Supporting Information

Semi-Transparent Low-Donor Content Organic Solar Cells Employing Cyclopentadithiophene-Based Conjugated Molecules

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Table Contents

1. ^{1}H NMR spectra of 2EH-CPDT($FBTTh_2$)$_2$ and 5EN-CPDT($FBTTh_2$)$_2$.

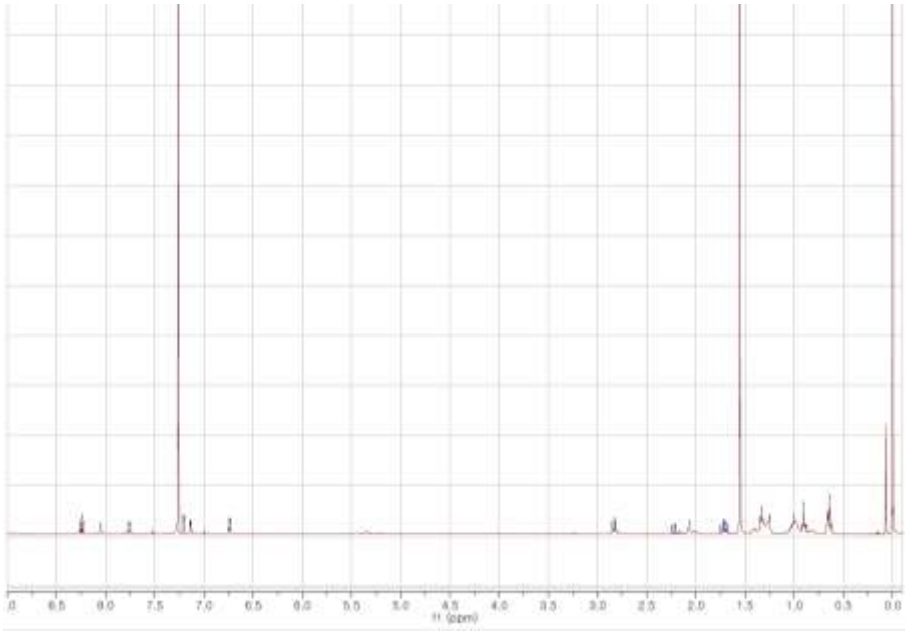

Fig. S1. ^{1}H NMR spectrum of 2EH-CPDT($FBTTh_2$)$_2$.

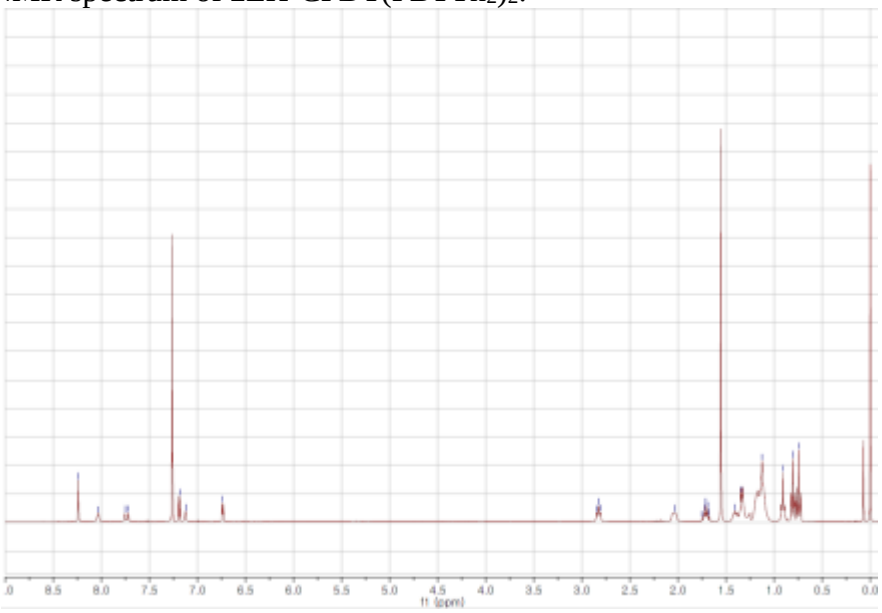

Fig. S2. ^{1}H NMR spectrum of 5EN-CPDT($FBTTh_2$)$_2$.

