

Supporting information

**Improved photovoltaic performance of 2D-conjugated
benzodithiophene-based polymer by the side chain
engineering at quinoxaline**

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1. Photovoltaic properties of polymer-based PSCs at different conditions

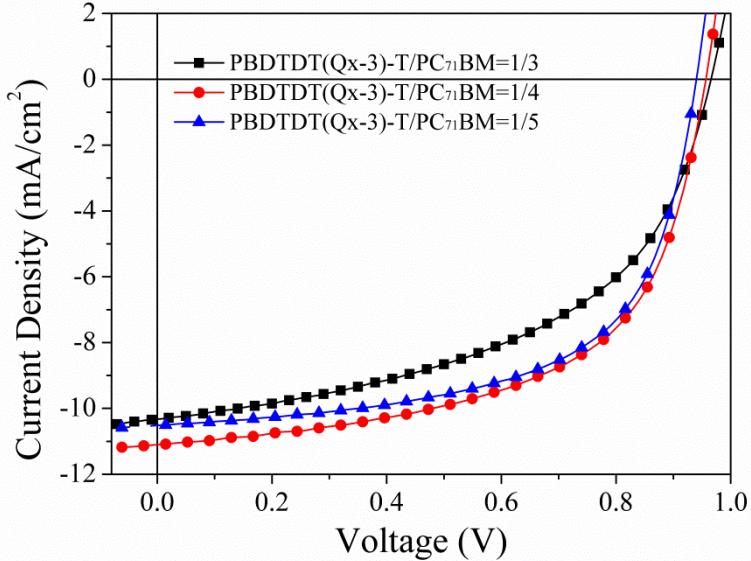


Fig. S1. *J-V* curves of the PBDTDT(Qx-3)-T/PC₇₁BM-based PSCs with different blend ratios (*w/w*) at an annealing temperature of 80 °C under illumination of AM 1.5G, 100 mW/cm².

Table S1. Photovoltaic properties of the PBDTDT(Qx-3)-T/PC₇₁BM-based PSCs with different blend ratios (*w/w*) at an annealing temperature of 80 °C under illumination of AM 1.5G, 100 mW/cm².

D/A Ratio	J_{sc} / mA cm ⁻²	V_{oc} / V	FF/ %	PCE _{max} / %
1/3	10.32	0.96	50.9	5.1
1/4	11.09	0.96	58.4	6.2
1/5	10.51	0.94	61.1	6.0

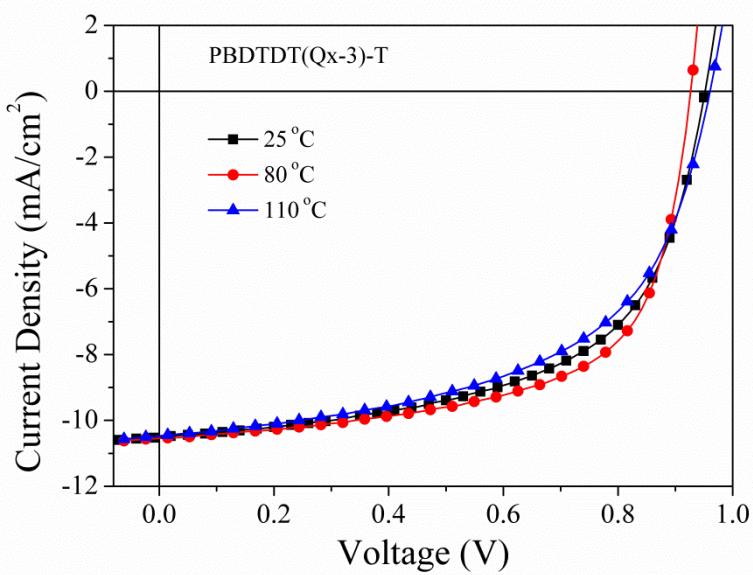


Fig. S2. *J-V* curves of the PBDTDT(Qx-3)-T/PC₇₁BM-based PSCs with different temperature at the optimized ratio of 1/4 under illumination of AM 1.5G, 100 mW/cm².

