Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Electronic Supplemental Information for

Ethanolamine-functionalized fullerene as an efficient electron transport layer for high-efficiency inverted polymer solar cells

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Contents

S1. FTIR spectra of C_{60}-ETA and ETA.

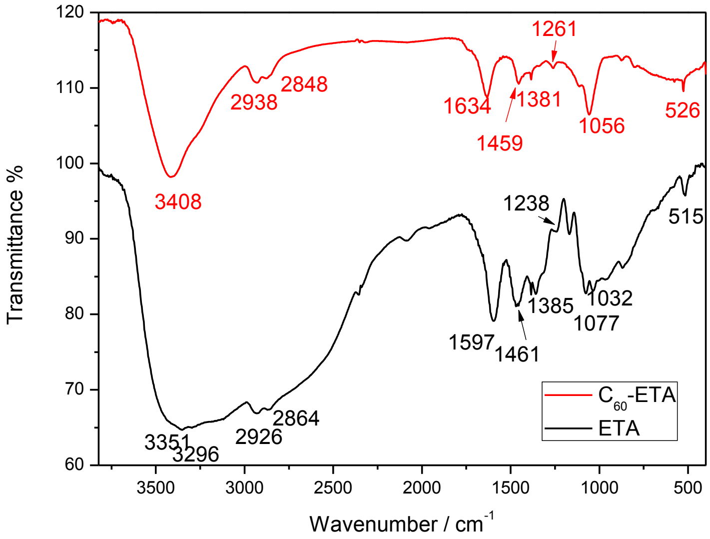

Figure S1. FTIR spectra of C_{60}-ETA and ETA.

S2. XPS analysis of C_{60}-ETA.

Table S1. The binding energies (BE) of C1s, N1s and O1s cores and calculated atomic percentage (Atom%) of C, N, O.

Core	Start BE (eV)	Peak BE (eV)	End BE (eV)	FWHM [a] (eV)	Area [b]	Atom% [c]	Atomic ratio [d]	Theor. Atomic ratio [e]
C1s	291.25	284.5	281.6	1.44	65402.24	78.17		
N1s	403.05	398.52	395.8	1.46	10982.78	8.10	9.65:1:1.7	9.5:1:1
O1s	535	531.65	527.5	1.72	27864.92	13.73		

[a] FWHM: full width at half maximum; [b] Integrated area; [c] Calculated from the percentage of the integrated area; [d] The atomic ratio of C:N:O; [d] Theoretical atomic ratio of C:N:O calculated according to the estimated average molecular formula of $C_{60}(NHC_2H_4OH)_8(H)_8$ (=$C_{76}N_8O_8H_{56}$). The deviation of atomic ratio of N:O is likely because of the well-known inaccuracy of O1s signal intensity measured by XPS. Note that the atomic ratio of C:N calculated from elemental analysis is ~9.44:1 according to the weight percentages of 78.43% and 9.69% for C and N, agreeing with those of the calculated one and measured by XPS.

S3. TGA analysis of C_{60}-ETA.

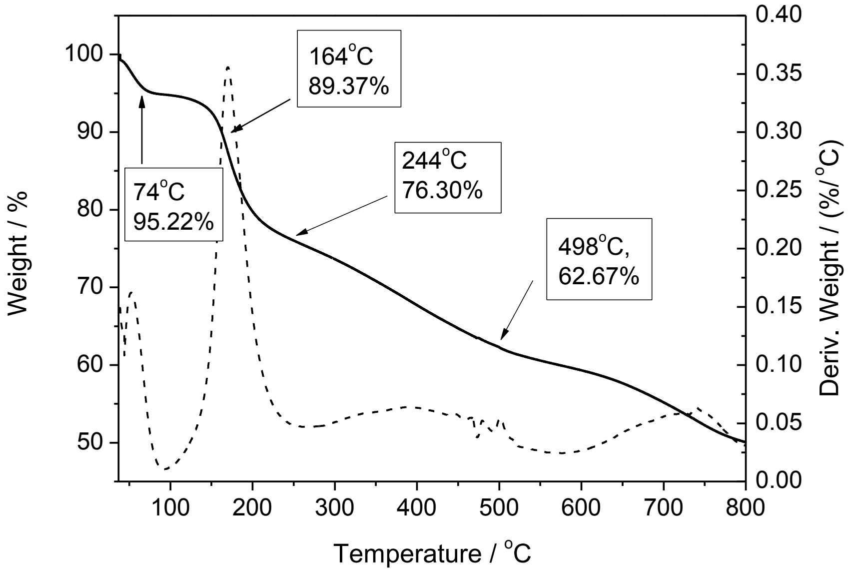

Figure S2. TGA curve (solid line) and differential thermo-gravimetric (DTG) curve (dashed line) of C_{60}-ETA.

