Supplementary Information for

Effects of Conjugation Spacers in Diketopyrrolopyrrole-Based Copolymers for All-Polymer-Based Photodiodes

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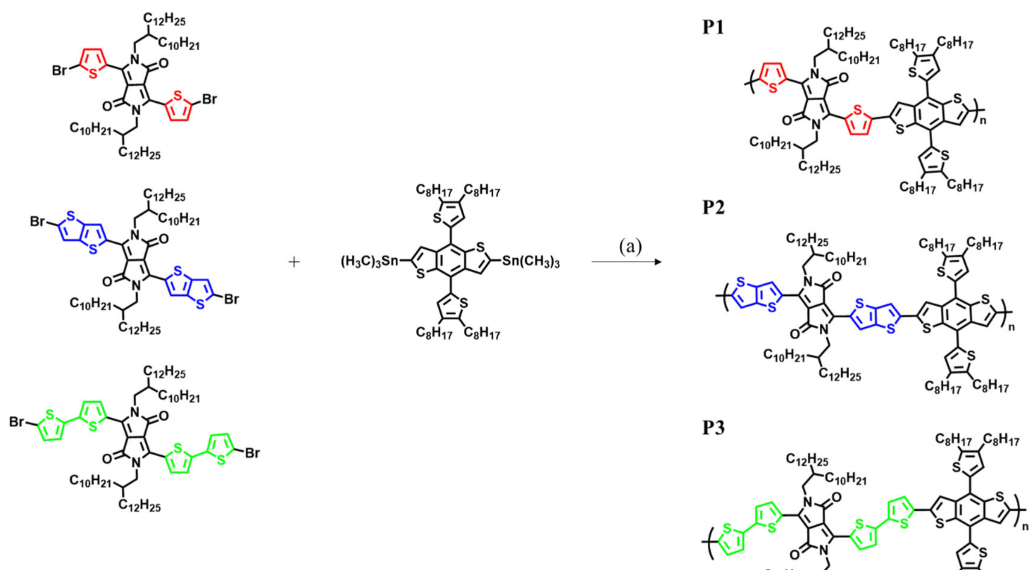
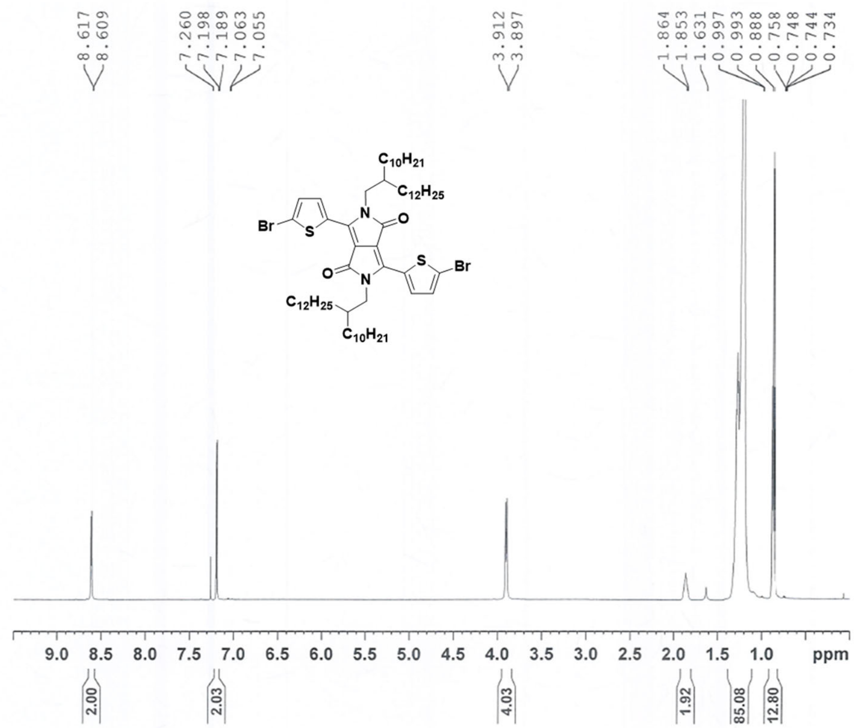


