Supporting Information for:

Study of ITO-free roll-to-roll compatible polymer solar cells using the one-step doctor blading technique

Yuanbao Lin,[a] Chaosheng Cai,[a] Yangdong Zhang,[a] Wenhao Zheng,[a] Junyu Yang,[a] Ergang Wang,[b] Lintao Hou[a,*]

[a] Siyuan Laboratory, Guangzhou Key Laboratory of Vacuum Coating Technologies and New Energy Materials, Key Laboratory of Optoelectronic Information and Sensing Technologies of Guangdong Higher Education Institutes, Department of Physics, Jinan University, Guangzhou 510632, PR China, *Email: thlt@jnu.edu.cn

[b]Department of Chemistry and Chemical Engineering, Chalmers University of Technology, SE-412 96, Göteborg, Sweden

Table S1 Photovoltaic parameters of Type I and Type II devices with various substrate temperatures (25, 40, 50, 60 and 70 ˚C) by doctor blading and spin coating at room temperature under illumination of AM 1.5G (100 mW/cm^2). Over 20 devices were tested for each averaged value[a].

Type	Fabrication condition	J_{sc} (mA/cm^2)	V_{oc}(V)	FF	Thickness (nm)	PCE_{max} [PCE_{ave}] (%)
Type I	Doctor-blading 25 ˚C	14.61	0.78	0.59	115	6.56 [6.40]
Type I	Doctor-blading 40 ˚C	13.78	0.77	0.59	110	6.32 [6.19]
Type I	Doctor-blading 50 ˚C	13.54	0.77	0.59	110	6.12 [6.01]
Type I	Doctor-blading 60 ˚C	12.80	0.79	0.59	105	5.94 [5.82]
Type I	Doctor-blading 70 ˚C	12.29	0.76	0.54	65	5.15 [5.02]
Type I	Spin coating 25 ˚C	15.35	0.78	0.62	90	7.36 [7.24]

Type II	Doctor-blading 25 ˚C	14.77	0.78	0.58	110	6.62 [6.44]
Type II	Doctor-blading 40 ˚C	14.22	0.77	0.62	110	6.83 [6.68]
Type II	Doctor-blading 50 ˚C	14.25	0.77	0.62	105	6.92 [6.77]
Type II	Doctor-blading 60 ˚C	14.96	0.78	0.61	100	7.11 [7.03]
Type II	Doctor-blading 70 ˚C	14.02	0.76	0.52	65	5.65 [5.52]
Type II	Spin coating 25 ˚C	15.80	0.78	0.61	95	7.65 [7.55]

[a] PCE_{max}: maximum power conversion efficiency; PCE_{ave}: average power conversion efficiency.

