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Supporting information

# Vacuum-depositable thiophene and benzothiadiazole based donor materials for organic solar cells

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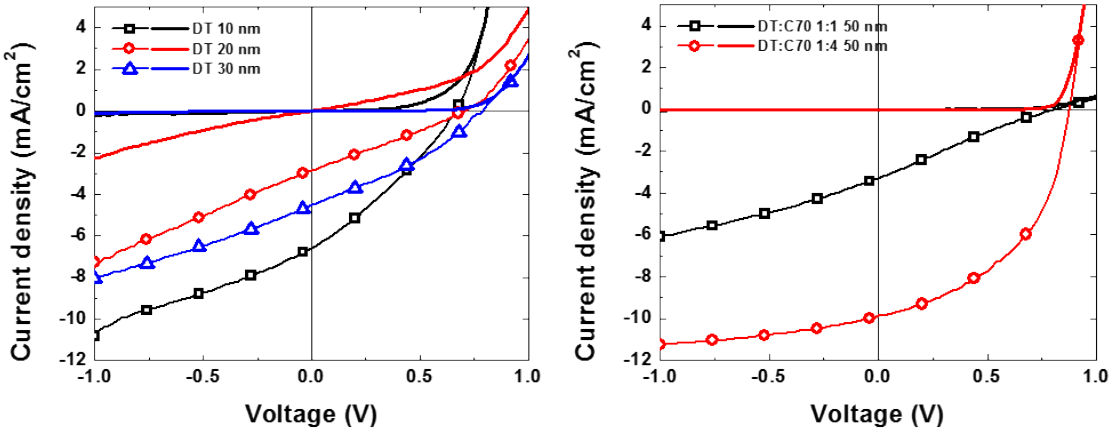


**Fig. S1**. J-V characteristic plots for **DT** based devices (left: PHJ devices, right: BHJ devices).

| | *PCE* /% | $J_{SC}$ / mA/cm$^2$ | $V_{OC}$ / V | *FF* | $R_pA$ / Ωcm$^2$ | $R_SA$ / Ωcm$^2$ |
|---|---|---|---|---|---|---|
| DT 10 nm | 1.32 | 6.58 | 0.67 | 0.30 | 6021.19 | 3.00 |
| DT 20 nm | 0.54 | 2.85 | 0.71 | 0.27 | 488.21 | 3.77 |
| DT 30 nm | 1.17 | 4.53 | 0.79 | 0.33 | $2.96\times10^4$ | 14.16 |
| DT:$C_{70}$ 1:1 50 nm | 0.60 | 3.29 | 0.81 | 0.23 | $4.49\times10^4$ | 143.30 |
| DT:$C_{70}$ 1:4 50 nm | 4.13 | 9.89 | 0.86 | 0.48 | $4.44\times10^7$ | 5.29 |

