Supporting Information

Single Phase, High Hole Mobility Cu_2O Film as Efficient and Robust Hole Transporting Layer for Organic Solar Cells

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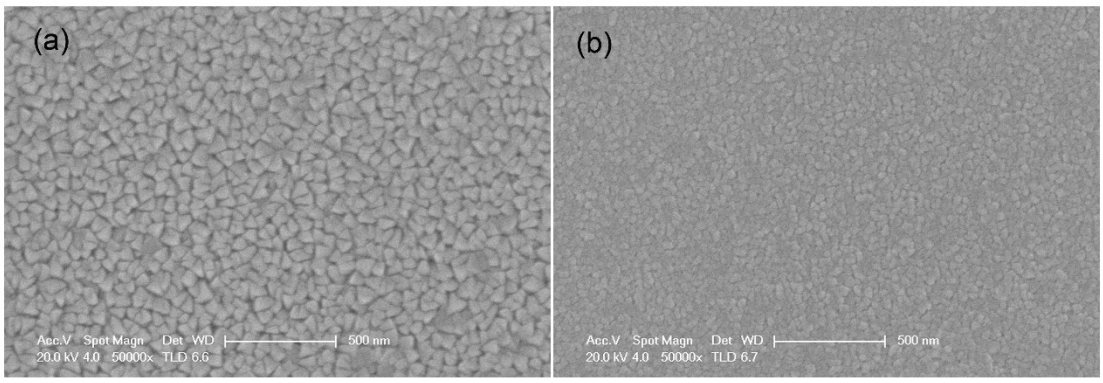

Figure S1. SEM pictures of typical Cu_2O (a) and CuO (b) hole transport layer.

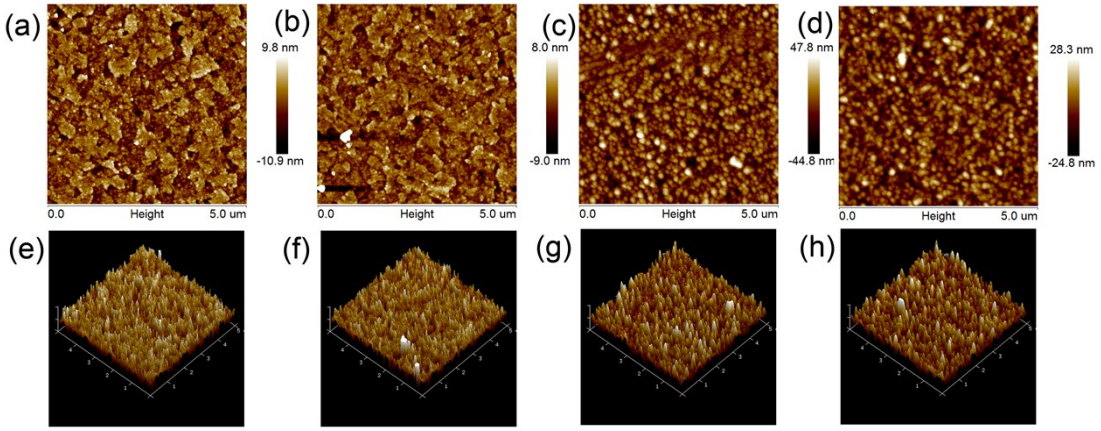

Figure S2. Typical AFM images of (a) ITO, (b) ITO/PEDOT:PSS, (b) ITO/Cu_2O and (d) ITO/CuO, respectively.

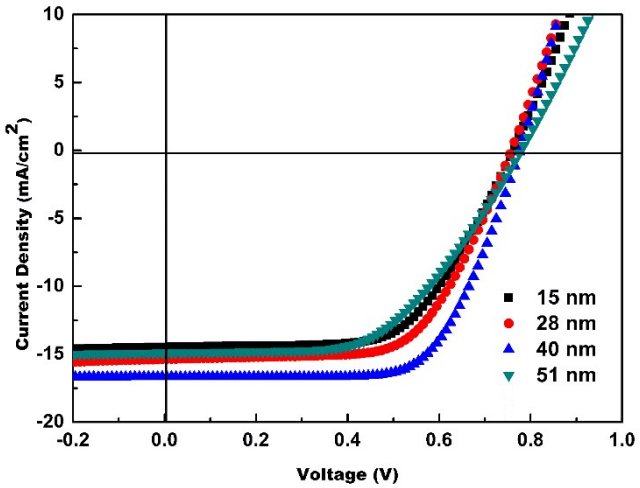

Figure S3. Current density–voltage (J–V) plots for PTB7:$PC_{71}BM$ bulk heterojunction solar cells based on different thickness of Cu_2O HTL.

