

Supporting Information

Efficient and Stable Carbon-based Perovskite Solar Cells Enabled by Inorganic Interface of CuSCN and Carbon Nanotubes

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Table S1 $J-V$ parameters of the C-PSCs with and without CuSCN HTL under the illumination of AM 1.5G, 100 mW cm⁻².

	J_{SC} (mA/cm ²)	V_{OC} (V)	FF(%)	PCE(%)
with CuSCN	21.72 ± 0.53	1.00 ± 0.01	68.96 ± 1.73	14.95 ± 0.30
w/o CuSCN	22.16 ± 0.82	0.84 ± 0.01	62.33 ± 6.68	11.70 ± 1.14

Table S2 $J-V$ parameters of the C-PSCs based on CuSCN HTLs deposited from different CuSCN/DES concentration under the illumination of AM 1.5G, 100 mW cm⁻². The champion values are shown in the brackets.

Concentration of CuSCN (mg mL ⁻¹)	J_{SC} (mA cm ⁻²)	V_{OC} (V)	FF(%)	PCE(%)
10	19.75 (19.9)	1.01 (1.02)	69.81 (72.15)	13.90 (14.60)
20	20.28 (20.2)	1.02 (1.02)	73.00 (73.60)	15.07 (15.16)
30	19.95 (20.0)	1.01 (1.02)	70.91 (72.40)	14.25 (14.83)
40	19.95 (19.1)	1.00 (1.01)	62.83 (70.69)	12.43 (13.63)
50	19.42 (19.5)	0.96 (0.96)	62.75 (65.60)	11.68 (12.31)

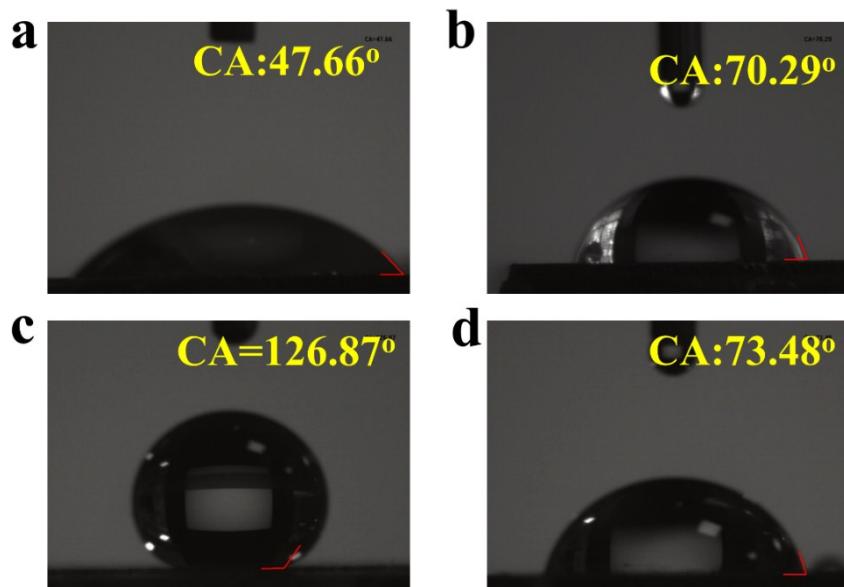


Figure S1. Contact angles test results of water on the surfaces of (a) perovskite, (b) CuSCN, (c) CNT, and (d) Au.

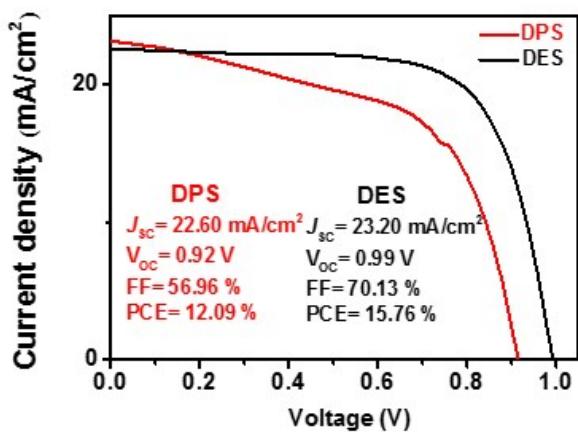


Figure S2. J - V curves of CuSCN inserted C-PSCs fabricated by dipropyl sulfide and diethyl sulfide solvent.

