

Supporting Information

Accelerated Explore of Efficient Ternary Solar Cell with PTB7:PC₇₁BM:SMPV1 Using Machine-Learning Methods

Chaorong Guo^a, Zhennan Li^a, Kuo Wang^a, Xunchen Zhou^a, Di Huang^{a,*}, Jiaojiao Liang^{a,*}, Ling Zhao^{b,*}

a, Hunan University of Technology, Zhuzhou 412008, China

b, Shandong Provincial Key Laboratory of Optical Communication Science and Technology, School of Physical Science and Information Technology, Liaocheng University, Liaocheng 252059, China

*corresponding author: dihuang@hut.edu.cn; liangjiaojiao@hut.edu.cn; zhaoling9966@163.com _

Experimental details

Data collection and preprocessing

We collected a total of 433 sets of data in 90 articles on PC₇₁BM based ternary organic solar cells from 2016 to 2021 in web of science. Each group of data collected includes HOMO and LUMO energy levels of donor, acceptor and the third component, as well as the corresponding J_{sc} and PCE under different doping ratios (the doping ratio is the weight ratio), which are used to analyze its electronic characteristics and device efficiency. Moreover, experimentally estimated energy levels (HOMO(D) and LUMO(D) of donors, HOMO(A) and LUMO(A) of acceptors, and HOMO(T) and LUMO(T) of the third components) and the device performance at different doping ratios (T(%), V_{oc}, J_{sc}, FF and PCE) is gained from ref[1-90] and they are shown in Table S1. The best PCE distribution histogram of ternary OSCs is shown in Figure S1. The average value of the best PCE of all devices is only 8.99%, mainly distributed around 9%.

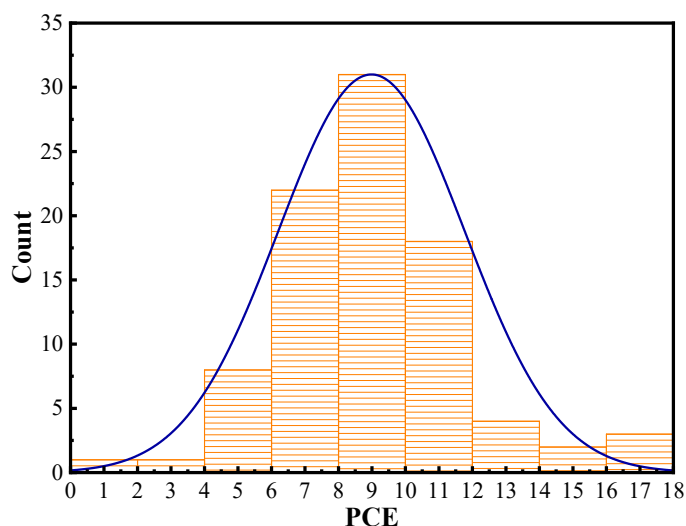


Figure S1 Optimal PCE distribution histogram of the original dataset of reported PC71BM-based ternary OSCs

Model establishment:

The algorithm network is all completed by python. After reading the data with pandas, the data set is divided into training set and test set, normalized and standardized. According to the characteristics of the data, the Scikit Learn class is called to initially obtain random forest (FR), K-nearest neighbors (KNN), and support vector machine (SVM) to establish the algorithm network model. Here each model is consists of input variables(HOMO(A) and LUMO(A) of the donor, HOMO(D) and LUMO(D) of the

acceptor, HOMO(T) and LUMO(T) of the third component, and doping ratio T(%)) and target variables (J_{sc} and PCE). We divide the data set based on 8:2, which means the training set with 80% of the data (347 groups) is applied for training to obtain the network model parameters of the three algorithms, and then we use the cross-validation method to evaluate the performance for the network model via the remaining 20% of the data (86 groups).

Model performance evaluation:

Using the coefficient of determination (R^2), the root mean square error (RMSE), the mean absolute error (MAE), and the mean absolute percent error (MAPE) judge the pros and cons of the algorithm. The calculation formulas are shown in (1) (2) (3) and (4).

$$R^2 = \frac{\left[\sum_{i=1}^n (x_i - \hat{x})(x'_i - \hat{x}') \right]}{\sum_{i=1}^n (x_i - \hat{x})^2 \cdot \sum_{i=1}^n (x'_i - \hat{x}')^2} \quad (1)$$

$$RMSE = \sqrt{\frac{\sum_{i=1}^n (x'_i - x_i)^2}{n}} \quad (2)$$

$$MAE = \frac{1}{n} \sum_{i=1}^n |x'_i - x_i| \quad (3)$$

$$MAPE = \frac{1}{n} \sum_{i=1}^n \frac{|x'_i - x_i|}{x_i} \quad (4)$$

where n is the total number of data; x_i and x'_i represent the original and predicted values, respectively; \hat{x} and \hat{x}' represent the average of the original and predicted values, respectively.

Material and solution preparation

SMPV1 and PTB7 were bought from 1-Material Company. Moreover, PTB7 has a ~200 kg/mol molecular weight and about 4 polydispersity. PC₇₁BM was purchased by Nano-C. All of materials were applied without any purification. In order to dissolve three solar cell materials, chlorobenzene (CB, 99.8%) was used, which was purchased from Sigma Aldrich. The mixed solution for binary device was ready from dissolving the component organic materials with 20mg (8mg for PTB7 and 12mg for PC₇₁BM) in 0.97mL of CB and 0.03mL DIO. For the ternary mixed solutions, SMPV1 was mixed by volume counted on the PTB7 volume. For example, a ternary mixed solution with 7.5wt% of SMVP1 was prepared by adding 15ul of SMVP1(16mg/ml) into the mixed solution containing 85ul of PTB7(16mg/ml) and 100ul of PC₇₁BM(24mg/ml). The concentration of the blend solutions always remain 20mg/ml. The blend solutions were stirred at 60°C overnight and stored in Glove box with N₂-filled for around 6 months.

Device fabrication

The glass substrates with 1.5cm×1.5cm is covered Indium tin oxide (ITO) with 1.5cm×1.5cm. It has the sheet resistance of 10 Ω/□ to be applied as the bottom electrode for devices. The ITO substrates were cleaned successively in ultrasonic bathes with containing deionized water and ethanol (each step for 20min), and then were dried by the N₂ gas before being applied. ZnO films were spun-coat at 5000 rpm

on the cleaned ITO substrates and dried for 20 min at 150°C on the hot plate to format an electron transport layer. Next, the substrates were transferred in a N₂-Filled glove box, and then the mixed solutions were spin-coat with 1000 rpm and 120 second on the ZnO films. After drying for 30min in Petri dish, the substrates were transferred into the chamber. Finally, MoOx and Ag were continuously evaporated on the substrates via the patterned shadow masks. MoOx and Ag layer's thickness was 4 nm and 120 nm respectively. For the duration of the evaporation, the vacuum level was remained at $\sim 7 \times 10^{-7}$ Torr. The deposition rate of MoOx was around 0.2 Å/s and the deposition rate of Ag was around 2 Å/s. The effective area (1.8 mm²) was determined by the vertical overlap of the top silver electrode and the bottom ITO anode; what's more, the area of the top Ag electrode was defined by the patterned shadow mask.

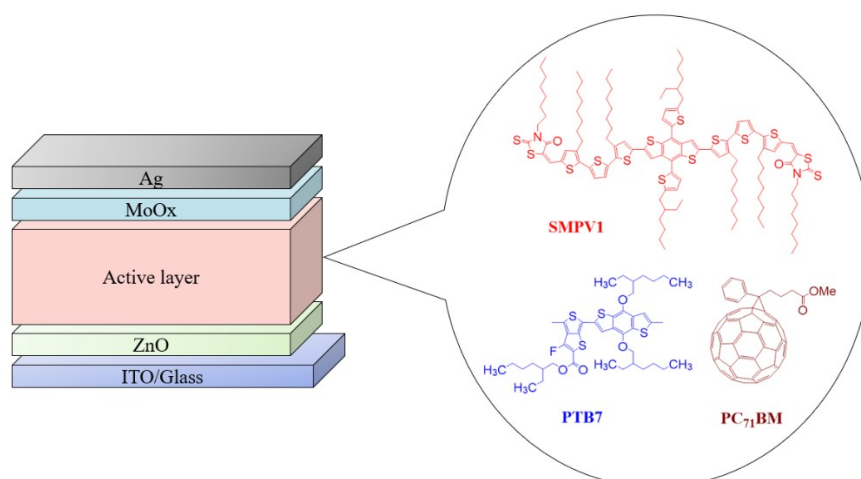


Figure S2 The chemical structures of SMPV1, PTB7 and PC₇₁BM and the structure diagram of devices.

Device measurement

The OSCs' J-V characteristics were measured by Keithley 2400 source equipment unit with a simulated AM 1.5G spectrum of 100 mW/cm² power in glove box. The EQE measurements were tested by a PV Measurements QEX7 system in a N₂-filled glove box.

Characterization

The UV-vis absorption spectrum was performed on Varian Cary 3E UV-vis spectrophotometer. And the PL spectra were carried out by the Perkin Elmer LS-55 spectrophotometer. In addition, the TRPL decays were tested by a Fluo Time 200 time correlated single photon counting spectrometer (Picoquant Germany) including a micro-channel plate photomultiplier (Hamamatsu R3809, response for 25 ps), a PicoHarp analyzer with 300 time (Picoquant, Germany) and a pulsed solid state diode laser (Maitai Spectra Physics with 8 MHz repetition rate, pulse width 85 fs, and frequency doubled at 495 nm).

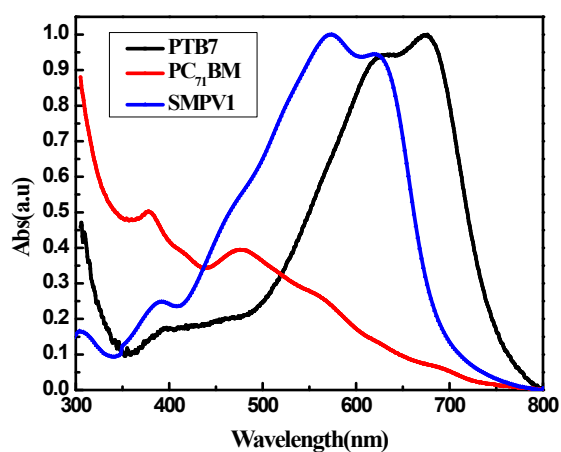


Figure S3 Absorption spectra of pure SMPV1, PTB7 and PC₇₁BM films.

