Supporting Information

All polymer solar cells with diketopyrrolopyrrole-polymers as electron donor and a naphthalenediimide-polymer as electron acceptor

Cheng Li,[a] Andong Zhang,[a] Zhaowei Wang,[b] Feng Liu,*[c] Yi Zhou,[b] Thomas P Russell,[d] Yongfang Li[a,b] and Weiwei Li*[a]

[a] *Beijing National Laboratory for Molecular Sciences, CAS Key Laboratory of Organic Solids, Institute of Chemistry, Chinese Academy of Sciences, Beijing 100190, P. R. China. E-mail: liweiwei@iccas.ac.cn*

[b] *Laboratory of Advanced Optoelectronic Materials, College of Chemistry, Chemical Engineering and Materials Science, Soochow University, Suzhou, Jiangsu 215123, China.*

[c] *Materials Science Divisions, Lawrence Berkeley National Laboratory, Berkeley 94720, CA, United States. E-mail: iamfengliu@gmail.com*

[d] *Department of Polymer Science and Engineering, University of Massachusetts, Amherst, MA, 01003, United States*

The supporting information contains Cyclic voltammograms of PDPP2TBDT and N2200 (Fig. S1), Characteristics of DPP polymer:N2200 solar cells fabricated from chloroform with different additives (Table S1 and Fig. S2), influence of the ratio of donor to acceptor (Table S2 and Fig. S3), and RSoXS, Guinier plot and Debye-Bueche plot of bulk heterojunction blended thin films (Fig. S4).

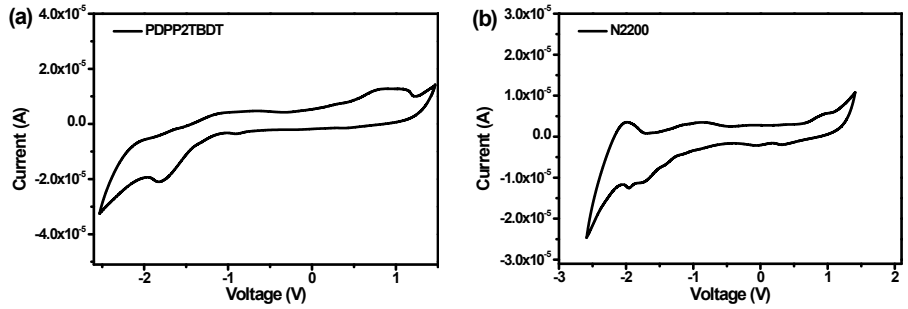


Fig. S1 Cyclic voltammograms of (a) PDPP2TBDT and (b) N2200 in *o*-DCB. Potential vs. Fc/Fc^+. CV of PDPPTPT, PDPP5T and PDPP2TDTP referred to the literatures: *Angew. Chem., Int. Ed.*, 2013, **52**, 8341-8344.; *Adv. Mater.*, 2014, **26**, 3304-3309.; and *J. Am. Chem. Soc.*, 2014, **136**, 12130-12136.

Table S1. Characteristics of DPP polymer:N2200 (1:1) solar cells fabricated from chloroform with different additives.

Donor	Thickness (nm)	Solvent	J_{sc}[a] (mA/cm^2)	V_{oc} (V)	FF	PCE[a] (%)
PDPPTPT	100	$CHCl_3$	0.44	0.83	0.39	0.14
	70	$CHCl_3$:DIO 2.5%	1.4	0.88	0.38	0.45
	90	$CHCl_3$:1-CN 3%	0.39	0.85	0.41	0.14
	70	$CHCl_3$: *o*-DCB 10%	1.2	0.88	0.40	0.41
PDPP5T	80	$CHCl_3$	2.1	0.70	0.43	0.62
	70	$CHCl_3$:DIO 2.5%	5.2	0.68	0.48	1.7
	90	$CHCl_3$:1-CN 3%	3.6	0.70	0.50	1.3
	90	$CHCl_3$:*o*-DCB 10%	5.0	0.67	0.48	1.6
PDPP2TBDT	80	$CHCl_3$	2.4	0.79	0.45	0.85
	80	$CHCl_3$:DIO 2.5%	4.0	0.80	0.48	1.5
	110	$CHCl_3$:1-CN 3%	0.85	0.76	0.44	0.28
	100	$CHCl_3$:*o*-DCB 10%	2.3	0.74	0.40	0.68
PDPP2TDTP	100	$CHCl_3$	3.7	0.49	0.41	0.75
	90	$CHCl_3$:DIO 2.5%	5.9	0.50	0.38	1.1
	120	$CHCl_3$:1-CN 3%	2.8	0.52	0.47	0.67
	120	$CHCl_3$:*o*-DCB 10%	3.7	0.49	0.41	0.75

[a] J_{sc} as calculated by integrating the EQE spectrum with the AM1.5 G spectrum.

