

## Electronic Supplementary Information

# Progress in Morphology Control from Fullerene to Nonfullerene Acceptors for Scalable High-Performance Organic Photovoltaics

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**Table S1.** Selected device performance of recently reported organic photovoltaics (OPVs) and OPV modules used in Figure 1. The (m) in 'Area' column indicates that the corresponding device is OPV module.

Year	Active layer materials	Area [cm <sup>2</sup> ]	V <sub>oc</sub> [V]	J <sub>sc</sub> [mA/cm <sup>2</sup> ]	FF [%]	PCE [%]	Ref.
<i>Fullerene acceptor-based OPVs</i>							
2015	pDPP5T-2S:PC <sub>71</sub> BM	-	0.54	15.50	67.00	5.60	1
2015	P390:PC <sub>71</sub> BM	-	0.55	17.50	65.00	6.10	1
2015	pDPP5T-2:PC <sub>71</sub> BM	-	0.54	17.30	67.00	6.30	1
2015	PIDT-PhanQ:PC <sub>71</sub> BM	0.0314	0.87	12.00	68.00	7.08	2
2015	PV2000:PC <sub>61</sub> BM	0.038	0.78	13.40	66.90	7.00	3
2015	TBTIT-h:PC <sub>71</sub> BM	0.045	0.72	17.70	71.00	9.10	4
2015	PffBT-T3(1,2)-2:PC <sub>71</sub> BM	0.056	0.82	18.90	66.80	10.70	5
2015	P3HT:MeSAF6	0.071	0.63	8.01	71.00	3.53	6
2015	P3HT:PC <sub>61</sub> BM	0.805	0.56	5.49	57.10	1.76	7
2015	PBDT-BT:PC <sub>71</sub> BM	0.1	0.92	15.40	66.00	9.40	8
2015	PPDT2FBT:PC <sub>71</sub> BM	0.13	0.80	15.40	67.00	8.28	9
2015	PBDTT-F-TT:PC <sub>71</sub> BM	0.031	0.81	18.30	71.00	10.50	10
2015	PBDTT-F-TT:PC <sub>71</sub> BM	1.0	0.80	15.80	57.00	7.21	10
2015	PCDTBT:PC <sub>71</sub> BM	1.65	0.87	9.50	45.00	3.70	11
2015	PCDTBT:PC <sub>71</sub> BM	4	0.87	9.60	50.00	4.90	11
2015	POD2T-DTBT:PC <sub>71</sub> BM	108(m)	6.24	1.05	56.00	3.64	12
2016	PffBT4T-2OD:PC <sub>71</sub> BM	0.04	0.77	18.40	70.00	9.90	13
2016	PTB7-Th:PC <sub>71</sub> BM	0.055	0.79	18.50	71.10	10.40	14
2016	PffBT4T-C9C13:PC <sub>71</sub> BM	0.059	0.78	19.80	73.00	11.30	15
2016	PCDTBT:FCN-2	0.08	0.90	8.66	71.20	5.55	16
2016	PBTZT- <i>stat</i> -BDTT-8:PC <sub>61</sub> BM	0.04	0.78	16.30	74.00	9.30	17
2016	PBTZT- <i>stat</i> -BDTT-8:PC <sub>61</sub> BM	1	0.80	14.30	68.00	7.50	17
2016	PBTZT- <i>stat</i> -BDTT-8:PC <sub>61</sub> BM	114.5(m)	7.00	119.70	62.00	4.50	17
2016	PBTZT- <i>stat</i> -BDTT-8:PC <sub>61</sub> BM	0.104	0.77	13.50	59.80	6.22	18
2016	PBTZT- <i>stat</i> -BDTT-8:PC <sub>61</sub> BM	35(m)	10.50	0.82	62.00	5.28	18
2016	P3HT:PC <sub>61</sub> BM	8(m)	4.30	9.43	40.00	2.04	19
2016	PTB7-Th:PC <sub>71</sub> BM	16.6(m)	2.37	4.87	58.00	7.40	20
2017	<i>p</i> -DTS(FBTTh <sub>2</sub> ) <sub>2</sub> :PCPDTBT:PC <sub>61</sub> BM	-	0.80	14.50	67.50	7.80	21
2017	PTB7-Th:PC <sub>71</sub> BM	-	0.79	18.50	69.80	10.15	22
2017	TQxFBT:PC <sub>71</sub> BM	0.04	0.62	11.02	61.00	4.18	23
2017	LGC-D013:PC <sub>71</sub> BM	0.0464	0.87	11.29	73.13	7.22	24
2017	PTB7-Th:CN-PC <sub>71</sub> BM	0.1	0.90	13.50	68.00	8.20	25

