Supporting Information

Enhanced Efficiency of Planar-Heterojunction Perovskite Solar Cells through a Thermal Gradient Annealing Process

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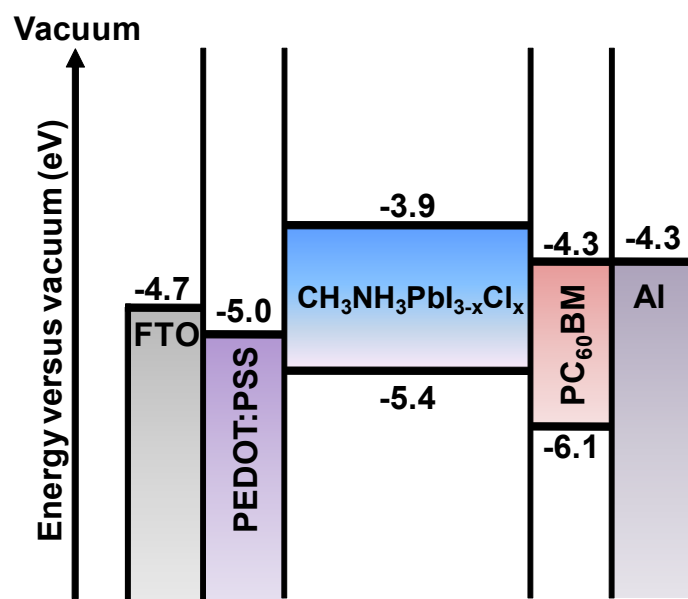
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Figure S1. Schematic energy level diagram of the components in the perovskite solar cells.[1-2]
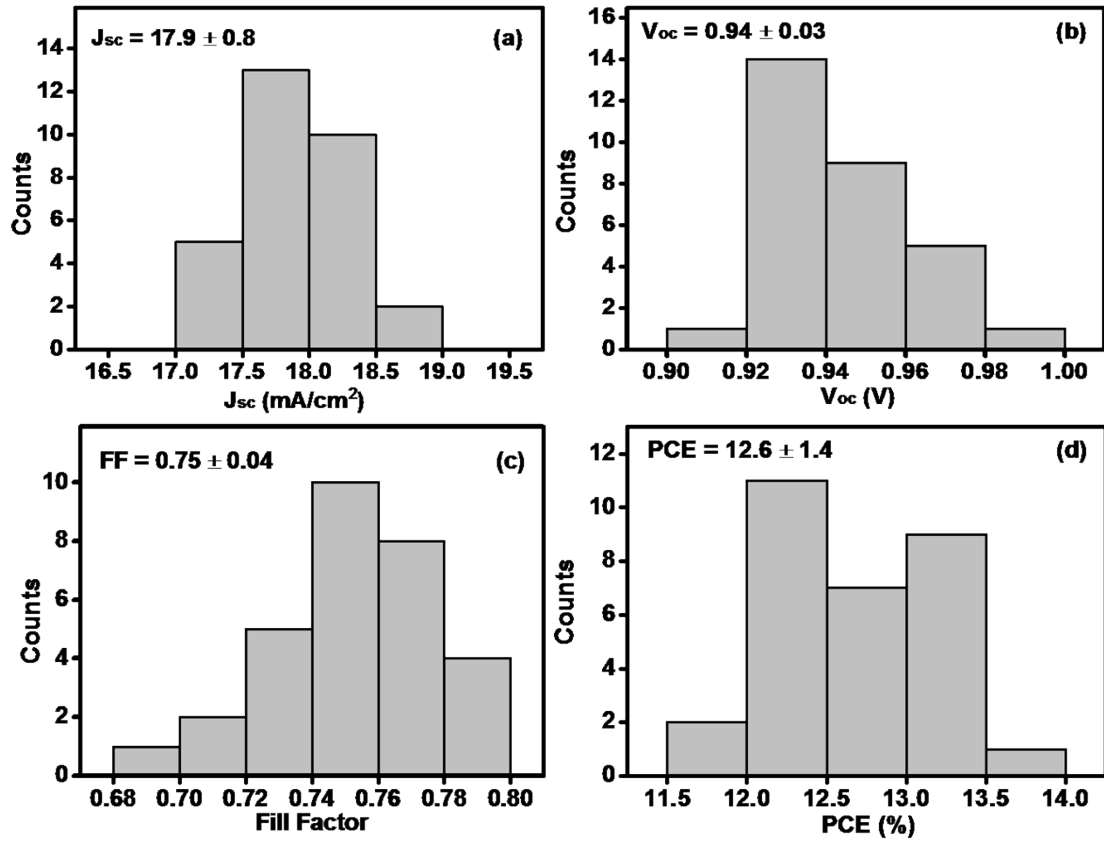
Figure S2. Device parameter (J_{sc}, V_{oc}, FF and PCE) distribution of perovskite solar cells with the gradient annealing process. 30 cells were tested and the average PCE is 12.6%.