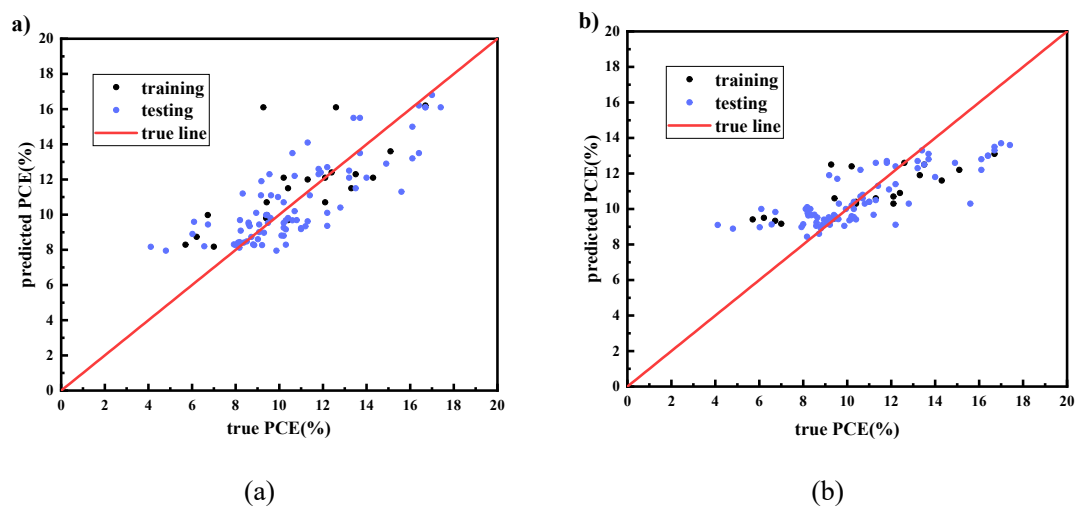


Figure S4 The plots of the relationship between the true PCE and the predicted PCE predicted by (a) KNN and (b) SVM

Table S1 Experimentally Estimated Energy Levels (HOMO(D) and LUMO(D) of Donors, HOMO(A) and LUMO(A) of Acceptors, and HOMO(T) and LUMO(T) of the Third Components) and the Device performance at different doping ratios (T(%),Voc,Jsc,FF,and PCE)														
Donor	Acceptor	Third Components	HOMO (D)	LUMO (D)	HOMO (A)	LUMO (A)	HOMO (T)	LUMO (T)	T (%)	Voc	Jsc	FF	PCE	Ref
DPP-2TPP	PC ₇₁ BM	DR3TBDTTF	-5.18	-3.77	-6	-4	-5.15	-3.1	20	0.82	17.78	76.5	11.0	1
			-5.18	-3.77	-6	-4	-5.15	-3.1	0	0.8	16.35	71.1	9.1	
			-5.18	-3.77	-6	-4	-5.15	-3.1	10	0.81	17.16	73.3	10.0	
			-5.18	-3.77	-6	-4	-5.15	-3.1	30	0.83	17.41	71.6	10.1	
DR3	ICC6	PC ₇₁ BM	-5.1	-3.4	-5.8	-4.2	-5.91	-4.1	0	0.87	15.2	64	8.4	2
			-5.1	-3.4	-5.8	-4.2	-5.91	-4.1	28	0.87	16.3	72	10.4	
DR3	PC ₇₁ BM	ICC6	-5.1	-3.4	-5.91	-4.1	-5.8	-4.2	33	0.81	14.1	60	6.9	2
			-5.1	-3.4	-5.91	-4.1	-5.8	-4.2	0	0.88	13.2	72	8.2	
EP02	MPU3	PC ₇₁ BM	-5.36	-3.02	-5.61	-3.76	-6.08	-4.1	0	1.05	14.57	58	8.92	3
			-5.36	-3.02	-5.61	-3.76	-6.08	-4.1	33	0.94	16.12	63	9.62	
			-5.36	-3.02	-5.61	-3.76	-6.08	-4.1	100	0.93	10.41	57	5.59	
LSC01	MPU3	PC ₇₁ BM	-5.16	-2.93	-5.61	-3.76	-6.08	-4.1	0	0.88	15.19	61	8.22	3
			-5.16	-2.93	-5.61	-3.76	-6.08	-4.1	33	0.83	16.82	65	9.16	
			-5.16	-2.93	-5.61	-3.76	-6.08	-4.1	100	0.79	12.85	62	6.35	
PTB7-Th	PC ₇₁ BM	FTR	-5.15	-3.55	-6.09	-3.9	-5.52	-3.51	0	0.77	17.02	60.8	8	4
			-5.15	-3.55	-6.09	-3.9	-5.52	-3.51	5	0.77	17.24	61.6	8.2	
			-5.15	-3.55	-6.09	-3.9	-5.52	-3.51	10	0.77	17.54	63.3	8.5	
			-5.15	-3.55	-6.09	-3.9	-5.52	-3.51	15	0.768	19.15	64.2	9.4	
			-5.15	-3.55	-6.09	-3.9	-5.52	-3.51	20	0.77	17.34	62	8.3	
PBDB-T	IDT-EDOT	PC ₇₁ BM	-5.33	-2.92	-5.43	-3.8	-5.96	-3.98	0	0.87	18.42	62.3	9.93	5

			-5.33	-2.92	-5.43	-3.8	-5.96	-3.98	17	0.86	20.5	63.6	11.1	
			-5.33	-2.92	-5.43	-3.8	-5.96	-3.98	33	0.86	20.61	63.4	11.1	
			-5.33	-2.92	-5.43	-3.8	-5.96	-3.98	50	0.88	20.84	66.7	12.0	
PBDB-T	PC71BM	IDT-EDOT	-5.33	-2.92	-5.96	-3.98	-5.43	-3.8	0	0.83	13.33	69.08	7.63	5
			-5.33	-2.92	-5.96	-3.98	-5.43	-3.8	17	0.85	17.96	68	10.3	
			-5.33	-2.92	-5.96	-3.98	-5.43	-3.8	33	0.87	19.57	67	11.3	
PBDB-T	ITIC	PC71BM	-5.3	-2.9	-5.5	-3.8	-6	-4	0	0.902	15.06	69	9.38	6
			-5.3	-2.9	-5.5	-3.8	-6	-4	20	0.892	15.98	71.7	10.2	
			-5.3	-2.9	-5.5	-3.8	-6	-4	100	0.856	13.64	70.3	8.21	
PFBT4F- BDT10	PC ₇₁ BM	IDIC	-5.47	-3.83	-6.07	-4.03	-5.64	-3.98	0	0.76	5.87	53.8	2.4	7
			-5.47	-3.83	-6.07	-4.03	-5.64	-3.98	25	0.76	17.54	65.5	8.72	
			-5.47	-3.83	-6.07	-4.03	-5.64	-3.98	37.	0.75	21.12	63.9	10.1	
			-5.47	-3.83	-6.07	-4.03	-5.64	-3.98	50	0.76	19.76	64.3	9.53	
PFBT4F- BDT10	IDIC	PC ₇₁ BM	-5.47	-3.83	-5.64	-3.98	-6.07	-4.03	0	0.79	13.56	65.1	6.97	7
			-5.47	-3.83	-5.64	-3.98	-6.07	-4.03	25	0.77	17.59	66.3	8.98	
			-5.47	-3.83	-5.64	-3.98	-6.07	-4.03	37.	0.77	17.8	68.2	9.27	
PM6	BTP-BO- 4Cl	PC ₇₁ BM	-5.51	-3.62	-5.66	-4.09	-6	-4	0	0.838	26.19	75.84	16.6 5	8
			-5.51	-3.62	-5.66	-4.09	-6	-4	8	0.847	26.44	77.65	17.3	
			-5.51	-3.62	-5.66	-4.09	-6	-4	50	0.847	23.47	73.18	14.5	
			-5.51	-3.62	-5.66	-4.09	-6	-4	100	0.911	12.5	73.22	8.34	
PM6	Y6	PC ₇₁ BM	-5.54	-3.65	-5.65	-4.1	-5.87	-3.91	0	0.83	25.12	74.53	15.5	9

			-5.54	-3.65	-5.65	-4.1	-5.87	-3.91	8	0.837	26.12	76.5	16.7	
PPDT2FBT	PC ₇₁ BM	IDT2BR	-5.45	-3.69	-6	-4.1	-5.52	-3.87	0	0.79	14.75	70	8.16	10
			-5.45	-3.69	-6	-4.1	-5.52	-3.87	10	0.82	15.5	71	9.02	
			-5.45	-3.69	-6	-4.1	-5.52	-3.87	20	0.84	14.88	69	8.62	
			-5.45	-3.69	-6	-4.1	-5.52	-3.87	40	0.88	13.68	60	7.22	
			-5.45	-3.69	-6	-4.1	-5.52	-3.87	60	0.91	10.23	42	3.91	
			-5.45	-3.69	-6	-4.1	-5.52	-3.87	80	0.98	7.71	39	2.95	
			-5.45	-3.69	-6	-4.1	-5.52	-3.87	100	1.11	8.4	55	5.16	
PTB7	PC ₇₁ BM	BT2TR	-5.51	-3.31	-5.9	-3.86	-5.23	-3.78	0	0.75	15.51	68.53	7.97	11
			-5.51	-3.31	-5.9	-3.86	-5.23	-3.78	5	0.74	16.47	68.99	8.41	
			-5.51	-3.31	-5.9	-3.86	-5.23	-3.78	10	0.74	16.48	70.75	8.63	
			-5.51	-3.31	-5.9	-3.86	-5.23	-3.78	15	0.74	17.55	70.92	9.21	
			-5.51	-3.31	-5.9	-3.86	-5.23	-3.78	30	0.74	15.94	65.55	7.73	
			-5.51	-3.31	-5.9	-3.86	-5.23	-3.78	50	0.73	15.13	62.64	6.92	
PTB7	PC ₇₁ BM	BT3TR	-5.51	-3.31	-5.9	-3.86	-5.14	-3.52	0	0.75	15.51	68.53	7.97	11
			-5.51	-3.31	-5.9	-3.86	-5.14	-3.52	5	0.75	16.57	70.68	8.78	
			-5.51	-3.31	-5.9	-3.86	-5.14	-3.52	10	0.74	17.04	70.17	8.85	
			-5.51	-3.31	-5.9	-3.86	-5.14	-3.52	15	0.75	15.99	69.77	8.26	
			-5.51	-3.31	-5.9	-3.86	-5.14	-3.52	30	0.76	15.17	69.76	8.04	
			-5.51	-3.31	-5.9	-3.86	-5.14	-3.52	50	0.76	14.21	62.71	6.77	
PTB7-Th	PC ₇₁ BM	C545T	-5.24	-3.62	-6.1	-3.9	-5.54	-2.8	0	0.78	17.72	65.29	8.98	12
			-5.24	-3.62	-6.1	-3.9	-5.54	-2.8	5	0.78	18.02	67.51	9.59	
			-5.24	-3.62	-6.1	-3.9	-5.54	-2.8	10	0.79	20.01	68.07	10.5	
			-5.24	-3.62	-6.1	-3.9	-5.54	-2.8	15	0.79	18.53	66.71	9.62	

