Electronic supplementary information (ESI)

Benzothiadiazole-benzodithiophene-based random copolymers for efficient thick-film polymer solar cells via solvent vapor annealing approach

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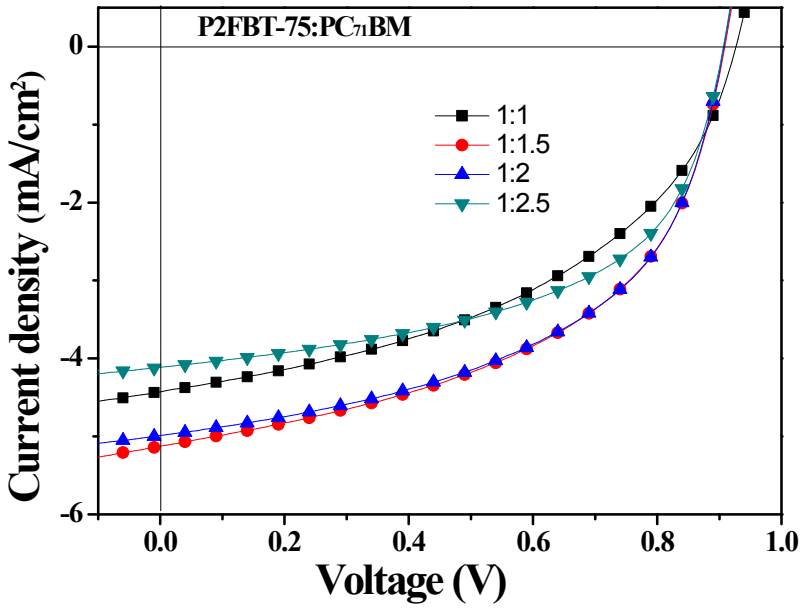

Fig. S1 *J*–*V* curves of solar cells based on **P2FBT-75**:$PC_{71}BM$ system with different D/A ratios.

Table S1 The photovoltaic parameters with different D/A ratios based on **P2FBT-75**:$PC_{71}BM$ system

P2FBT-75:$PC_{71}BM$ Weight Ratio	Thickness (nm)	V_{oc} (V)	J_{sc} (mA cm^{-2})	FF	PCE_{max} (PCE_{ave}) (%)
1:1	150	0.92	4.42	0.45	1.88 (1.84)
1:1.5	130	0.91	5.12	0.51	2.36 (2.33)
1:2	130	0.91	4.98	0.52	2.36 (2.31)
1:2.5	140	0.91	4.11	0.55	2.03 (1.96)

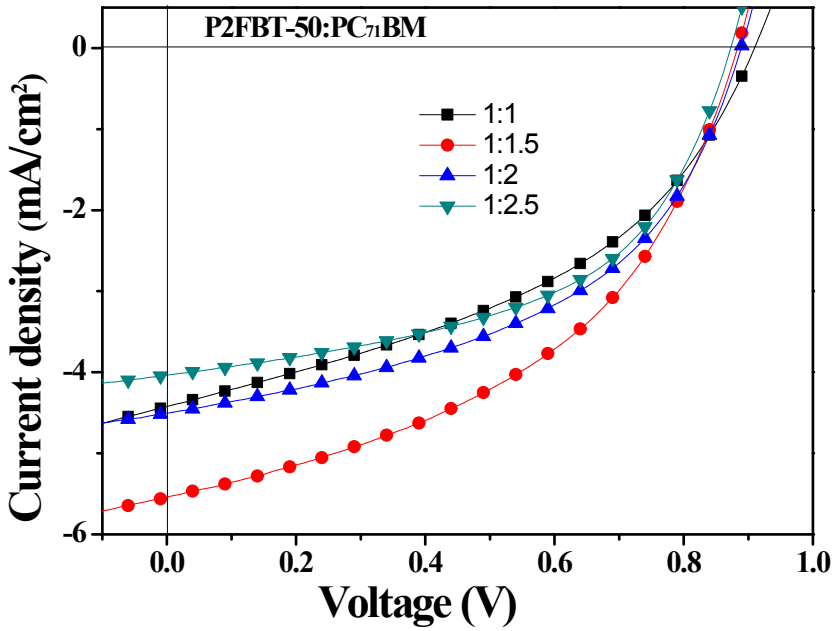

Fig. S2 *J*–*V* curves of solar cells based on **P2FBT-50**:$PC_{71}BM$ system with different D/A ratios.

