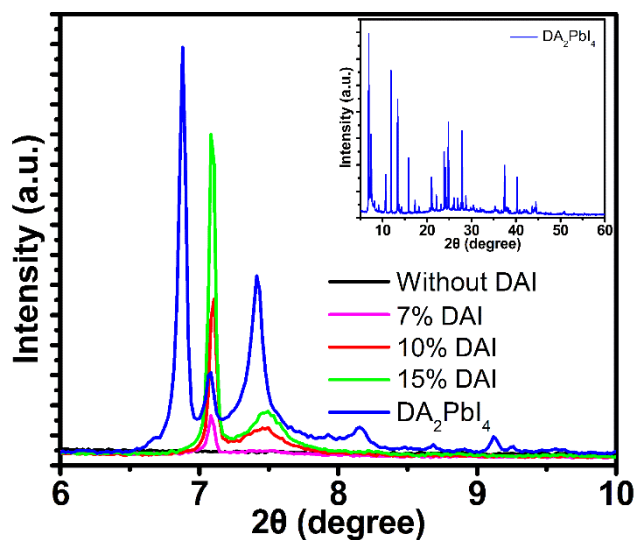


Figure S3. *J-V* characteristics of the perovskite devices without and with 7%, 10% and 15% DAI contents. The measurements were conducted during reverse scanning under one sun illumination at 100 mW cm<sup>-2</sup>. The devices based on the perovskite film with 10% DAI content exhibits the best performance.

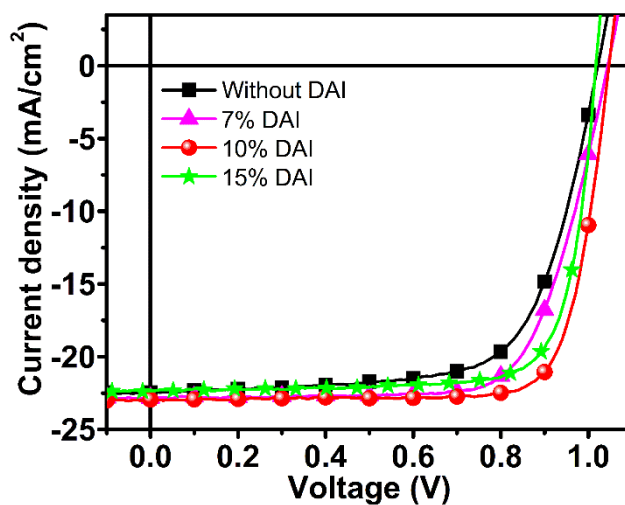


Table S1. Performance parameters obtained from the *J-V* characteristics of the perovskite devices without and with 7%, 10% and 15% DAI contents.

DA content (%)	$J_{sc}$ (mAcm <sup>-2</sup> )	$V_{oc}$ (V)	FF (%)	PCE (%)
0	22.47	1.02	68.60	15.73
7	22.83	1.04	72.09	17.12
10	22.95	1.05	79.04	19.05
15	22.33	1.02	77.91	17.72

Figure S4. The performance of best devices without and with 10% DAI content films under reverse scan (1.2V--0.2 V) and forward scan (-0.2V-1.2 V). The hysteresis of the  $(\text{DA}_2\text{PbI}_4)_{0.05}\text{MAPbI}_3$  perovskite solar cell is slightly reduced.

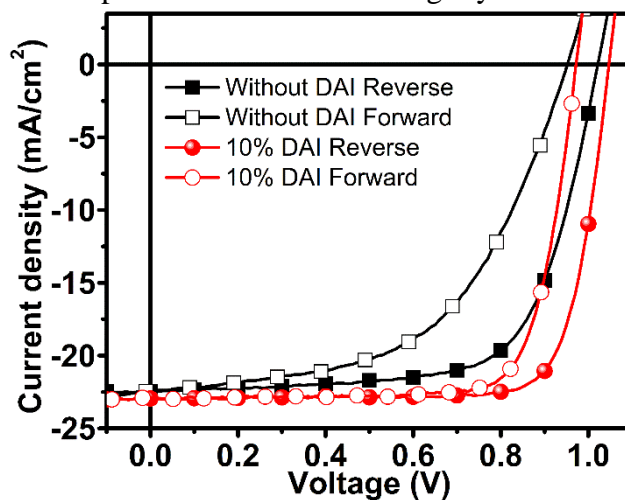


Table S2. Performance parameters of the device without and with 10% DA contents under reverse scan (1.2V-0.2 V) and forward scan (-0.2V-1.2 V).

DA content	Scan direction	$J_{sc}$ (mA cm <sup>-2</sup> )	$V_{oc}$ (V)	FF (%)	PCE (%)
Without	Reverse	22.47	1.02	68.60	15.73
	Forward	22.44	0.95	54.56	11.63
10% DAI	Reverse	22.95	1.05	79.04	19.05
	Forward	22.92	0.97	77.73	17.26

Figure S5. The long-term stability of normalized PCE of the fabricated devices without and with 10% DA content. The PCE of the  $(\text{DA}_2\text{PbI}_4)_{0.05}\text{MAPbI}_3$  device shows better stability than the  $\text{MAPbI}_3$  device.

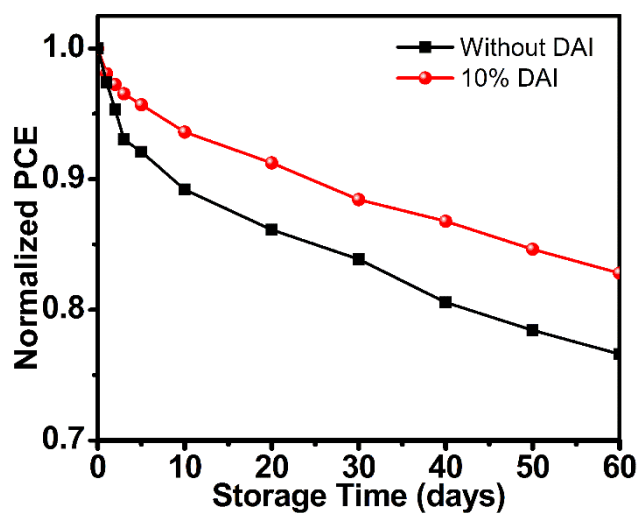


Table S3. Fitted parameters of the TRPL curves of ITO/perovskite films.

DA content	B <sub>1</sub> (%)	τ <sub>1</sub> (ns)	B <sub>2</sub> (%)	τ <sub>2</sub> (ns)	τ <sub>average</sub> (ns)
Without	41.76	8.59	58.24	66.24	61.34
7%	51.90	38.02	48.10	88.66	72.65
10%	42.40	34.59	57.60	103.04	89.48
15%	47.76	4.88	52.24	39.16	35.65