			-5.24	-3.62	-6.1	-3.9	-5.54	-2.8	20	0.79	17.51	66.69	9.06	
PTB7	PC ₇₁ BM	C545T	-5.15	-3.31	-6.1	-3.9	-5.54	-2.8	0	0.72	16.09	68.01	7.92	12
			-5.15	-3.31	-6.1	-3.9	-5.54	-2.8	5	0.72	16.67	71.22	8.59	
			-5.15	-3.31	-6.1	-3.9	-5.54	-2.8	10	0.73	17.7	72.64	9.42	
			-5.15	-3.31	-6.1	-3.9	-5.54	-2.8	15	0.73	15.94	71.55	8.37	
			-5.15	-3.31	-6.1	-3.9	-5.54	-2.8	20	0.73	15.4	69.31	7.84	
PTB7-Th	COi8DFIC	PC ₇₁ BM	-5.39	-3.12	-5.5	-3.88	-5.55	-3.67	0	0.701	22.32	60	9.39	13
			-5.39	-3.12	-5.5	-3.88	-5.55	-3.67	30	0.711	25.13	68	12.0	
			-5.39	-3.12	-5.5	-3.88	-5.55	-3.67	100	0.819	15.26	62	7.74	
TBFC150-BDD	BTP-4F	PC ₇₁ BM	-5.45	-3.26	-5.15	-4.1	-5.96	-4	0	0.849	22.43	55.82	10.58	14
			-5.45	-3.26	-5.15	-4.1	-5.96	-4	17	0.86	24.64	62.04	13.1	
			-5.45	-3.26	-5.15	-4.1	-5.96	-4	100	0.913	12.16	59.55	6.58	
PTQ10	Y6	PC ₇₁ BM	-5.54	-2.98	-5.65	-4.1	-6	-4	0	0.851	24.64	71.67	15.0	15
			-5.54	-2.98	-5.65	-4.1	-6	-4	14	0.85	25.32	74.69	16.0	
			-5.54	-2.98	-5.65	-4.1	-6	-4	25	0.847	25.12	71	15.1	
			-5.54	-2.98	-5.65	-4.1	-6	-4	100	0.94	8.32	55.12	4.31	
PTB7-Th	PC71BM	Coumarin-7	-5.24	-3.62	-6.1	-3.7	-5.13	-2.8	0	0.78	18.26	65.49	9.26	16
			-5.24	-3.62	-6.1	-3.7	-5.13	-2.8	5	0.78	18.61	69.74	10.0	
			-5.24	-3.62	-6.1	-3.7	-5.13	-2.8	10	0.78	22.26	70.71	12.2	
			-5.24	-3.62	-6.1	-3.7	-5.13	-2.8	15	0.77	20.88	70.29	11.2	
			-5.24	-3.62	-6.1	-3.7	-5.13	-2.8	20	0.76	18.93	66.63	9.81	
PTB7-Th	PC ₇₁ BM	PffBT4T-2OD	-5.25	-3.2	-6	-4	-5.38	-2.83	0	0.79	18.2	71.4	10.31	17

			-5.25	-3.2	-6	-4	-5.38	-2.83	5	0.78	18.3	73.7	10.6	
			-5.25	-3.2	-6	-4	-5.38	-2.83	10	0.78	18.6	75.7	11	
			-5.25	-3.2	-6	-4	-5.38	-2.83	15	0.78	18.5	74.8	10.8	
			-5.25	-3.2	-6	-4	-5.38	-2.83	20	0.77	18.4	73.9	10.5	
PTB7-Th	PC ₇₁ BM	PBDB-T	-5.23	-3.65	-6	-4.1	-5.21	-3.41	0	0.795	16.51	63.06	8.28	18
			-5.23	-3.65	-6	-4.1	-5.21	-3.41	5	0.795	16.92	64	8.62	
			-5.23	-3.65	-6	-4.1	-5.21	-3.41	10	0.801	17.36	65.21	9.11	
			-5.23	-3.65	-6	-4.1	-5.21	-3.41	15	0.806	17.6	65.62	9.3	
			-5.23	-3.65	-6	-4.1	-5.21	-3.41	20	0.79	16.83	66.23	8.83	
			-5.23	-3.65	-6	-4.1	-5.21	-3.41	25	0.795	16.31	62.11	7.92	
PBDTNS-BDD	Y6	PC ₇₁ BM	-5.32	-3.48	-5.65	-4.1	-5.96	-4	0	0.79	22.86	69.37	12.5 5	19
			-5.32	-3.48	-5.65	-4.1	-5.96	-4	14	0.811	24.66	74.39	14.8	
			-5.32	-3.48	-5.65	-4.1	-5.96	-4	100	0.912	11.66	66.26	7.05	
PffBT4T-2OD	PC ₇₁ BM	IDFBR	-5.34	-3.69	-6	-4	-5.75	-3.7	0	0.789	14.97	59.3	7.37	20
			-5.34	-3.69	-6	-4	-5.75	-3.7	3	0.794	16.49	61.1	8.17	
			-5.34	-3.69	-6	-4	-5.75	-3.7	5	0.795	16.61	62.5	8.51	
			-5.34	-3.69	-6	-4	-5.75	-3.7	10	0.801	14.01	55.1	6.83	
			-5.34	-3.69	-6	-4	-5.75	-3.7	100	1.136	4	44.5	2.13	
PBT-OTT	PC ₇₁ BM	ITIC	-5.56	-3.67	-6	-4.15	-5.64	-4.04	0	0.83	13.3	58.5	6.74	21
			-5.56	-3.67	-6	-4.15	-5.64	-4.04	10	0.86	13.9	63.6	7.92	
			-5.56	-3.67	-6	-4.15	-5.64	-4.04	20	0.87	14.8	63	8.18	
			-5.56	-3.67	-6	-4.15	-5.64	-4.04	30	0.87	14.5	55.5	7.24	

			-5.56	-3.67	-6	-4.15	-5.64	-4.04	40	0.88	11.5	53.3	5.6	
			-5.56	-3.67	-6	-4.15	-5.64	-4.04	50	0.89	8.28	42.1	3.31	
			-5.56	-3.67	-6	-4.15	-5.64	-4.04	100	0.97	10.27	51	5.43	
PTB7-Th	PC ₇₁ BM	IT-M	-5.1	-3.3	-6.1	-4.3	-5.51	-3.91	0	0.796	16.73	63.81	8.5	22
			-5.1	-3.3	-6.1	-4.3	-5.51	-3.91	5	0.808	17.08	66.95	9.24	
			-5.1	-3.3	-6.1	-4.3	-5.51	-3.91	10	0.814	17.56	67.51	9.65	
			-5.1	-3.3	-6.1	-4.3	-5.51	-3.91	15	0.82	17.82	67.54	9.87	
			-5.1	-3.3	-6.1	-4.3	-5.51	-3.91	20	0.826	17.62	63.94	9.31	
			-5.1	-3.3	-6.1	-4.3	-5.51	-3.91	25	0.832	17.29	60.55	8.71	
BTR	PC ₇₁ BM	BDT-OH	-5.36	-3.39	-6.11	-4.3	-5.49	-3.45	0	0.93	13.95	69.6	9.05	23
			-5.36	-3.39	-6.11	-4.3	-5.49	-3.45	20	0.93	14.62	74.2	10.1	
			-5.36	-3.39	-6.11	-4.3	-5.49	-3.45	100	0.9	13.56	65.3	8	
PBDB-T	PC ₇₁ BM	ITDCN	-5.41	-3.53	-5.97	-3.98	-5.52	-3.7	0	0.8	12.13	54.99	5.34	24
			-5.41	-3.53	-5.97	-3.98	-5.52	-3.7	5	0.83	11.76	58.89	5.75	
			-5.41	-3.53	-5.97	-3.98	-5.52	-3.7	10	0.82	11.62	62.54	5.96	
			-5.41	-3.53	-5.97	-3.98	-5.52	-3.7	15	0.83	12.57	62.93	6.56	
			-5.41	-3.53	-5.97	-3.98	-5.52	-3.7	20	0.82	10.22	65.72	5.51	
			-5.41	-3.53	-5.97	-3.98	-5.52	-3.7	30	0.84	9.35	66.05	5.19	
PBT1-C	IT-2F	PC ₇₁ BM	-5.42	-3.41	-5.67	-4.02	-5.92	-3.9	0	0.879	17.28	72.7	11.0	25
			-5.42	-3.41	-5.67	-4.02	-5.92	-3.9	9	0.882	17.74	75.7	11.8	
			-5.42	-3.41	-5.67	-4.02	-5.92	-3.9	17	0.892	18.19	75.1	12.1	
			-5.42	-3.41	-5.67	-4.02	-5.92	-3.9	23	0.893	18.1	74.1	11.9	
			-5.42	-3.41	-5.67	-4.02	-5.92	-3.9	29	0.901	17.76	73.2	11.7	
			-5.42	-3.41	-5.67	-4.02	-5.92	-3.9	38	0.898	17.69	73.5	11.6	

			-5.42	-3.41	-5.67	-4.02	-5.92	-3.9	50	0.893	17.64	71.3	11.2	
			-5.42	-3.41	-5.67	-4.02	-5.92	-3.9	100	0.914	12.28	78	8.75	
FG1	MPU4	PC ₇₁ BM	-5.35	-3.62	-5.65	-3.96	-6.1	-4.1	0	0.97	19.54	59	11.1	26
			-5.35	-3.62	-5.65	-3.96	-6.1	-4.1	25	0.89	21.91	68	13.2	
			-5.35	-3.62	-5.65	-3.96	-6.1	-4.1	100	0.84	12.5	63	6.62	
PM6	IT-4F	PC ₇₁ BM	-5.42	-3.61	-5.61	-4.08	-5.82	-3.94	0	0.851	20.62	74.7	13.1	27
			-5.42	-3.61	-5.61	-4.08	-5.82	-3.94	9	0.849	21.48	75.29	13.7	
PM6	BTP-4Cl	PC ₇₁ BM	-5.42	-3.61	-5.64	-4.1	-5.82	-3.94	0	0.865	25.26	71.4	15.6	27
			-5.42	-3.61	-5.64	-4.1	-5.82	-3.94	9	0.866	25.57	73.84	16.3	
PTB7-Th	PC ₇₁ BM	BDTTBO-BT	-5.22	-3.64	-6	-4	-5.36	-3.55	0	0.78	17.5	66	9.2	28
			-5.22	-3.64	-6	-4	-5.36	-3.55	10	0.79	19.14	67.7	10.4	
			-5.22	-3.64	-6	-4	-5.36	-3.55	100	0.8	4.33	37.1	1.3	
PTB7-Th	PC ₇₁ BM	BDTTBO-BzT	-5.22	-3.64	-6	-4	-5.47	-3.52	0	0.78	17.5	66	9.2	28
			-5.22	-3.64	-6	-4	-5.47	-3.52	10	0.8	18.03	64.7	9.4	
			-5.22	-3.64	-6	-4	-5.47	-3.52	100	0.83	9.81	42.4	3.8	
PTB7-Th	PC ₇₁ BM	BDTTBO-TT	-5.22	-3.64	-6	-4	-5.41	-3.54	0	0.78	17.5	66	9.2	28
			-5.22	-3.64	-6	-4	-5.41	-3.54	10	0.78	17.75	67.5	9.6	
			-5.22	-3.64	-6	-4	-5.41	-3.54	100	0.79	10.36	51.3	4.4	
MV72	PC ₇₁ BM	MV71	-5.29	-3.67	-6	-4	-5.24	-3.55	0	0.92	11.25	39	4.03	29
			-5.29	-3.67	-6	-4	-5.24	-3.55	20	0.89	13.02	58	6.72	
DR3TSBDT	Y6	PC ₇₁ BM	-5.07	-3.3	-5.65	-4.1	-6	-4	0	0.879	21.67	55.21	10.5	30
			-5.07	-3.3	-5.65	-4.1	-6	-4	10	0.875	23	58.09	11.6	
			-5.07	-3.3	-5.65	-4.1	-6	-4	30	0.87	22.47	64.72	12.6	

