

Polydopamine/ZnO electron transport layers enhance charge extraction in inverted non-fullerene organic solar cells

Nafees Ahmad,^{ad} Xuning Zhang,^{ab} Yang Shuo,^{ad} Dongyang Zhang,^{ab} Wang Jianqiu,^a Saud uz Zafar,^{ad} Li Yanxun,^{ad} Yuan Zhang,^b Sabir Hussain,^{ad} Zhihai Cheng,^c Anbu Kumaresan,^{ad} Huiqiong Zhou,^{a,*}

^aCAS Key Laboratory of Nanosystem and Hierarchical Fabrication, CAS Center for Excellence in Nanoscience, National Center for Nanoscience and Technology, Beijing 100190, P. R. China.

*Email: zhouhq@nanoctr.cn

^bSchool of Chemistry, Beijing Advanced Innovation Center for Biomedical Engineering, Beihang University, Beijing 100191, P. R. China

^cBeijing Key Laboratory of Optoelectronic Functional Materials and Micro-nano Devices, Department of Physics, Renmin University of China, Beijing 100872, P. R. China

^dUniversity of Chinese Academy of Sciences, Beijing 100049, P.R.China.

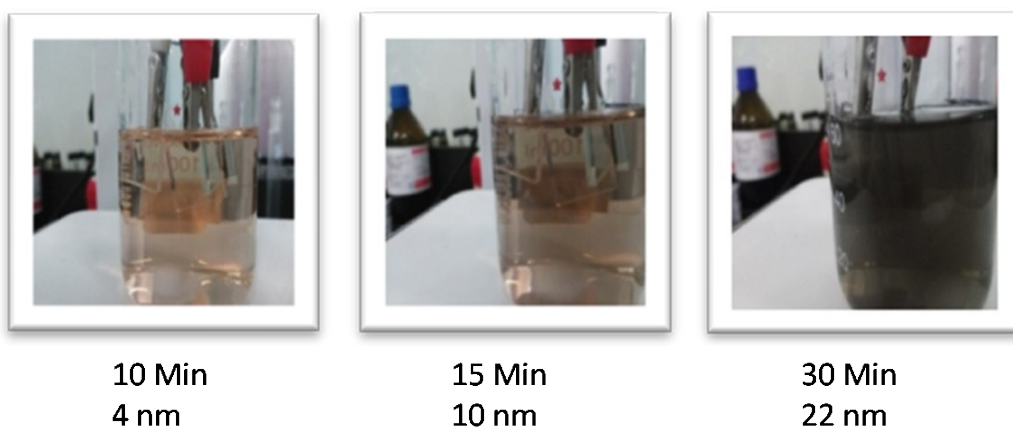


Fig. S1 Photographic images of PDA solution with a different time interval

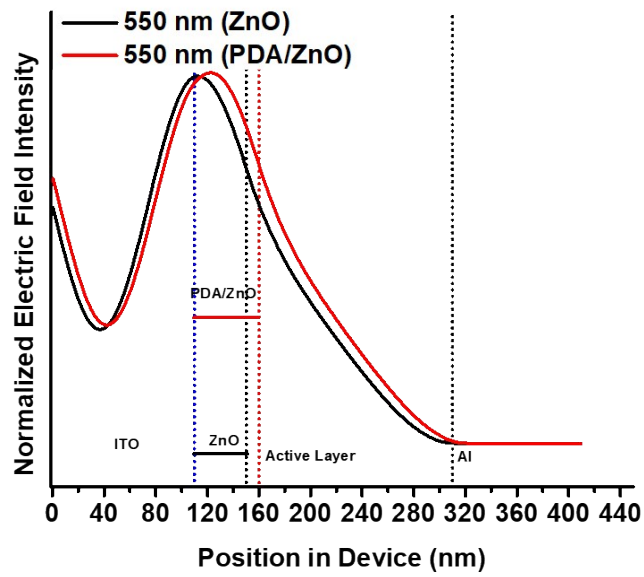


Fig. S2 Optical field distribution in solar cell devices based on ZnO or PDA/ZnO ETLs.

