# Solvent Annealing on Moropholoy Control Enables High Efficiency All-small-molecule Organic Solar Cells

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## **Experimental Section**

#### 1. Materials

All reagents and solvents, unless otherwise specified, were purchased from Energy Chemical, Tansoole, Suna Tech, Aldrich, and JiangSu GE-Chem Biotech., Ltd. and were used without further purification. BTR-Cl and Y6 were synthesized.

#### 2. Thin film Characterizations

i. Ultraviolet-visible light (UV-vis) absorbance spectra were recorded on a Perkin
Eimer Lambda 365 spectrophotometer. The contact angle was measured by DSA-100
(KRUSS Germany).

ii. Topographic images of the films were obtained from a Bruker atomic force microscopy (AFM) with the type of dimension edge with Scan AsystTM in the tapping mode using an etched silicon cantilever at a nominal load of ~40nN, and the scanning rate for a 2  $\mu$ m×2  $\mu$ m image size was 1.5 Hz.

iii. Transmission electron microscope (TEM) studies were conducted with a JEM-2100Plus electron microscopy to investigate the phase distribution of the active layer.

### 3. Device Fabrication and characterizations

The device structures were ITO/PEDOT:PSS/Active layer/PNDIT-F3N/Ag. ITO coated glass substrates were cleaned with detergent water, deionized water, acetone and isopropyl alcohol in an ultrasonic bath sequentially for 15 min, and further treated with UV exposure for 15 min in a UV-ozone chamber. A thin layer (ca. 30 nm) of

PEDOT:PSS (Bayer Baytron 4083) was first spin-coated on the substrates with 4000 rpm and baked at 120 °C for 10 min under ambient conditions. The substrates were then transferred into a nitrogen-filled glove box. The all concentration was 18 mg/ml chloroform solution with D:A ratio of 1.6:1 (w/w). After spin coating, the TA-treatment blends were at 120 °C for 10 mins. The CS<sub>2</sub>-treatment blends were annealed with CS<sub>2</sub> for 50s. Then Phen-NaDPO as the electron transporting layer was spin-coated on the active layer by 2000 rpm. Finally, the substrates were transferred to a thermal evaporator, and top electrode was evaporated at a pressure of  $2 \times 10^{-5}$  Pa.

The external quantum efficiency (*EQE*) was performed using certified IPCE equipment (Enli Technology Co., Ltd. RC-BAS04). The J-V curves were measured under AM 1.5 G (100 mW cm<sup>-2</sup>) (Enli Technology Co., Ltd. SS-X50R). The J-V measurement signals were recorded by a Keithley 2400 source-measure unit. Device area of each cell was 0.1 cm<sup>2</sup>.

#### 4. SCLC Mobility Measurements

The carrier mobility (hole and electron mobility) of photoactive layer was determined by fitting the dark current of hole/electron-only diodes to the space-charge-limited current (SCLC) model. Hole-only diode configuration: Glass/ITO/PEDOT:PSS/active layer/MoO<sub>3</sub>/Ag; Electron-only diode configuration: Glass/ITO/ZnO/Phen-NaDPO/active layer/Phen-NaDPO/Ag.  $V_{bi}$ =0 was used for both fittings. The active layer thickness was determined by a Tencor surface profilometer. The electric-field dependent SCLC mobility was estimated using the following

equation:

$$J(V) = \frac{9}{8}e_0e_rm_0exp\left(0.89b_{\sqrt{\frac{V-V_{bi}}{L}}}\right)\frac{(V-V_{bi})^2}{L^3}$$

## 5. Photocurrent density VS. effective voltage

The J<sub>ph</sub> is defined as J<sub>ph</sub> = J<sub>L</sub> - J<sub>D</sub>, where JL is the current density under illumination and JD is that in the dark, respectively. V<sub>eff</sub> is given by V<sub>eff</sub> = V<sub>0</sub> - V<sub>A</sub>, where V<sub>0</sub> is the voltage when Jph is equal to 0, and VA is the applied bias voltage. The exciton dissociation efficiency ( $\eta_{diss} = J_{SC}/J_{sat}$ ) and charge collection efficiency ( $\eta_{coll} = J_{max}$ <sub>power</sub>/J<sub>sat</sub>) were calculated under short-circuit and maximum power out-put conditions, respectively.