			-5.07	-3.3	-5.65	-4.1	-6	-4	40	0.858	22.19	67.27	12.8	
			-5.07	-3.3	-5.65	-4.1	-6	-4	50	0.852	21.43	69.19	12.6	
			-5.07	-3.3	-5.65	-4.1	-6	-4	70	0.849	18.4	67.11	10.5	
			-5.07	-3.3	-5.65	-4.1	-6	-4	100	0.936	12.04	65.39	7.4	
PTB7-Th	IEICO-4F	PC ₇₁ BM	-5.24	-3.36	-5.44	-4.19	-5.96	-3.98	0	0.73	21.3	60	9.44	31
			-5.24	-3.36	-5.44	-4.19	-5.96	-3.98	10	0.74	22.64	63	10.5	
			-5.24	-3.36	-5.44	-4.19	-5.96	-3.98	20	0.74	23.14	60	10.2	
			-5.24	-3.36	-5.44	-4.19	-5.96	-3.98	30	0.74	21.9	58	9.36	
			-5.24	-3.36	-5.44	-4.19	-5.96	-3.98	50	0.76	20.91	51	8.04	
VC7	IT-4F	PC ₇₁ BM	-5.3	-3.9	-5.67	-4.14	-6.1	-4.1	0	0.84	21.94	63	11.6	32
			-5.3	-3.9	-5.67	-4.14	-6.1	-4.1	25	0.87	23.74	73	15.0	
			-5.3	-3.9	-5.67	-4.14	-6.1	-4.1	100	0.89	15.98	66	9.39	
PCDTBT	PC ₇₁ BM	ITIC	-5.5	-3.6	-5.9	-3.9	-5.5	-3.8	0	0.875	12.02	58.1	6.11	33
			-5.5	-3.6	-5.9	-3.9	-5.5	-3.8	20	0.906	12.5	54.9	6.21	
			-5.5	-3.6	-5.9	-3.9	-5.5	-3.8	25	0.907	11.73	49.4	5.25	
PTB7-Th	Y6	PC ₇₁ BM	-5.22	-3.64	-5.65	-4.1	-5.96	-3.98	0	0.67	20.16	56.77	7.71	34
			-5.22	-3.64	-5.65	-4.1	-5.96	-3.98	17	0.67	24.68	58.02	9.55	
			-5.22	-3.64	-5.65	-4.1	-5.96	-3.98	100	0.82	13.92	58.8	6.67	
PBDTTPD-HT	PC ₇₁ BM	DRCN5T	-5.36	-3.5	-6.02	-4.15	-5.5	-3.9	0	0.869	12.4	71.4	7.72	35
			-5.36	-3.5	-6.02	-4.15	-5.5	-3.9	17	0.929	13	74.9	9.08	
PM6	Y6	PC ₇₁ BM	-5.5	-3.56	-5.7	-4.1	-5.92	-3.9	0	0.845	24.89	74.37	15.7	36
			-5.5	-3.56	-5.7	-4.1	-5.92	-3.9	8	0.85	25.36	75.66	16.3	
			-5.5	-3.56	-5.7	-4.1	-5.92	-3.9	12.	0.85	25.8	74.66	16.3	

			-5.5	-3.56	-5.7	-4.1	-5.92	-3.9	17	0.85	25.7	76.35	16.6	
			-5.5	-3.56	-5.7	-4.1	-5.92	-3.9	25	0.853	25.05	75.15	16.0	
			-5.5	-3.56	-5.7	-4.1	-5.92	-3.9	42	0.865	23.94	73.85	15.3	
			-5.5	-3.56	-5.7	-4.1	-5.92	-3.9	67	0.876	19.24	49.74	8.39	
			-5.5	-3.56	-5.7	-4.1	-5.92	-3.9	100	0.965	11.56	53.9	6.01	
P3HT	PC ₇₁ BM	2DPP-BDT	-4.9	-3	-6	-4	-5	-3.4	0	0.59	8.45	65	3.23	37
			-4.9	-3	-6	-4	-5	-3.4	20	0.61	11.88	56.7	4.11	
			-4.9	-3	-6	-4	-5	-3.4	100	0.8	2.45	57.7	1.14	
PFBBDT-8tfTPD	IT-4F	PC ₇₁ BM	-5.33	-3.43	-5.71	-4.18	-6	-4.12	0	0.89	19.91	72	12.8 1	38
			-5.33	-3.43	-5.71	-4.18	-6	-4.12	15	0.9	20.82	73	13.6	
PFBBDT-8tfTPD	Y6	PC ₇₁ BM	-5.33	-3.43	-5.65	-4.29	-6	-4.12	0	0.84	24.99	72	15.0 5	38
			-5.33	-3.43	-5.65	-4.29	-6	-4.12	15	0.85	25.96	74	16.4	
PM6	FCTT-FIC	PC ₇₁ BM	-5.47	-3.67	-5.56	-4.03	-6	-3.9	0	0.9	19.49	69.73	12.2	39
			-5.47	-3.67	-5.56	-4.03	-6	-3.9	33	0.92	19.86	73.2	13.3	
			-5.47	-3.67	-5.56	-4.03	-6	-3.9	50	0.92	18.48	72.71	12.3	
			-5.47	-3.67	-5.56	-4.03	-6	-3.9	60	0.92	17.83	71.48	11.7	
PBDB-T	TC-FIC	PC ₇₁ BM	-5.36	-3.54	-5.42	-4	-6	-3.9	0	0.9	21.87	58.7	11.5	40
			-5.36	-3.54	-5.42	-4	-6	-3.9	33	0.88	23.7	64.2	13.3	
			-5.36	-3.54	-5.42	-4	-6	-3.9	50	0.88	23.8	64.4	13.4	
			-5.36	-3.54	-5.42	-4	-6	-3.9	60	0.88	23.78	63.9	13.3	
PTB7-Th	PC ₇₁ BM	BTTCN	-5.12	-3.6	-6.1	-3.9	-5.77	-3.68	0	0.804	15.68	67.7	8.53	41
			-5.12	-3.6	-6.1	-3.9	-5.77	-3.68	3	0.804	17.15	68.4	9.43	

			-5.12	-3.6	-6.1	-3.9	-5.77	-3.68	6	0.807	16.39	65.9	8.72	
DRCN5T	PC ₇₁ BM	PBDB-T	-5.32	-3.77	-6	-4	-5.28	-3.48	0	0.94	14.06	58.56	7.74	42
			-5.32	-3.77	-6	-4	-5.28	-3.48	10	0.92	15.64	63.59	9.15	
			-5.32	-3.77	-6	-4	-5.28	-3.48	20	0.9	15.98	65.72	9.45	
			-5.32	-3.77	-6	-4	-5.28	-3.48	30	0.9	15.15	63.37	8.64	
			-5.32	-3.77	-6	-4	-5.28	-3.48	40	0.89	14.66	59.02	7.7	
			-5.32	-3.77	-6	-4	-5.28	-3.48	100	0.85	13.16	67.94	7.6	
PMTT56	IT-2F	PC ₇₁ BM	-5.39	-3.4	-5.52	-3.96	-5.94	-3.98	0	0.945	18.67	71.4	12.6	43
			-5.39	-3.4	-5.52	-3.96	-5.94	-3.98	25	0.932	19.75	71.4	13.2	
PBDB-T-2F	Y6	PC ₇₁ BM	-5.45	-3.65	-5.6	-4.3	-6.1	-3.8	0	0.84	25.9	73	15.8	44
			-5.45	-3.65	-5.6	-4.3	-6.1	-3.8	17	0.84	26	78	17	
PBDB-T	IPIC-4Cl	PC ₇₁ BM	-5.33	-3.29	-5.51	-3.95	-6.1	-4	0	0.813	22.2	74	13.4	45
			-5.33	-3.29	-5.51	-3.95	-6.1	-4	9	0.823	22.6	73.2	13.6	
			-5.33	-3.29	-5.51	-3.95	-6.1	-4	23	0.822	23.3	74.6	14.3	
			-5.33	-3.29	-5.51	-3.95	-6.1	-4	33	0.822	20.4	72.3	12.1	
DR3TBDTT	PC71BM	PTB7-Th	-5.02	-3.27	-6.1	-3.9	-5.24	-3.62	0	0.834	11.89	44.4	4.4	46
			-5.02	-3.27	-6.1	-3.9	-5.24	-3.62	3	0.835	10.13	59.9	5.1	
			-5.02	-3.27	-6.1	-3.9	-5.24	-3.62	7	0.824	10.86	60.5	5.4	
			-5.02	-3.27	-6.1	-3.9	-5.24	-3.62	10	0.82	11.38	61.5	5.7	
			-5.02	-3.27	-6.1	-3.9	-5.24	-3.62	25	0.821	10.12	45.4	3.8	
			-5.02	-3.27	-6.1	-3.9	-5.24	-3.62	50	0.823	5.41	38.6	1.7	
			-5.02	-3.27	-6.1	-3.9	-5.24	-3.62	100	0.826	4.74	33.1	1.3	
DTS	PC ₇₁ BM	SIDT	-5.12	-3.34	-6.1	-4.3	-5.21	-3.36	0	0.773	13.95	64	6.9	47
			-5.12	-3.34	-6.1	-4.3	-5.21	-3.36	20	0.8	14.36	65.3	7.5	

			-5.12	-3.34	-6.1	-4.3	-5.21	-3.36	30	0.812	14.68	66.3	7.9	
			-5.12	-3.34	-6.1	-4.3	-5.21	-3.36	40	0.827	14.82	55.9	8.2	
			-5.12	-3.34	-6.1	-4.3	-5.21	-3.36	50	0.842	15.41	67.5	8.8	
			-5.12	-3.34	-6.1	-4.3	-5.21	-3.36	60	0.855	14.42	65.7	8.1	
			-5.12	-3.34	-6.1	-4.3	-5.21	-3.36	70	0.869	12.65	65.5	7.2	
			-5.12	-3.34	-6.1	-4.3	-5.21	-3.36	100	0.911	10.72	65.5	6.4	
CSO1	MPU3	PC ₇₁ BM	-5.32	-3.6	-5.61	-3.74	-6	-4	0	1.07	13.04	56	7.81	48
			-5.32	-3.6	-5.61	-3.74	-6	-4	25	0.97	16.27	63	9.94	
			-5.32	-3.6	-5.61	-3.74	-6	-4	100	0.79	10.48	58	4.8	
P3TCO-1	ITIC	PC ₇₁ BM	-5.39	-3.17	-5.51	-3.78	-5.96	-3.98	0	0.943	16.96	62.82	10.0	49
			-5.39	-3.17	-5.51	-3.78	-5.96	-3.98	17	0.939	18.05	66.67	11.3	
			-5.39	-3.17	-5.51	-3.78	-5.96	-3.98	100	0.935	11.98	58.65	6.57	
PBDB-T	PC ₇₁ BM	BDTC-4Cl	-5.26	-3.63	-6	-4.19	-5.35	-3.75	0	0.847	13.21	72.6	8.12	50
			-5.26	-3.63	-6	-4.19	-5.35	-3.75	50	0.856	21.19	67.2	12.1	
			-5.26	-3.63	-6	-4.19	-5.35	-3.75	100	0.864	18.56	59.5	9.54	
PBDB-T	DTFT9-FIC	PC ₇₁ BM	-5.36	-3.54	-5.49	-4.01	-6	-3.9	0	0.86	19.01	58.61	9.58	51
			-5.36	-3.54	-5.49	-4.01	-6	-3.9	25	0.88	20.58	60.74	11	
			-5.36	-3.54	-5.49	-4.01	-6	-3.9	40	0.88	20.59	65.27	11.8	
			-5.36	-3.54	-5.49	-4.01	-6	-3.9	50	0.86	19.62	66.3	11.1	
PTB7	PC ₇₁ BM	EP-PDI	-5.15	-3.31	-6.1	-4.2	-6.1	-3.8	0	0.68	14.2	52.6	5.35	52
			-5.15	-3.31	-6.1	-4.2	-6.1	-3.8	10	0.7	14.8	54.1	5.79	
			-5.15	-3.31	-6.1	-4.2	-6.1	-3.8	20	0.71	15.3	55.7	6.33	
			-5.15	-3.31	-6.1	-4.2	-6.1	-3.8	30	0.72	17.5	58.2	7.33	