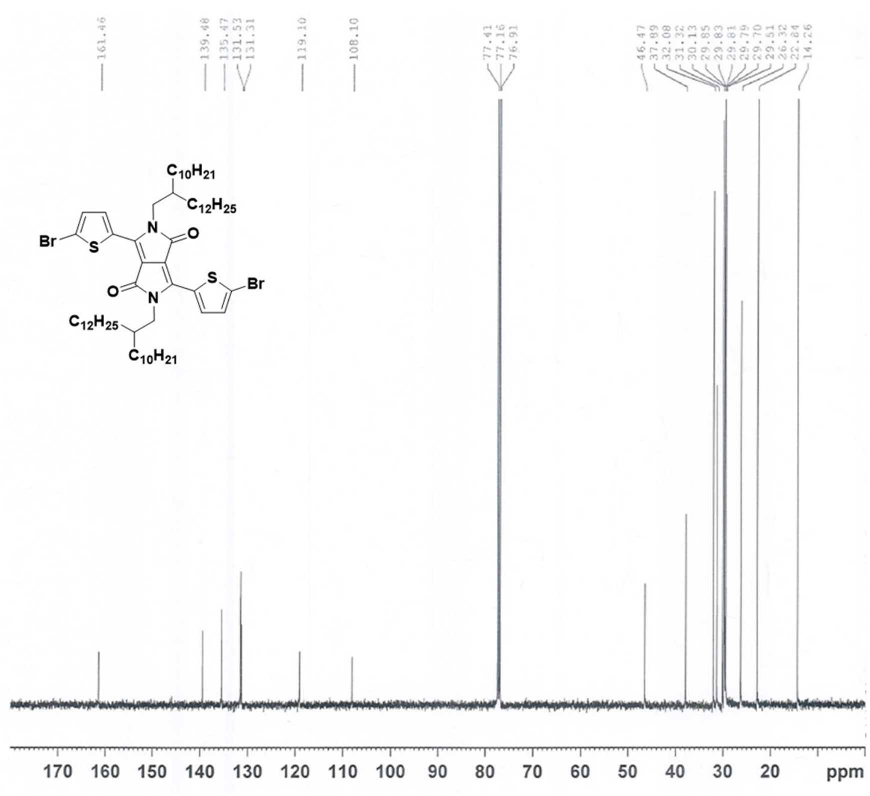
(a) $Pd(PPh_3)_4$, toluene/DMF 110°C

Figure S1. Synthetic procedures for P1, P2 and P3

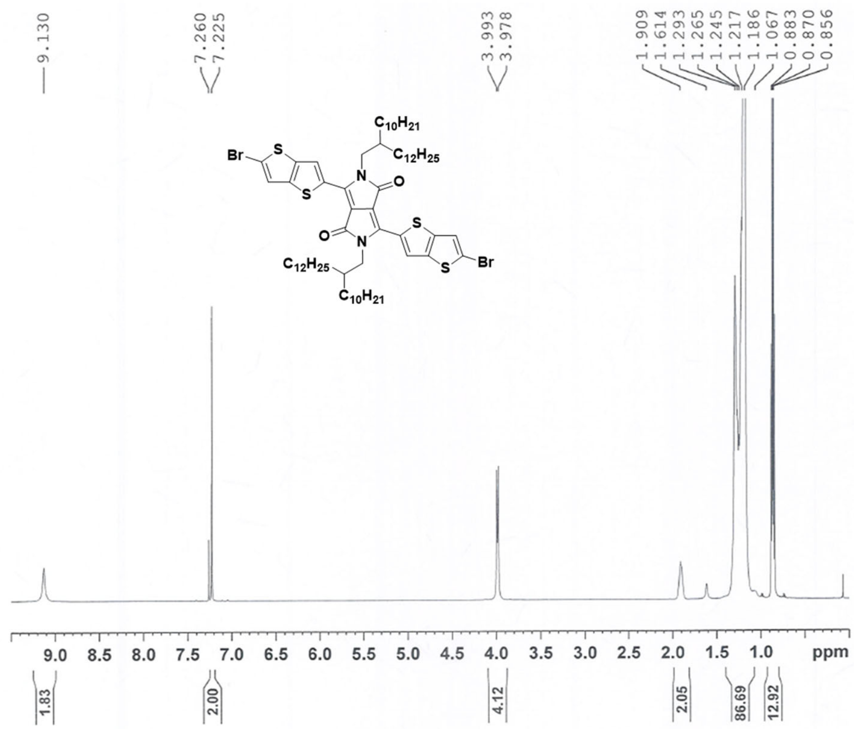
(a) ^{1}H NMR spectrum (500MHz, $CDCl_3$) of Br-T-DPP-T-Br



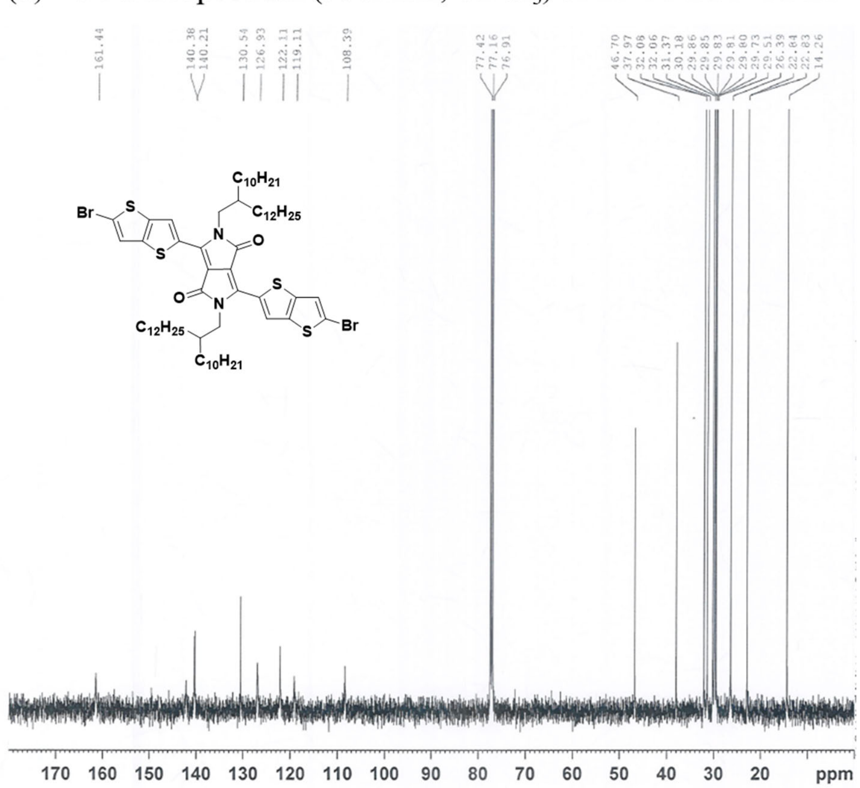
(b) ^{13}C NMR spectrum (500MHz, $CDCl_3$) of Br-T-DPP-T-Br