Table S2 The photovoltaic parameters with different D/A ratios based on **P2FBT-50**:$PC_{71}BM$ system

P2FBT-50:$PC_{71}BM$ Weight Ratio	Thickness (nm)	V_{oc} (V)	J_{sc} (mA cm^{-2})	FF	PCE_{max} (PCE_{ave}) (%)
1:1	130	0.90	4.42	0.42	1.76 (1.57)
1:1.5	140	0.88	5.54	0.45	2.23 (2.20)
1:2	140	0.89	4.50	0.47	1.91 (1.85)
1:2.5	130	0.87	4.03	0.52	1.82 (1.80)

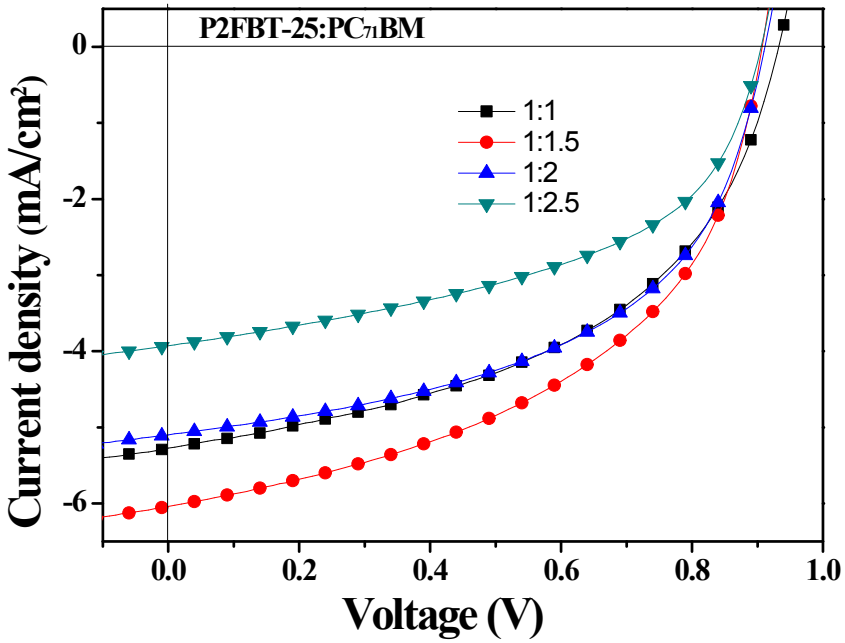

Fig. S3 *J*–*V* curves of solar cells based on **P2FBT-25**:$PC_{71}BM$ system with different D/A ratios.

Table S3 The photovoltaic parameters with different D/A ratios based on **P2FBT-25**:$PC_{71}BM$ system

P2FBT-25:$PC_{71}BM$ Weight Ratio	Thickness (nm)	V_{oc} (V)	J_{sc} (mA cm^{-2})	FF	PCE_{max} (PCE_{ave}) (%)
1:1	140	0.93	5.27	0.48	2.39 (2.12)
1:1.5	150	0.91	6.03	0.48	2.67 (2.64)
1:2	150	0.91	5.09	0.52	2.41 (2.39)
1:2.5	150	0.91	3.92	0.49	1.76 (1.70)

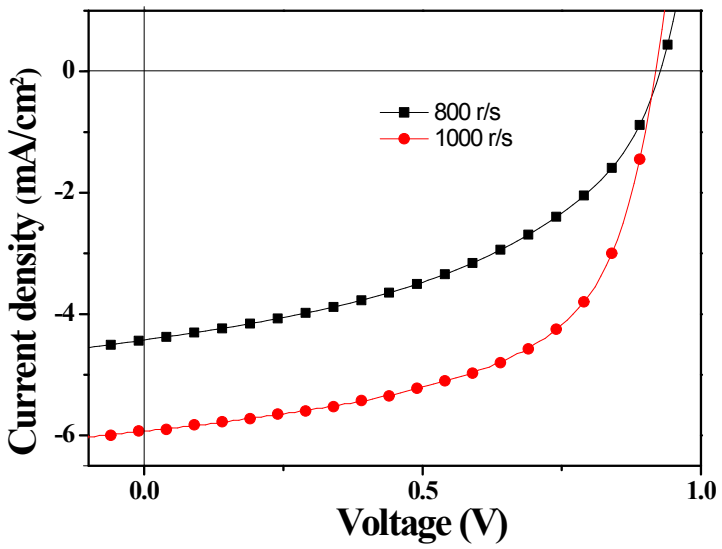

Fig. S4 *J*–*V* curves of solar cells based on **P2FBT-75**:$PC_{71}BM$ (1:1.5) system with different spin speed (r/s).