Year	Active layer materials	Area [cm <sup>2</sup> ]	V <sub>oc</sub> [V]	J <sub>sc</sub> [mA/cm <sup>2</sup> ]	FF [%]	PCE [%]	Ref.
2017	PTB7-Th:PyF5	0.104	0.84	13.80	56.00	6.40	26
2017	PDTBTBz-2F <sub>anti</sub> :PC <sub>71</sub> BM	0.13	0.97	14.00	72.00	9.80	27
2017	SMPV1:PC <sub>61</sub> BM	0.1	0.95	12.72	67.03	8.10	28
2017	SMPV1:PC <sub>61</sub> BM	1	0.94	10.17	64.85	6.20	28
2017	SMPV1:PC <sub>61</sub> BM	5.5	0.93	8.54	47.00	3.73	28
2017	P3HT:PC <sub>61</sub> BM	0.04	0.62	10.40	54.00	3.50	29
2017	P3HT:PC <sub>61</sub> BM	10.8(m)	1.89	2.50	57.00	2.70	29
2017	PBDTTT-EFT:PC <sub>71</sub> BM	0.04	0.84	16.80	67.00	9.40	29
2017	PBDTTT-EFT:PC <sub>71</sub> BM	10.8(m)	2.51	4.20	55.00	5.90	29
2017	BTR:PC <sub>71</sub> BM	0.1	0.90	10.40	69.60	6.56	30
2017	BTR:PC <sub>71</sub> BM	10(m)	3.76	1.84	65.97	4.80	30
2017	PCDTBT:PC <sub>71</sub> BM	5.6	0.87	10.70	39.60	3.69	31
2017	PCDTBT:PC <sub>71</sub> BM	33.5(m)	4.55	1.82	39.20	3.25	31
2017	POD2T-DTBT:PC <sub>71</sub> BM	24(m)	5.66	1.20	58.00	3.93	32
2017	PDTBT- <i>alt</i> -TT:PC <sub>71</sub> BM	24(m)	6.10	1.45	63.10	5.58	32
2017	PTB7-Th; <i>p</i> -DTS(FBTTh <sub>2</sub> ) <sub>2</sub> :PC <sub>71</sub> BM	1.25	0.73	18.38	61.88	8.28	33
2017	PTB7-Th; <i>p</i> -DTS(FBTTh <sub>2</sub> ) <sub>2</sub> :PC <sub>71</sub> BM	5	0.70	16.01	51.06	5.75	33
2017	PTB7-Th; <i>p</i> -DTS(FBTTh <sub>2</sub> ) <sub>2</sub> :PC <sub>71</sub> BM	10(m)	1.43	7.65	53.25	5.82	33
2017	PTB7-Th; <i>p</i> -DTS(FBTTh <sub>2</sub> ) <sub>2</sub> :PC <sub>71</sub> BM	20(m)	2.71	3.89	49.19	5.18	33
2018	PCDTBT:Et <sub>2</sub> - <i>cis</i> -1-[70]PBC	-	0.84	9.24	59.00	4.60	34
2018	PffBT4T-2OD:PC <sub>71</sub> BM	0.026	0.76	17.30	70.00	9.31	35
2018	PffBT4T-2OD:PC <sub>71</sub> BM	0.041	0.74	13.89	58.85	6.11	36
2018	PBTIBDT:PC <sub>71</sub> BM	0.06	0.96	8.87	65.70	5.59	37
2018	P3HT:PC <sub>61</sub> BM	0.09	0.66	12.75	49.95	4.20	38
2018	SM2:PC <sub>71</sub> BM	0.1	0.90	10.50	67.00	6.50	39
2018	BDT[2F]QdC:PC <sub>71</sub> BM	0.1	0.94	11.40	66.00	7.10	40
2018	PDT2fBT-BT10:PC <sub>71</sub> BM	0.2	0.74	18.92	73.45	10.31	41
2018	PDT2fBT-BT10:PC <sub>71</sub> BM	1	0.75	18.23	66.23	9.03	41
2018	PTB7-Th:PC <sub>71</sub> BM	16(m)	3.04	4.50	55.00	7.50	42
2019	BQR:PC <sub>71</sub> BM	0.04	0.95	12.80	62.00	7.30	43
2019	2F-DRCN5T:PC <sub>71</sub> BM	0.1	1.08	11.90	63.60	8.13	44
2019	PTB7-Th:FB-C60	0.1	0.83	17.10	67.50	9.60	45
2019	PV2000:PC <sub>71</sub> BM	23.7(m)	4.02	2.87	65.30	7.56	46
2019	PTB7-Th; <i>p</i> -DTS(FBTTh <sub>2</sub> ) <sub>2</sub> :PC <sub>71</sub> BM	0.01	0.70	20.82	69.27	10.14	47
2019	PTB7-Th; <i>p</i> -DTS(FBTTh <sub>2</sub> ) <sub>2</sub> :PC <sub>71</sub> BM	1	0.73	17.06	57.38	7.11	47
2019	PffBT4T-2OD:PC <sub>71</sub> BM	0.04	0.76	15.80	71.00	8.50	48