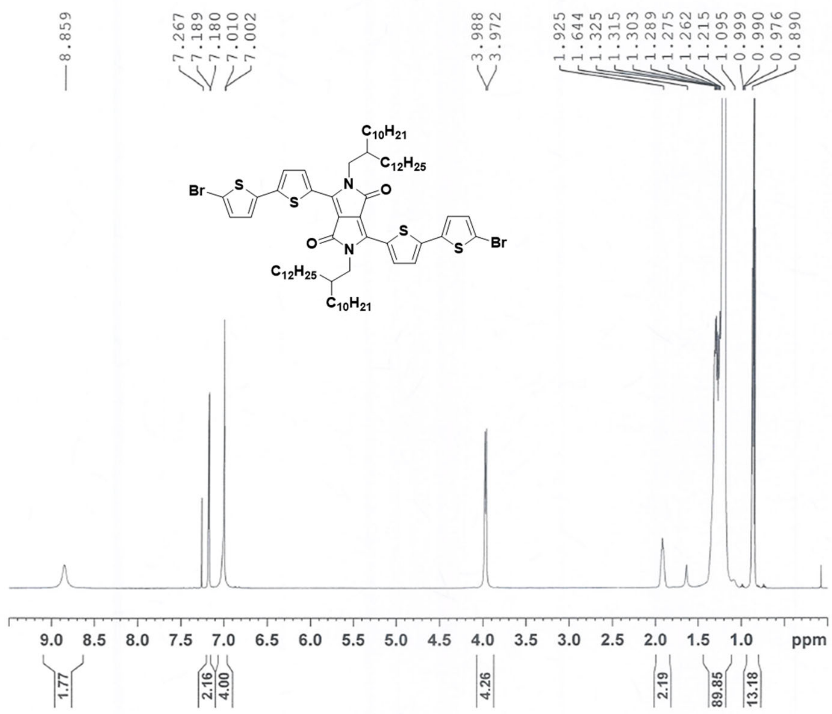
(c) ^{1}H NMR spectrum (500MHz, $CDCl_3$) of Br-TT-DPP-TT-Br



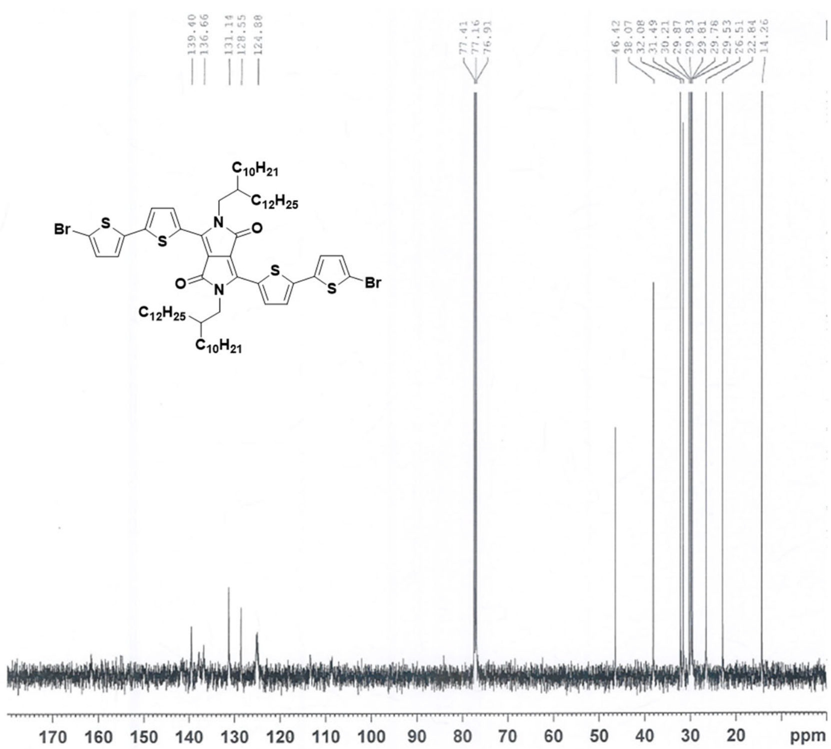
(d) ^{13}C NMR spectrum (500MHz, $CDCl_3$) of Br-TT-DPP-TT-Br



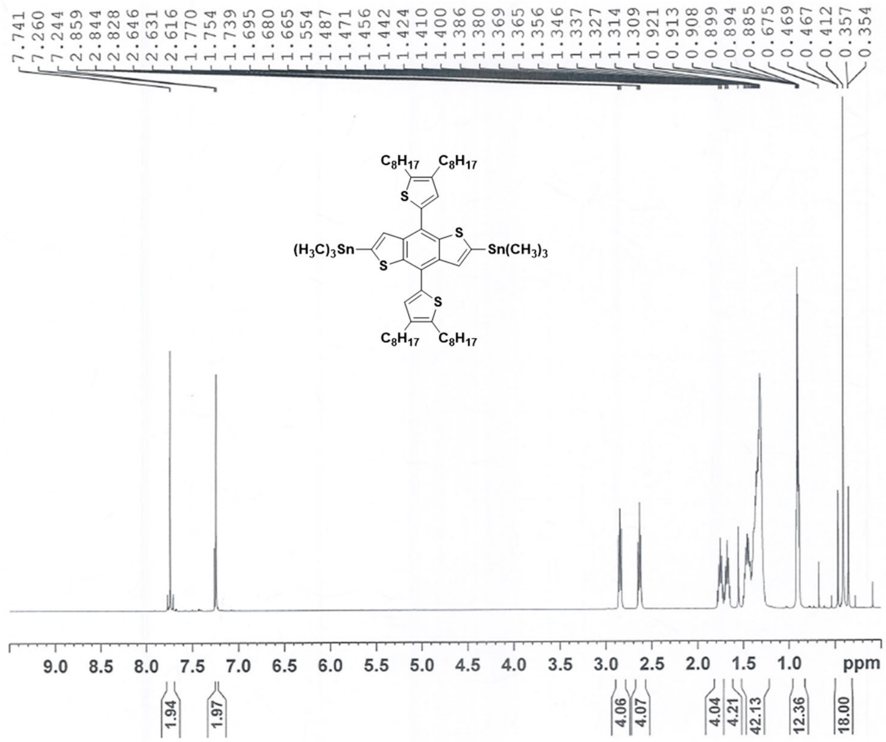
(e) ^{1}H NMR spectrum (500MHz, $CDCl_3$) of Br-BT-DPP-BT-Br



