Supporting information

Cuprous thiocyanate as Inorganic Hole Transport Material for Carbon Based Flexible Perovskite Solar Cells.

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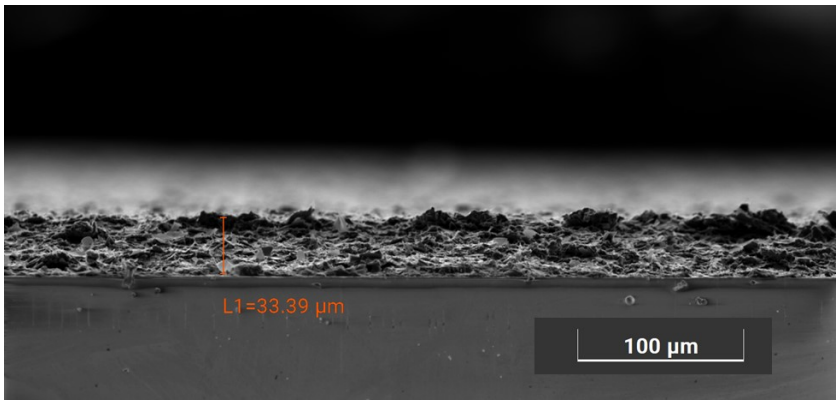

Figure S1: Cross-section SEM image showing the dry film thickness of the carbon top electrode.

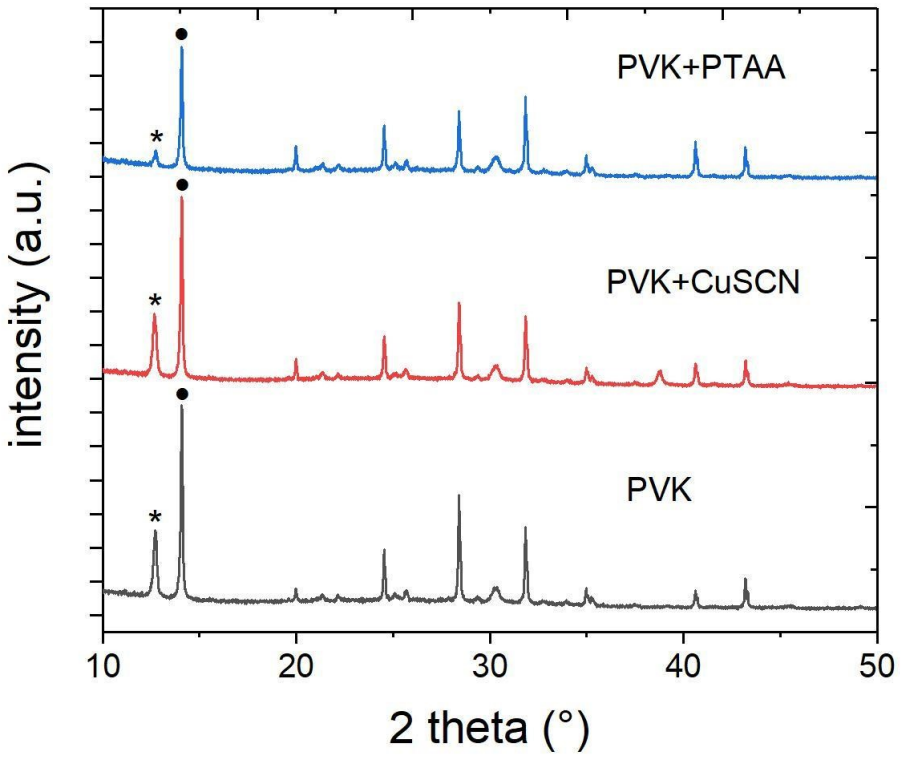

Figure S2: XRD diffraction patterns of the perovskite film (black), the perovskite film covered by the CuSCN layer (10 mg/ml, red), the perovskite film covered by the PTAA layer (12 mg/ml, blue), all deposited on glass/ ITO/ SnO_2. Asterisks and solid dots indicate the 12.6° PbI_2 and 14.1° perovskite peaks.

