

Supporting Information

Highly Efficient Planar Perovskite Solar Cells Achieved by Simultaneous Defect Engineering and Formation Kinetic Control

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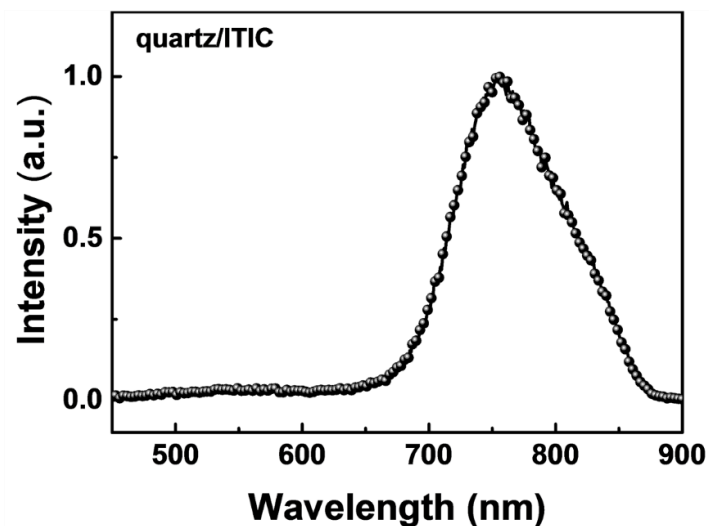


Figure S1. Normalized PL spectrum of ITIC film on quartz substrate. The ITIC film is formed by spin-coating ITIC saturated solution in DMF onto UVO treated quartz substrate.

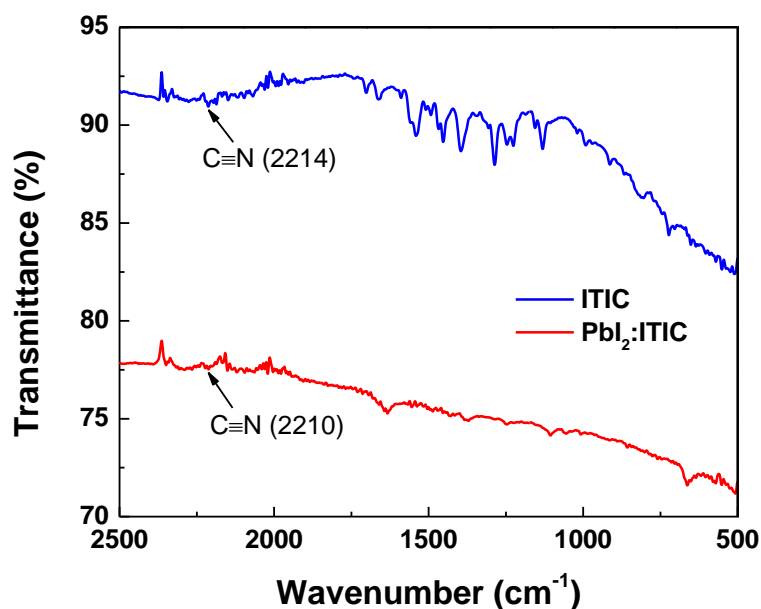


Figure S2. FTIR spectra of ITIC and PbI_2 :ITIC (2 mg ml^{-1}) films.

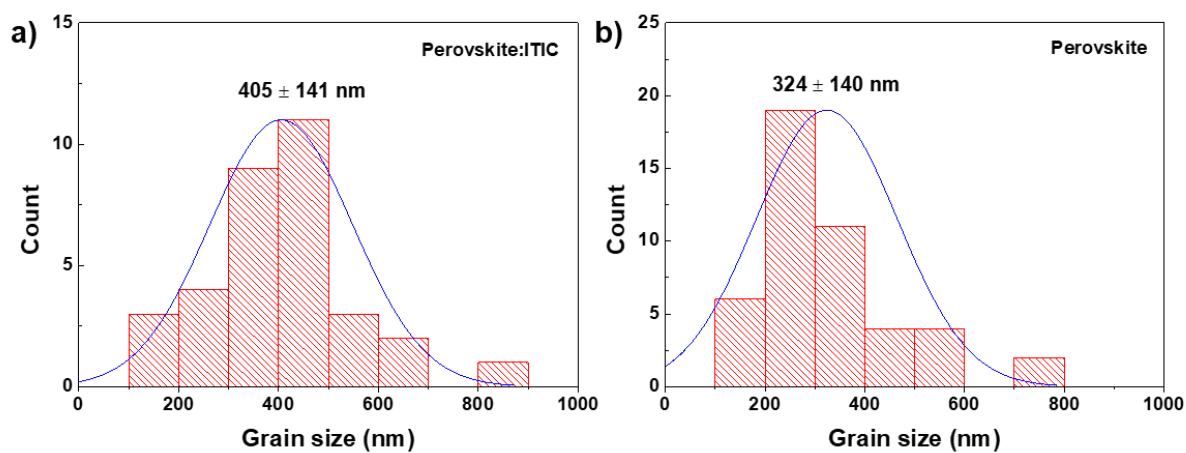


Figure S3. Grain size distributions of a) perovskite and b) perovskite:ITIC films in Figure 3.