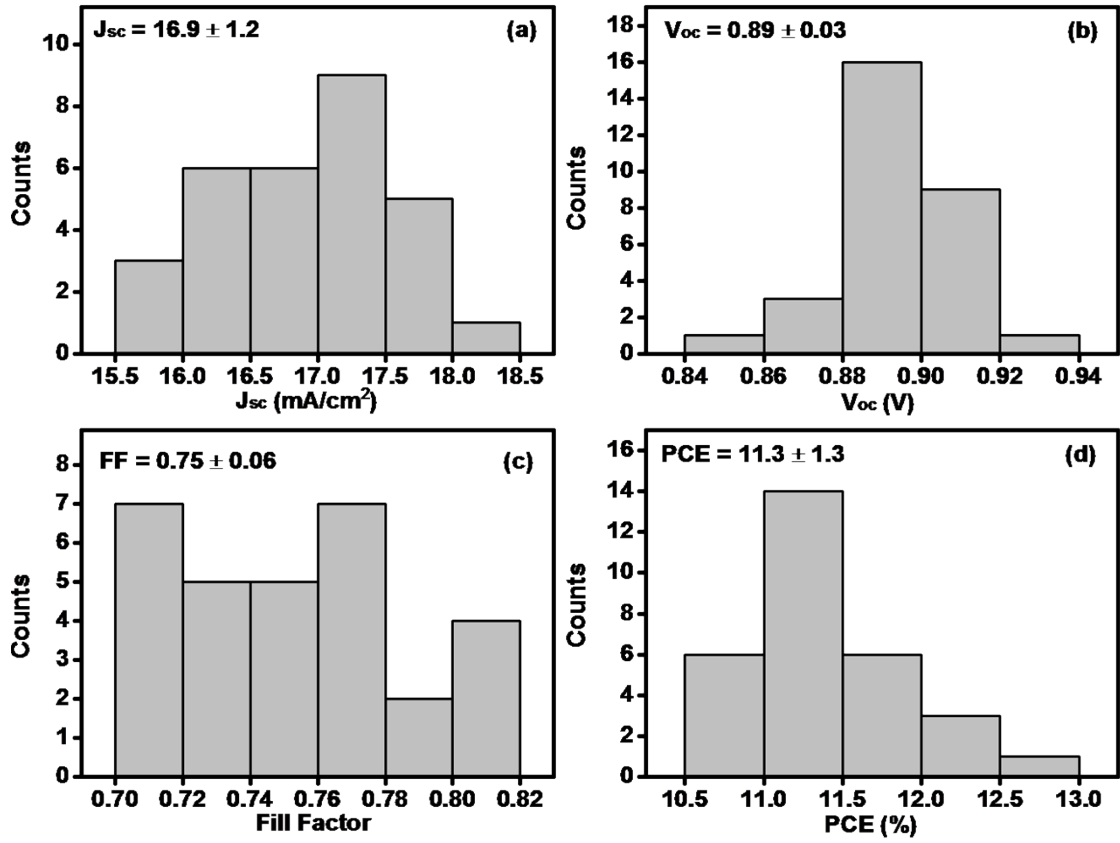
Figure S3. Device parameter (J_{sc}, V_{oc}, FF and PCE) distribution of perovskite solar cells with the direct annealing process. 30 cells were tested and the average PCE is 11.3%.
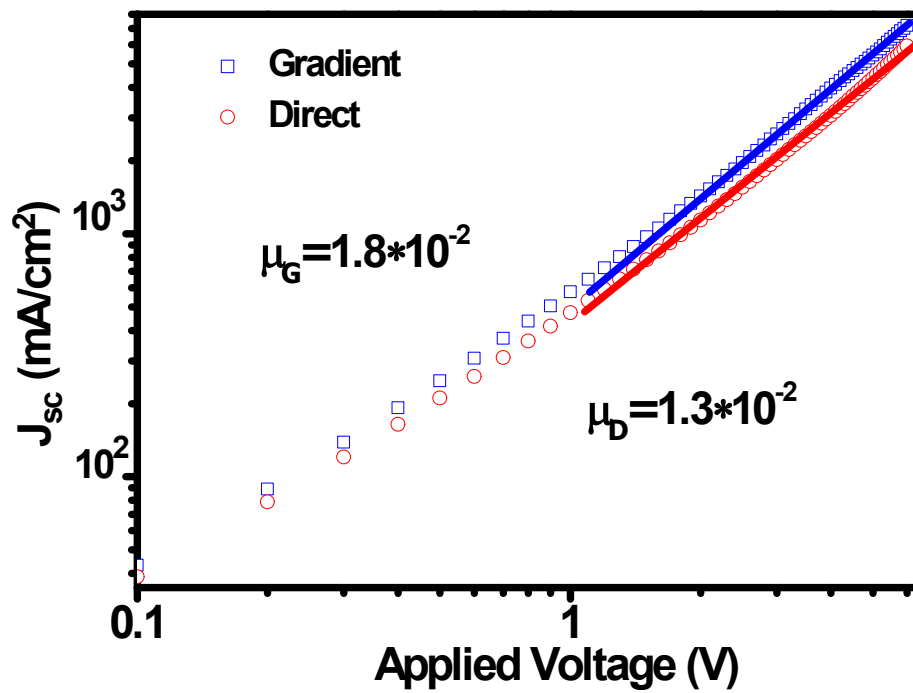
Figure S4. **Current-voltage (I-V) characteristics and space-charge-limited current (SCLC) fittings of the hole-only diode with GA and DA processes (FTO/PEDOT:PSS/CH$_3$NH$_3$PbI$_{3-x}$Cl$_x$/MoO$_x$/Al).**