Table S2. Photovoltaic properties of the PBDTDT(Qx-3)-T/PC₇₁BM-based PSCs with different temperature at the optimized ratio of 1/4 under illumination of AM 1.5G, 100 mW/cm².

Temperature/ °C	J_{sc} / mA cm ⁻²	V_{oc} / V	FF/ %	PCE _{max} / %
25	11.09	0.96	58.4	6.2
80	10.50	0.95	58.5	5.8
110	10.46	0.96	55.4	5.6

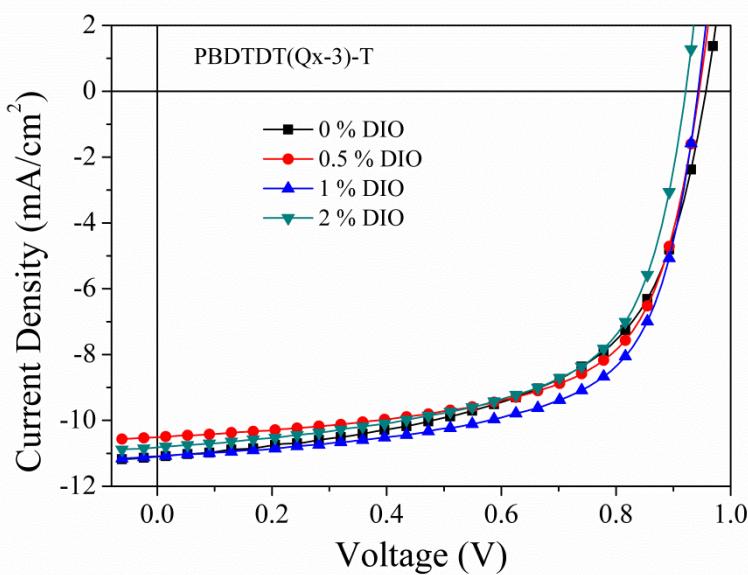


Fig. S3. J - V curves of the PBTDT(Qx-3)-T/PC₇₁BM-based PSCs with different DIO additive concentrations at the optimized ratio of 1/4 and annealing temperature of 80 °C under illumination of AM 1.5G, 100 mW/cm².

Table S3. Photovoltaic properties of the PBTDT(Qx-3)-T/PC₇₁BM-based PSCs with different DIO additive concentrations at the optimized ratio of 1/4 and annealing temperature of 80 °C under illumination of AM 1.5G, 100 mW/cm².

DIO additive concentrations	J_{sc} / mA cm ⁻²	V_{oc} / V	FF/ %	PCE _{max} / %
0%	11.09	0.96	58.4	6.2
0.5%	10.69	0.94	64.3	6.5
1%	11.28	0.94	64.7	6.9
2%	10.82	0.93	62.1	6.2