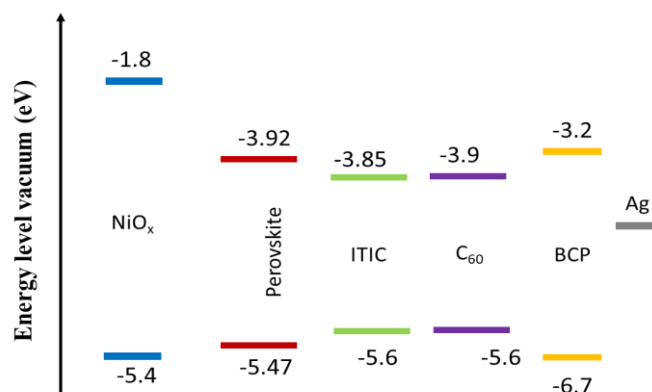


Figure S4. The corresponding energy-level diagram of perovskite solar cells in Figure 4a.

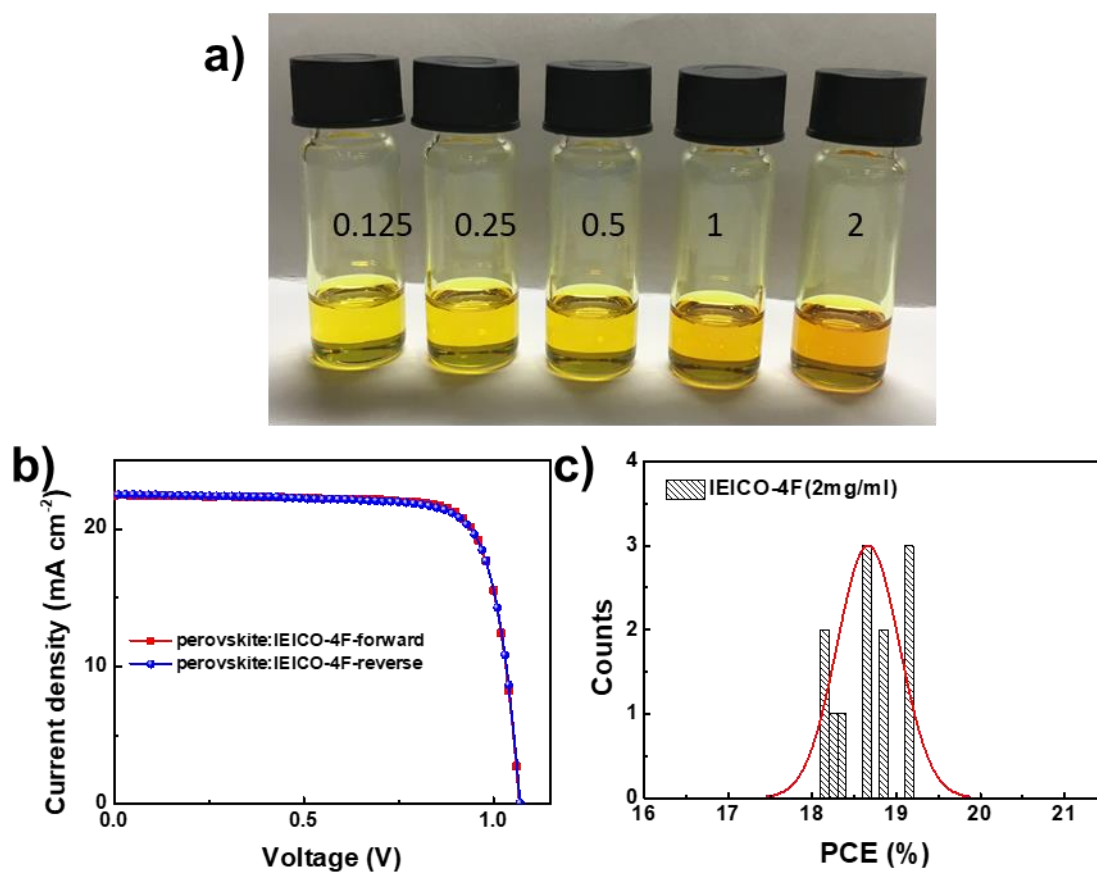


Figure S5. a) Photographs of perovskite and perovskite:IEICO-4F precursor solutions (0.125 mg mL^{-1} , 0.25 mg mL^{-1} , 0.5 mg mL^{-1} , 1 mg mL^{-1} , and 2 mg mL^{-1}). b) J - V curves of the best perovskite: IEICO-4F based solar cells using evaporated C_{60} as ETL. c) Histograms of the device efficiencies of perovskite: IEICO-4F based solar cells.