			-5.15	-3.31	-6.1	-4.2	-6.1	-3.8	40	0.72	19.3	59.2	8.23	
			-5.15	-3.31	-6.1	-4.2	-6.1	-3.8	50	0.72	18.1	54.7	7.14	
PTBTz-2	ITIC	PC ₇₁ BM	-5.48	-3.52	-5.63	-3.97	-6	-3.9	0	0.89	19.8	59.05	10.4	53
			-5.48	-3.52	-5.63	-3.97	-6	-3.9	20	0.9	20.04	59.69	10.7	
			-5.48	-3.52	-5.63	-3.97	-6	-3.9	35	0.89	20.75	60.94	11.2	
			-5.48	-3.52	-5.63	-3.97	-6	-3.9	50	0.88	19.17	57.53	9.68	
PTB7	PC ₇₁ BM	BTA2	-5.51	-3.3	-6	-4	-5.41	-3.38	0	0.73	15.3	65.25	7.2	54
			-5.51	-3.3	-6	-4	-5.41	-3.38	10	0.74	16.7	64.14	8	
PBDB-TF	HF-PCIC	PC71BM	-5.48	-3.64	-5.53	-3.83	-5.54	-3.87	0	0.89	17.24	70.98	10.9	55
			-5.48	-3.64	-5.53	-3.83	-5.54	-3.87	15	0.9	18.1	70.81	11.5	
			-5.48	-3.64	-5.53	-3.83	-5.54	-3.87	30	0.89	19.29	70.18	12.3	
PBDB-T	IDTC-4Cl	PC ₇₁ BM	-5.26	3.63	-5.5	-3.79	-6	-4.19	0	0.822	19.19	60.2	9.5	56
			-5.26	3.63	-5.5	-3.79	-6	-4.19	20	0.829	19.14	65.6	10.4	
PTB7-Th	PC ₇₁ BM	P8TT	-5	-3.4	-5.8	-4	-5.29	-3.31	0	0.795	16.67	63.7	8.44	57
			-5	-3.4	-5.8	-4	-5.29	-3.31	6	0.811	16.81	63	8.59	
PTB7-Th	PC ₇₁ BM	P8TTT	-5	-3.4	-5.8	-4	-5.17	-3.16	6	0.802	17.26	65.6	9.08	57
J52	IEICO-4F	PC71BM	-5.21	-2.99	-5.44	-4.19	-6.1	-3.9	0	0.675	22.27	61.3	9.21	58
			-5.21	-2.99	-5.44	-4.19	-6.1	-3.9	20	0.69	22.6	65.7	10.2	
			-5.21	-2.99	-5.44	-4.19	-6.1	-3.9	40	0.698	22.7	67.4	10.6	
			-5.21	-2.99	-5.44	-4.19	-6.1	-3.9	60	0.713	19.67	69.3	9.73	
			-5.21	-2.99	-5.44	-4.19	-6.1	-3.9	100	0.723	10.15	69.7	5.12	
PBDB-T	IDT-2O	PC ₇₁ BM	-5.33	-2.92	-5.72	-3.85	-5.96	-3.98	0	0.86	15.7	71.6	9.65	59
			-5.33	-2.92	-5.72	-3.85	-5.96	-3.98	20	0.87	16.8	72.11	10.6	
			-5.33	-2.92	-5.72	-3.85	-5.96	-3.98	40	0.88	16.35	71.21	10.2	

			-5.33	-2.92	-5.72	-3.85	-5.96	-3.98	60	0.88	15.76	69.78	9.78	
			-5.33	-2.92	-5.72	-3.85	-5.96	-3.98	80	0.87	15.18	69.46	9.24	
			-5.33	-2.92	-5.72	-3.85	-5.96	-3.98	100	0.86	13.3	64.67	7.47	
PTB7	PC ₇₁ BM	FeS2	-5.2	-3.3	-6.1	-3.9	-4.9	-4.2	0	0.73	14.48	47	4.98	60
			-5.2	-3.3	-6.1	-3.9	-4.9	-4.2	25	0.64	11.15	23	1.57	
			-5.2	-3.3	-6.1	-3.9	-4.9	-4.2	50	0.77	15.31	52	6.02	
			-5.2	-3.3	-6.1	-3.9	-4.9	-4.2	100	0.71	15.21	50	5.48	
PBDB-T	NCIC	PC ₇₁ BM	-5.36	-3.54	-5.37	-3.73	-6	-3.9	0	1	12.69	57.6	7.31	61
			-5.36	-3.54	-5.37	-3.73	-6	-3.9	33	0.9	15.55	52.7	7.38	
			-5.36	-3.54	-5.37	-3.73	-6	-3.9	50	0.88	16.78	56.4	8.32	
			-5.36	-3.54	-5.37	-3.73	-6	-3.9	60	0.84	17.03	56.4	8.29	
PBDB-T	NCFIC	PC ₇₁ BM	-5.36	-3.54	-5.43	-3.94	-6	-3.9	0	0.88	15.19	56.3	7.52	61
			-5.36	-3.54	-5.43	-3.94	-6	-3.9	33	0.86	16.97	61.8	9.01	
			-5.36	-3.54	-5.43	-3.94	-6	-3.9	50	0.84	16.98	61.9	8.83	
			-5.36	-3.54	-5.43	-3.94	-6	-3.9	60	0.84	17.79	61.4	9.18	
LQ-51	PC ₇₁ BM	PCDTBT	-5.1	-3.4	-6.1	-4.3	-5.5	-3.6	0	0.83	9.47	47.77	3.75	62
			-5.1	-3.4	-6.1	-4.3	-5.5	-3.6	9	0.84	9.74	49.43	4.04	
			-5.1	-3.4	-6.1	-4.3	-5.5	-3.6	23	0.84	10.19	50.76	4.35	
			-5.1	-3.4	-6.1	-4.3	-5.5	-3.6	33	0.85	10.12	51.64	4.44	
			-5.1	-3.4	-6.1	-4.3	-5.5	-3.6	41	0.85	10.86	51.98	4.8	
			-5.1	-3.4	-6.1	-4.3	-5.5	-3.6	50	0.87	10.46	50.92	4.64	
			-5.1	-3.4	-6.1	-4.3	-5.5	-3.6	100	0.87	6.52	57.59	3.27	
PTB7-Th	PC ₇₁ BM	CPDT-(TIC)2	-5.22	-3.64	-6.1	-4.3	-5.51	-4.08	0	0.778	16.21	60.1	7.58	63
			-5.22	-3.64	-6.1	-4.3	-5.51	-4.08	3.3	0.8	16.33	64.8	8.46	

			-5.22	-3.64	-6.1	-4.3	-5.51	-4.08	6.7	0.795	17.21	64.3	8.8	
			-5.22	-3.64	-6.1	-4.3	-5.51	-4.08	13.	0.792	17.5	60.6	8.4	
			-5.22	-3.64	-6.1	-4.3	-5.51	-4.08	26.	0.788	18.53	55.5	8.1	
			-5.22	-3.64	-6.1	-4.3	-5.51	-4.08	40	0.787	18.12	48.9	6.98	
			-5.22	-3.64	-6.1	-4.3	-5.51	-4.08	60	0.735	5.51	29.1	1.18	
			-5.22	-3.64	-6.1	-4.3	-5.51	-4.08	5	0.803	19	61.6	9.48	
PTB7-Th	PC ₇₁ BM	DFNPy	-5.24	-3.61	-6	-4	-5.54	-2.79	0	0.77	18.39	65.49	9.26	64
			-5.24	-3.61	-6	-4	-5.54	-2.79	5	0.77	18.66	66.13	9.59	
			-5.24	-3.61	-6	-4	-5.54	-2.79	10	0.78	19.14	67.26	10.0	
			-5.24	-3.61	-6	-4	-5.54	-2.79	15	0.78	19.45	67.61	10.2	
			-5.24	-3.61	-6	-4	-5.54	-2.79	20	0.78	18.14	67.35	9.49	
PBDB-T	PC ₇₁ BM	IT-M	-5.33	-3.53	-6.1	-4.3	-5.58	-3.98	0	0.836	11.99	67.54	6.77	65
			-5.33	-3.53	-6.1	-4.3	-5.58	-3.98	30	0.863	13.98	67.26	8.16	
			-5.33	-3.53	-6.1	-4.3	-5.58	-3.98	50	0.871	15.29	68.29	9.1	
			-5.33	-3.53	-6.1	-4.3	-5.58	-3.98	70	0.897	15.51	67.74	9.43	
			-5.33	-3.53	-6.1	-4.3	-5.58	-3.98	80	0.915	16.44	67.58	10.1	
			-5.33	-3.53	-6.1	-4.3	-5.58	-3.98	90	0.926	15.44	69.07	9.87	
			-5.33	-3.53	-6.1	-4.3	-5.58	-3.98	100	0.93	14.59	65.7	8.88	
PBDB-T-2Cl	Y6	PC ₇₁ BM	-5.51	-3.71	-5.65	-4.1	-5.96	-3.98	0	0.868	24.98	71.42	15.4 9	66
			-5.51	-3.71	-5.65	-4.1	-5.96	-3.98	8	0.868	25.33	73.93	16.2	
			-5.51	-3.71	-5.65	-4.1	-5.96	-3.98	14	0.868	25.44	75.66	16.7	
			-5.51	-3.71	-5.65	-4.1	-5.96	-3.98	20	0.868	25.28	74.23	16.2	
			-5.51	-3.71	-5.65	-4.1	-5.96	-3.98	29	0.868	24.9	72.27	15.6	