Table S4 The photovoltaic parameters based on **P2FBT-75**:$PC_{71}BM$ (1:1.5) system with different spin speed (r/s)

P2FBT-75:$PC_{71}BM$ Spin Speed (r/s)	Thickness (nm)	V_{oc} (V)	J_{sc} (mA cm^{-2})	FF	PCE_{max} (PCE_{ave}) (%)
800	130	0.91	5.12	0.51	2.36 (2.33)
1000	100	0.92	5.92	0.58	3.16 (3.13)

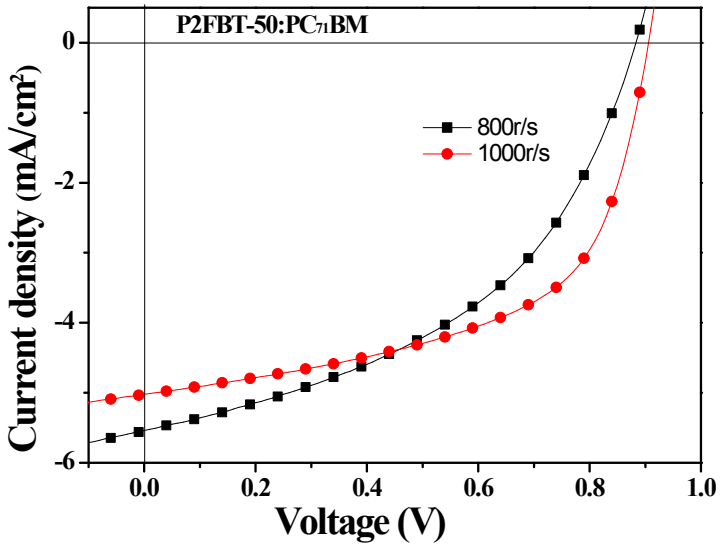

Fig. S5 *J*–*V* curves of solar cells based on **P2FBT-50**:$PC_{71}BM$ (1:1.5) system with different spin speed (r/s).

Table S5 The photovoltaic parameters based on **P2FBT-50**:$PC_{71}BM$ (1:1.5) system with different spin speed (r/s)

P2FBT-50:$PC_{71}BM$ Spin Speed (r/s)	Thickness (nm)	V_{oc} (V)	J_{sc} (mA cm^{-2})	FF	PCE_{max} (PCE_{ave}) (%)
800	140	0.88	5.54	0.45	2.23 (2.20)
1000	100	0.90	5.02	0.57	2.59 (2.51)

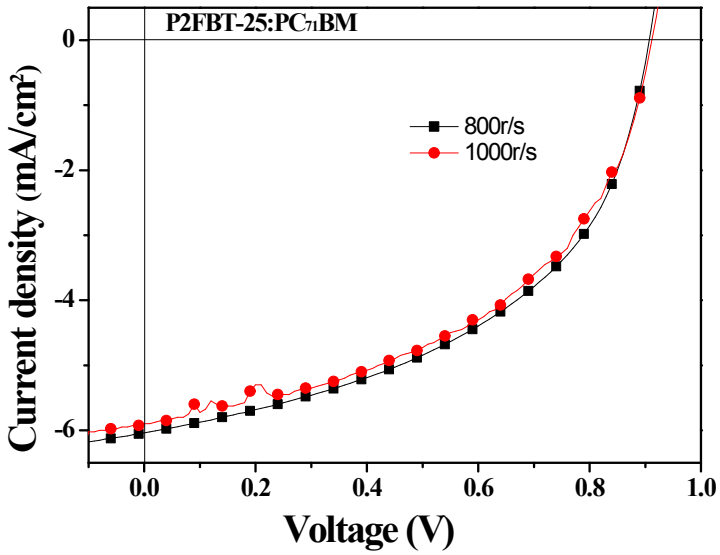

Fig. S6 *J*–*V* curves of solar cells based on **P2FBT-25**:$PC_{71}BM$ (1:1.5) system with different spin speed (r/s).