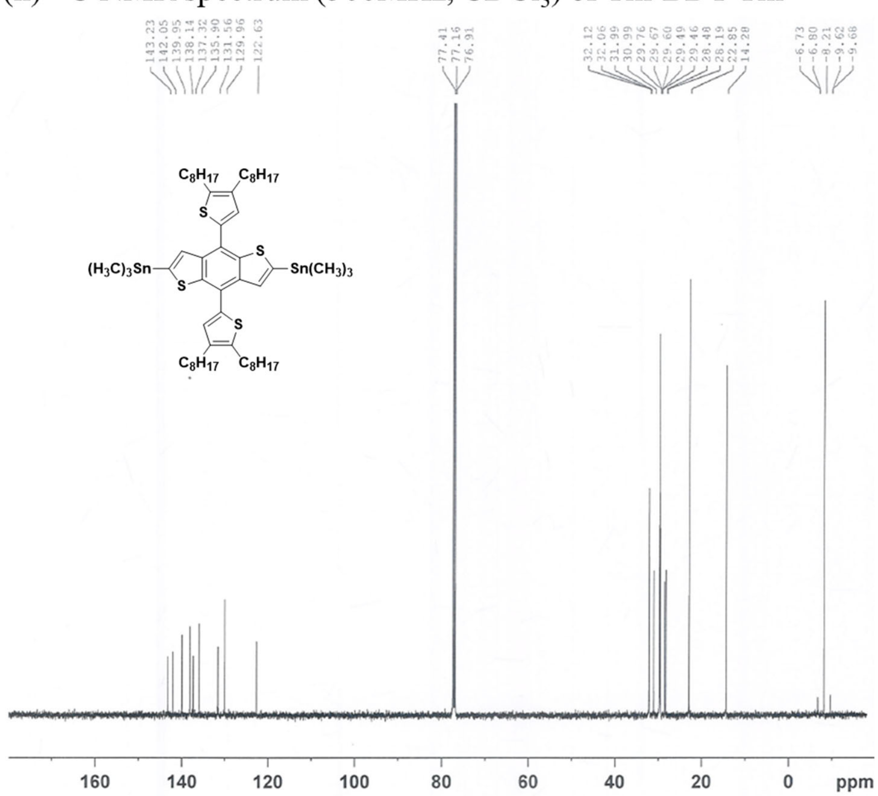
(f) ^{13}C NMR spectrum (500MHz, $CDCl_3$) of Br-BT-DPP-BT-Br



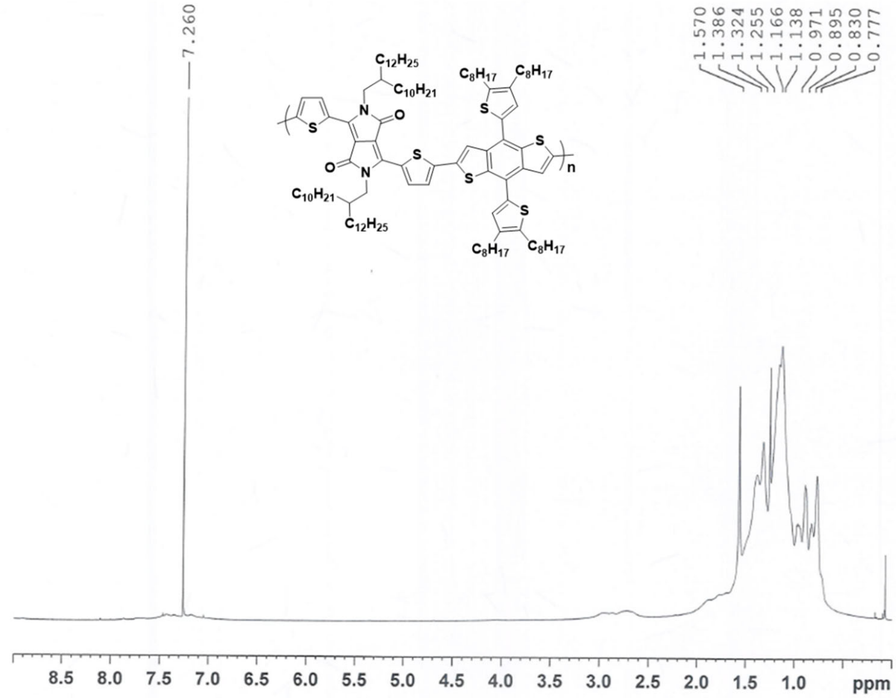
(g) ^{1}H NMR spectrum (500MHz, $CDCl_3$) of Tin-BDT-Tin



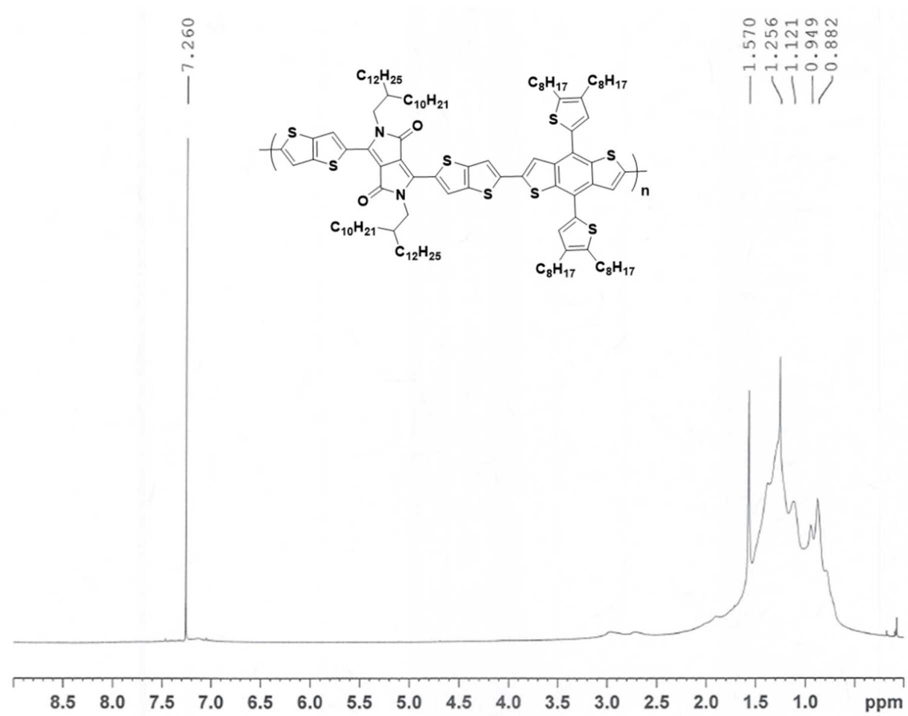
(h) ^{13}C NMR spectrum (500MHz, $CDCl_3$) of Tin-BDT-Tin