Year	Active layer materials	Area [cm <sup>2</sup> ]	V <sub>oc</sub> [V]	J <sub>sc</sub> [mA/cm <sup>2</sup> ]	FF [%]	PCE [%]	Ref.
2019	PffBT4T-2OD:PC <sub>71</sub> BM	1	0.75	15.40	69.00	8.00	48
2019	LGC-D073:PC <sub>71</sub> BM	0.1	0.84	11.30	62.00	5.82	49
2019	LGC-D073:PC <sub>71</sub> BM	24(m)	3.30	3.10	54.00	5.50	49
2019	PF2:PC <sub>71</sub> BM	0.12	0.75	19.50	72.00	10.50	50
2019	PF2:PC <sub>71</sub> BM	66(m)	11.70	0.89	59.00	6.10	50
2020	BTID-0F:PC <sub>71</sub> BM	0.04	0.94	13.73	65.35	8.47	51
2020	P3HT:2b	0.05	0.37	9.40	67.00	4.60	52
2020	PBDB-T:PC <sub>71</sub> BM	1.35	0.83	13.02	64.06	6.91	53
2020	BDT-Th10:PC <sub>71</sub> BM	0.5	0.77	17.32	65.66	8.71	54
2020	BDT-Th10:PC <sub>71</sub> BM	58.5(m)	7.53	1.55	66.34	7.74	54
<i>Nonfullerene acceptor-based OPVs</i>							
2015	PiI-tT-PS5:P(TP)	0.04	1.01	7.04	46.00	3.27	55
2015	P3HT:IDT-2BR	0.04	0.84	8.91	68.10	5.12	56
2015	PTB7-Th:ITIC	0.04	0.81	14.21	59.10	6.80	57
2015	P3HT:F(DPP) <sub>2</sub> B <sub>2</sub>	0.054	0.78	2.20	35.00	0.60	58
2015	PBDTTT-C-T:DC-IDT2T	1.1	0.80	3.09	40.11	1.02	59
2016	P3HT:o-IDTBR	0.0045	0.73	14.10	62.00	6.40	60
2016	PTB7-Th:ATT-1	0.03	0.87	16.48	70.00	10.07	61
2016	PTB7-Th:B-DIPDI	0.0314	0.78	13.02	62.00	6.29	62
2016	PBDT-TS1:PPDIODT	0.069	0.74	12.80	55.00	5.21	63
2016	PTB7-Th:IEIC	0.66	0.94	6.86	35.17	2.26	64
2016	PTB7-Th:IEIC	0.98	0.90	5.39	36.71	1.79	64
2016	PBDB-T:ITIC	0.13	0.90	16.81	74.20	11.21	65
2016	PBDB-T:ITIC	1	0.89	16.12	75.40	10.78	65
2017	PTB7-Th:FRd <sub>2</sub>	-	0.83	15.70	72.30	9.40	66
2017	PTB7-Th:βTPB6-c	0.0314	0.92	14.70	56.00	7.56	67
2017	PffBT4T-2OD:EH-IDTBR	0.045	1.08	14.65	60.00	9.50	68
2017	J71:BDT-IC	0.047	0.92	17.3	65.5	10.5	69
2017	PffBT4T-B:ITIC-Th	0.059	0.97	15.59	61.80	9.40	70
2017	PBDT-TS1:PPDIODT	0.069	0.74	14.50	52.20	5.60	71
2017	PTB7-Th:ITIC	0.1	0.80	14.97	65.00	8.11	72
2017	PTB7-Th:PPDIE	10	0.64	15.50	50.00	5.00	73
2018	PTB7-Th:IDTT-T	0.03	1.02	18.00	65.00	11.80	74
2018	PTB7-Th:NFDTSB	0.038	0.75	20.14	63.30	9.60	75
2018	PB3T:I-TM	0.04	0.98	17.30	70.00	11.90	76
2018	PB3T:I-TM	1	0.98	15.60	66.00	10.10	76