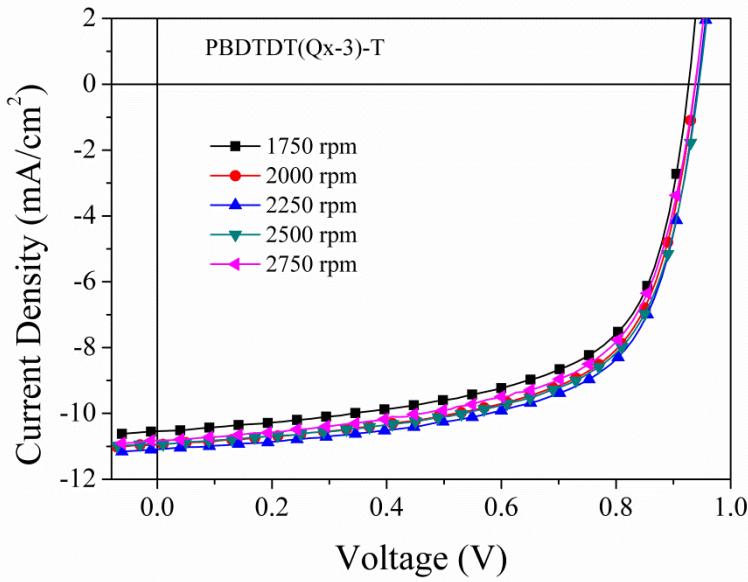


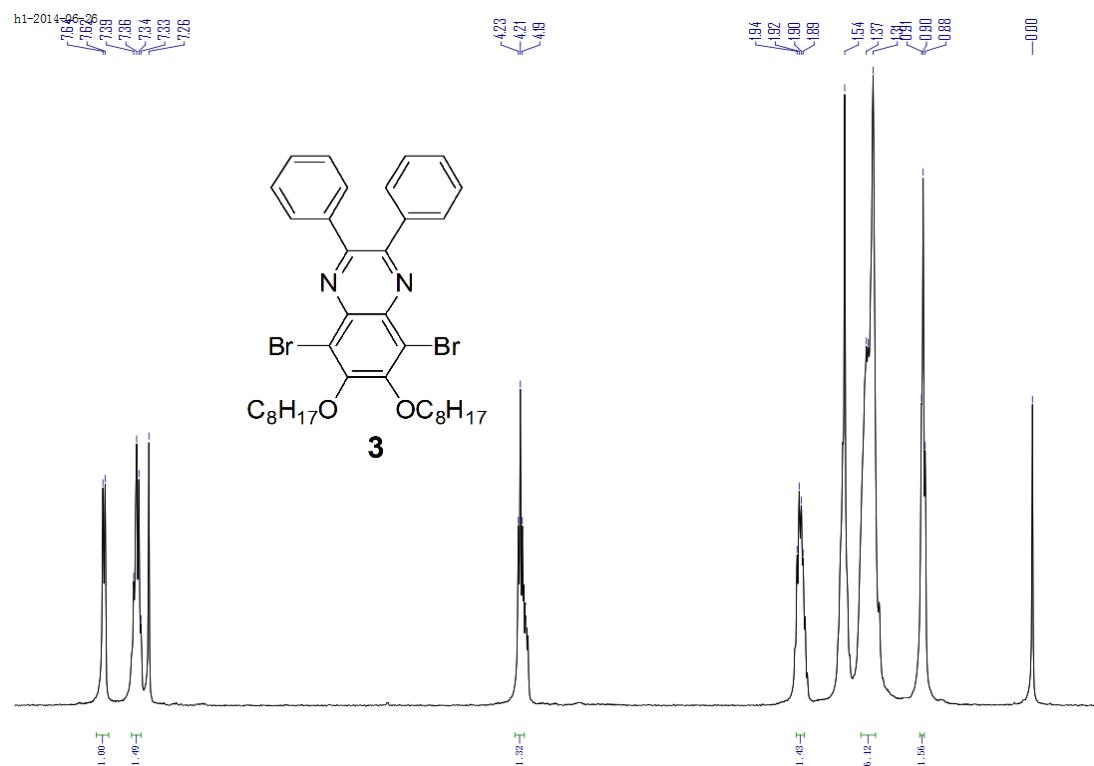
Fig. S4. J - V curves of the PBTDT(Qx-3)-T/PC₇₁BM-based PSCs with different spin-coating rates at the optimized ratio of 1/4, annealing temperature of 80 °C and 1% DIO additive under illumination of AM 1.5G, 100 mW/cm².

Table S4. Photovoltaic properties of the PBTDT(Qx-3)-T/PC₇₁BM-based PSCs with different spin-coating rates at the optimized ratio of 1/4, annealing temperature of 80 °C and 1% DIO additive under illumination of AM 1.5G, 100 mW/cm².