(i) ^{1}H NMR spectrum (500MHz, $CDCl_3$) of P1(T-DPP-T-BDT)



(j) ^{1}H NMR spectrum (500MHz, $CDCl_3$) of P2(TT-DPP-TT-BDT)



(k) [1]H NMR spectrum (500MHz, $CDCl_3$) of P3(BT-DPP-BT-BDT)

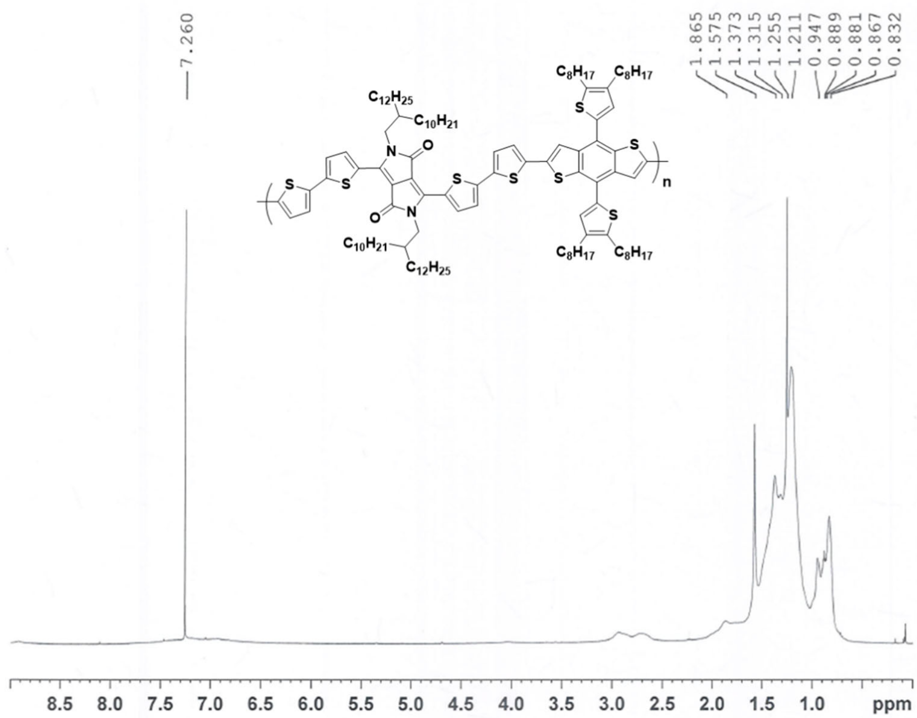


Figure S2. NMR characterizations of monomers (a-h) and polymers (i-k) used in this study

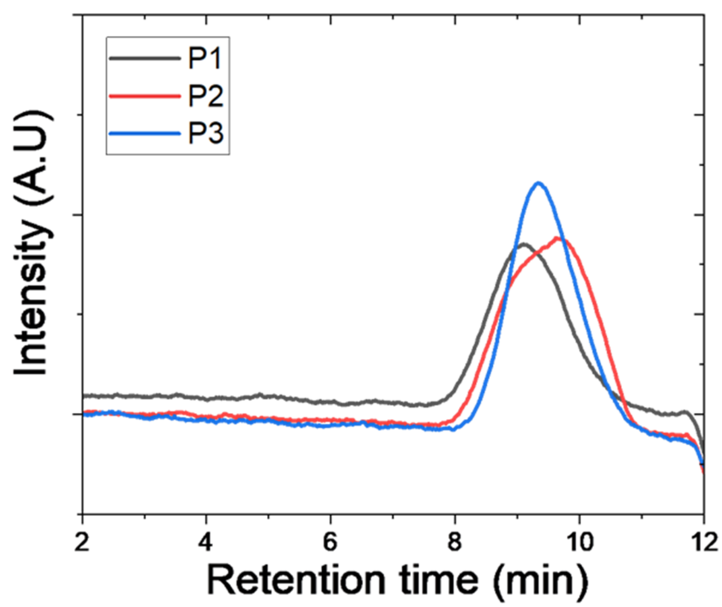


Figure S3. GPC profiles of three PDs (P1, P2, and P3)