			-5.51	-3.71	-5.65	-4.1	-5.96	-3.98	45	0.868	23.9	68.29	14.1	
			-5.51	-3.71	-5.65	-4.1	-5.96	-3.98	100	0.97	11.73	63.83	7.28	
DR3TBDTT	PC ₇₁ BM	DR3TBDTT-E	-5.02	-3.27	-6.1	-3.9	-5.22	-3.46	0	0.88	13.52	74.9	8.9	67
			-5.02	-3.27	-6.1	-3.9	-5.22	-3.46	10	0.896	14.97	76.5	10.2	
			-5.02	-3.27	-6.1	-3.9	-5.22	-3.46	20	0.901	12.67	74.7	8.52	
			-5.02	-3.27	-6.1	-3.9	-5.22	-3.46	40	0.895	12.56	61.5	6.92	
			-5.02	-3.27	-6.1	-3.9	-5.22	-3.46	60	0.902	12.38	58.4	6.52	
			-5.02	-3.27	-6.1	-3.9	-5.22	-3.46	80	0.92	11.24	54.7	5.66	
			-5.02	-3.27	-6.1	-3.9	-5.22	-3.46	100	0.944	10.85	68.2	6.99	
PTB7-Th	3TT-FIC	PC ₇₁ BM	-5.24	-3.66	-5.42	-4.17	-6.19	-4	0	0.662	25.89	71.2	12.2	68
			-5.24	-3.66	-5.42	-4.17	-6.19	-4	11	0.666	27.36	71.9	13.1	
			-5.24	-3.66	-5.42	-4.17	-6.19	-4	20	0.669	27.73	73	13.5	
			-5.24	-3.66	-5.42	-4.17	-6.19	-4	27	0.671	27.29	69	12.6	
PTB7-Th	PC ₇₁ BM	TPB	-5.2	-3.6	-6	-3.9	-5.7	-3.9	0	0.78	17.2	70	9.4	69
			-5.2	-3.6	-6	-3.9	-5.7	-3.9	5	0.77	17.8	70	9.7	
			-5.2	-3.6	-6	-3.9	-5.7	-3.9	10	0.78	19.4	68	10.2	
			-5.2	-3.6	-6	-3.9	-5.7	-3.9	20	0.77	19.4	67	10	
			-5.2	-3.6	-6	-3.9	-5.7	-3.9	30	0.76	13.6	65	6.7	
PTB7-Th	PC ₇₁ BM	PTN	-5.2	-3.6	-6.1	-3.9	-5.28	-2.24	0	0.77	18.66	61.03	8.91	70
			-5.2	-3.6	-6.1	-3.9	-5.28	-2.24	5	0.77	19.74	62.34	9.81	
			-5.2	-3.6	-6.1	-3.9	-5.28	-2.24	10	0.78	20.18	64.2	10.4	
			-5.2	-3.6	-6.1	-3.9	-5.28	-2.24	15	0.78	21.47	68.31	11.4	
			-5.2	-3.6	-6.1	-3.9	-5.28	-2.24	20	0.78	20.24	62.02	9.79	

PTB7-Th	PC ₇₁ BM	EH-5T-TTC	-5.24	-3.66	-6	-4	-5.19	-3.19	0	0.77	11.4	36.5	3.2	71
			-5.24	-3.66	-6	-4	-5.19	-3.19	10	0.778	15	52	6.09	
OFQx-T	PC ₇₁ BM	ITIC	-5.44	-3.55	-6.19	-4	-5.49	-3.81	0	0.86	12.26	72	7.59	72
			-5.44	-3.55	-6.19	-4	-5.49	-3.81	50	0.89	14.35	64	8.17	
OFQx-T	PC ₇₁ BM	PTB7-Th	-5.44	-3.55	-6.19	-4	-5.38	-3.56	0	0.86	12.26	72	7.59	72
			-5.44	-3.55	-6.19	-4	-5.38	-3.56	50	0.82	14.77	72	8.72	
PTB7-Th	IEICO-4F	PC ₇₁ BM	-5.22	-3.64	-5.44	-4.19	-5.96	-3.98	0	0.74	20.62	58.55	8.96	73
			-5.22	-3.64	-5.44	-4.19	-5.96	-3.98	6	0.74	23.63	58	10.1	
PM6	BTCT-2Cl	PC ₇₁ BM	-5.54	-3.65	-5.56	-3.95	-5.96	-3.98	0	0.877	24.4	70.4	15.1	74
			-5.54	-3.65	-5.56	-3.95	-5.96	-3.98	17	0.881	25.1	72.6	16.1	
BTR	Y6	PC ₇₁ BM	-5.3	-3.5	-5.6	-4.1	-6.1	-4.2	0	0.846	22.13	57.67	10.8	75
			-5.3	-3.5	-5.6	-4.1	-6.1	-4.2	20	0.855	22.45	58.93	11.3	
			-5.3	-3.5	-5.6	-4.1	-6.1	-4.2	30	0.859	22.21	62	11.8	
			-5.3	-3.5	-5.6	-4.1	-6.1	-4.2	40	0.86	21.11	62.52	11.3	
			-5.3	-3.5	-5.6	-4.1	-6.1	-4.2	50	0.863	19.18	64.13	10.6	
			-5.3	-3.5	-5.6	-4.1	-6.1	-4.2	100	0.955	8.08	63.53	4.9	
PFT	IT-4F	PC ₇₁ BM	-5.68	-3.71	-5.74	-4.1	-6.1	-3.98	0	0.88	17.15	71.6	10.8	76
			-5.68	-3.71	-5.74	-4.1	-6.1	-3.98	9	0.89	17.55	72.92	11.3	
			-5.68	-3.71	-5.74	-4.1	-6.1	-3.98	17	0.9	18.42	74.61	12.3	
			-5.68	-3.71	-5.74	-4.1	-6.1	-3.98	20	0.91	18.49	74.92	12.6	
			-5.68	-3.71	-5.74	-4.1	-6.1	-3.98	23	0.91	18.23	74.3	12.3	
			-5.68	-3.71	-5.74	-4.1	-6.1	-3.98	33	0.92	17.5	71.82	11.5	
			-5.68	-3.71	-5.74	-4.1	-6.1	-3.98	50	0.93	16.7	65.6	10.1	
			-5.68	-3.71	-5.74	-4.1	-6.1	-3.98	100	0.94	13.23	64	7.96	

CS03	DPP8	PC ₇₁ BM	-5.13	-3.48	-5.34	-3.81	-6.1	-4.1	0	0.88	13.86	61	7.44	77
			-5.13	-3.48	-5.34	-3.81	-6.1	-4.1	20	0.82	16.04	68	8.94	
			-5.13	-3.48	-5.34	-3.81	-6.1	-4.1	100	0.69	12.46	59	5.07	
PM6	PC ₇₁ BM	N2200-F	-5.5	-3.6	-6	-4	-5.8	-3.9	0	0.92	12.59	67	7.38	78
			-5.5	-3.6	-6	-4	-5.8	-3.9	30	0.91	13.01	69	8.11	
			-5.5	-3.6	-6	-4	-5.8	-3.9	100	0.89	12.26	63	7.34	
TDTBTA	MPU4	PC ₇₁ BM	-5.38	-3.3	-5.54	-3.7	-6.1	-4.3	0	1.04	20.38	62	13.1	79
			-5.38	-3.3	-5.54	-3.7	-6.1	-4.3	25	0.97	22.65	71	15.6	
			-5.38	-3.3	-5.54	-3.7	-6.1	-4.3	100	0.89	11.22	67	6.69	
PDBT-F	IDIC	PC ₇₁ BM	-5.39	-3.57	-5.69	-3.91	-5.79	-3.85	0	0.87	17.65	71.5	11.0	80
			-5.39	-3.57	-5.69	-3.91	-5.79	-3.85	10	0.89	18.69	70.88	11.8	
			-5.39	-3.57	-5.69	-3.91	-5.79	-3.85	20	0.89	19.41	64.14	11.0	
			-5.39	-3.57	-5.69	-3.91	-5.79	-3.85	50	0.91	16.06	64.49	9.45	
			-5.39	-3.57	-5.69	-3.91	-5.79	-3.85	100	0.93	12.63	61.96	7.28	
PCDTBT	PC ₇₁ BM	PV12	-5.4	-3.55	-5.96	-4.26	-5.49	-3.9	0	0.84	10.87	57.1	5.28	81
			-5.4	-3.55	-5.96	-4.26	-5.49	-3.9	10	0.87	11.5	61	6.21	
			-5.4	-3.55	-5.96	-4.26	-5.49	-3.9	15	0.88	12.01	63	6.73	
			-5.4	-3.55	-5.96	-4.26	-5.49	-3.9	20	0.86	11.63	62.8	6.39	
			-5.4	-3.55	-5.96	-4.26	-5.49	-3.9	30	0.84	11.22	59.4	5.62	
			-5.4	-3.55	-5.96	-4.26	-5.49	-3.9	100	0.8	5.91	60.9	2.93	
PIDTBT	PC ₇₁ BM	ITIC	-5.36	-3.52	-5.96	-3.98	-5.51	-3.78	0	0.87	12	53.2	5.7	82
			-5.36	-3.52	-5.96	-3.98	-5.51	-3.78	25	0.87	14.2	54	7	
			-5.36	-3.52	-5.96	-3.98	-5.51	-3.78	37.	0.87	12.9	53.2	6.1	
			-5.36	-3.52	-5.96	-3.98	-5.51	-3.78	50	0.91	12.1	53.4	6.1	

			-5.36	-3.52	-5.96	-3.98	-5.51	-3.78	62.	0.91	11.2	52.5	5.6	
			-5.36	-3.52	-5.96	-3.98	-5.51	-3.78	71	0.94	10.1	50.5	4.9	
			-5.36	-3.52	-5.96	-3.98	-5.51	-3.78	100	0.97	8.3	49	4.2	
DR3	ICC6	PC ₇₁ BM	-5.11	-3.4	-5.82	-4.18	-5.91	-4.1	0	0.87	15.2	64	8.7	83
			-5.11	-3.4	-5.82	-4.18	-5.91	-4.1	29	0.87	16.3	72	10.8	
			-5.11	-3.4	-5.82	-4.18	-5.91	-4.1	41	0.86	16.4	70	10.3	
			-5.11	-3.4	-5.82	-4.18	-5.91	-4.1	50	0.85	16.4	69	9.9	
			-5.11	-3.4	-5.82	-4.18	-5.91	-4.1	67	0.81	14.1	60	7.2	
PTB7-Th	PC ₇₁ BM	PBT1-S	-5.22	-3.64	-6.1	-3.9	-5.43	-3.33	0	0.82	16.4	71.2	9.5	84
			-5.22	-3.64	-6.1	-3.9	-5.43	-3.33	5	0.82	16	72	9.8	
			-5.22	-3.64	-6.1	-3.9	-5.43	-3.33	10	0.82	17.3	72.2	10.3	
			-5.22	-3.64	-6.1	-3.9	-5.43	-3.33	15	0.83	16.5	68	9.3	
			-5.22	-3.64	-6.1	-3.9	-5.43	-3.33	100	0.83	11.8	68	7.5	
PTB7	PC ₇₁ BM	DIB-SQ	-5.2	-3.3	-6	-4.3	-5.3	-3.5	0	0.75	14.12	64.83	6.86	85
			-5.2	-3.3	-6	-4.3	-5.3	-3.5	3	0.75	14.86	67.01	7.47	
			-5.2	-3.3	-6	-4.3	-5.3	-3.5	6	0.75	15.29	69.09	7.92	
			-5.2	-3.3	-6	-4.3	-5.3	-3.5	9	0.75	14.55	66.12	7.22	
			-5.2	-3.3	-6	-4.3	-5.3	-3.5	12	0.75	14.01	63.3	6.65	
			-5.2	-3.3	-6	-4.3	-5.3	-3.5	100	0.77	8.28	35.92	2.29	
PTB7-Th	PC ₇₁ BM	DB-Qx	-5.4	-3.8	-6.1	-4.3	-5.6	-3.6	0	0.81	14.05	52.01	5.98	86
			-5.4	-3.8	-6.1	-4.3	-5.6	-3.6	10	0.8	15.93	62.2	8.2	
			-5.4	-3.8	-6.1	-4.3	-5.6	-3.6	20	0.8	15.5	66.92	8.4	
			-5.4	-3.8	-6.1	-4.3	-5.6	-3.6	30	0.8	15.4	69.08	8.64	
			-5.4	-3.8	-6.1	-4.3	-5.6	-3.6	40	0.8	15.15	68.05	8.46	