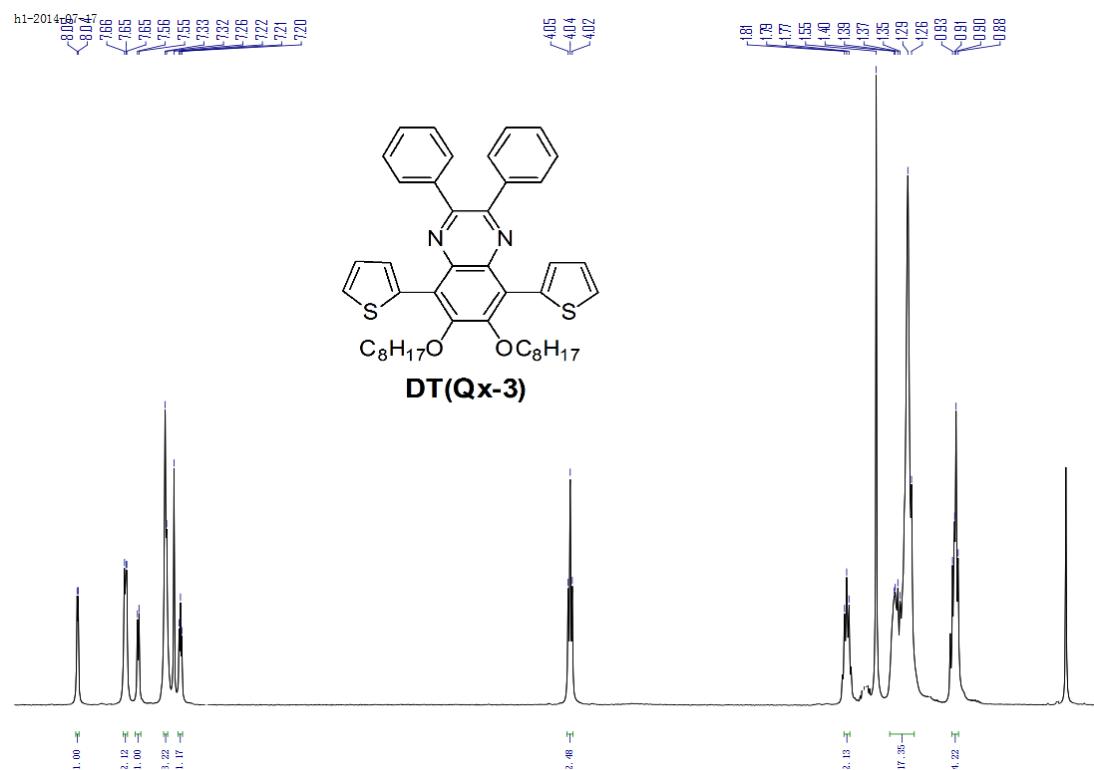
spin-coating rates/ rpm	J_{sc} / mA cm ⁻²	V_{oc} / V	FF/ %	PCE _{max} / %
1750	10.73	0.93	63.4	6.3
2000	11.13	0.94	63.9	6.7
2250	11.28	0.94	64.7	6.9
2500	11.11	0.94	64.2	6.7
2750	11.02	0.94	63.0	6.5