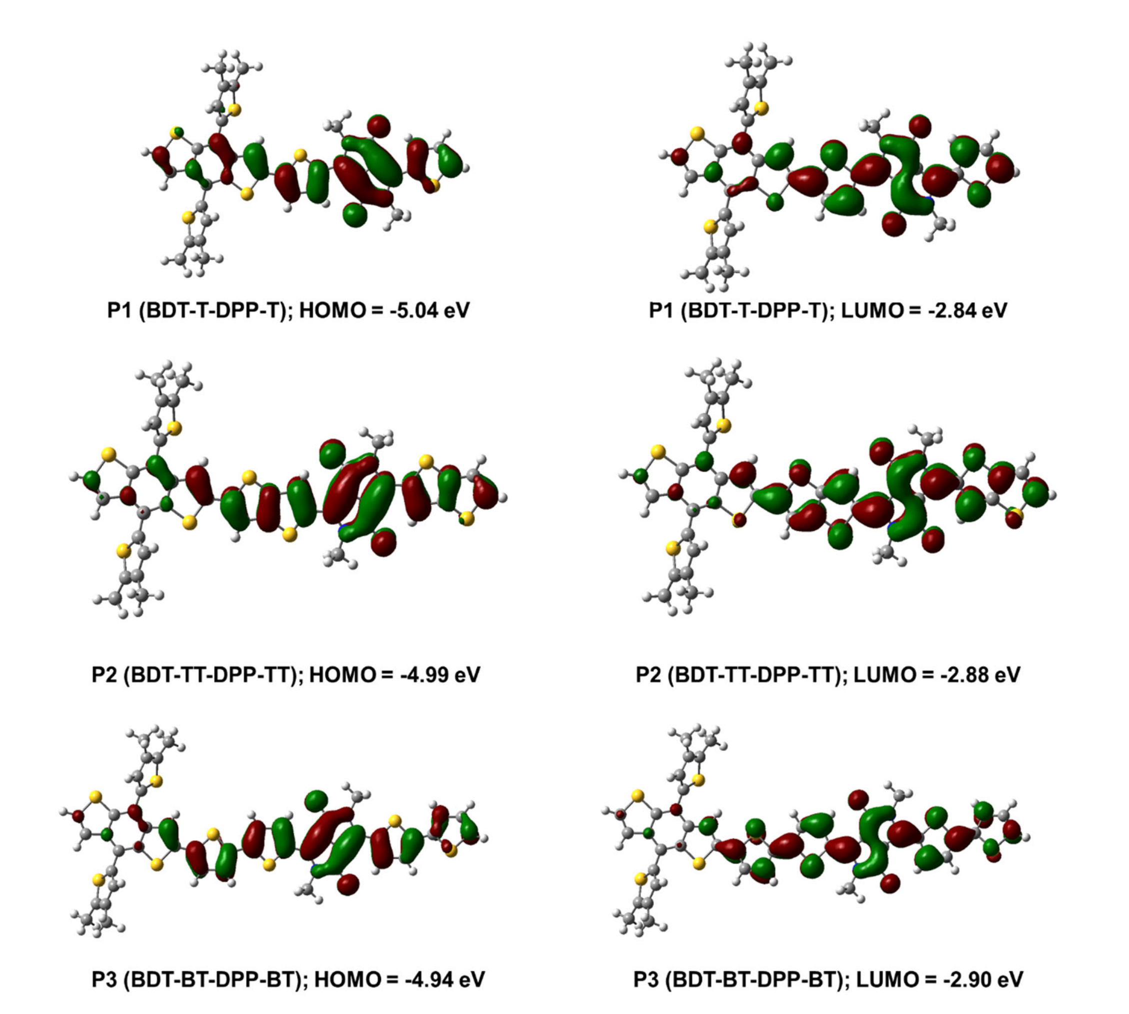


Figure S4. DFT calculation for estimation of HOMO/LUMO levels of P1, P2 and P3 polymers

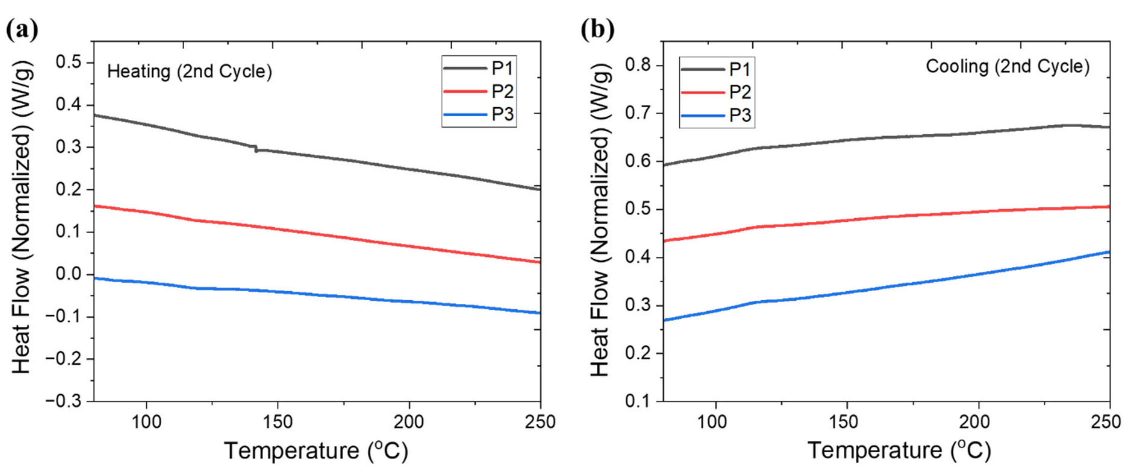


Figure S5. DSC measurements for P1, P2 and P3 ((a) 2nd cycle of heating, (b) 2nd cycle of cooling)

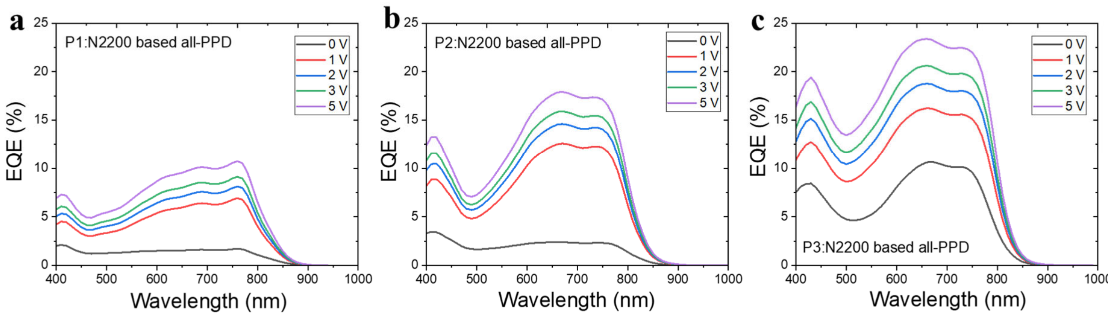


Figure S6. EQE vs bias dependency of P1 (a), P2 (b), and P3-based all-PPD devices (c)