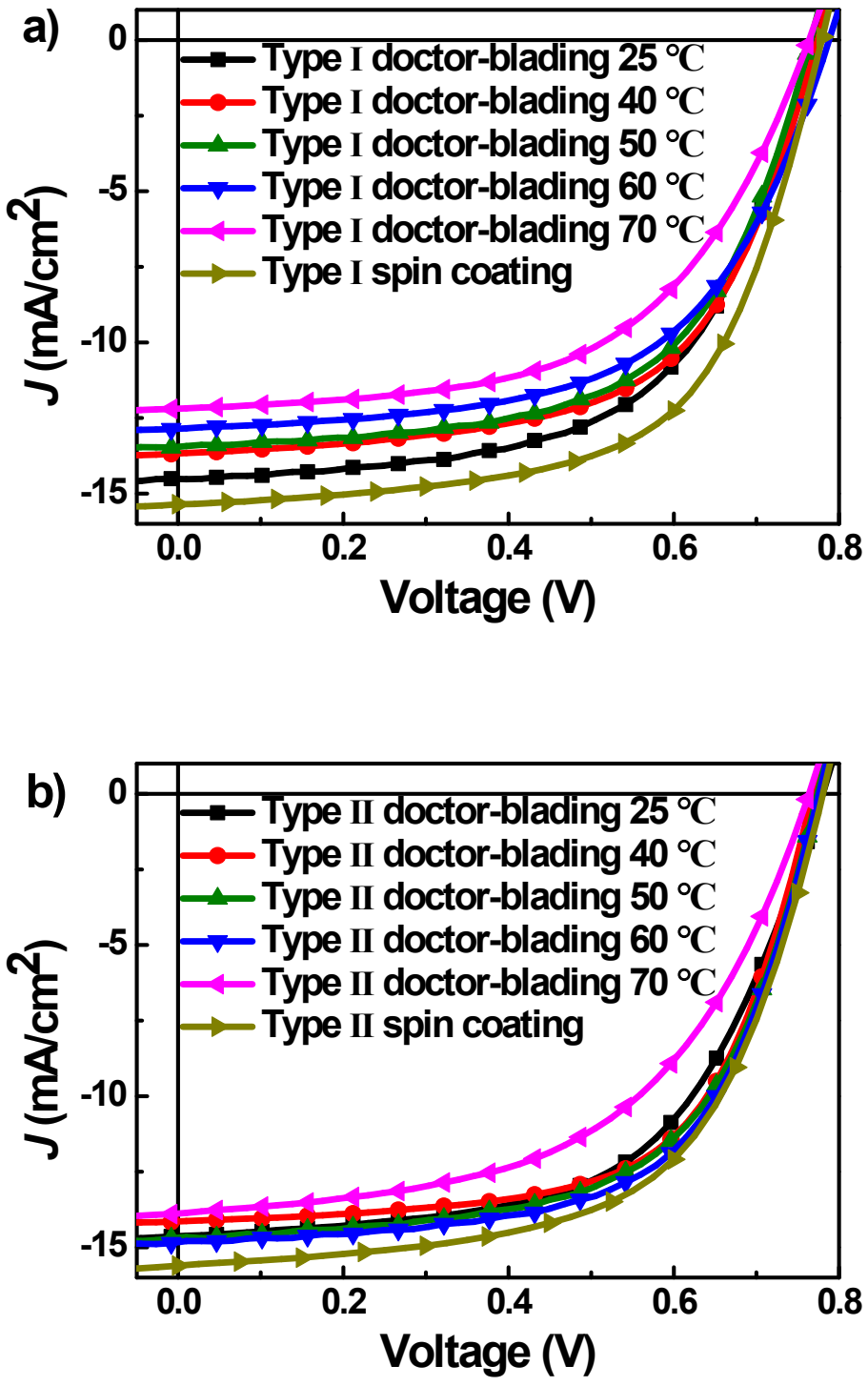

Fig. S1 *J-V* curves of a) Type I and b) Type II devices with various substrate temperatures (25, 40, 50, 60 and 70 ˚C) by doctor blading and by spin coating at room temperature.

Owens Method

This method is used to calculate the solid surface energy and is based on the following model：

$\gamma_s = \gamma_s^D + \gamma_s^P, \gamma_l = \gamma_l^D + \gamma_l^P.$

where γ_s is the surface energy of the solid, which is composed of the dispersion force γ_s^D and polarity force γ_s^P. Similarly, γ_l is the surface energy of the liquid and consists of a dispersion force γ_l^D and polarity force γ_l^P. Then,

$\gamma_l(1 + cos\theta) = 2(\gamma_s^D\gamma_l^D)^{1/2} + 2(\gamma_s^P\gamma_l^P)^{1/2}.$

If the surface energies γ_l^D and γ_l^P of the testing liquid are known and its contact angle on solid surface is measured, there are still two unknown quantities (γ_s^D, γ_s^P) remaining in the formula. Therefore, to determine γ_s^D and γ_s^P, two known testing liquids are required.

$\gamma_{l1}(1 + cos\theta_1) = 2(\gamma_s^D\gamma_{l1}^D)^{1/2} + 2(\gamma_s^P\gamma_{l1}^P)^{1/2}.$

$\gamma_{l2}(1 + cos\theta_2) = 2(\gamma_s^D\gamma_{l2}^D)^{1/2} + 2(\gamma_s^P\gamma_{l2}^P)^{1/2}.$

After obtaining γ_s^D and γ_s^P, $\gamma_s$is determined using $\gamma_{s=}\gamma_s^D+\gamma_s^P$.