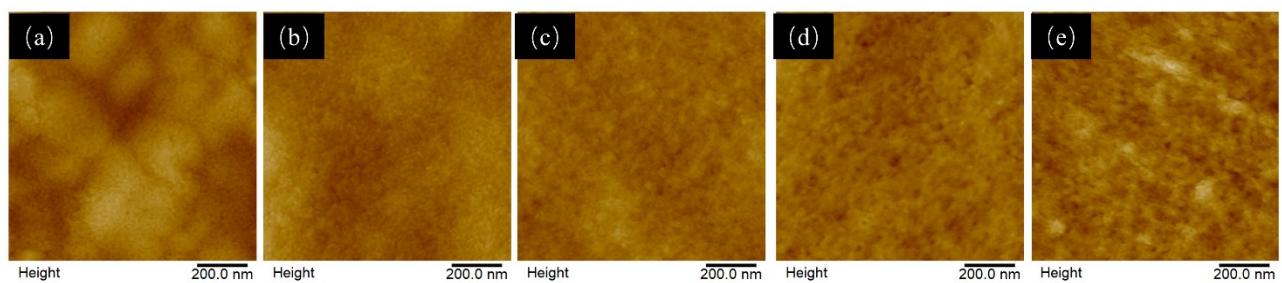


Figure S3. The surface topography images of CuSCN deposited from precursor solution with concentration of (a) 10 mg mL^{-1} , (b) 20 mg mL^{-1} , (c) 30 mg mL^{-1} , (d) 40 mg mL^{-1} (e) 50 mg mL^{-1} deposited on perovskite.

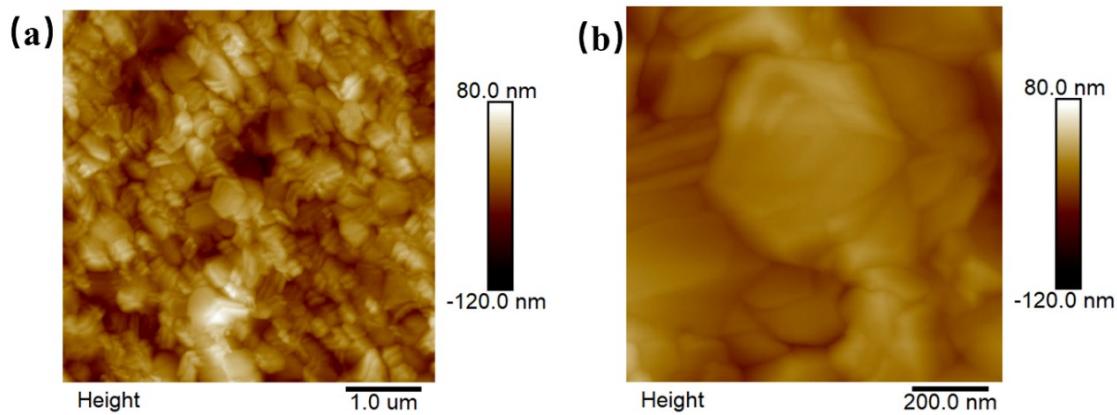


Figure S4. AFM topography of perovskite on FTO/compact TiO_2 /mesoporous TiO_2 substrate with a scan area of (a) $5 \mu\text{m}^2$ and (b) $1 \mu\text{m}^2$.