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2018	PTB7-Th:ITIC	0.14	0.83	16.00	71.00	9.54	77
2018	PTB7-Th:ITIC	2.03	0.81	14.70	63.00	7.60	77
2018	FTAZ:IT-M	0.56	0.93	16.40	64.60	9.80	78
2018	PBTA-TF:IT-M	1	0.95	17.13	65.00	10.60	79
2018	PTB7-Th:PNDI-T10	2.03	0.82	12.94	63.00	6.65	80
2018	PBTIBDTT:ITIC-F	3.48(m)	4.53	2.92	65.10	8.60	81
2018	PBDB-T:ITIC	18(m)	11.60	0.99	55.00	6.30	82
2018	P3HT:IDTBR	59.52(m)	8.39	0.81	64.90	4.40	83
2018	P3HT:IDTBR	59.52(m)	8.53	0.91	64.90	5.00	83
2019	PBDB-TF:BTP-4F-12	0.037	0.86	25.30	76.00	16.40	84
2019	PBDB-TF-T1:BTP-4F-12	1.07	0.84	24.40	72.00	14.80	84
2019	PTB7-Th:CO/8DFIC	0.04	0.69	27.30	71.00	13.80	85
2019	J71/ITC6-IC (LbL)	0.04	0.96	17.61	67.54	11.42	86
2019	J71/ITC6-IC (LbL)	0.2	0.97	17.30	66.19	11.13	86
2019	J71/ITC6-IC (LbL)	1	0.97	16.16	65.79	10.35	86
2019	PTQ10/IDIC (LbL)	0.04	0.95	17.14	69.13	11.28	86
2019	PTQ10/IDIC (LbL)	0.2	0.96	16.68	69.32	11.13	86
2019	PTQ10/IDIC (LbL)	1	0.97	15.89	67.90	10.42	86
2019	PM6:IT-4F	0.04	0.85	19.70	67.00	11.20	48
2019	PM6:IT-4F	1	0.84	19.50	65.00	10.60	48
2019	PM6/IT-4F (LbL)	0.04	0.84	20.70	71.00	12.30	48
2019	PM6/IT-4F (LbL)	1	0.84	20.00	68.00	11.40	48
2019	PM6:Y6	0.05	0.82	25.20	76.10	15.70	87
2019	FTAZ:IT-M	0.069	0.95	18.19	70.41	12.22	88
2019	PBDB-TF:BTP-4F	0.09	0.83	24.90	75.30	15.60	89
2019	PBDB-TF:BTP-4CI	0.09	0.87	25.40	75.00	16.50	89
2019	PBDB-TF:BTP-4CI	1	0.86	25.00	71.30	15.30	89
2019	PTB7-Th:EH-ID	0.1	1.03	16.51	62.50	10.63	90
2019	PTB7-T:BAF-2HDT	0.1	0.90	15.40	71.50	9.90	91
2019	PBDB-T:ITIC	0.1	0.88	16.97	62.70	9.59	92
2019	PM6:IT-4F	0.12	0.86	20.80	72.00	12.88	93
2019	PBDB-T-SF:IT-4F	0.1	0.88	20.55	71.66	12.90	94
2019	PBDB-T-SF:IT-4F	0.2	0.87	20.39	69.71	12.32	94
2019	PBDB-T-SF:IT-4F	0.4(m)	1.74	10.02	69.45	12.12	94
2019	PBDB-T-SF:IT-4F	1	0.88	19.76	64.70	11.19	94
2019	PBDB-T-SF:IT-4F	2(m)	1.73	9.50	54.78	9.01	94