S4. Transmittance spectra of ITO and ITO/C_{60}-ETA

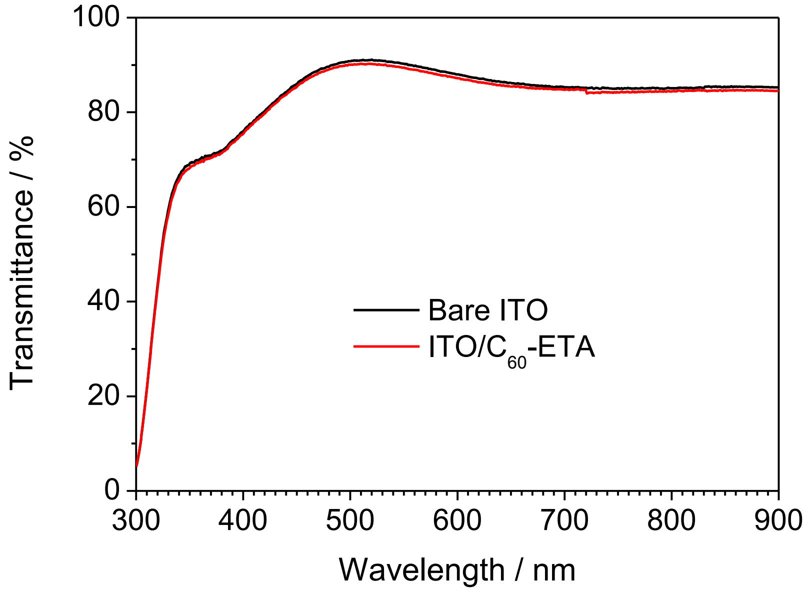

Figure S3. Transmittance spectra of bare ITO and ITO/C_{60}-ETA.

S5. AFM height images of ITO with C_{60}-ETA or ZnO layer.

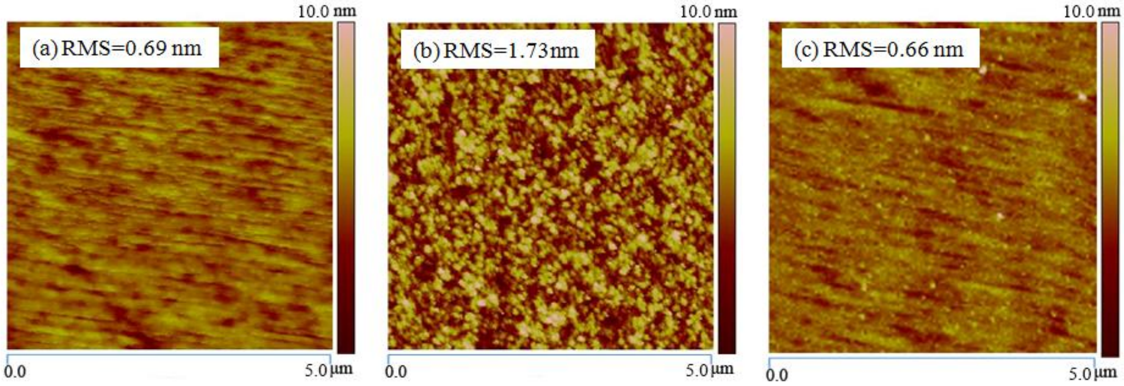

Figure S4. AFM height images (5 µm × 5 µm) of bare ITO (a), ITO/ZnO (b), ITO/C_{60}-ETA (c).

S6. Enhancement ratios of the photovoltaic parameters.