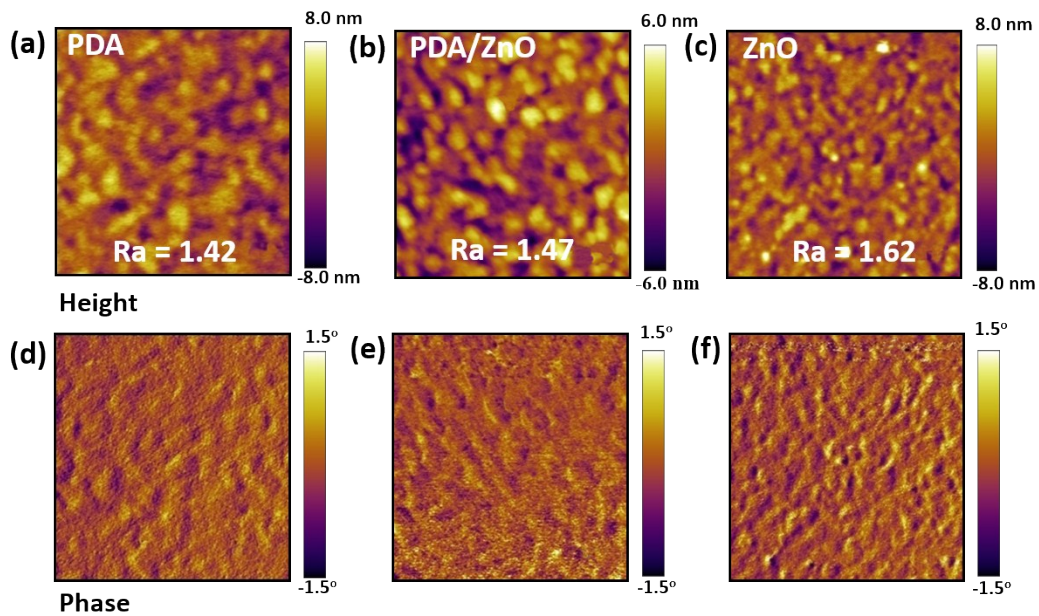


Fig. S3 AFM height and phase Images based on PDA (a, d) PDA/ZnO(b, e) and ZnO (c, f)

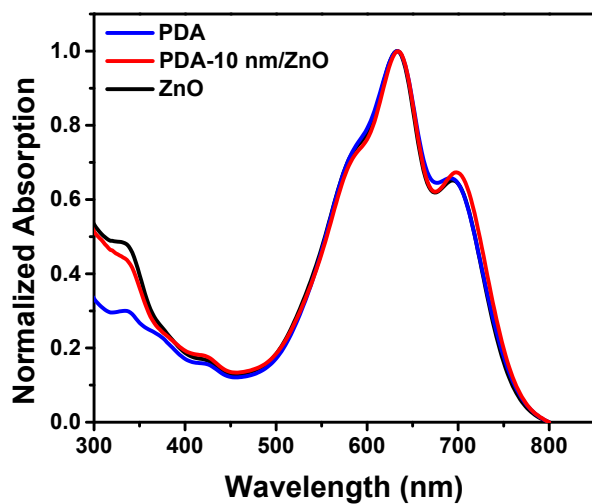


Fig. S4 Normalized absorption spectra of BHJ coated on PDA, PDA/ZnO and ZnO thin films ETLs.

Table. S1 Conductivity results based on PDA, PDA-10/ZnO and ZnO ETLs.

Applied Voltage	ZnO (nA)	PDA-10/ZnO (pA)
-4	-6.45	-920.203
-3	-4.295	-11.428
-2	-3.826	363.412
-1	5.447	403.292
0	8.026	-0.10546
+1	8.91	5.428
+2	21.334	422.43
+3	23.891	493.489
+4	51.307	683.39

Table. S2 Photovoltaic parameter of devices (PBDBT:ITIC) based on PDA, PDA/ZnO, and ZnO ETLs.