**Table S1**. OPV device performances for **DT** based devices.

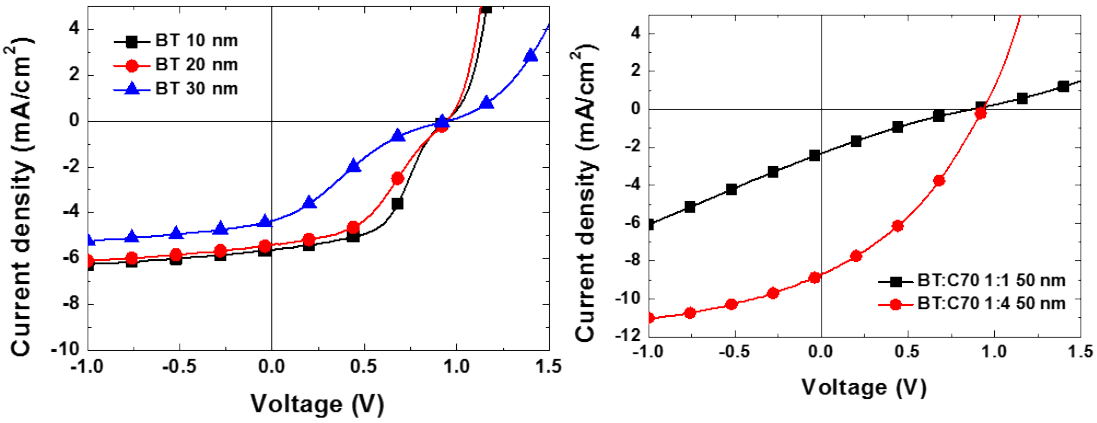


**Fig. S2**. J-V characteristic plots for **BT** based devices (left: PHJ devices, right: BHJ devices).

| | *PCE* /% | $J_{SC}$ / mA/cm$^2$ | $V_{OC}$ / V | *FF* | $R_pA$ / Ωcm$^2$ | $R_SA$ / Ωcm$^2$ |
|---|---|---|---|---|---|---|
| BT 10 nm | 2.69 | 5.61 | 0.94 | 0.51 | $3.09\times10^7$ | 2.30 |
| BT 20 nm | 2.15 | 5.40 | 0.96 | 0.41 | $6.45\times10^7$ | 5.51 |
| BT 30 nm | 0.66 | 3.57 | 0.95 | 0.19 | $12.14\times10^7$ | 315.62 |
| BT:$C_{70}$ 1:1 50 nm | 0.35 | 2.03 | 0.86 | 0.20 | $4.14\times10^7$ | 367.49 |
| BT:$C_{70}$ 1:4 50 nm | 2.81 | 8.60 | 0.94 | 0.35 | $12.53\times10^7$ | 13.36 |

**Table S2**. OPV device performances for **BT** based devices.

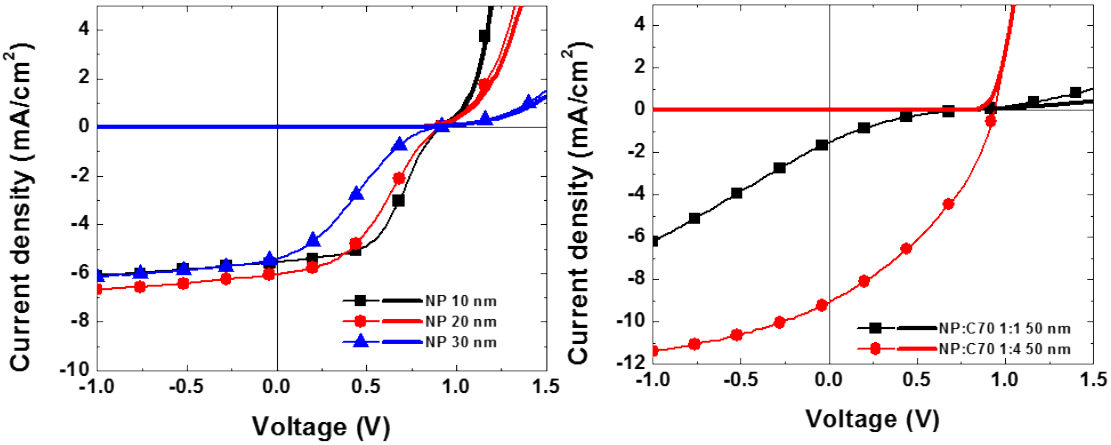


**Fig. S3**. J-V characteristic plots for **NP** based devices (left: PHJ devices, right: BHJ devices).

| | *PCE* /% | $J_{SC}$ / mA/cm$^2$ | $V_{OC}$ / V | *FF* | $R_PA$ / Ω$cm^2$ | $R_SA$ / Ω$cm^2$ |
|---|---|---|---|---|---|---|
| NP 10 nm | 2.56 | 5.62 | 0.92 | 0.50 | $7.39\times10^7$ | 3.56 |
| NP 20 nm | 2.16 | 6.04 | 0.91 | 0.39 | $8.71\times10^7$ | 20.62 |
| NP 30 nm | 1.36 | 5.46 | 0.88 | 0.28 | $4.57\times10^7$ | 218.41 |
| NP:$C_{70}$ 1:1 50 nm | 0.13 | 1.10 | 0.77 | 0.16 | $4.57\times10^7$ | 1301.53 |
| NP:$C_{70}$ 1:4 50 nm | 3.11 | 8.99 | 0.93 | 0.37 | $3.24\times10^7$ | 7.92 |