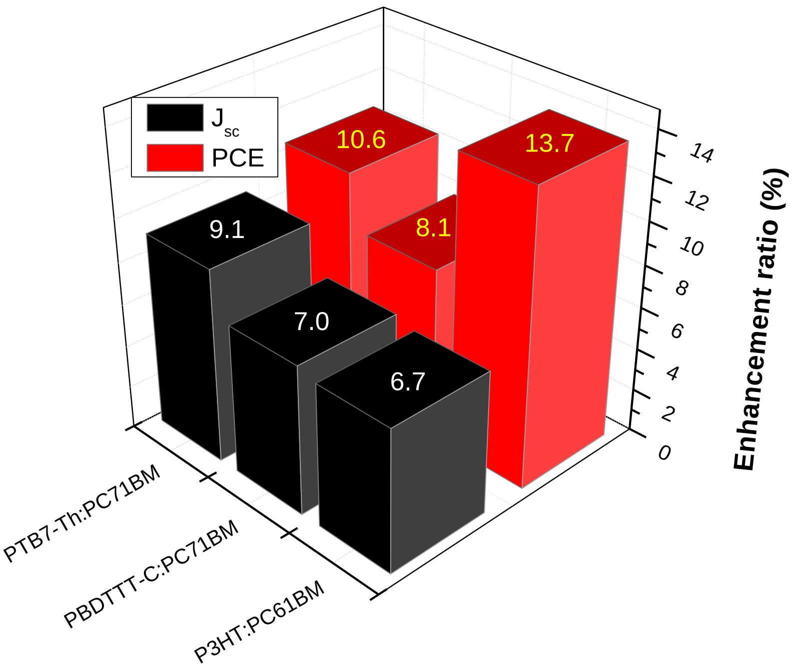

Figure S5. Enhancement ratios of Jsc and PCE for the C_{60}-ETA-incorporated devices relative to those of ZnO-incorporated ones.

S7. UV-vis absorption spectra of different active layers on ITO/C_{60}-ETA or ITO/ZnO.

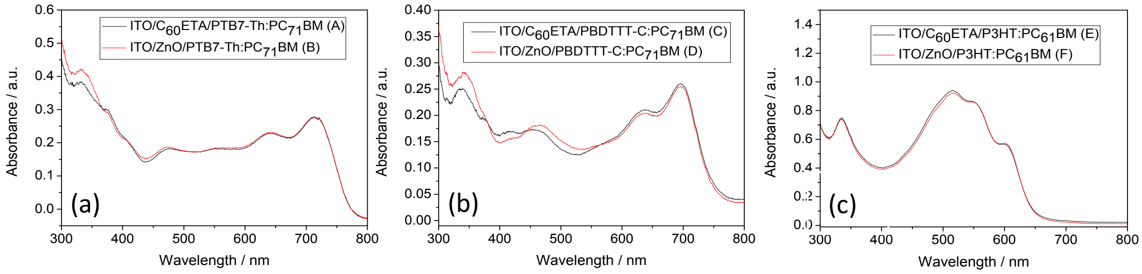

Figure S6. UV-vis absorption spectra of PTB7-Th:$PC_{71}BM$ (a), PBDTTT-C:$PC_{71}BM$ (b) and P3HT:$PC_{61}BM$ (c) active layer films on ITO/C_{60}-ETA or ITO/ZnO.

S8. Electron mobilities of different active layer films on ITO/C_{60}-ETA or ITO/ZnO.

Table S2. Electron mobilities of different active layer films on ITO/C_{60}-ETA or ITO/ZnO.

Active layer	Device	ETL	μ_e ($cm^2 V^{-1} s^{-1}$)[a]
PTB7-Th:$PC_{71}BM$	**A**	C_{60}-ETA	5.54×10^{-4}
	B	ZnO	1.51×10^{-4}
PBDTTT-C:$PC_{71}BM$	**C**	C_{60}-ETA	4.19×10^{-4}
	D	ZnO	1.58×10^{-4}
P3HT:$PC_{61}BM$	**E**	C_{60}-ETA	9.60×10^{-4}
	F	ZnO	1.27×10^{-4}

[a] Measured by electron-only devices with the structure of ITO/ETL/active layer/Ca/Al.

S9. Determination of work function of ITO/C_{60}-ETA or ITO/ZnO by SKPM.