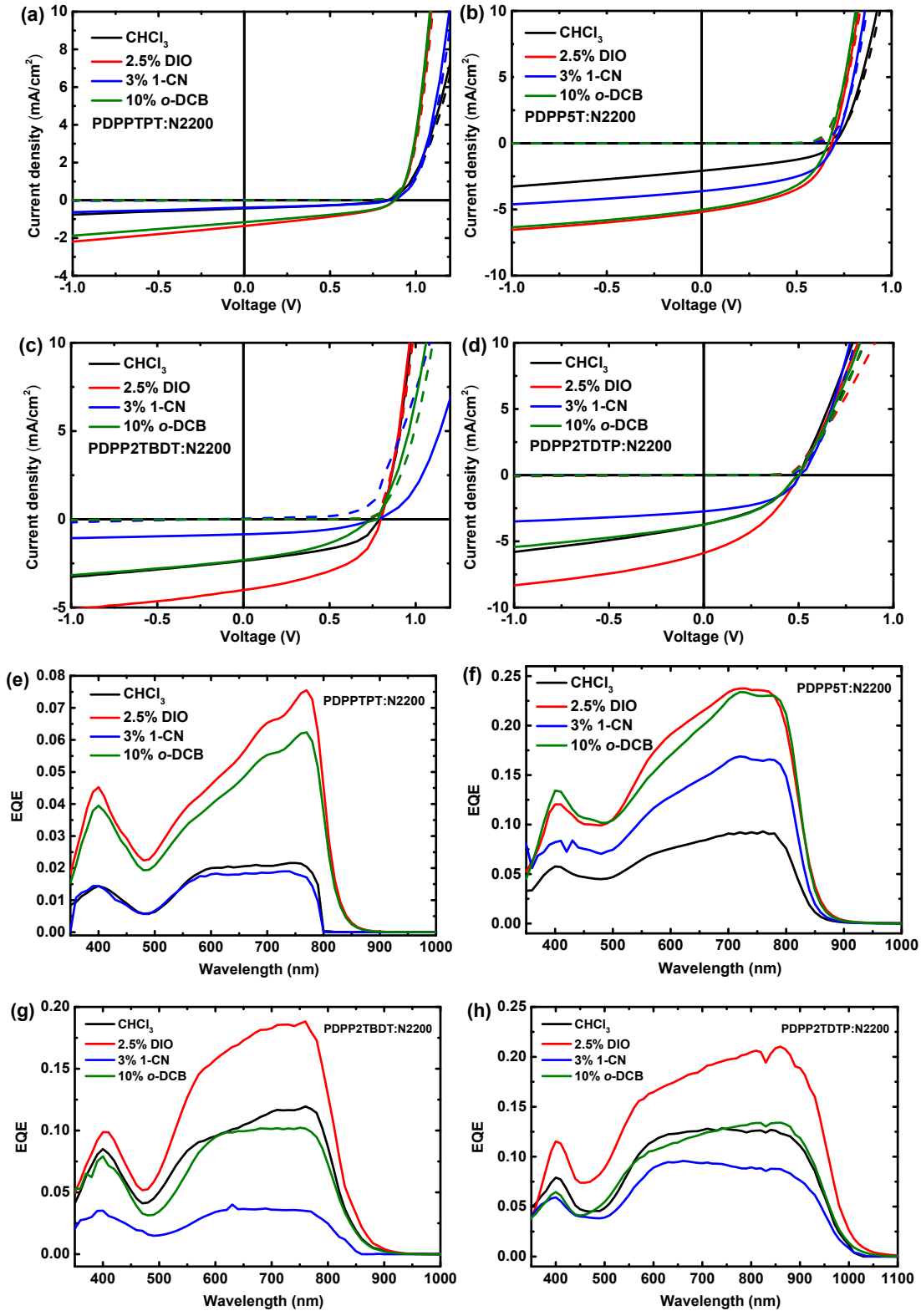
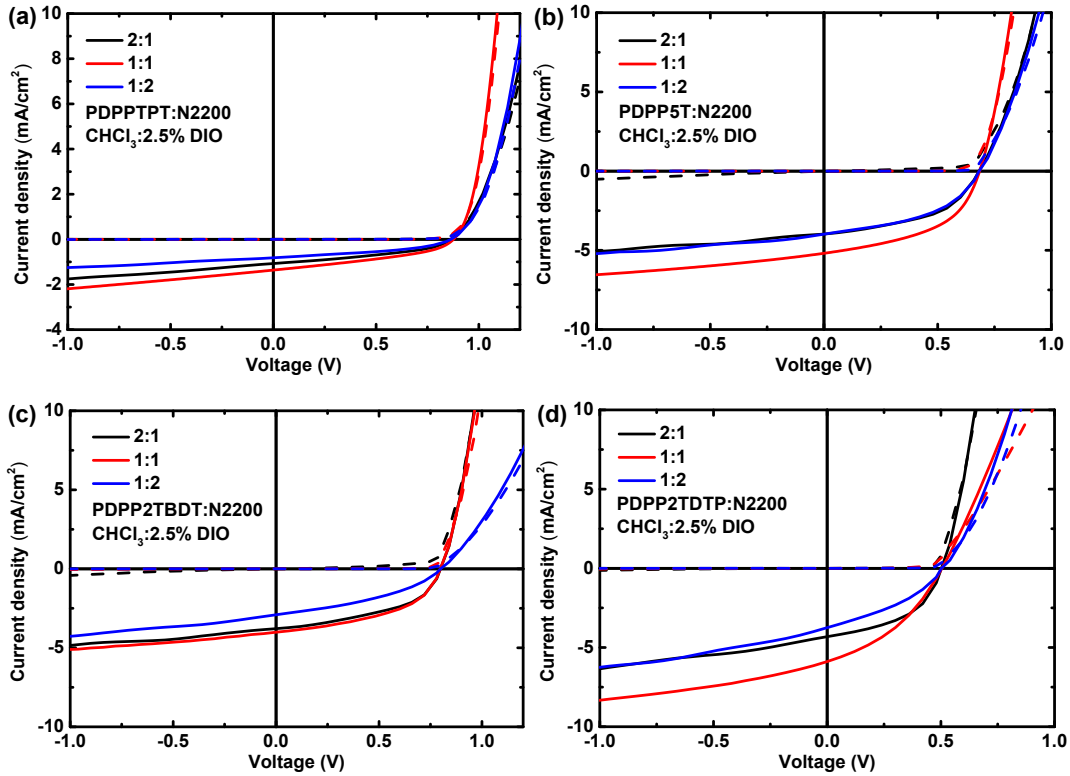


