Supporting Information

A Water-Soluble Metallophthalocyanine Derivative as Cathode Interlayer for Highly Efficient Polymer Solar Cells

Xiao Cheng, Shuheng Sun, Youchun Chen, YajunGao, Lin Ai, Tao Jia, Fenghong Li and Yue Wang**

State Key Laboratory of Supramolecular Structure and Materials, Jilin University

Qianjin Avenue,Changchun, 130012, P. R. China

E-mail: fhli@jlu.edu.cn; yuewang@jlu.edu.cn

Space charge limited current (SCLC) measurements of electron-only devices

In order to obtain the electron mobility in the polymer solar cells, we carried out SCLC measurements of electron-only devices, which are **Device V**(ITO/Al/PTB7:$PC_{71}BM$/Al), **Device VI** (ITO/Al/PTB7:$P_{71}CBM$/0.6% acetic acid/Al), **Device VII**(ITO/Al/PTB7:$PC_{71}BM$/PFN/Al) and **Device VIII**(ITO/Al/PTB7:$PC_{71}BM$/VOPc($OPyCH_3I)_8$/Al). The electron mobility can be measured in the SCLC regime as described by

$$J=9\varepsilon_0\varepsilon_r\mu V^2/8L^3, \qquad (1)$$

whereε_0 is the permittivity of free space (8.8542×10^{-12} F/m), ε_r is the dielectric constant of the active layer, μ_e is the electron mobility, V is the voltage drop across the device, L is the active layer thickness. The above equation holds if the mobility is field independent. ε_r is assumed to be 3.9 and L is 120nm in our analysis. Figure S1 presents our $J^{0.5}$-V analysis for the four electron-only devices (**Devices V-VIII**), where V_r (the voltage drop due to contact resistance and series resistance across the electrodes) and V_{bi} (the built-in voltage due to the difference in work function of the two electrodes at both sides of active layer) are subtracted from experimental applied voltage. The contact resistance and series resistance related with V_r was measured in the reference devices without active layer. For **Devices V** and **VI**, the reference device is ITO/Al/Al and the obtained resistance is 15 Ω. For **Device VII** , the reference device is ITO/Al/PFN/Al and the resistance is 14.4 Ω. For **Device VIII**, the reference device is ITO/Al/VOPc($OPyCH_3I)_8$/Al and the resistance is 40.3 Ω. The V_{bi} was deduced from the best fit of the $J^{0.5}$ versus V_{appl} plot at voltages above 1.1 V to Eq. (1)

as summarized in **Table S1**. A straight line going through the origin of $J^{0.5}$-V curves for the four devices signifies that the mobility is field independent at field up to 2×10^5 V/cm. The field independent mobilities calculated from Eq. (1) are 2.7×10^{-5} cm^2/V s for **Device V**, 3.6×10^{-5} cm^2/V s for **Device VI**, 4.6×10^{-4} cm^2/V s for **Device VII** and 7.1×10^{-4} cm^2/V s for **Device VIII**presented in **Table S1**.For comparison, we also fabricated other four electro only devices (**Devices V_R, VI_R, VII_R, $VIII_R$**) with the active layer of 170 nm, parameters of which are as well shown in **Table S1**.

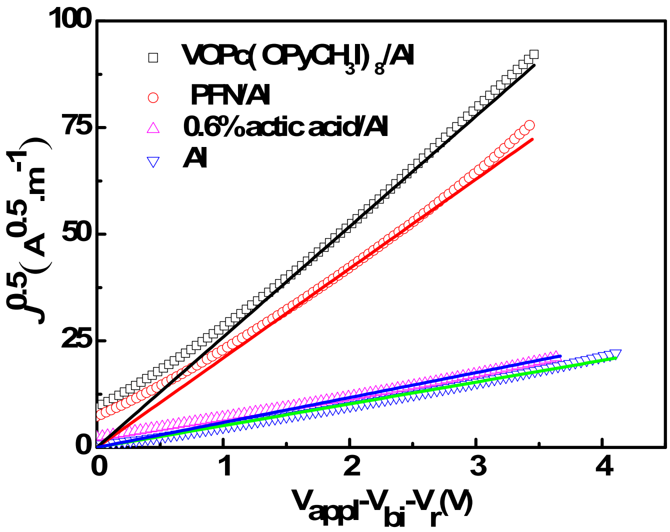

Figure S1. $J^{0.5}$ vs. V_{appl}-V_{bi}-V_r plots for the electron-only devices with $VOPc(OPyCH_3I)_8$ (black line), PFN (red line) as a cathode interlayer, and with (magenta line) and without (blue line) 0.6% acetic acid treatment at the surface of active layer.

Table S1. Mobility and related parameters for the electron-only devices.

Electron-only device	Resistance related with Vr (Ω)	V_{bi} (V)	mobility (cm^2/V s)
V (120 nm)	15	0.32	2.7×10^{-5}
VI (120 nm)	15	0.25	3.6×10^{-5}
VII (120 nm)	14.4	0.51	4.6×10^{-4}
VIII (120 nm)	40.3	0.48	7.1×10^{-4}
V_R (170 nm)	15	0.32	1.3×10^{-5}
VI_R (170 nm)	15	0.25	2.4×10^{-5}
VII_R (170 nm)	14.4	0.51	1.7×10^{-4}
$VIII_R$ (170 nm)	40.3	0.48	3.3×10^{-4}

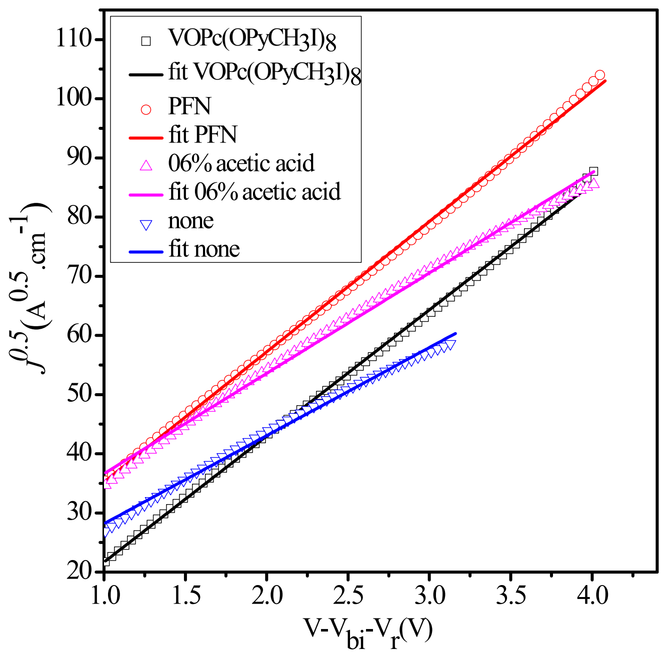

Figure S2. $J^{0.5}$ vs. V_{appl}-V_{bi}-V_r plots for the hole-only devices with VOPc($OPyCH_3I$)$_8$ (black squares and line), PFN (red circles and line) and 0.6% acetic acid treatments (magenta up triangles and line) at the surface of active layer, and without any treatment at the at the surface of active layer (blue down triangles and line).