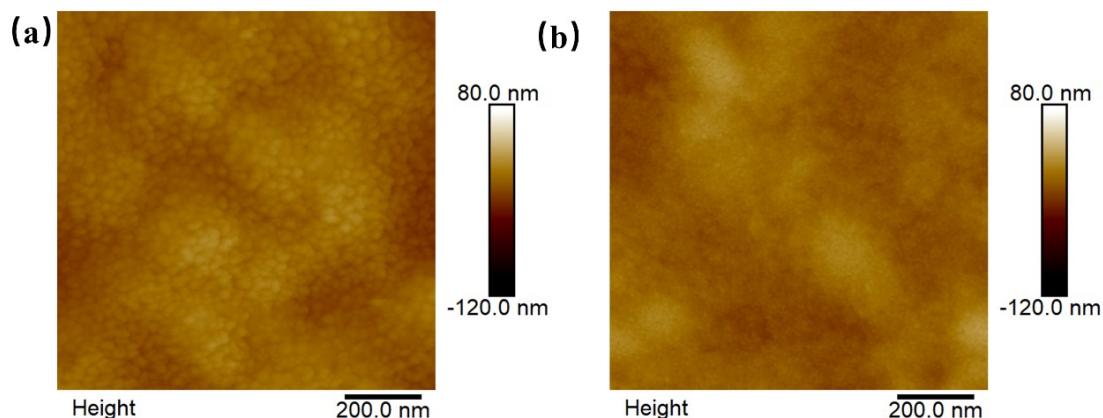


Figure S5. AFM topography images of CuSCN deposited on perovskite (a) before and (b) after annealing at 50 °C for 10 min. The scan area is 1 μm^2 .

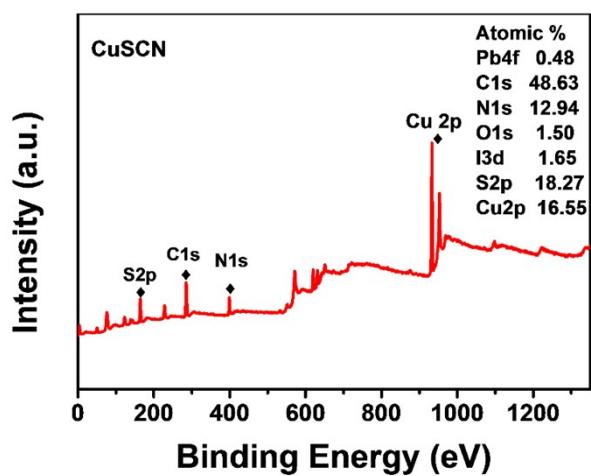


Figure S6. Full range XPS spectra of CuSCN film on FTO/TiO₂/Perovskite substrate.

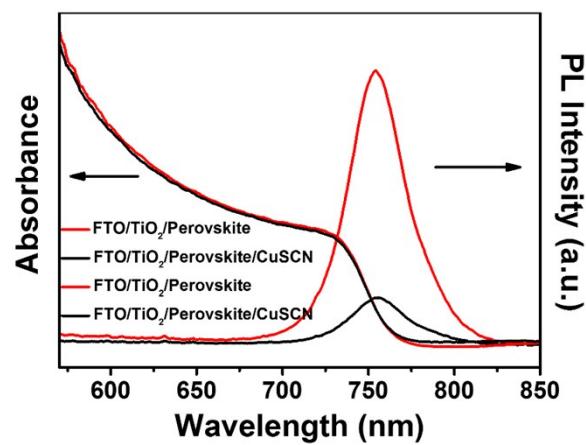


Figure S7. UV-visible spectroscopy and PL spectra of perovskite with (black line) and without CuSCN (red line)

Table S3 The extracted XPS characteristics of CuSCN film on FTO/TiO₂/Perovskite substrate,

and the original data shown in Figure S6.

Name	Start BE (eV)	Peak BE (eV)	End BE (eV)	FWHM (eV)	Atomic (%)
Pb4f	152.6	138.42	132.8	0.91	0.48
C1s	297.6	284.66	278.8	1.16	48.63
N1s	409.6	398.58	391.8	0.85	12.94
O1s	544.6	532.48	524.8	2.15	1.5
I3d	639.6	619.35	609.8	1.21	1.65
S2p	174.6	163.35	156.8	1	18.27
Cu2p	964.6	932.6	924.8	1.23	16.55