2. UV-Vis absorption spectra of blend films

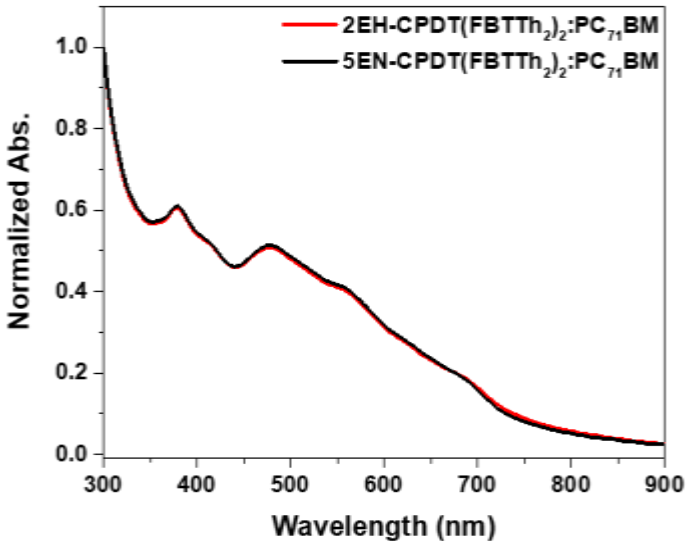

Fig. S3. UV-Vis absorption spectra of BHJ films of 2EH-CPDT(FBTTh$_2$)$_2$:PC$_{71}$BM (1:9) and 5EN-CPDT(FBTTh$_2$)$_2$:PC$_{71}$BM (1:9).

3. The UPS spectra of neat films

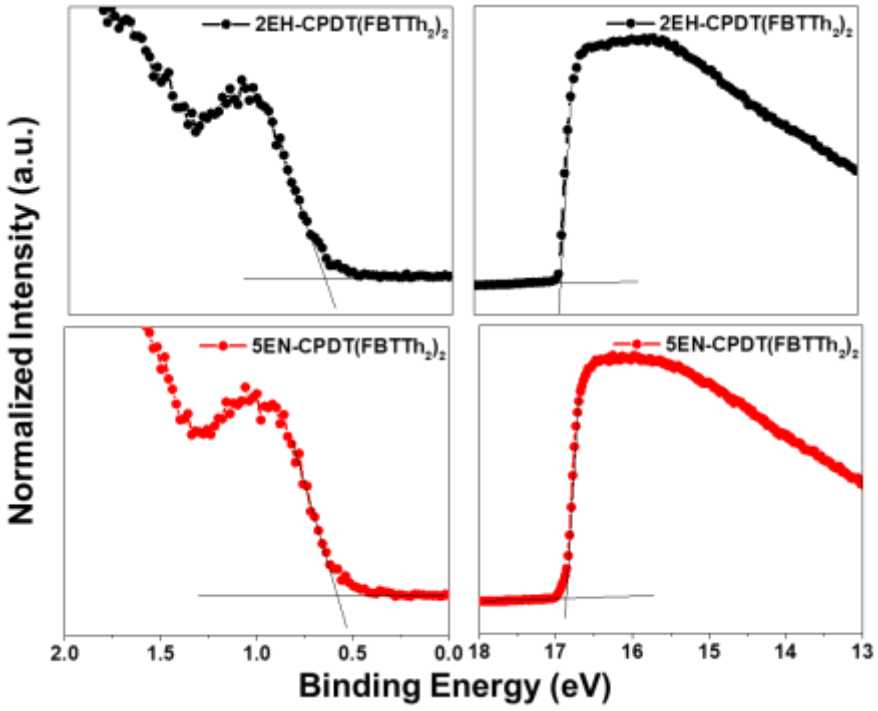

Fig. S4. Ultraviolet photoelectron spectra of 2EH-CPDT(FBTTh$_2$)$_2$ and 5EN-CPDT(FBTTh$_2$)$_2$ using HeI emission (hv =21.2 eV) as a light source. The calculated HOMO levels of 2EH-CPDT(FBTTh$_2$)$_2$ and 5EN-CPDT(FBTTh$_2$)$_2$ are -5.02 eV and -4.92 eV, respectively.