Table S1. OSC performance parameters for PTB7:$PC_{71}BM$ fabricated on glass/ITO/Cu_2O substrates with different thicknesses of Cu_2O.

HTL thickness [nm]	V_{OC} (V)	J_{SC} (mA/cm^2)	FF (%)	R_{series} (Ω·cm^2)	R_{shunt} (kΩ·cm^2)	PCE (%)
15	0.76	14.46	61.2	4.69	816.9	6.72
28	0.76	15.36	62.9	4.26	826.7	7.34
40	0.78	16.65	66.2	3.72	851.1	8.61
51	0.78	14.9	54.5	9.55	759.5	6.34

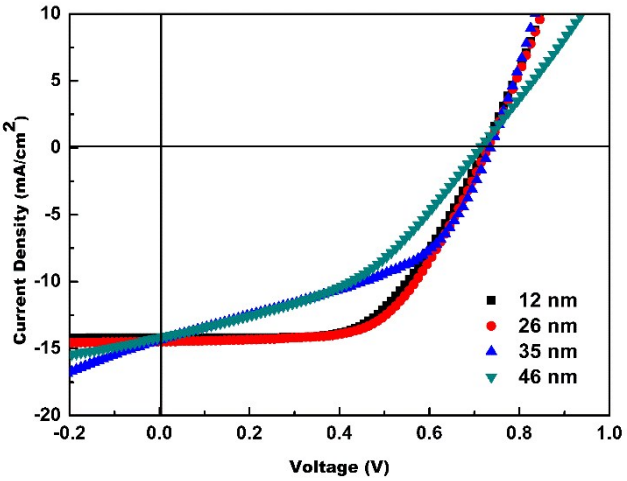

Figure S4. Current density–voltage (J–V) plots for PTB7:$PC_{71}BM$ bulk heterojunction solar cells based on different thickness of CuO HTL.

Table S2. OSC performance parameters for PTB7:$PC_{71}BM$ fabricated on glass/ITO/CuO substrates with different thicknesses of CuO.

HTL thickness [nm]	V_{OC} (V)	J_{SC} (mA/cm^2)	FF (%)	R_{series} (Ω·cm^2)	R_{shunt} (Ω·cm^2)	PCE (%)
12	0.72	14.18	59.0	9.6	769.1	6.02
26	0.73	14.48	59.5	9.75	781.9	6.28
35	0.74	14.37	45.0	11.1	611.1	4.79
46	0.71	14.16	42.5	16.9	595.2	4.28

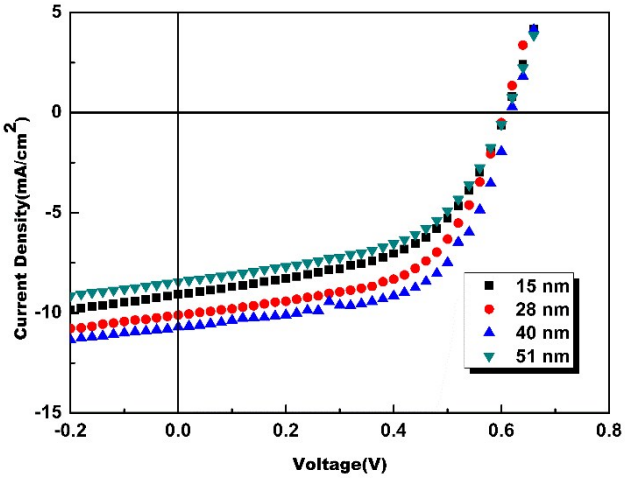

Figure S5. Current density–voltage (J–V) plots for P3HT:$PC_{61}BM$ bulk heterojunction solar cells based on different thickness of Cu_2O HTL.

Table S3. OSC performance parameters for PTB7:$PC_{71}BM$ fabricated on glass/ITO/Cu_2O substrates with different thicknesses of Cu_2O.