2. ^1H NMR, ^{13}C NMR and MS data of monomers and ^1H NMR data of polymer

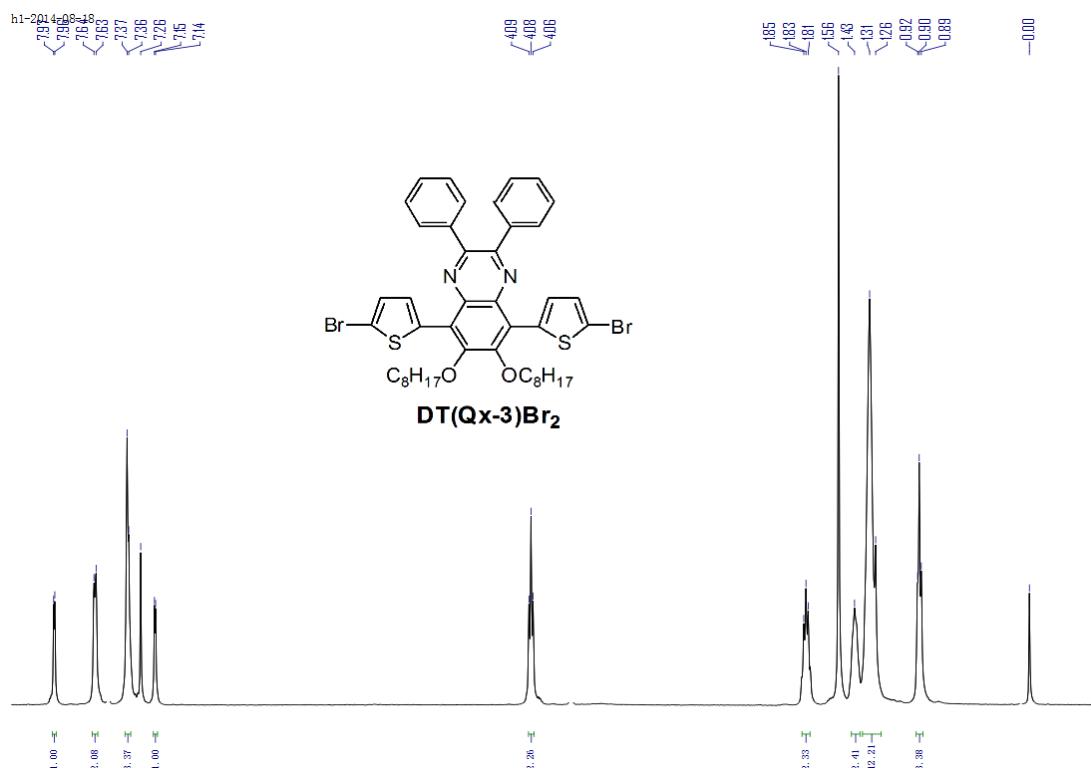
^1H NMR plot of **3**



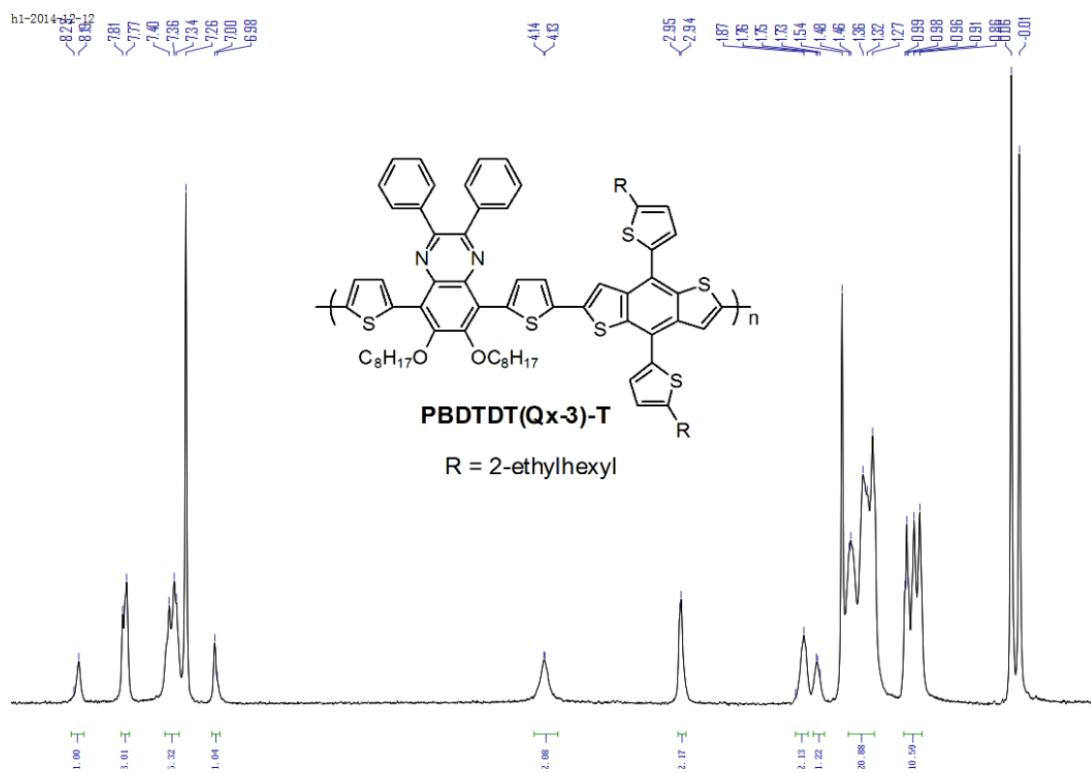
^1H NMR plot of DT(Qx-3)