**Table S3**. OPV device performance for **NP** based devices.

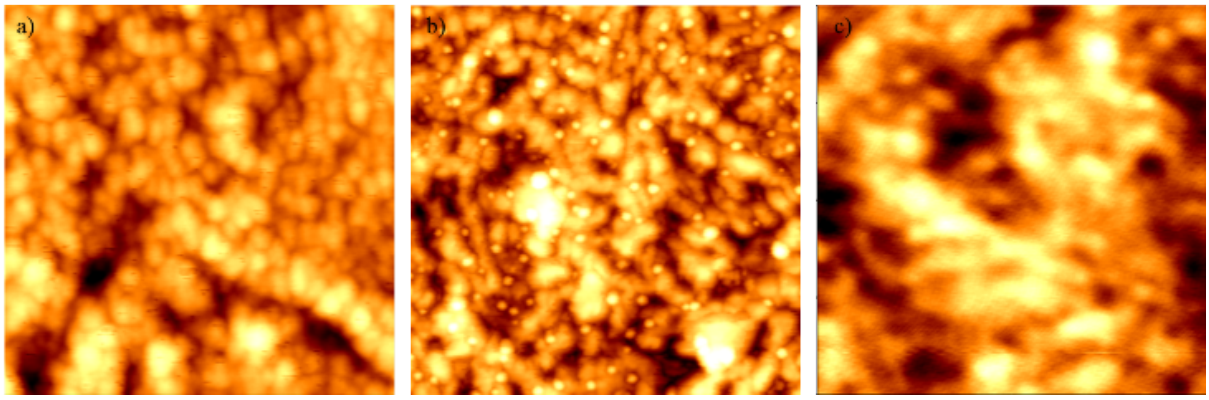


**Fig. S4**. AFM images of a) **NP**, b) **BT** and c) **DT** films. The film thickness is 10 nm and scope range is 1000 nm×1000 nm.