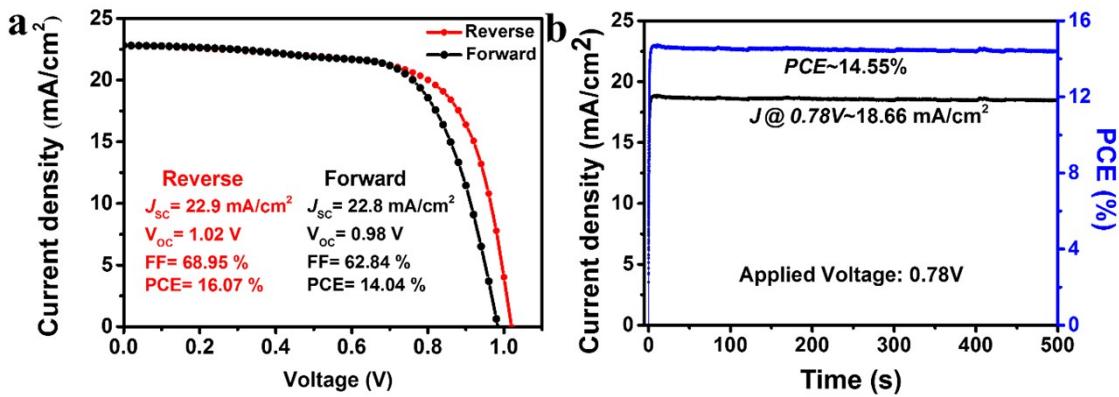


Figure S8. (a) J - V curves measured in the forward and reverse scanning directions, (b) corresponding stabilized power output measured at 0.78 V under AM 1.5G illumination of 100 mW/cm².

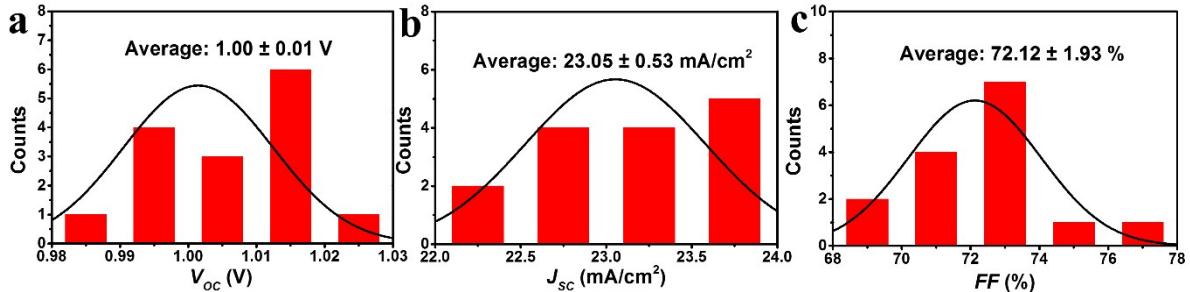


Figure S9. (a) V_{oc} , (b) J_{sc} and (c) FF histogram of one batch of devices (15 in total).

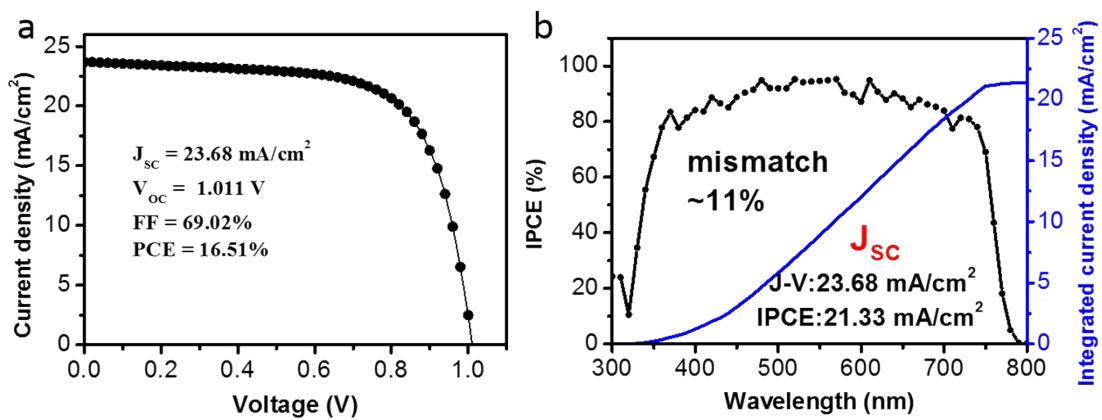


Figure S10. (a) J - V curve and (b) IPCE result measured at Xiamen University.