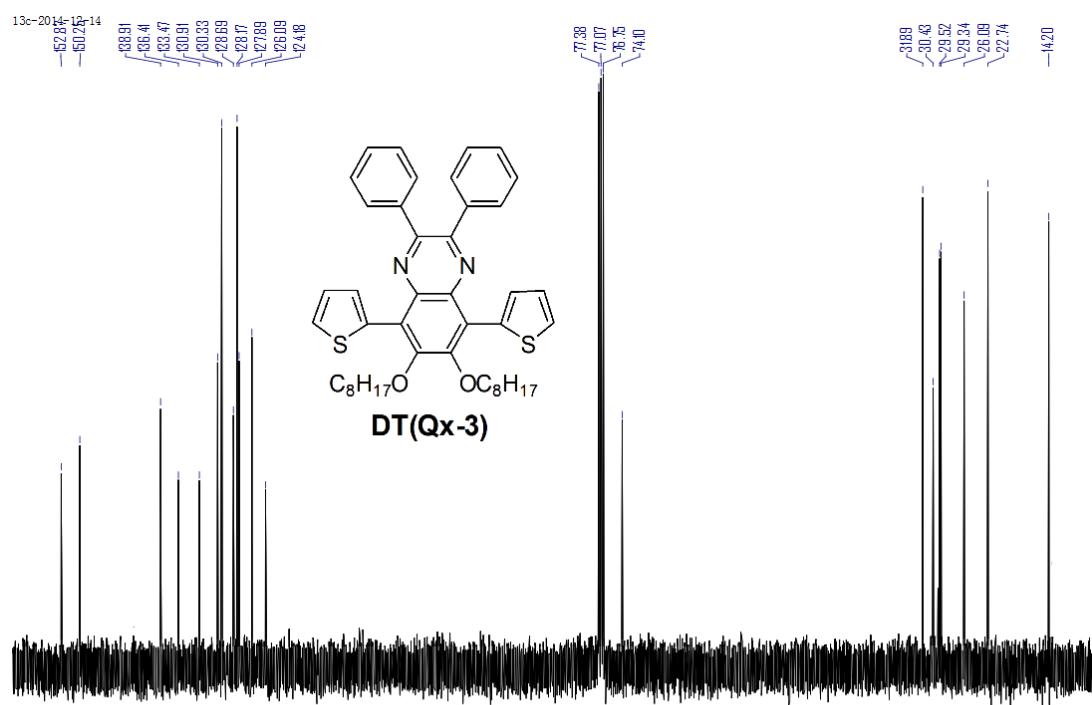
¹H NMR plot of DT(Qx-3)Br₂



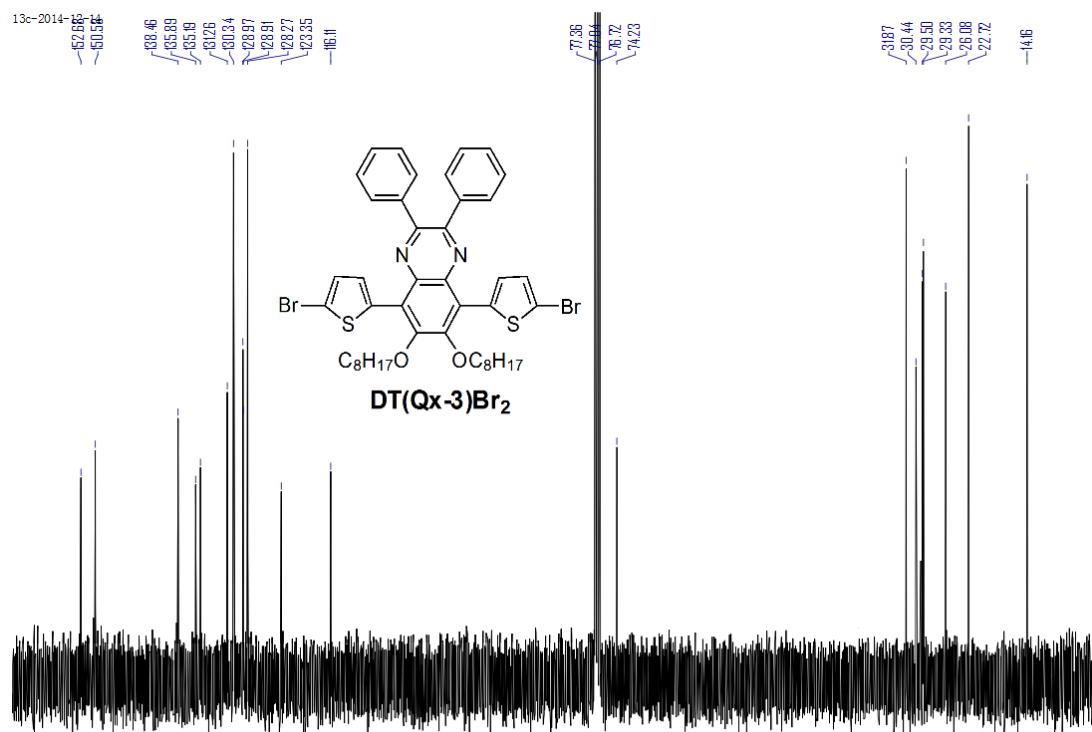