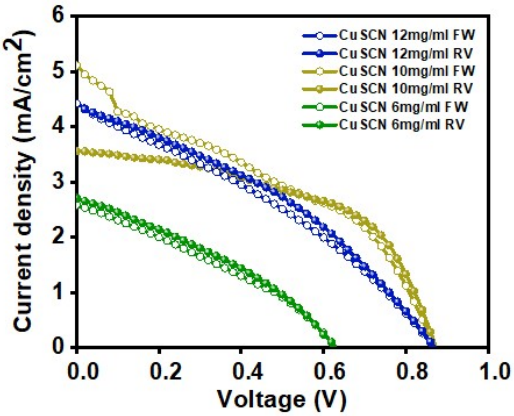

Figure S3: JV curves of F-PSCs with CuSCN at different concentrations using a gold top electrode.

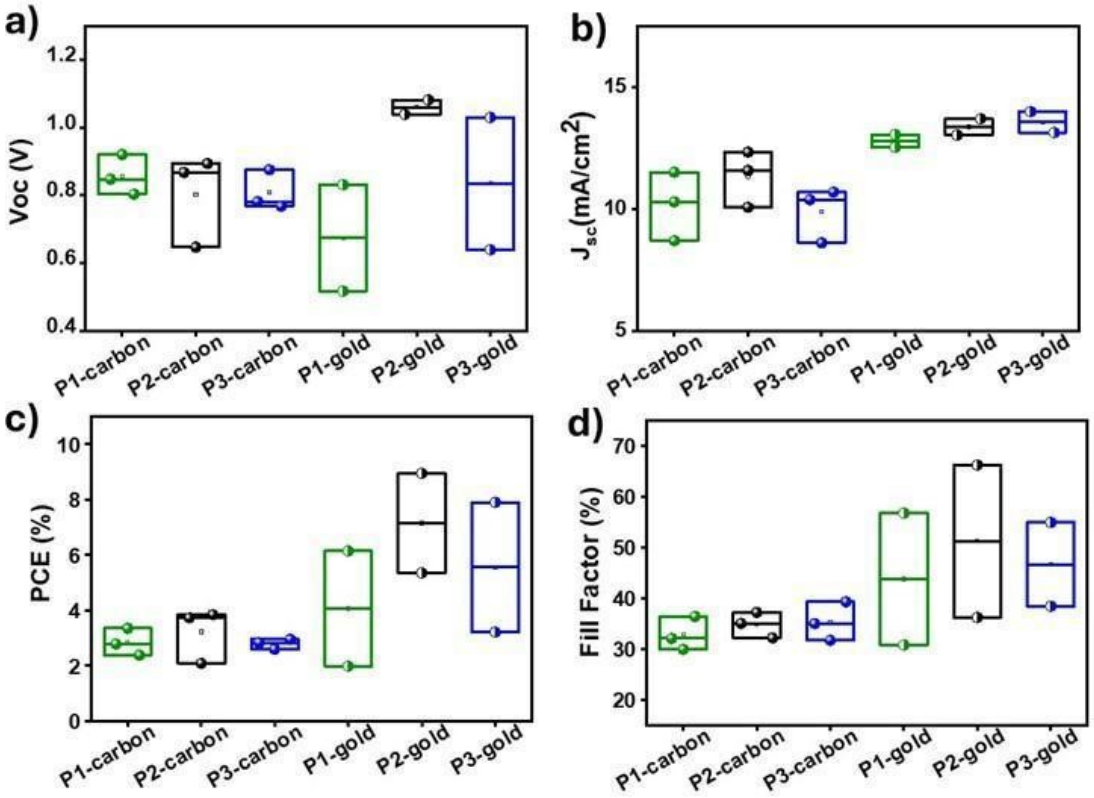

Figure S4. Photovoltaic parameters of flexible perovskite solar cells (PSCs) with an active area of 1 cm^2 using different concentrations namely P1= 6 mg/ml, P2= 12 mg/ml, P3= 18 mg/ml of commercially available PTAA (MW= 105 kDa) with carbon and gold top electrode, measured under standard test conditions (STC, AM1.5G, 1000 W/m^2, 25 °C).