PTB7	PC ₇₁ BM	GO-TNF	-5.15	-3.3	-6	-4.3	-5.66	-4.13	0	0.76	16.2	61.8	7.61	87
			-5.15	-3.3	-6	-4.3	-5.66	-4.13	1	0.76	16.54	63	7.92	
			-5.15	-3.3	-6	-4.3	-5.66	-4.13	2	0.76	17.21	64	8.37	
			-5.15	-3.3	-6	-4.3	-5.66	-4.13	3	0.76	16.53	62.4	7.84	
PffBT4T-2OD	PC ₇₁ BM	PCDTBT8	-5.34	-3.69	-6	-4	-5.4	-3.27	0	0.75	19.5	72.2	10.5 7	88
			-5.34	-3.69	-6	-4	-5.4	-3.27	5	0.76	19.2	74.3	10.8	
			-5.34	-3.69	-6	-4	-5.4	-3.27	10	0.77	19	75.1	11.0	
			-5.34	-3.69	-6	-4	-5.4	-3.27	15	0.79	18.8	74.7	11.1	
			-5.34	-3.69	-6	-4	-5.4	-3.27	20	0.81	17.9	73.1	10.5	
			-5.34	-3.69	-6	-4	-5.4	-3.27	30	0.82	16.2	67.1	9.1	
PBDB-T	m-INPOIC	PC ₇₁ BM	-5.33	-3.29	-5.41	-3.97	-6	-4	0	0.85	21.3	66.9	12.1	89
			-5.33	-3.29	-5.41	-3.97	-6	-4	13	0.857	22.8	71.6	14	
			-5.33	-3.29	-5.41	-3.97	-6	-4	23	0.858	20.2	67.3	11.6	
PTB7-Th	PC ₇₁ BM	N2200	-5.24	-3.66	-6	-4	-5.49	-4.04	0	0.81	15.2	69.6	8.6	90
			-5.24	-3.66	-6	-4	-5.49	-4.04	17	0.82	14.3	53	6.2	
			-5.24	-3.66	-6	-4	-5.49	-4.04	33	0.82	14	52.5	6	
			-5.24	-3.66	-6	-4	-5.49	-4.04	50	0.83	12.3	52	5.3	
			-5.24	-3.66	-6	-4	-5.49	-4.04	67	0.8	9.3	49.1	3.7	
			-5.24	-3.66	-6	-4	-5.49	-4.04	100	0.8	10.4	56.5	4.7	

Supplemental References

1. V. Piradi, X. Xu, Z. Wang, J. Ali, Q. Peng, F. Liu and X. Zhu, *ACS Appl. Mater. Interfaces*, 2019, **11**, 6283-6291.
2. S. Karuthedath, Y. Firdaus, R. Z. Liang, J. Gorenflot, P. M. Beaujuge, T. D. Anthopoulos and F. Laquai, *Adv. Energy Mater*, 2019, **9**,1901443.
3. C. Rodríguez-Seco, L. Cabau, M. Privado, P. de la Cruz, F. Langa, G. D. Sharma and E. Palomares, *ACS Appl. Energy Mater*, 2020, **3**, 12506-12516.
4. X. Fu, H. Xu, D. Zhou, X. Cheng, L. Huang, L. Chen and Y. Chen, *J. Mater. Sci*, 2018, **53**, 8398-8408.
5. C. e. Zhang, P. Jiang, X. Zhou, H. Liu, Q. Guo, X. Xu, Y. Liu, Z. Tang, W. Ma and Z. Bo, *J. Mater. Chem. A*, 2020, **8**, 2123-2130.
6. B. Wang, Y. Fu, C. Yan, R. Zhang, Q. Yang, Y. Han and Z. Xie, *Front Chem*, 2018, **6**, 198.
7. L. Qing, A. Zhong, W. Chen, Y. Cao and J. Chen, *Polymer*, 2020, **186**,122050.
8. D. Xia, Z. Zhang, C. Zhao, J. Wang, J. Xia, G. Chen, S. Li, Z. Tang, S. You and W. Li, *J Colloid Interface Sci*, 2021, **601**, 70-77.
9. X. Li, L. Zhou, X. Lu, L. Cao, X. Du, H. Lin, C. Zheng and S. Tao, *Mater. Chem. Front*, 2021, **5**, 3850-3858.
10. M. Kim, J. Lee, D. H. Sin, H. Lee, H. Y. Woo and K. Cho, *ACS Appl. Mater*, 2018, **10**, 25570-25579.
11. B. Zhu, X. Chen, S. Huang and X. Peng, *Dyes Pigm*, 2019, **164**, 148-155.
12. X. Du, H. Lin, X. Chen, S. Tao, C. Zheng and X. Zhang, *Nanoscale*, 2018, **10**, 16455-16467.
13. L. Duan, X. Meng, Y. Zhang, H. Yi, K. Jin, F. Haque, C. Xu, Z. Xiao, L. Ding and A. Uddin, *Mater. Chem. Front*, 2019, **3**, 1085-1096.
14. X. Liu, S. Du, Z. Fu, C. Chen, J. Tong, J. Li, N. Zheng, R. Zhang and Y. Xia, *Sol. Energy*, 2021, **222**, 18-26.
15. B. Qiu, S. Chen, C. Sun, J. Yuan, X. Zhang, C. Zhu, S. Qin, L. Meng, Y. Zhang, C. Yang, Y. Zou and Y. Li, *Sol. RRL*, 2020, **4**,1900540.
16. X. Du, S. Tao, L. Li, W. Wang, C. Zheng, H. Lin, X. Zhang and X. Zhang, *Sol. RRL*, 2018, **2**,1800038.
17. W. Li, Y. Yan, Y. Gong, J. Cai, F. Cai, R. S. Gurney, D. Liu, A. J. Pearson, D. G. Lidzey and T. Wang, *Adv. Funct. Mater*, 2018, **28**,1704212.
18. J. Ren, Y. Sun, S. Huang, Z. Huai, L. Wang, W. Kong and S. Yang, *Org. Electron*, 2020, **78**,105587.
19. X. Liu, Z. Liang, S. Du, J. Tong, J. Li, R. Zhang, X. Shi, L. Yan, X. Bao and Y. Xia, *ACS Appl. Energy Mater*, 2021, **4**, 1774-1783.
20. C. Xu, M. Wright, D. Ping, H. Yi, X. Zhang, M. D. A. Mahmud, K. Sun, M. B. Upama, F. Haque and A. Uddin, *Org. Electron*, 2018, **62**, 261-268.
21. H. Hwang, D. H. Sin, C. Park and K. Cho, *Sci Rep*, 2019, **9**, 12081.
22. Y. Sun, G. Li, L. Wang, Z. Huai, R. Fan, S. Huang, G. Fu and S. Yang, *Sol. Energy Mater. Sol. Cells*, 2018, **182**, 45-51.
23. H. Tang, T. Xu, C. Yan, J. Gao, H. Yin, J. Lv, R. Singh, M. Kumar, T. Duan, Z. Kan, S. Lu and G. Li, *Adv Sci (Weinh)*, 2019, **6**, 1901613.
24. J. Chen, C. Tang, S. Guo, Z. Wang, Z. He, Y.-J. Hwang, W. Yan, H. Xin, W. Huang, *Org. Electron*. 2020,**77**,105419.

25. H. Fu, C. Li, P. Bi, X. Hao, F. Liu, Y. Li, Z. Wang and Y. Sun, *Adv. Funct. Mater.*, 2019, **29**,1807006.
26. M. Privado, F. G. Guijarro, P. de la Cruz, R. Singhal, F. Langa and G. D. Sharma, *ACS Appl. Mater. Interfaces*, 2021, **13**, 6461-6469.
27. K.-N. Zhang, Z.-N. Jiang, T. Wang, J.-W. Qiao, L. Feng, C.-C. Qin, H. Yin, S.-K. So and X.-T. Hao, *Nano Energy*, 2021, **79**,105513.
28. C.-H. Chen, Y.-J. Lu, Y.-W. Su, Y.-C. Lin, H.-K. Lin, H.-C. Chen, H.-C. Wang, J.-X. Li, K.-H. Wu and K.-H. Wei, *Org. Electron*, 2019, **71**, 185-193.
29. M. Vartanian, P. de la Cruz, S. Biswas, G. D. Sharma and F. Langa, *Nanoscale*, 2018, **10**, 12100-12108.
30. C. Xu, J. Wang, Q. An, X. Ma, Z. Hu, J. Gao, J. Zhang and F. Zhang, *Nano Energy*, 2019, **66**.
31. J. Lee, J.-H. Lee, H. Yao, H. Cha, S. Hong, S. Lee, J. Kim, J. R. Durrant, J. Hou and K. Lee, *J. Mater. Chem. A*, 2020, **8**, 6682-6691.
32. H. Dahiya, V. Cuesta, P. de la Cruz, F. Langa and G. D. Sharma, *ACS Appl. Energy Mater.*, 2021, **4**, 4498-4506.
33. T. Sano, S. Inaba and V. Vohra, *ACS Appl. Energy Mater.*, 2019, **2**, 2534-2540.
34. Z. Yin, S. Mei, L. Chen, P. Gu, J. Huang, X. Li, H.-Q. Wang and W. Song, *Org. Electron*, 2021, **99**,106308.
35. D. H. Kim, J. Ryu, F. T. A. Wibowo, S. Y. Park, J. Y. Kim, S.-Y. Jang and S. Cho, *ACS Appl. Energy Mater.*, 2020, **3**, 8375-8382.
36. T. Yan, W. Song, J. Huang, R. Peng, L. Huang and Z. Ge, *Adv Mater.*, 2019, **31**, e1902210.
37. A. A. Mohapatra, V. Kim, B. Puttaraju, A. Sadhanala, X. Jiao, C. R. McNeill, R. H. Friend and S. Patil, *ACS Appl. Energy Mater.*, 2018, **1**, 4874-4882.
38. J. W. Ha, C. E. Song, H. S. Kim, D. H. Ryu, W. S. Shin and D. H. Hwang, *ACS Appl Mater Interfaces*, 2020, **12**, 51699-51708.
39. Y.-J. Xue, F.-Y. Cao, P.-K. Huang, Y.-C. Su and Y.-J. Cheng, *J. Mater. Chem. A*, 2020, **8**, 5315-5322.
40. S.-L. Chang, F.-Y. Cao, K.-H. Huang, W.-L. Lee, M.-H. Lee, C.-S. Hsu and Y.-J. Cheng, *J. Mater. Chem. A*, 2020, **8**, 12141-12148.
41. Y. Wang, W. Xu, J. Yi, C. Zuo, Y. Gong, Y. Liu, W.-Y. Lai and W. Huang, *J. Mater. Chem. A*, 2018, **6**, 15977-15984.
42. K.-N. Zhang, X.-Y. Yang, M.-S. Niu, Z.-C. Wen, Z.-H. Chen, L. Feng, X.-J. Feng and X.-T. Hao, *Org. Electron*, 2019, **66**, 13-23.
43. C.-H. Zhang, W. Wang, W. Huang, J. Wang, Z. Hu, Z. Lin, T. Yang, F. Lin, Y. Xing, J. Bai, H. Sun and Y. Liang, *Chem. Mater.*, 2019, **31**, 3025-3033.
44. Y. Lin, B. Adilbekova, Y. Firdaus, E. Yengel, H. Faber, M. Sajjad, X. Zheng, E. Yarali, A. Seitkhan, O. M. Bakr, A. El-Labban, U. Schwingenschlogl, V. Tung, I. McCulloch, F. Laquai and T. D. Anthopoulos, *Adv Mater.*, 2019, **31**, e1902965.
45. R. Geng, X. Song, H. Feng, J. Yu, M. Zhang, N. Gasparini, Z. Zhang, F. Liu, D. Baran and W. Tang, *ACS Energy Lett.*, 2019, **4**, 763-770.
46. J. Yin, W. Zhou, Q. Ai, X. Meng, S. Liu, Z. Yu, J. Zeng and Y. Chen, *Chin. J. Chem.*, 2018, **36**, 437-442.
47. R. Datt, R. Sharma, S. Bishnoi and V. Gupta, *Mater. Lett.*, 2019, **251**, 122-125.
48. M. Privado, C. R. Seco, R. Singhal, P. d. l. Cruz, F. Langa, G. D. Sharma and E. Palomares, *ACS*