Fig. S2 (a) – (d) *J-V* characteristics in dark (dashed lines) and under white light illumination (solid lines) of solar cells of DPP polymers blended with N2200 (1:1) fabricated from $CHCl_3$ without or with additive. (e) – (h) EQE of the same devices. (a) and (e) PDPPTPT, (b) and (f) PDPP5T, (c) and (g) PDPP2TBDT, (d) and (h) PDPP2TDTP.

Table S2. Characteristics of DPP polymer:N2200 solar cells fabricated from $CHCl_3$:2.5% DIO with different ratio of donor to acceptor.

Donor	Ratio	Thickness (nm)	J_{sc}[a] (mA/cm^2)	V_{oc} (V)	FF	PCE[a] (%)
PDPPTPT	2:1	70	1.1	0.86	0.39	0.36
	1:1	70	1.4	0.88	0.38	0.45
	1:2	100	0.82	0.86	0.40	0.28
PDPP5T	2:1	70	4.0	0.68	0.48	1.3
	1:1	70	5.2	0.68	0.48	1.7
	1:2	80	4.0	0.69	0.46	1.3
PDPP2TBDT	2:1	80	3.8	0.80	0.48	1.4
	1:1	80	4.0	0.80	0.48	1.5
	1:2	110	2.9	0.80	0.38	0.89
PDPP2TDTP	2:1	100	4.3	0.50	0.48	1.0
	1:1	90	5.9	0.50	0.38	1.1
	1:2	80	3.8	0.51	0.36	0.69

[a] J_{sc} as calculated by integrating the EQE spectrum with the AM1.5 G spectrum.