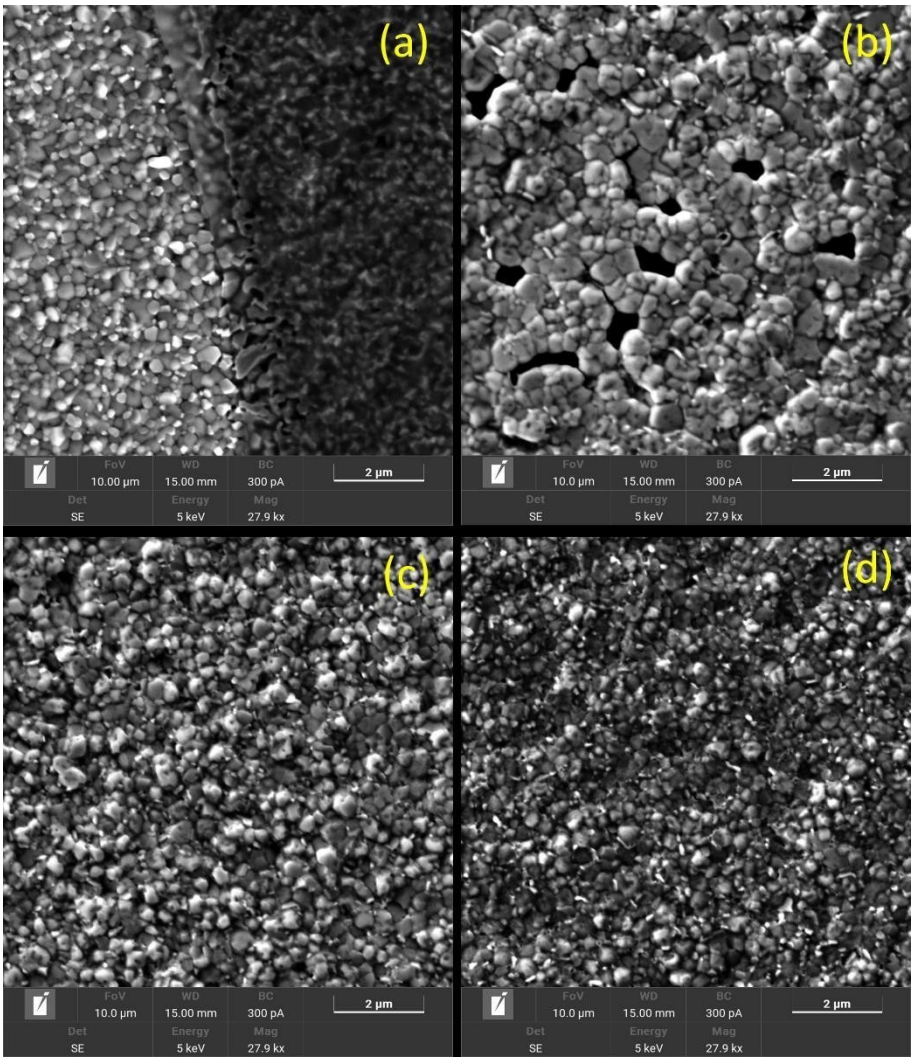

Figure S5. The top-view SEM images of: (a) the perovskite film partially covered by the PTAA layer, and the CuSCN layers at different concentrations: (b) 6 mg/ml, (c) 10 mg/ml, and (d) 12 mg/ml.

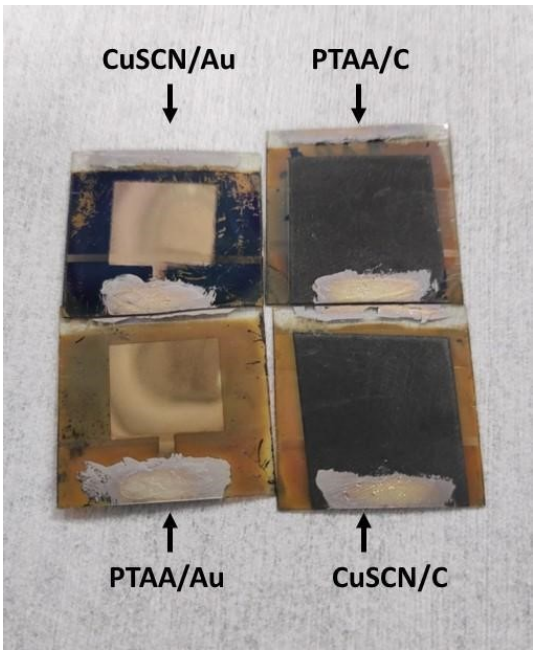

Figure S6: After one week of thermal stress ISOS T-1

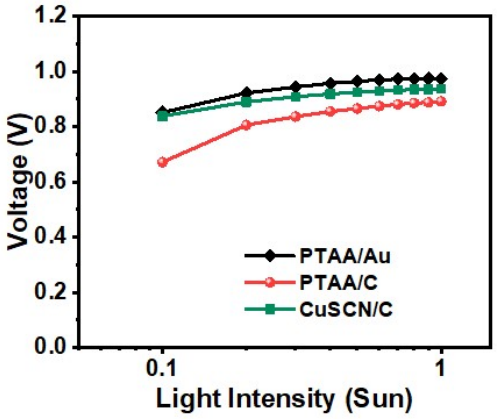

Figure S7: V_{oc} at different sun intensities.