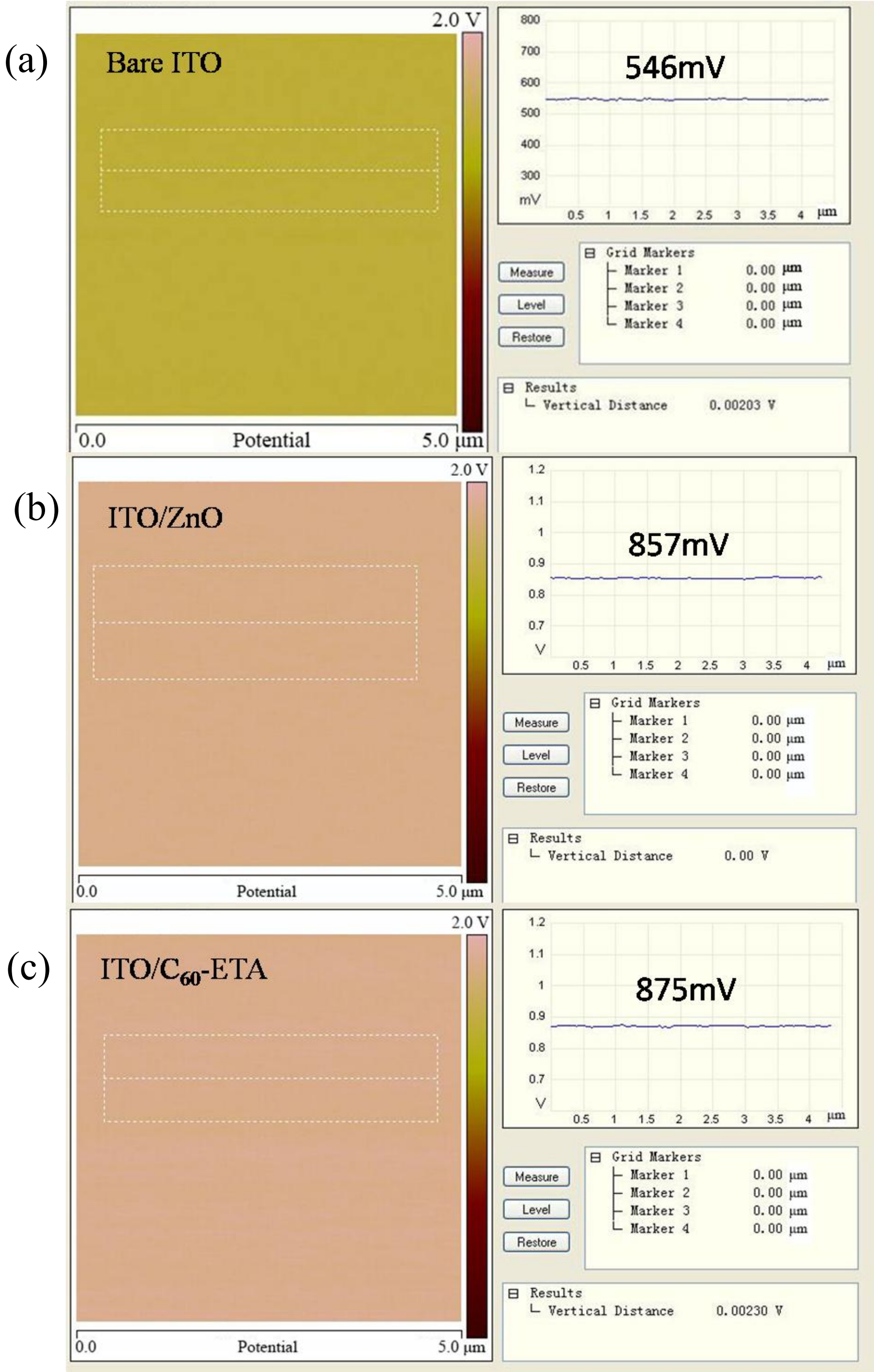

Figure S7. Surface potential images (5 μm × 5 μm) and the surface potentials of bare ITO (a), ITO/ZnO (b) and ITO/C_{60}-ETA (c).

Table S3. The surface potentials and work functions of ETLs.

Device	ITO/ETL		
	without ETL (bare)	ZnO ETL	C_{60}-ETA ETL
Surface potential (SP, mV)	546	857	875
ΔSP (mV) [a]	-	311	329
ΔΦ (eV) [b]	-	0.31	0.33
Φ (eV)	-4.7 [c]	-4.39	-4.37

[a] ΔSP is the surface potential change of ITO/ETL relative to the bare ITO;

[b] Φ is the work function of film sample, ΔΦ is the work function change of ITO/ETL relative to the bare ITO. ΔΦ =eΔSP;

[c] The work function of the bare ITO (Φ(bare ITO)= -4.7 eV) is referred to ref. S1.

Φ(ITO/ETL)= Φ(bare ITO) + ΔΦ.

Reference:

[S1]. Z. He, C. Zhong, S. Su, M. Xu, H. Wu, Y. Cao, *Nature Photon.* 2012, ***6***, 593.