- Energy Lett*, 2018, **3**, 2418-2424.
49. C. Xue, T. Zhang, K. Ma, P. Wan, L. Hong, B. Xu and C. An, *Macromol Rapid Commun*, 2019, **40**, e1900246.
 50. Y.-Q.-Q. Yi, H. Feng, N. Zheng, X. Ke, B. Kan, M. Chang, Z. Xie, X. Wan, C. Li and Y. Chen, *Chem. Mater*, 2019, **31**, 904-911.
 51. F.-Y. Cao, P.-K. Huang, Y.-C. Su, W.-C. Huang, S.-L. Chang, K.-E. Hung and Y.-J. Cheng, *J. Mater. Chem. A*, 2019, **7**, 17947-17953.
 52. R. Singh, S. C. Shin, H. Lee, M. Kim, J. W. Shim, K. Cho and J. J. Lee, *Chem. Eur*, 2019, **25**, 6154-6161.
 53. D. Huang, F. Bian, D. Zhu, X. Bao, C. Hong, P. Zhou, Y. Huang and C. Yang, *J. Phys. Chem. C*, 2019, **123**, 14976-14984.
 54. L. Liu, H. Zhang, B. Xiao, Y. Liu, B. Xu, C. Wang, S. Wen, E. Zhou, G. Chen, C. Im and W. Tian, *Front. Chem. Sci. Eng*, 2020, **15**, 127-137.
 55. L. Zhan, S. Li, S. Zhang, X. Chen, T. K. Lau, X. Lu, M. Shi, C. Z. Li and H. Chen, *ACS Appl Mater Interfaces*, 2018, **10**, 42444-42452.
 56. Y.-Q.-Q. Yi, H. Feng, X. Ke, J. Yan, M. Chang, X. Wan, C. Li and Y. Chen, *J. Mater. Chem. C*, 2019, **7**, 4013-4019.
 57. C.-H. Tsai, Y.-A. Su, P.-C. Lin, C.-C. Shih, H.-C. Wu, W.-C. Chen and C.-C. Chueh, *J. Mater. Chem. C*, 2018, **6**, 6920-6928.
 58. H. Shi, R. Xia, G. Zhang, H.-L. Yip and Y. Cao, *Adv. Energy Mater*, 2019, **9**, 1803438.
 59. C. e. Zhang, S. Feng, Y. Liu, S. Ming, H. Lu, D. Ma, X. Xu, Y. Wu and Z. Bo, *J. Mater. Chem. A*, 2018, **6**, 6854-6859.
 60. O. Amargos-Reyes, J. L. Maldonado, O. Martinez-Alvarez, M. E. Nicho, J. Santos-Cruz, J. Nicasio-Collazo, I. Caballero-Quintana and C. Arenas-Arrocena, *Beilstein J Nanotechnol*, 2019, **10**, 2238-2250.
 61. F.-Y. Cao, W.-C. Huang, S.-L. Chang and Y.-J. Cheng, *Chem. Mater*, 2018, **30**, 4968-4977.
 62. Y. Zhu, J. Liu, J. Zhao, Y. Li, B. Qiao, D. Song, Y. Huang, Z. Xu, S. Zhao and X. Xu, *Materials (Basel)*, 2018, **11**, 759.
 63. Y. Zhang, X. Liu, H. Gu, L. Yan, H. Tan, C.-Q. Ma and Y. Lin, *Org. Electron*, 2020, **77**, 105530.
 64. L. Li, H. Lin, X. Kong, X. Du, X. Chen, L. Zhou, S. Tao, C. Zheng and X. Zhang, *Nanoscale*, 2018, **10**, 9971-9980.
 65. Z. Chen, H. Chen, C. Feng, X. Wang, Z. He and Y. Cao, *J. Mater. Chem. C*, 2021, **9**, 7658-7664.
 66. J. Gao, J. Wang, Q. An, X. Ma, Z. Hu, C. Xu, X. Zhang and F. Zhang, *Sci. China. Chem*, 2019, **63**, 83-91.
 67. Z. Wang, X. Zhu, J. Zhang, K. Lu, J. Fang, Y. Zhang, Z. Wang, L. Zhu, W. Ma, Z. Shuai and Z. Wei, *J Am Chem Soc*, 2018, **140**, 1549-1556.
 68. H. H. Gao, Y. Sun, X. Wan, X. Ke, H. Feng, B. Kan, Y. Wang, Y. Zhang, C. Li and Y. Chen, *Adv Sci (Weinh)*, 2018, **5**, 1800307.
 69. V. Sharapov, Q. Wu, A. Neshchadin, D. Zhao, Z. Cai, W. Chen and L. Yu, *J. Phy. Chem. C*, 2018, **122**, 11305-11311.
 70. X. Du, B. Liu, L. Li, X. Kong, C. Zheng, H. Lin, Q. Tong, S. Tao and X. Zhang, *J. Mater. Chem. A*, 2018, **6**, 23840-23855.
 71. L. Krishnan Jagadamma, R. G. D. Taylor, Alexander L. Kanibolotsky, M. T. Sajjad, I. A. Wright, P. N. Horton, S. J. Coles, I. D. W. Samuel and P. J. Skabara, *Sustainable Energy Fuels*,

- 2019, **3**, 2087-2099.
72. Y. Zhao, L. Zhou, X. Wu, X. Wang, Y. Li, Y. Qi, L. Jiang, G. Chen and Y. Zou, *Chin. Chem. Lett.* 2021, **32**, 1359-1362.
73. Z. Wang, J. Ji, W. Lin, Y. Yao, K. Zheng and Z. Liang, *Adv. Funct. Mater.*, 2020, **30**,2001564.
74. X. Li, M.-A. Pan, T.-K. Lau, W. Liu, K. Li, N. Yao, F. Shen, S. Huo, F. Zhang, Y. Wu, X. Li, X. Lu, H. Yan and C. Zhan, *Chem. Mater.*, 2020, **32**, 5182-5191.
75. Z. Li, C. Yan, L. Xiao, H. Mao, J. Liu, W. Tan and Y. Min, *Org. Electron.*, 2021, **93**,106135.
76. A. D. Fenta, C.-F. Lu, A. T. Gidey and C.-T. Chen, *ACS Appl. Energy Mater.*, 2021, **4**, 5274-5285.
77. C. R. Seco, A. Vidal-Ferran, R. Misra, G. D. Sharma and E. Palomares, *ACS Appl. Energy Mater.*, 2018, **1**, 4203-4210.
78. F. Liu, C. Li, J. Li, C. Wang, C. Xiao, Y. Wu and W. Li, *Chin. Chem. Lett.*, 2020, **31**, 865-868.
79. M. Privado, H. Dahiya, P. de la Cruz, M. L. Keshtov, F. Langa and G. D. Sharma, *J. Mater. Chem. C*, 2021, **9**, 16272-16281.
80. J. Huang, R. Peng, L. Xie, W. Song, L. Hong, S. Chen, Q. Wei and Z. Ge, *J. Mater. Chem. A*, 2019, **7**, 2646-2652.
81. Y. Sun, B. Guo, Y. Chen, W. Zhang, X. Li, G. Yu and F. Li, *New J. Chem.*, 2018, **42**, 5314-5322.
82. C.-P. Chen, Y.-C. Li, Y.-Y. Tsai and Y.-W. Lu, *Sol. Energy Mater. Sol. Cells*, 2018, **183**, 120-128.
83. R. Z. Liang, Y. Zhang, V. Savikhin, M. Babics, Z. Kan, M. Wohlfahrt, N. Wehbe, S. Liu, T. Duan, M. F. Toney, F. Laquai and P. M. Beaujuge, *Adv. Energy Mater.*, 2018, **9**,1802836.
84. Y. Xie, L. Huo, B. Fan, H. Fu, Y. Cai, L. Zhang, Z. Li, Y. Wang, W. Ma, Y. Chen and Y. Sun, *Adv. Funct. Mater.*, 2018, **28**,1800627.
85. H.-X. Qi, B.-H. Yu, S. Liu, M. Zhang, X.-L. Ma, J. Wang and F.-J. Zhang, *Chin. Phys. B*, 2018, **27**.
86. M. N. Shah, M. F. Shah, J. Ma, M. I. Shah, Y. Yang and X. Pan, *J. Mater. Sci.*, 2020, **56**, 2528-2538.
87. M. M. Stylianakis, D. M. Kosmidis, K. Anagnostou, C. Polyzoidis, M. Krassas, G. Kenanakis, G. Viskadourous, N. Kornilios, K. Petridis and E. Kymakis, *Nanomaterials (Basel)*, 2020, **10**,89.
88. W. Li, J. Cai, F. Cai, Y. Yan, H. Yi, R. S. Gurney, D. Liu, A. Iraqi and T. Wang, *Nano Energy*, 2018, **44**, 155-163.
89. H. Feng, X. Song, Z. Zhang, R. Geng, J. Yu, L. Yang, D. Baran and W. Tang, *Adv. Funct. Mater.*, 2019, **29**,1903269.
90. C.-P. Chen, Y.-Y. Tsai, Y.-C. Chen and Y.-H. Li, *Sol. Energy*, 2018, **176**, 170-177.