HTL thickness [nm]	V_{OC} (V)	J_{SC} (mA/cm^2)	FF (%)	R_{series} (Ω·cm^2)	R_{shunt} (kΩ·cm^2)	PCE (%)
15	0.60	9.07	52.9	9.9	709.1	2.88
28	0.60	10.11	56.4	9.26	792.6	3.42
40	0.60	10.7	60.4	9.1	801.1	3.87
51	0.58	9.21	52.0	9.5	706.5	2.47

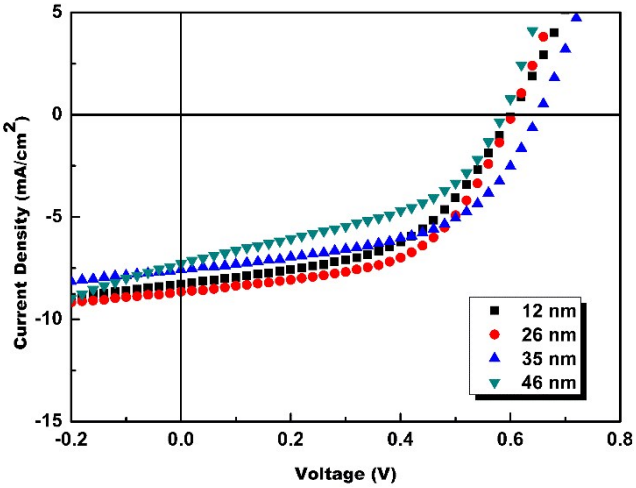

Figure S6. Current density–voltage (J–V) plots for P3HT:$PC_{61}BM$ bulk heterojunction solar cells based on different thickness of CuO HTL.

Table S4. OSC performance parameters for P3HT:$PC_{71}BM$ fabricated on glass/ITO/CuO substrates with different thicknesses of CuO.

HTL thickness [nm]	V_{OC} (V)	J_{SC} (mA/cm^2)	FF (%)	R_{series} (Ω·cm^2)	R_{shunt} (kΩ·cm^2)	PCE (%)
12	0.60	8.28	50.3	10.6	669.1	2.49
26	0.60	8.65	54.4	9.26	726.8	2.82
35	0.60	7.57	53.0	9.71	711.1	2.39
46	0.58	7.27	45.3	11.5	527.5	2.26

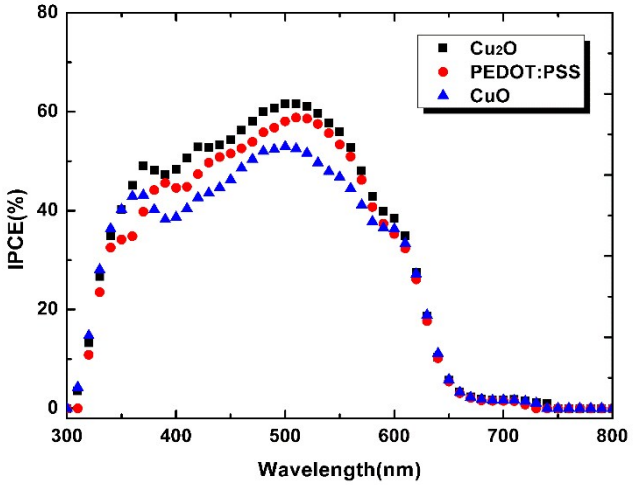

Figure S7. The IPCE spectra for P3HT:$PC_{61}BM$ bulk heterojunction solar cells based on different HTLs

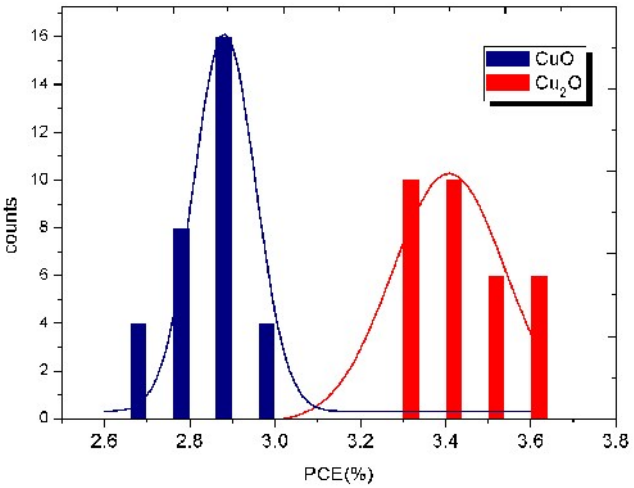

Figure S8. The PCE distribution of 32 independently fabricated P3HT:$PC_{61}BM$ bulk heterojunction solar cells based on different HTLs.