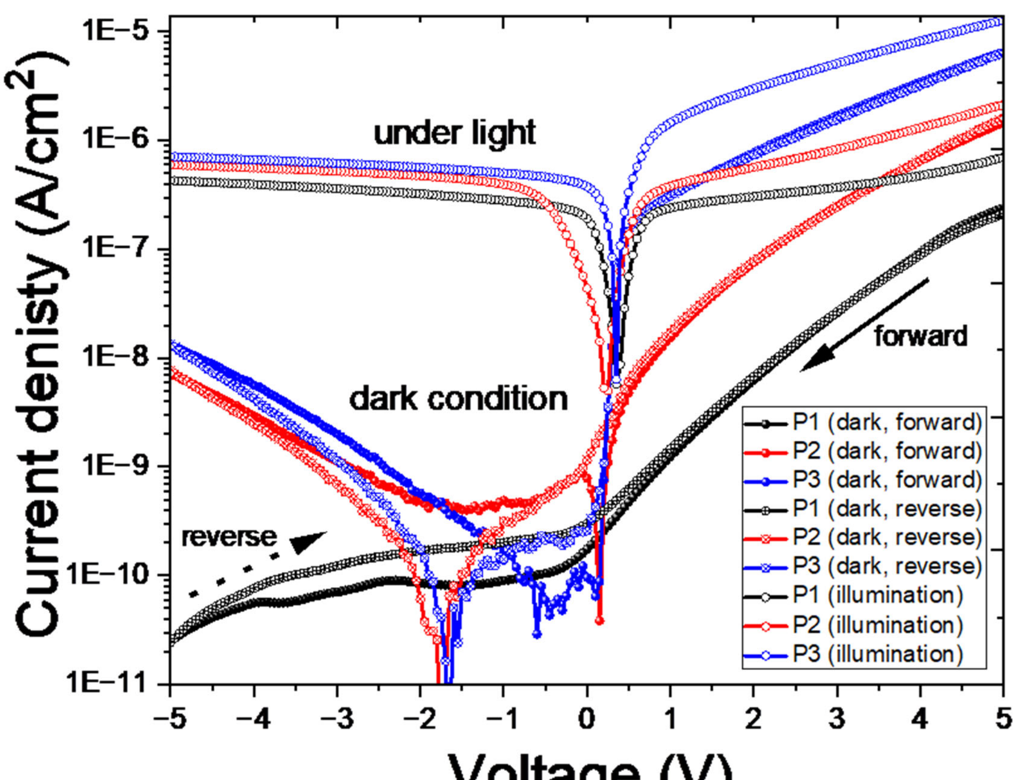


Figure S7. J-V curves of three PDs based all-PPDs under the dark condition (forward and reverse scan) and under the white light

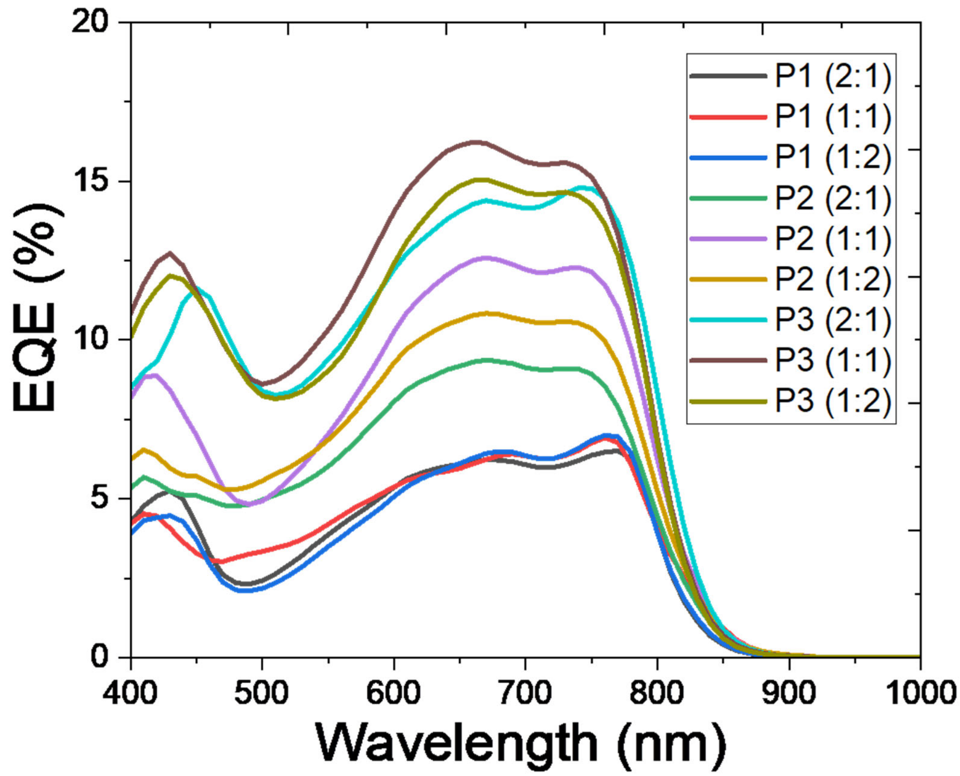


Figure S8. EQE curves of three P_Ds based all-PPDs with different P_D:P_A weight ratios (reverse bias = −1V)

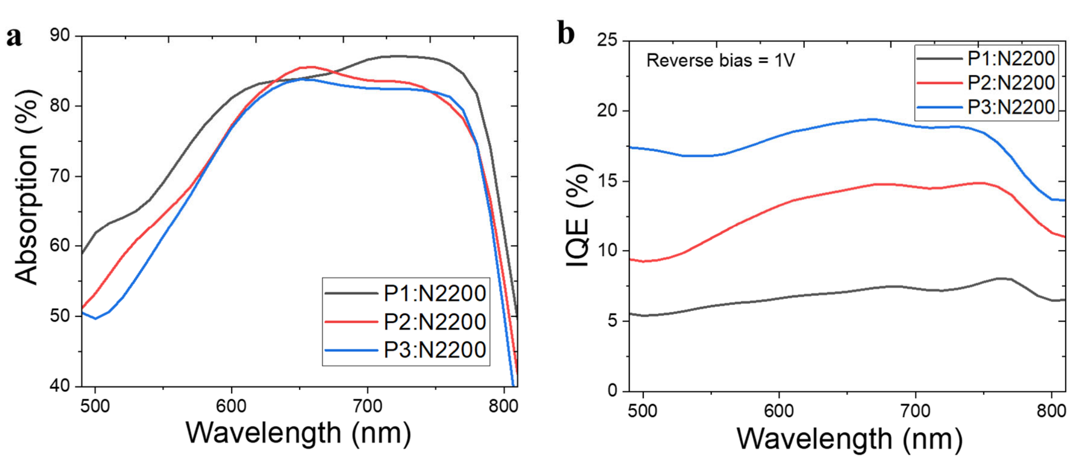


Figure S9. (a) Device absorption spectrums, and (b) IQE spectrums (reverse bias = 1V) of P1, P2, and P3 based all-PPDs.