¹H NMR plot of PBDTDT(Qx-3)-T



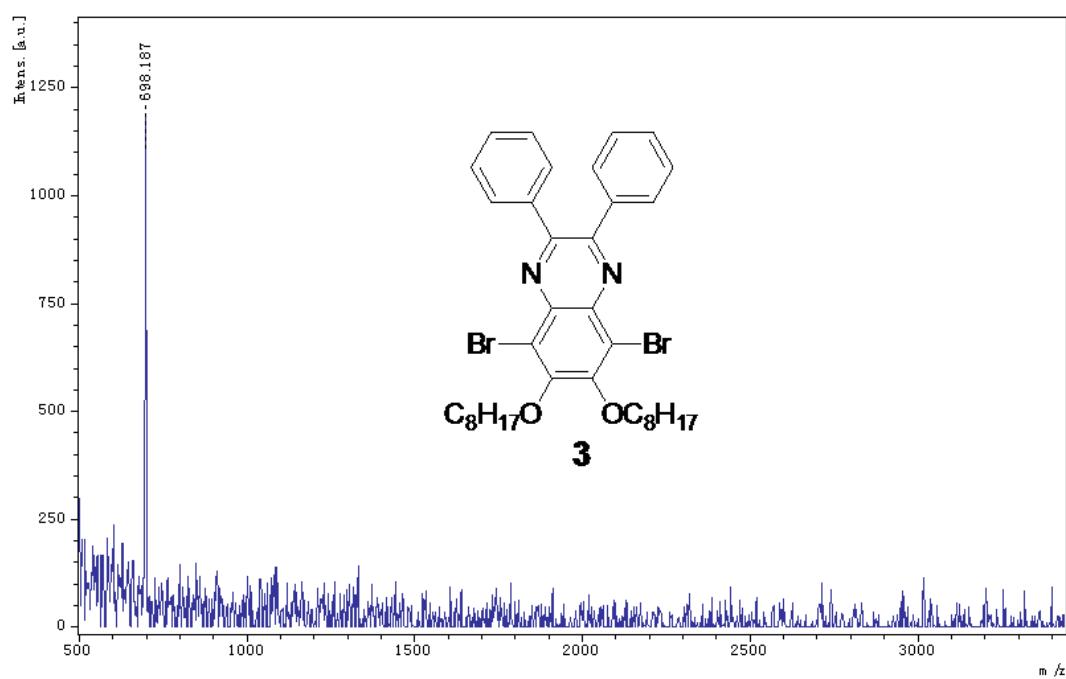
¹³C NMR plot of DT(Qx-3)