ETL	Voc (V)	Jsc /mA.cm ⁻²	FF /%	PCE / %
PDA	0.34(0.34±0.02)	13.65(12.06±1.99)	48.43(43.53±3.41)	2.24(2.10±0.11)
PDA-4 nm/ZnO	0.87(0.87±0.001)	16.98(16.94±0.40)	66.38(66.23±1.33)	9.92(9.82±0.08)
PDA-10nm/ZnO	0.88(0.88±0.01)	17.86(17.76±0.32)	70.91(69.89±0.54)	11.14(10.98±0.10)
PDA-22 nm/ZnO	0.87(0.87±0.01)	17.28(17.14±0.28)	67.18(67.05±0.73)	10.21(10.11±0.06)
ZnO 30 nm	0.87(0.87±0.01)	16.77(16.75±0.22)	67.82(67.42±0.68)	10.15(10.04±0.15)

The average values and standard deviations (listed in bracket) were calculated based on data extracted from 12 devices

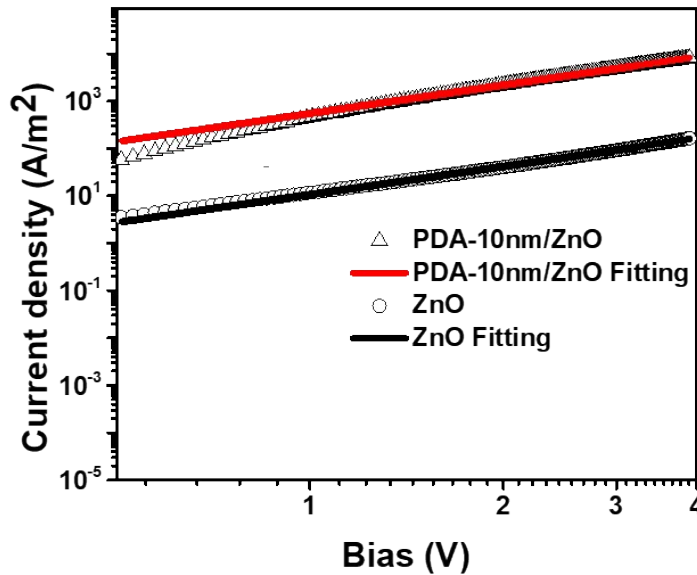


Fig. S5 J-V characteristics of electron only device in configuration of ITO/ETL (PDA/ZnO)/BHJ/Al, solid lines represent best fit using SCLC model.

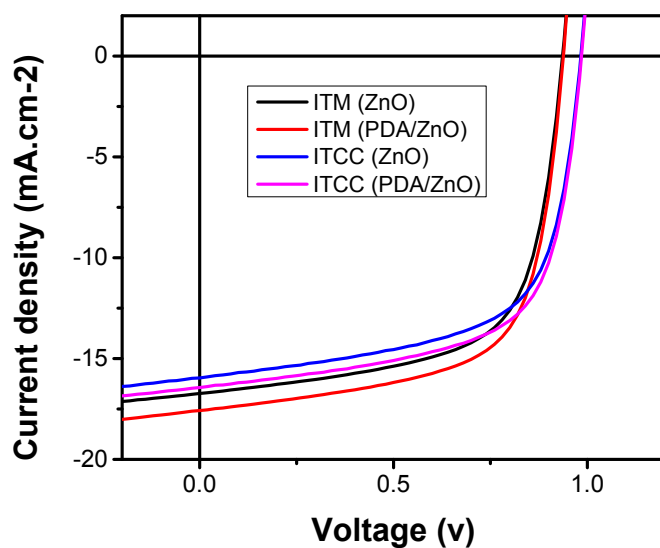


Fig. S6 Current density versus voltage (J-V) characteristics PBDBT-ITIM and PBDBT-ITCC solar cells with PDA/ZnO ETLs under AM 1.5 G solar irradiation (100 mW/cm^2).

Table. S3 Photovoltaic parameter of devices based on PDA/ZnO, and ZnO ETLs with ITM and ITCC Acceptor with same Donor PBDB-T

ETL	BHJ	Voc (V)	Jsc / mA.cm^{-2}	FF /%	PCE / %
ZnO	PBDBT:ITM	0.92	16.72	66.49	10.2
PDA-10 nm/ZnO		0.92	17.57	67.19	10.9
ZnO	PBDBT:ITCC	0.98	15.95	63.97	10.0
PDA-10 nm/ZnO		0.98	16.53	65.16	10.5