Table S6 The photovoltaic parameters based on **P2FBT-25**:$PC_{71}BM$ (1:1.5) system with different spin speed (r/s)

P2FBT-25:$PC_{71}BM$ Spin Speed (r/s)	Thickness (nm)	V_{oc} (V)	J_{sc} (mA cm^{-2})	FF	PCE_{max} (PCE_{ave}) (%)
800	150	0.91	6.03	0.48	2.67 (2.64)
1000	100	0.93	5.80	0.55	2.98 (2.91)

Table S7 Photovoltaic parameters with different contents of DIO based on **P2FBT-75**:$PC_{71}BM$ system

Active layer (1:1.5)	DIO	V_{oc} (V)	J_{sc} (mA cm^{-2})	FF	PCE (%)[a]
P2FBT-75: $PC_{71}BM$	0.5%	0.88	7.05	0.45	2.83 (2.81)
P2FBT-75: $PC_{71}BM$	1%	0.91	8.99	0.57	4.71 (4.64)
P2FBT-75: $PC_{71}BM$	2%	0.88	7.36	0.46	3.02 (2.95)
P2FBT-75: $PC_{71}BM$	3%	0.88	7.23	0.42	2.71 (2.70)
P2FBT-75: $PC_{71}BM$	5%	0.90	7.72	0.43	3.04 (3.00)

[a] The values in parentheses stand for the average PCEs from over 10 devices.

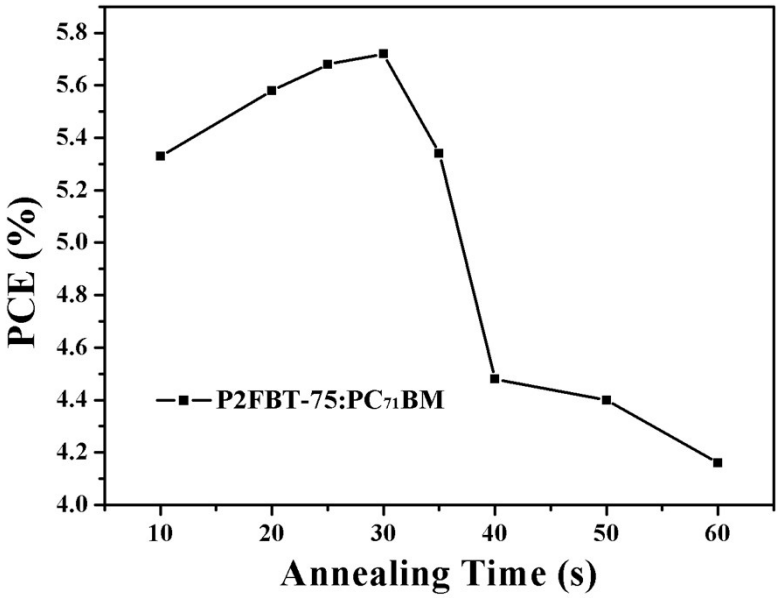

Fig. S7 PCE versus difference solvent vapor annealing time (s) of the optimal PSC devices based on **P2FBT-75**:$PC_{71}BM$ system.

Table S8 The optimal photovoltaic parameters with CH_2Cl_2 and THF vapor annealing with 30 s of optimal PSC devices

Active layer (1:1.5)	SVA	V_{oc} (V)	J_{sc} (mA cm^{-2})	FF	PCE (%)[a]
P2FBT-25: $PC_{71}BM$	CH_2Cl_2	0.87	8.31	0.51	3.71 (3.66)
P2FBT-50: $PC_{71}BM$	CH_2Cl_2	0.86	8.48	0.43	3.17 (2.92)
P2FBT-75: $PC_{71}BM$	CH_2Cl_2	0.89	10.15	0.53	4.81 (4.69)
P2FBT-75: $PC_{71}BM$	THF	0.90	6.91	0.43	2.74 (2.49)

[a] The values in parentheses stand for the average PCEs from over 10 devices.