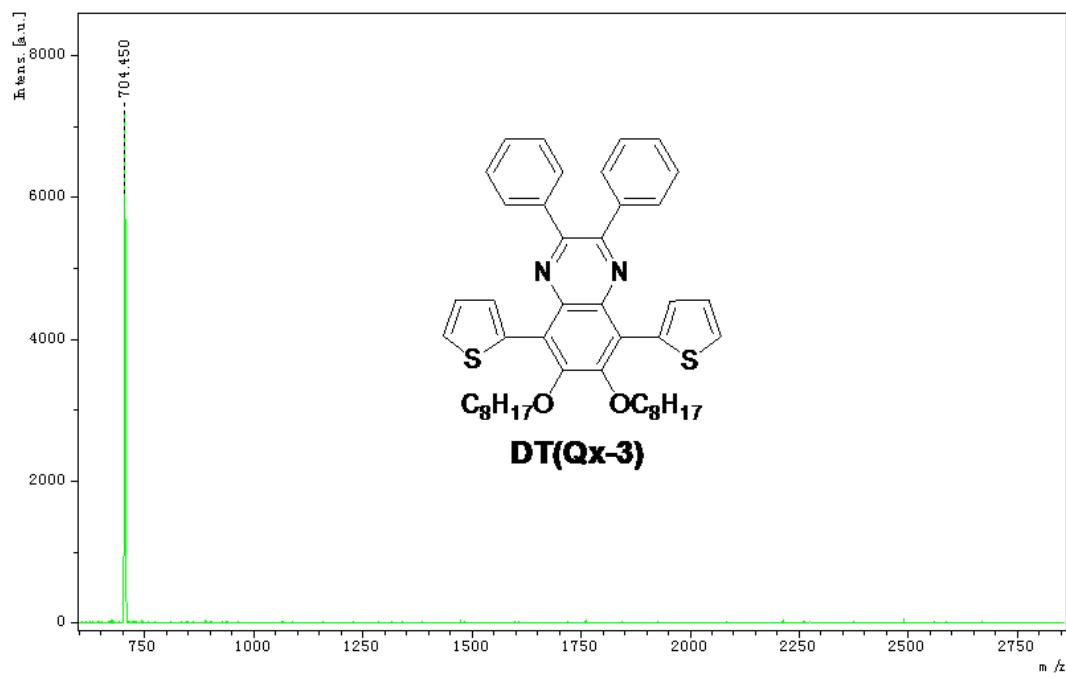
¹³C NMR plot of DT(Qx-3)Br₂



MALDI-TOF plot of **3**



MALDI-TOF plot of **DT(Qx-3)**



MALDI-TOF plot of **DT(Qx-3)Br₂**