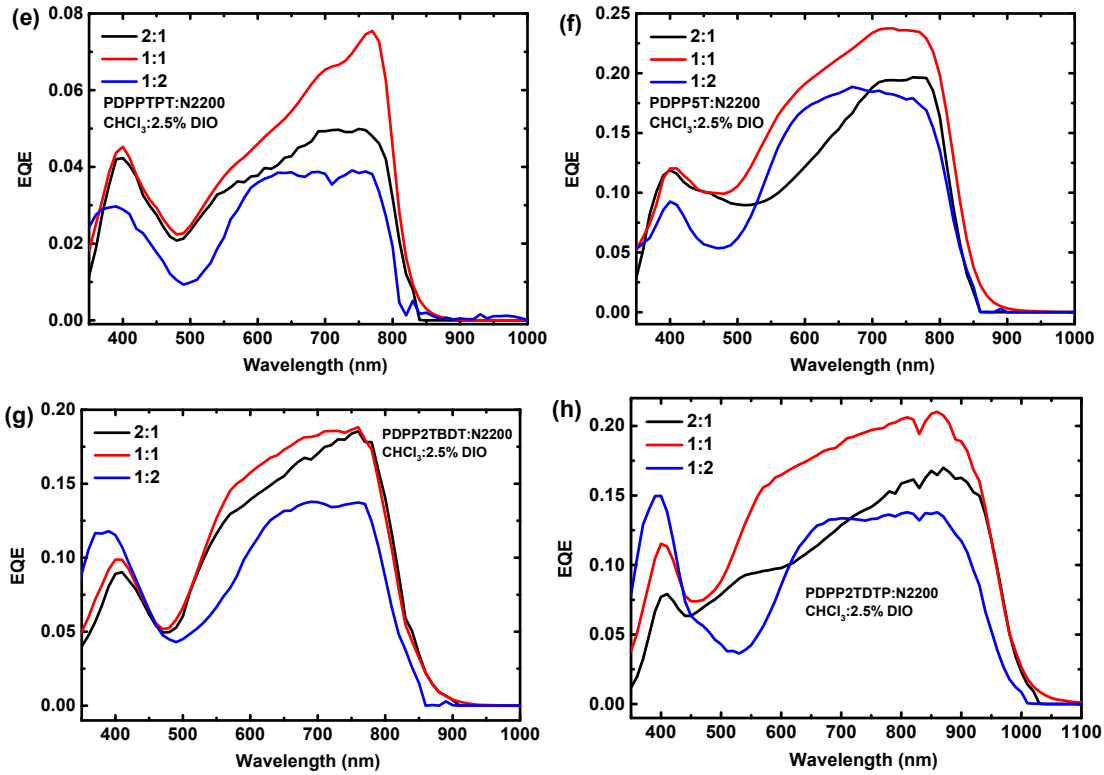


Fig. S3 (a) – (d) *J-V* characteristics in dark (dashed lines) and under white light illumination (solid lines) of solar cells of DPP polymer:N2200 fabricated from $CHCl_3$:2.5% DIO with different ratio of donor to acceptor. (e) – (h) EQE of the same devices. (a) and (e) PDPPTPT, (b) and (f) PDPP5T, (c) and (g) PDPP2TBDT, (d) and (h) PDPP2TDTP.

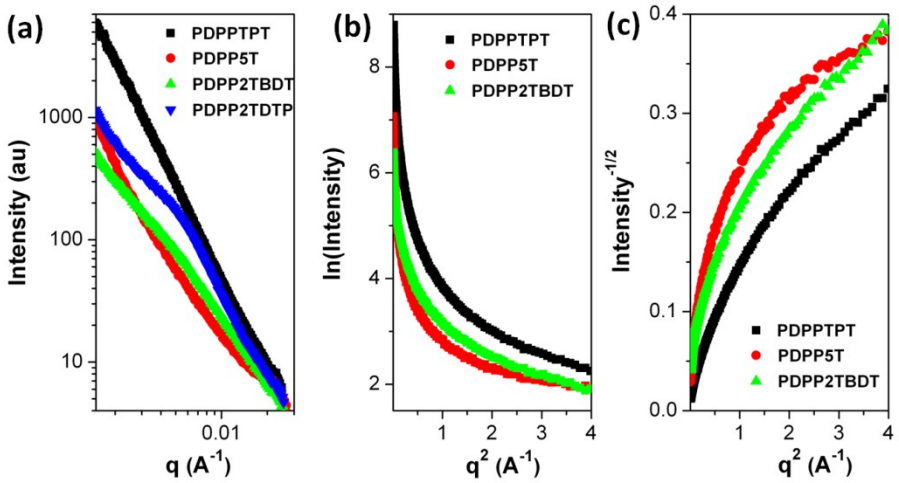


Fig. S4 (a) RSoXS; (b) Guinier plot; (c) Debye-Bueche plot of bulk heterojunction blended thin films at 287 eV photon energy.