Table S1: PV parameters of F-PSCs with CuSCN at different concentrations with gold top electrode.

concentration (mg/ml)	Scan	V_{oc}(V)	J_{sc}(mA/cm^2)	Fill factor (%)	PCE (%)
6	FW	0.53±0.06	12.1±0.28	31.0±2.80	2.01±0.46
	RV	0.67±0.22	12.7±0.36	43.7±18.3	4.06±2.93
12	FW	1.05±0.03	14.2±1.51	48.0±19.1	7.07±1.88
	RV	1.05±0.02	13.3±0.46	51.0±21.1	7.14±2.54
18	FW	0.83±0.27	13.1±0.52	42.6±12.1	4.95±3.07
	RV	0.83±0.27	13.5±0.60	46.6±11.6	5.56±3.30

Table S2: Statistical data of Photovoltaic (PV) parameters of Gold F-PSCs employed with PTAA at three different concentrations.

Concentration CuSCN	Scan	V_{oc}(V)	J_{sc}(mA/cm^2)	Fill factor (%)	PCE (%)
6 mg/ml	FW	0.62	2.57	31.98	0.52
	RV	0.63	2.68	33.7	0.57
10 mg/ml	FW	0.86	5.10	35.85	1.58
	RV	0.87	3.54	52.8	1.63
12 mg/ml	FW	0.86	4.41	32.67	1.25
	RV	0.87	4.37	35.82	1.36

Table S3: Statistical data of Photovoltaic (PV) parameters of Carbon F-PSCs employed with PTAA at three different concentrations.

concentration (mg/ml)	Scan	V_{oc}(V)	J_{sc}(mA/cm^2)	Fill factor (%)	PCE (%)
6	FW	0.86±0.05	9.90±1.38	32.2±1.81	2.7±0.34
	RV	0.85±0.05	10.15±1.40	32.7±3.28	2.84±0.48
12	FW	0.80±0.13	11.31±0.32	34.3±4.58	3.19±0.97
	RV	0.8±0.13	11.31±2.52	34.7±2.52	3.22±0.98
18	FW	0.80±0.05	9.96±1.05	35.9±4.32	2.88±0.43
	RV	0.80±0.05	9.88±1.12	35.2±3.79	2.79±0.18

Table S4: Fitting parameters of EIS.

	PTAA/C	CuSCN/C
Chi-Sqr	0.009032	0.033705
Sum-Sqr	0.71354	2.7975
R1(Ω)	64.12	34.09

R1(Error)	1.6159	2.7722
R1(Error%)	2.5201	8.132
R2(Ω)	1253	1860
R2(Error)	75.747	83.729
R2(Error%)	6.0453	4.5016
CPE2-T($F.cm^{-2}$)	1.52E-07	2.77E-07
CPE2-T(Error)	2.03E-08	4.53E-08
CPE2-T(Error%)	13.338	16.346
CPE2-P	0.92906	0.82475
CPE2-P(Error)	0.014868	0.014524
CPE2-P(Error%)	1.6003	1.761
R3(Ω)	478.6	349.9
R3(Error)	105.55	149.22
R3(Error%)	22.054	42.646
CPE3-T($F.cm^{-2}$)	4.04E-05	5.79E-05
CPE3-T(Error)	2.19E-05	8.27E-05
CPE3-T(Error%)	54.21	142.86
CPE3-P	0.73677	0.88414
CPE3-P(Error)	0.15013	0.36845
CPE3-P(Error%)	20.377	41.673

References:

1. Dong, H., Ran, C., Gao, W. *et al.* Metal Halide Perovskite for next-generation optoelectronics: progresses and prospects. *eLight* **3**, 3 (2023).
2. Haeger, T., Heiderhoff, R. & Riedl, T. Thermal properties of metal-halide perovskites. *J. Mater. Chem. C* **8**, 14289–14311 (2020).