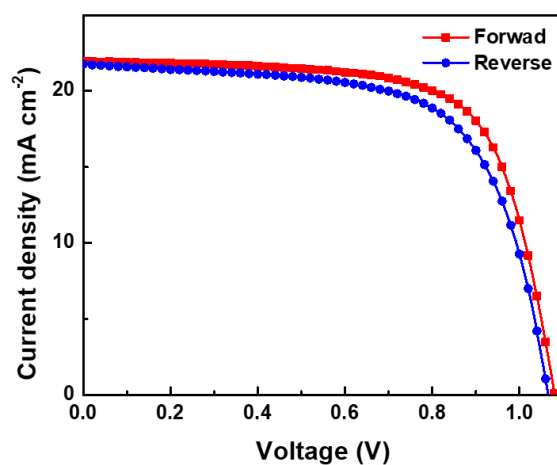


Figure S6. *J-V* curves of the best perovskite: IEICO-4F based solar cells using solution processed PCBM as ETL.

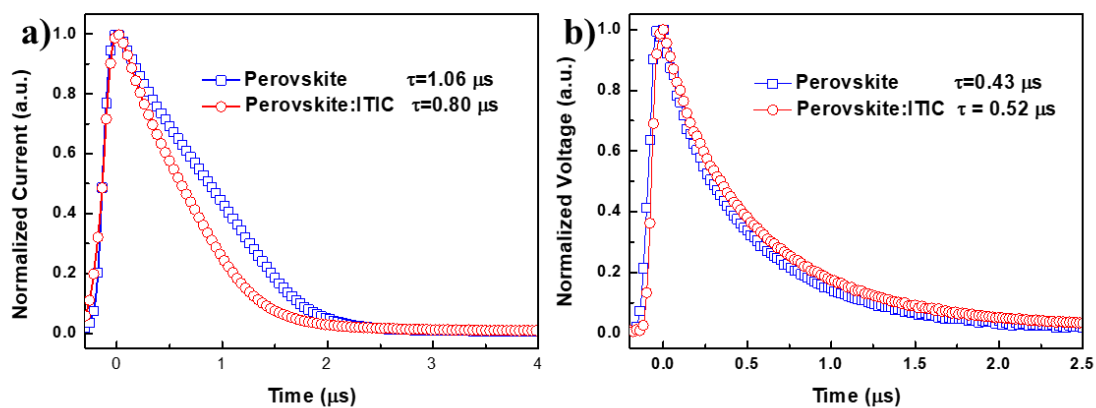


Figure S7. a) Photocurrent decay measured by TPC. b) Photovoltage decay under 0.5 Sun illumination measured by TPV.

Table S1. The photovoltaic parameters of PVSCs based different concentrations of ITIC.

concentration of ITIC (mg mL ⁻¹)	scan direction	J_{SC} (mA cm ⁻²)	V_{OC} (V)	FF	PCE(%)
w/o	forward	21.61	1.06	0.777	17.81
	reverse	21.87	1.06	0.760	17.62
0.125	forward	21.84	1.07	0.783	18.27
	reverse	21.95	1.06	0.781	18.13
0.25	forward	21.82	1.09	0.784	18.59
	reverse	21.97	1.09	0.770	18.49
0.5	forward	22.24	1.09	0.800	19.42
	reverse	22.43	1.08	0.799	19.37
1	forward	22.40	1.10	0.801	19.77
	reverse	22.44	1.09	0.801	19.56
2	forward	22.80	1.09	0.809	20.10
	reverse	22.47	1.09	0.801	19.62

Table S2. The photovoltaic parameters of perovskite:IEICO-4F based PVSCs using solution processed PCBM as ETL.

Non-fullerene with cyano group		J_{SC} (mA cm ⁻²)	V_{OC} (V)	FF	PCE (%)
	Champion-F	21.95	1.08	0.69	16.47
IEICO-4F(2mg/ml)	Champion-R	21.76	1.07	0.65	15.20
	Average	21.11±0.77	1.08±0.01	0.67±0.03	15.30±0.49