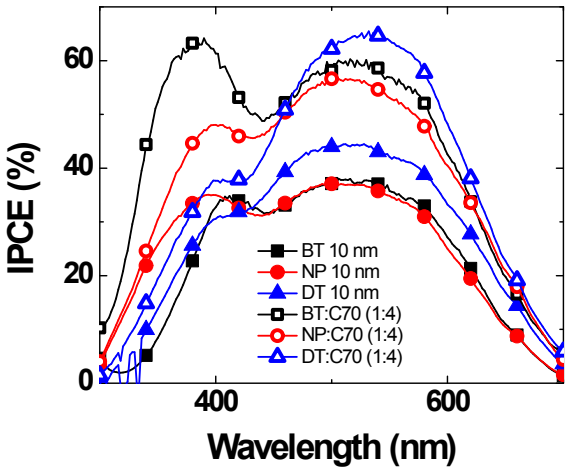


**Fig. S5**. IPCE data for PHJ devices (active layer thickness: 10 nm) and BHJ devices (donor:$C_{70}$=1:4)

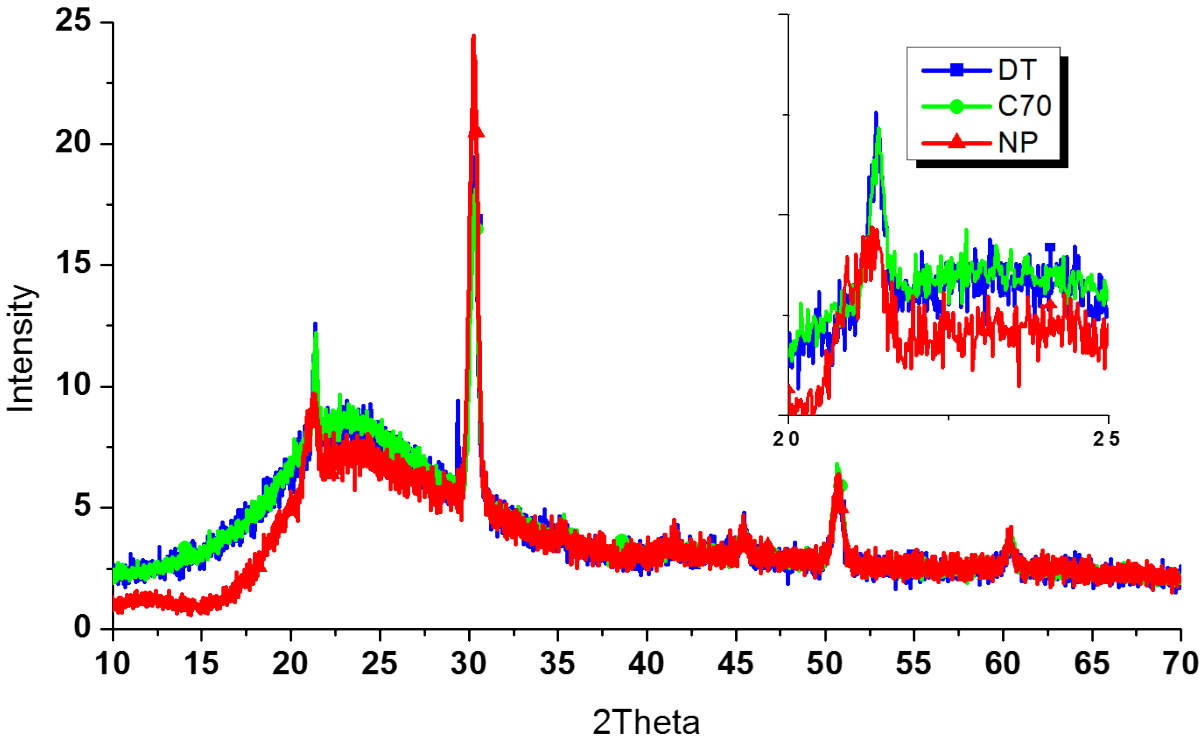


**Fig. S6**. X-ray diffraction spectra for $C_{70}$, **NP**:$C_{70}$=1:4, **DT**:$C_{70}$=1:4 blended thin film on the ITO. (Inset: enlarged spectra range from 2θ=20 to 25). Measuring condition: detector, LYNXEYE XE (0D mode); generator: 40 kV, 40 mA; 2θ range: 10-70 degree; step: 0.02; scan speed: 0.5 sec/step; wavelength (λ): Cu *Kα*1 - 1.5418 Å.