Table S1. Device parameters of perovskite solar cells measured in the reverse and forward scanning directions.

Annealing process	Device Number	J_{sc} (mA/cm^2) reverse/forward	V_{oc} (V) reverse/forward	FF (%) reverse/forward	PCE (%) reverse/forward
Gradient Annealing	G1	18.6/18.6	0.96/0.96	78.3/78.0	14.0/13.9
	G2	17.7/17.9	0.94/0.95	74.9/72.3	12.5/12.3
	G3	17.7/18.0	0.98/0.98	73.7/71.2	12.8/12.5
	G4	17.8/17.7	0.94/0.93	75.8/72.7	12.7/12.0
	G5	18.1/18.0	0.96/0.97	74.5/74.6	13.0/13.0
Direct Annealing	D1	17.9/17.7	0.92/0.91	76.6/72.3	12.6/11.6
	D2	17.8/17.8	0.88/0.88	74.5/71.7	11.7/11.2
	D3	16.0/15.7	0.90/0.89	80.5/69.3	11.6/9.70
	D4	17.2/16.9	0.88/0.87	73.1/68.1	11.1/10.0
	D5	17.6/17.0	0.88/0.88	76.4/74.1	11.8/11.1

1. Y. Liu, Z., Q. Chen, W. Chang, H. Zhou, T.-B. Song, E. Young, Y. Yang, J. You, G. Li, and Y. Yang, *Nano Lett.,* 2015, **15**, 662-668

2. Y. Sun, G. C.Welch,W. L. Leong, C. J. Takacs, G. C. Bazan,   and Alan J. Heeger, *Nature Mater.,* 2012, **11**, 44-48.