4. DFT calculated geometry

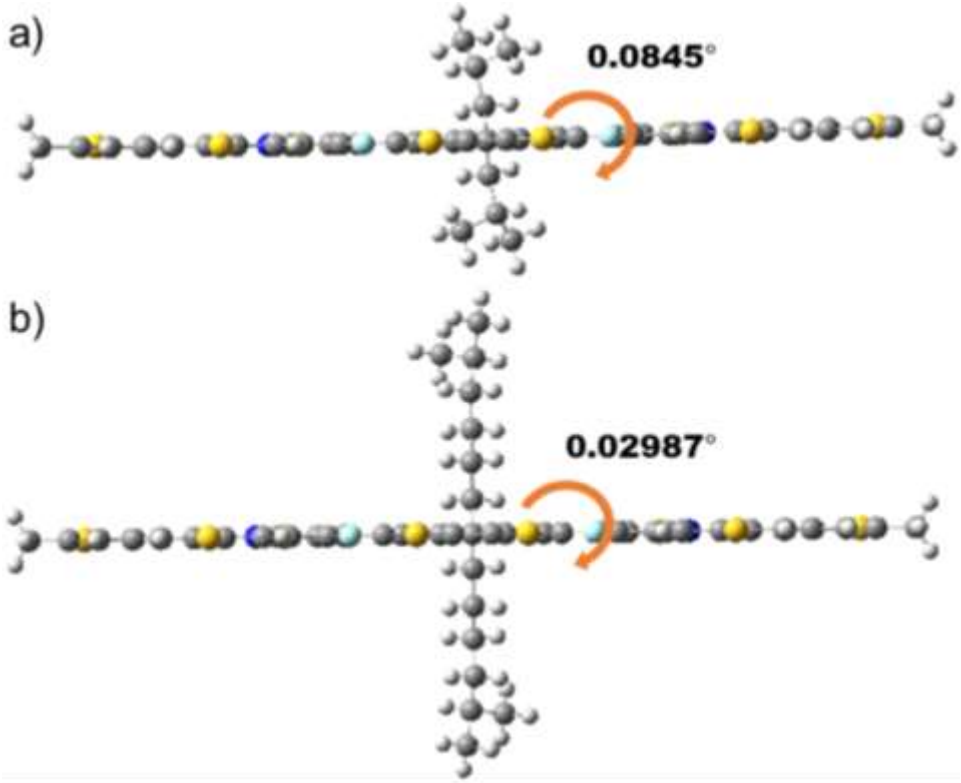

Fig. S5. DFT calculated geometry (side view) of a) 2EH-CPDT(FBTTh$_2$)$_2$ and b) 5EN-CPDT(FBTTh$_2$)$_2$.

5. The OSCs characteristics

Table S1. The OSCs characteristics composed of 2EH-CPDT(FBTTh$_2$)$_2$:PC$_{71}$BM (1:9) with post treatment.

2EH-CPDT(FBTTh$_2$)$_2$:PC$_{71}$BM (1:9)	***J_{SC} (mA cm^{-2})***	***V_{OC} (V)***	***FF (%)***	***PCE (%)***
Annealing at 150 ºC for 10 min	2.88	0.61	24.7	0.43
0.5% DIO	1.68	0.60	32.0	0.32
1% DIO	0.51	0.29	31.7	0.05

Table S2. The OSC characteristics with different ratio composition of 2EH-CPDT(FBTTh$_2$)$_2$ and 5EN-CPDT(FBTTh$_2$)$_2$ with PC$_{71}$BM.

	2EH-CPDT(FBTTh$_2$)$_2$:PC$_{71}$BM				***5EN-CPDT(FBTTh$_2$)$_2$:PC$_{71}$BM***			
D:A Ratio	**J_{SC} (mA cm^{-2})**	**V_{OC} (V)**	**FF (%)**	**PCE (%)**	**J_{SC} (mA cm^{-2})**	**V_{OC} (V)**	**FF (%)**	**PCE (%)**
5:5	4.85	0.82	41.4	1.64	N/A[a]	N/A[a]	N/A[a]	N/A[a]
4:6	4.64	0.75	37.9	1.32	1.68	0.58	14.5	0.13
3:7	4.87	0.79	41.0	1.57	1.83	0.55	13.3	0.13
2:8	5.30	0.79	42.2	1.76	2.10	0.62	13.6	0.17
1:9	9.50	0.81	41.4	3.19	6.29	0.62	39.1	1.52
1:10	7.00	0.77	45.1	2.43	5.00	0.60	38.2	1.15
1:13	5.14	0.63	27.5	0.91	1.23	0.61	20.8	0.16

[a] The film formation was not properly formed for OSCs.