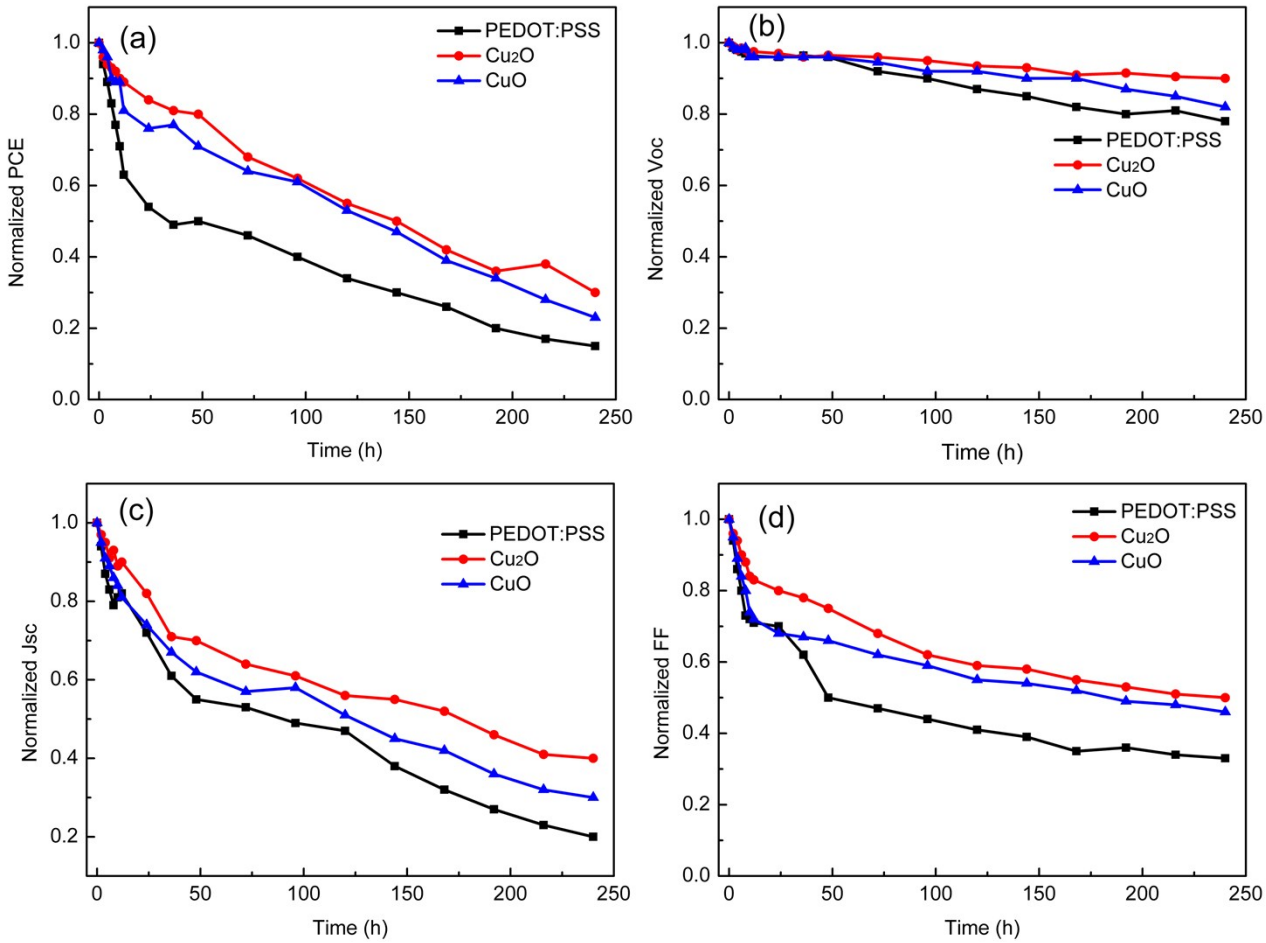

Figure S9. Normalized (a) PCE, (b) V_{OC}, (c) J_{SC} and (d) FF of PTB7:$PC_{71}BM$-based OSCs as a function of storage time under an ambient atmosphere.