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2019	PM6:IT-4F	1	0.86	21.10	72.00	13.20	95
2019	PM6:IT-4F	12.6(m)	2.56	6.23	64.02	10.21	96
2019	SMD2:ITIC	80(m)	8.80	1.12	53.10	5.25	97
2019	PBDB-T:PC <sub>71</sub> BM:ITIC	216(m)	14.20	0.91	59.00	7.69	98
2020	PM6:FO-2F	-	0.88	22.26	77.00	15.05	99
2020	PT2:Y6	0.04	0.83	26.70	74.40	16.50	100
2020	D18:Y6Se	0.04	0.84	27.98	75.30	17.70	101
2020	D18:Y6	0.04	0.86	27.70	76.60	18.22	102
2020	TPD-3F:IT-4F	0.04	0.90	20.60	72.40	13.40	103
2020	TPD-3F:IT-4F	20.4(m)	4.52	3.50	64.00	10.13	103
2020	NF3000-P:NF3000-N	0.04	0.94	19.30	67.60	12.30	104
2020	NF3000-P:NF3000-N	10.8(m)	2.76	5.29	67.00	9.80	104
2020	NF3000-P:NF3000-N	216(m)	13.50	1.25	56.10	9.50	104
2020	PM6:Y6	0.04	0.84	25.22	72.49	15.37	105
2020	PM6:Y6	1	0.84	25.52	65.74	14.01	105
2020	PM6:Y6	3.3(m)	2.51	8.61	55.78	12.06	105
2020	PM6:Y6	11.52(m)	3.21	6.25	50.12	10.15	105
2020	PM6/Y6 (LbL)	0.04	0.83	25.90	75.68	16.35	105
2020	PM6/Y6 (LbL)	1	0.83	25.64	71.42	15.23	105
2020	PM6/Y6 (LbL)	3.3(m)	2.49	8.72	63.92	13.88	105
2020	PM6/Y6 (LbL)	11.52(m)	3.20	6.41	57.85	11.86	105
2020	PBDB-TF:BTP-4Cl-12	0.06	0.86	15.60	77.60	17.00	106
2020	PM6:BTP-eC9	0.062	0.84	26.20	81.10	17.80	107
2020	PM6:BTP-eC7	1	0.81	20.30	53.30	8.75	107
2020	PM6:BTP-eC9	1	0.83	25.70	75.90	16.20	107
2020	PM6:BTP-eC11	1	0.84	25.30	72.20	15.40	107
2020	TPD-3F-51K:IT4F	5.95	0.90	20.90	73.50	13.80	103
2020	PM6:DTY6	18(m)	5.11	3.89	72.50	14.40	108
2020	PTB7-Th:EH-IDTBR:T2-OEHRH	55.5(m)	11.47	1.29	63.00	9.32	109
2020	PBDB-T:ITIC	58.5(m)	8.80	1.71	60.00	9.03	53
2021	PM6:Y6	-	0.85	25.75	74.07	16.26	110
2021	PM6:L8-BO	0.03152	0.87	25.72	81.50	18.32	111
2021	PM6:Y6:Y6-BO:PC <sub>71</sub> BM	0.032	0.85	26.67	78.49	17.84	112
2021	PM6:Y6	0.04	0.84	26.34	70.47	15.63	113
2021	PM6:Y6	0.56	0.83	25.99	63.17	13.64	113
2021	PBDB-T:ITIC	0.0422	0.84	16.87	57.80	8.19	114

<b>Year</b>	<b>Active layer materials</b>	<b>Area [cm<sup>2</sup>]</b>	<b>V<sub>OC</sub> [V]</b>	<b>J<sub>sc</sub> [mA/cm<sup>2</sup>]</b>	<b>FF [%]</b>	<b>PCE [%]</b>	<b>Ref.</b>
2021	PM6-Ir:Y6	0.05	0.84	26.26	75.51	16.79	115
2021	PM6-Ir/Y6 (LbL)	0.05	0.85	26.69	76.64	17.21	115
2021	PBDB-T:Y6	0.05	0.72	25.50	59.47	10.68	115
2021	PBDB-T/Y6 (LbL)	0.05	0.72	25.94	61.68	11.44	115
2021	PBDB-T:PYT	0.05	0.89	22.46	70.58	14.10	115
2021	PBDB-T/PYT (LbL)	0.05	0.89	22.95	73.88	15.10	115
2021	PBDB-T-2F:BT-BO-L4F	0.06	0.83	27.80	69.50	16.60	116
2021	PM6:Y6	0.08	0.83	24.95	74.55	15.51	117
2021	PM6:Y6	1	0.84	24.48	67.87	13.87	117
2021	PBDB-T:ITIC-M	0.125	0.92	19.16	69.00	12.06	118
2021	D18:Y6	0.173	0.87	25.24	73.60	16.10	119

## References

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