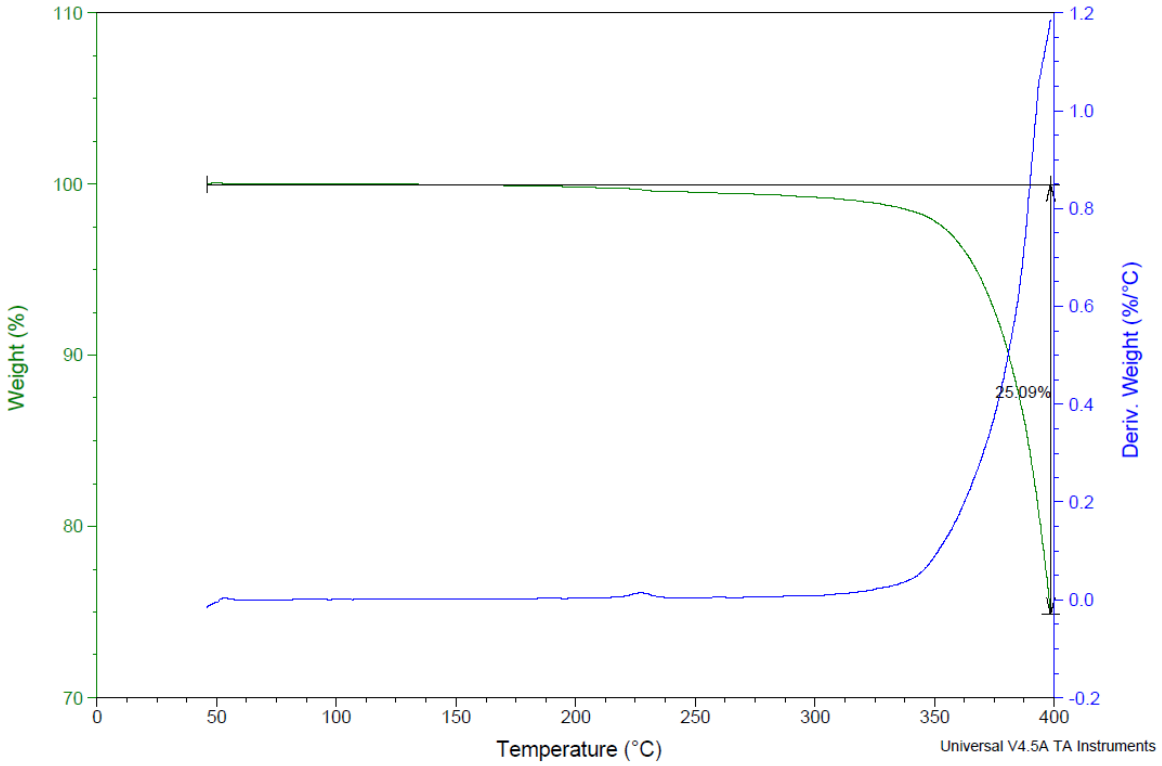


**Fig. S7**. TGA data for **DT**. $N_2$, 10 K/min.

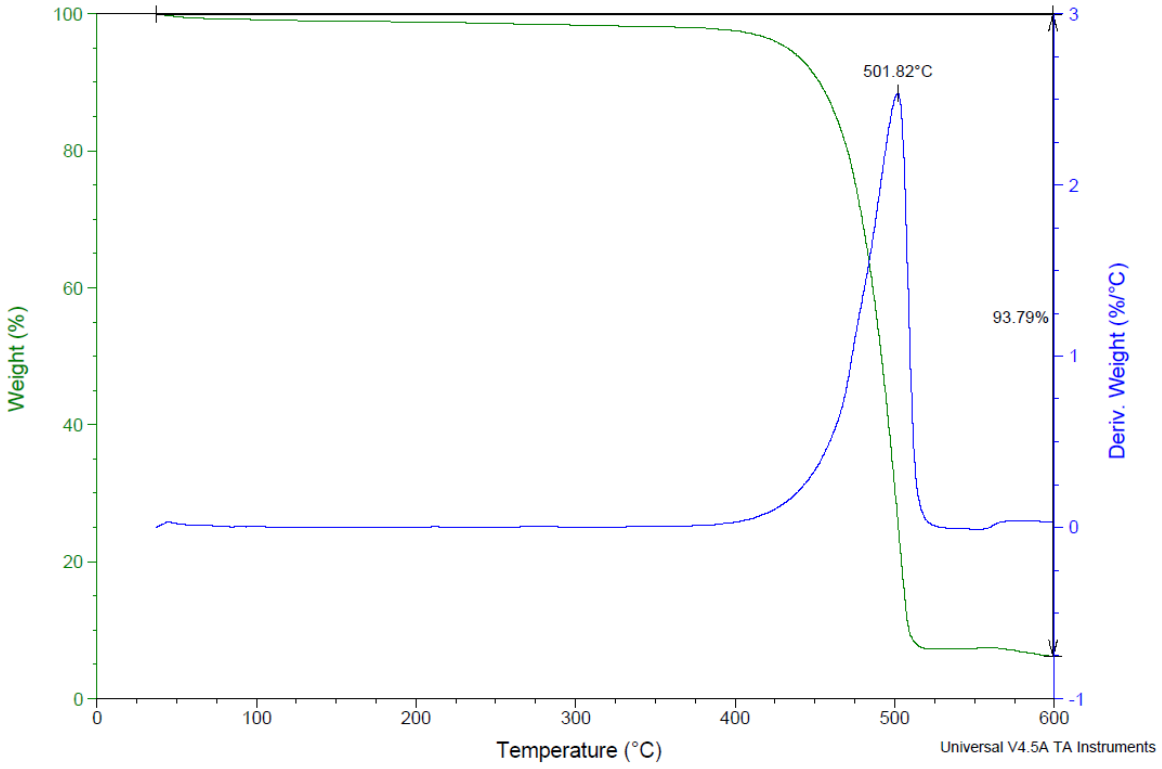


**Fig. S8**. TGA data for **NP**. $N_2$, 10 K/min.