Table S2 Parameters of the testing liquids used in the surface energy measurement.

Liquid	Polar force (γ_l^P)	Dispersion force (γ_l^D)	Surface energy (γ_l)	γ_l^P/γ_l^D
Water	51	21.8	72.8	2.36
Formamide	18.7	39.5	58.2	0.47

Table S3 Contact angles of water and formamide on various materials films, which were converted into the surface energy values based on Owens method.

Solid surface	Water contact angle	Formamide contact angle	Solid surface energy (mN/m)
Al/TiOx	61˚	70˚	43.9
PFN	55˚	65˚	49.3
BHJ	94˚	80˚	20.2
PFN:BHJ spin coating	94˚	80˚	20.2
PFN:BHJ doctor blading 25 ˚C	95˚	80˚	20.4
PFN:BHJ doctor blading 60 ˚C	92˚	75˚	23.6

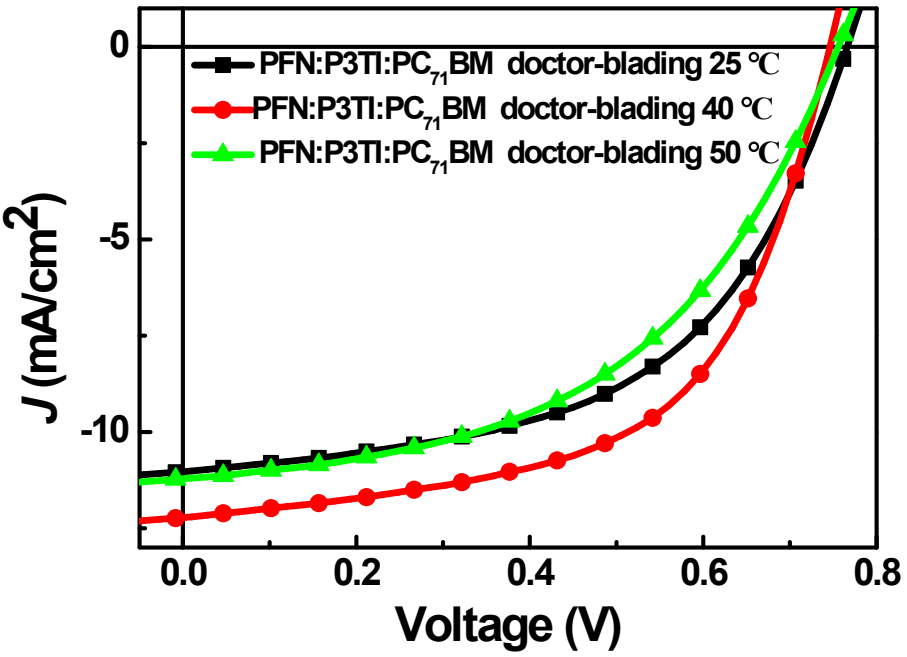

Fig. S2 *J-V* curves of PFN:P3TI:$PC_{71}BM$ devices with various doctor-blading substrate temperature (25, 40 and 60˚C).

Table S4 Photovoltaic parameters of PFN:P3TI:$PC_{71}BM$ devices with various doctor-blading substrate temperatures (25, 40 and 60 ˚C) under illumination of AM 1.5G (100 mW/cm^2). Over 20 devices were tested for each averaged value[a].

Active layer	Fabrication	J_{sc} (mA/cm^2)	V_{oc} (V)	FF	Thickness (nm)	PCE_{max} [PCE_{ave}] (%)
3wt% PFN: P3TI:$PC_{71}BM$	Doctor-blading 25 ˚C	11.29	0.76	0.50	120	4.47 [4.25]
	Doctor-blading 40 ˚C	12.41	0.75	0.56	111	4.74 [4.55]
	Doctor-blading 60 ˚C	11.39	0.76	0.49	99	3.77 [3.58]

[a] PCE_{max}: maximum power conversion efficiency; PCE_{ave}: average power conversion efficiency.