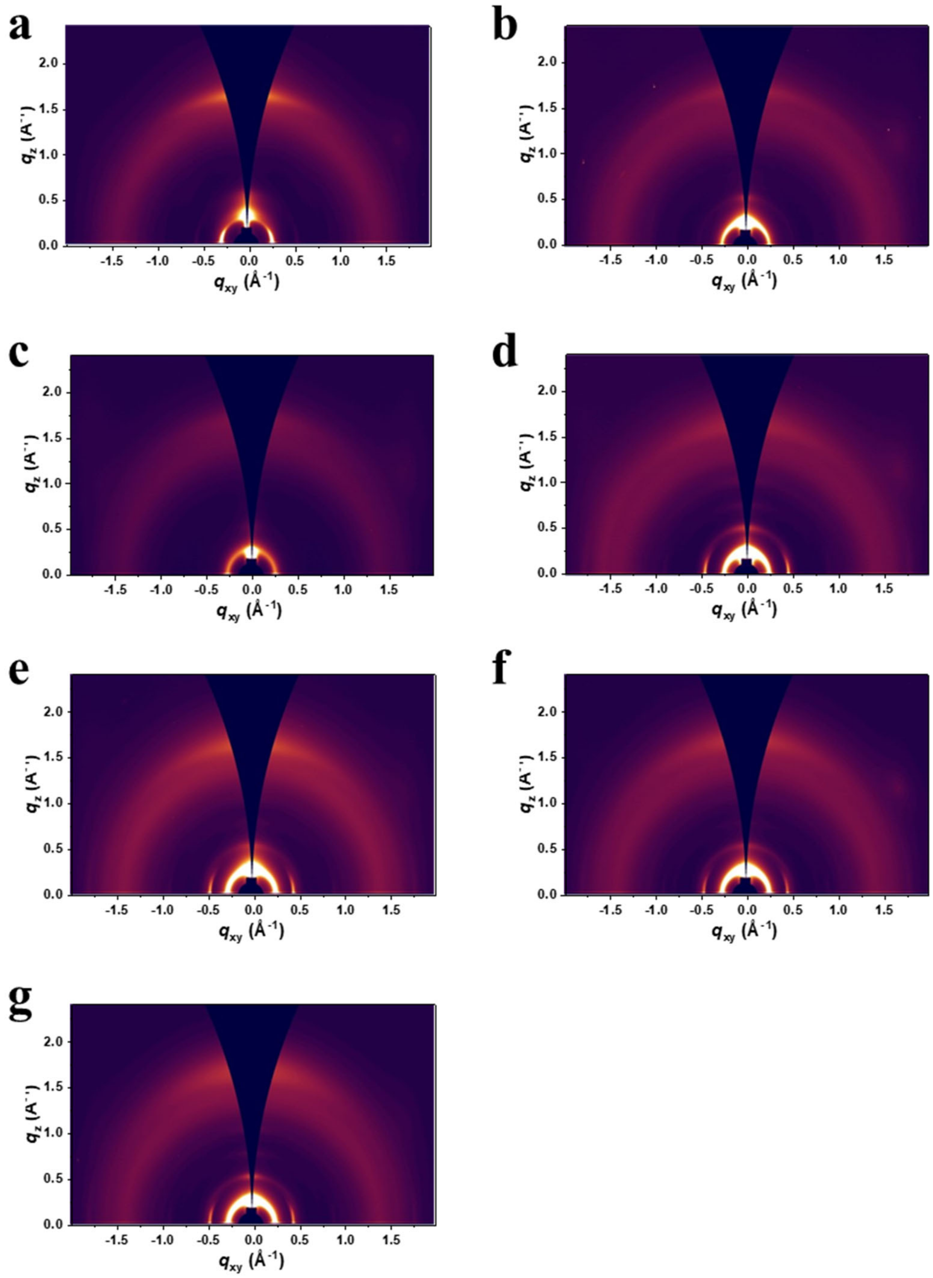


Figure S10. GIXD reciprocal mapping images of pure polymers and all-polymer blends. (a) P1, (b) P2, (c) P3, (d) N2200; (e) P1:N2200, (f) P2:N2200, (g) P3:N2200.

Table S1. Material information of three P_{DS} used in this study (Amount, M_n, M_w, and PDI)

	Amount (mg)	M_n (kg/mol)	M_w (kg/mol)	PDI (M_w/M_n)
P1 (MC) (used in this study)	135.6	60.1	137.4	2.29

P1 (CF)	64.6	81.0	167.9	2.07
P2 (MC)	223.9	34.7	89.9	2.60
P2 (CF) (used in this study)	14.5	37.8	95.9	2.54
P3 (MC)	34.0	35.7	74.8	2.10
P3 (CF) (used in this study)	246.0	42.2	89.3	2.12

Table S2. Comparison of our work with representative OPDs based on all-polymer-based photo-active materials.

Ref.	Photo-active layers	Top electrode	Bottom electrode	Detectivity D* (Jones)	Wavelength (nm)
This work	P1:N2200	Ag	ITO	8.3×10^{12}	720
	P3:N2200			5.9×10^{12}	650
[16]	NT40 :PNDI-2T(N2200)	Al	ITO	2.6×10^{13}	720
[33]	PTzBI-Ph :PNDI-2T(N2200)	Al	ITO	5.7×10^{12}	600
[34]	PDPPT :PNDI	Al	ITO	3.4×10^{12}	850
[35]	PDTP-DPP :PNDI	Al	ITO	2.4×10^{12}	900
[36]	PBDP-T :PNDI-DTBT	Ag	ITO	4.8×10^{12}	660
[37]	P3HT :PIDT-2TPD	Al	ITO	1.1×10^{12}	610
[38]	PSBOTz :PNE	Ag	ITO	1.8×10^{12}	532