6. 1d GIWAXS line cuts in the q_z and q_{xy} directions

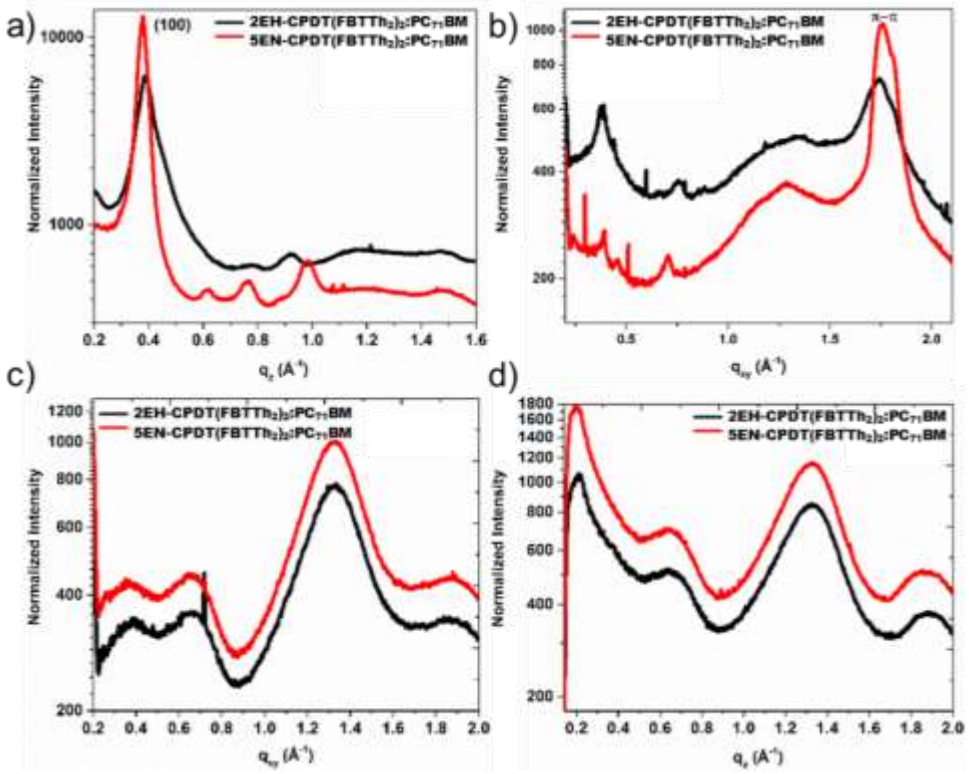

Fig. S6. 1d GIWAXS line cuts in the a) q_{xy} and b) q_z direction for neat 2EH-CPDT(FBTTh$_2$)$_2$ and 5EN-CPDT(FBTTh$_2$)$_2$ films and line cuts in the c) q_{xy} and d) q_z direction for 1:9 weight ratio of blend films 2EH-CPDT(FBTTh$_2$)$_2$:PC$_{71}$BM and 5EN-CPDT(FBTTh$_2$)$_2$:PC$_{71}$BM.

Table S3. GIWAXS parameters of 2EH-CPDT(FBTTh$_2$)$_2$ and 5EN-CPDT(FBTTh$_2$)$_2$ films. Lamellar and π-π stacking distances were determined using 2π/q, and crystal coherence length (CCL) was determined using 2π/FWHM.

	q_{xy}			q_z		
	Lamellar stacking (Å)	**π-π stacking (Å)**	**CCL (π-π peak nm)**	**Lamellar stacking (Å)**	**π-π stacking (Å)**	**CCL (Lamellar peak nm)**
2EH-CPDT(FBTTh$_2$)$_2$	16.8	3.6	1.8	16.2	N/A	7.7
5EN-CPDT(FBTTh$_2$)$_2$	16.0	3.6	3.9	16.6	N/A	16.9