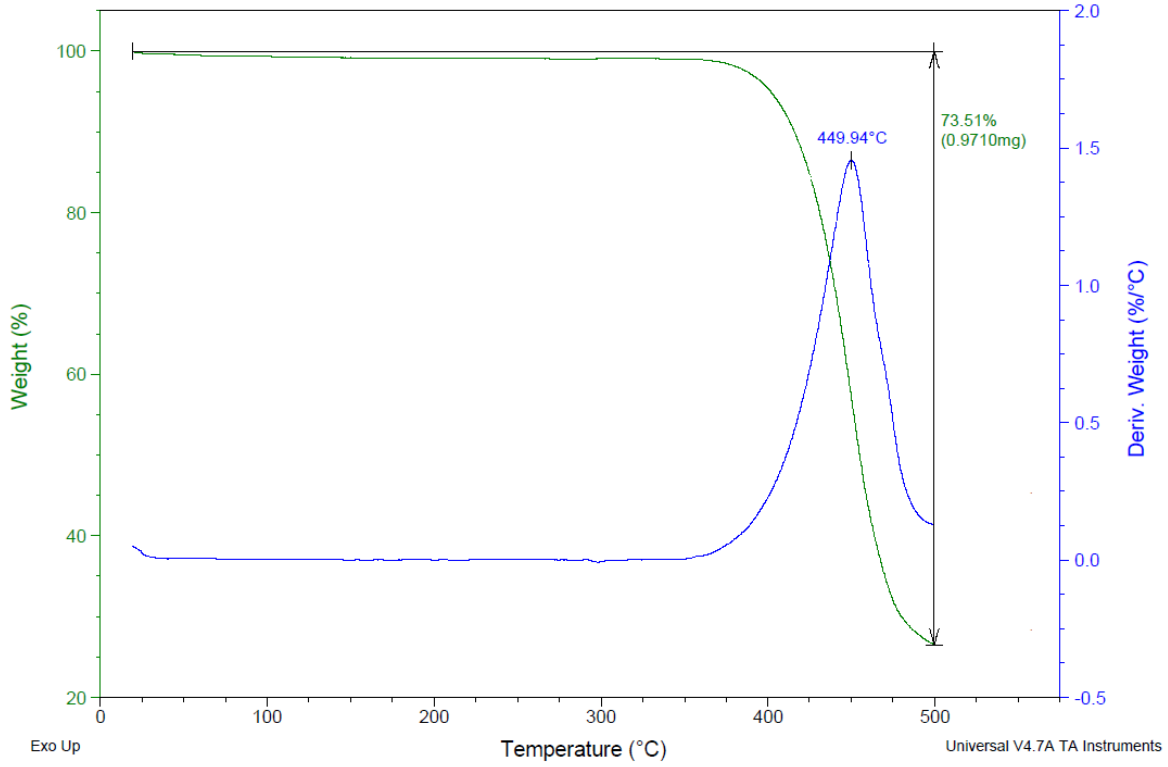


**Fig. S9**. TGA data for **BT**. $N_2$, 10 K/min.

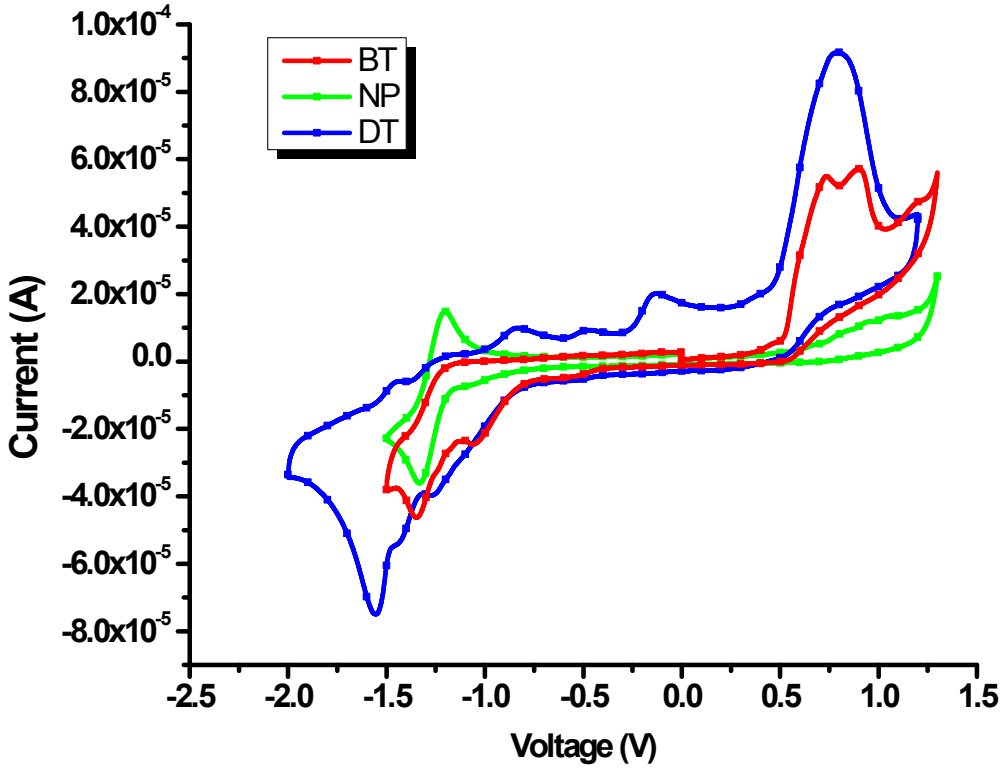


**Fig. S10**. CV data for **BT**, **DT** and **NP**.