Supporting Information

One key issue in characterization of organic solar cells with solution processed interfacial layer

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Device Fabrication: OSCs were fabricated with a structure ITO/PEDOT:PSS/active layers/PDIN/Al. The patterned indium tin oxide (ITO) glass coated substrates (sheet resistance 15 Ω/□) were pre-cleaned by sequential ultrasonic treatment in detergent, deionized water and ethanol, respectively. The cleaned ITO substrates were blow-dried by high pure nitrogen gas and then treated by oxygen plasma for 1 min to improve its work function and clearance. Subsequently, poly(3,4-ethylenedioxythiophene):poly(styrene sulfonate) (PEDOT:PSS, clevios PVP Al 4083, purchased from H.C. Starck Co., Ltd.) solution was spin-coated on the ITO substrates at 5000 round per minute (RPM) for 30 s and then annealed at 150℃ for 15 min in air. After annealing treatment, the ITO substrates coated PEDOT:PSS films were transferred to a high-purity nitrogen-filled glove box to fabricate active layers. The polymer donor J71 (purchased from Solarmer Materials Inc), nonfullerene acceptors IT-2Cl (synthesized by Yang's group of Wuhan University) with 1:1 weight ratio were dissolved in chloroform to prepare 17 mg/ml blend solutions. After heated and stirred at 40℃ about 3 h, the blend solutions were spin-coated on PEDOT:PSS films at 2500 RPM for 30 s and then the active layer on the substrate were placed in a small petri dish to perform solvent vapor annealed (SVA) treatment by carbon disulphide for 30 s and then annealed at 80℃ for 5 min. After that, PDIN solution (2 mg/ml in methanol with 0.25 vol% acetic acid) was spin-coated on the top of active layers at 5000 RPM for 30 s to prepare cathode interlayer. Finally, the cathode of Al was

deposited by thermal evaporation with a shadow mask under 10^{-4} Pa and the thickness of 100 nm was monitored by a quartz crystal microbalance. The active area is approximately 3.65 mm^2, which is defined by the overlapping area of ITO anode and Al cathode.

Device Measurement: The shadow mask with well-defined aperture (2.89 mm^2) is utilized to define the active area in OSCs measured with mask. The current density-voltage (J-V) curves of all the organic solar cells were measured by a Keithley 2400 unit in high-purity nitrogen-filled glove box. The AM 1.5G irradiation was provided by an XES-40S2 (SAN-EI ELECTRIC Co., Ltd) solar simulator (AAA grade, 70×70 mm^2 photobeam size) with light intensity of 100 mW/cm^2, which was calibrated by standard silicon solar cells (purchased from Zolix INSTRUMENTS CO. LTD). The external quantum efficiency (EQE) spectra of organic solar cells were measured in air conditions by a Zolix Solar Cell Scan 100. The ultraviolet-visible (UV-Vis) absorption spectra of neat and blend films were obtained using a Shimadzu UV-3101 PC spectrometer. The morphology of the PEDOT:PSS films was investigated by atomic force microscopy (AFM, Dimension Icon). Transmission electron microscopy (TEM) images of active layers were obtained by a JEOL JEM-1400 transmission electron microscope operated at 80 kV.

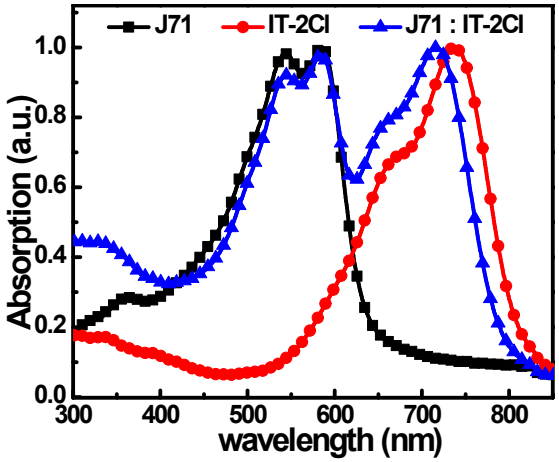

Fig. S1 absorption spectra of neat J71, IT-2Cl and J71:IT-2Cl blend films.

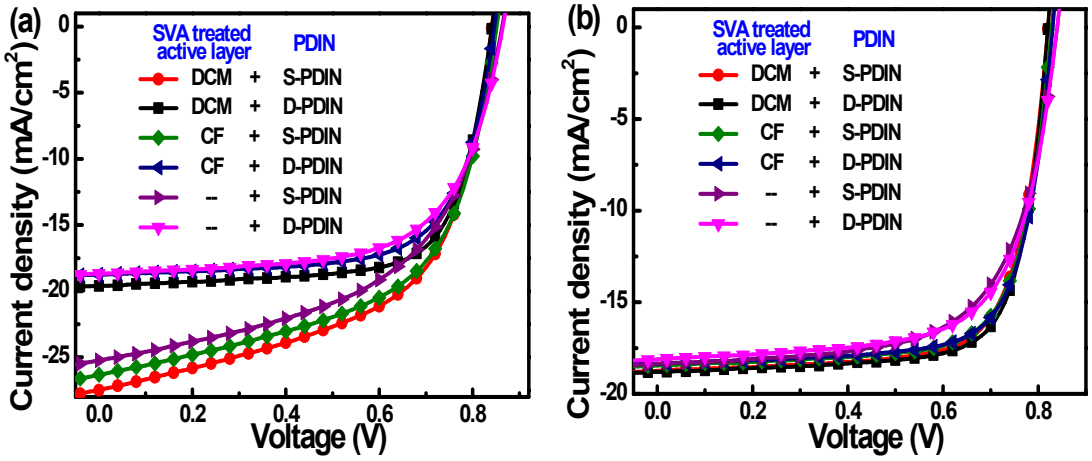

Fig. S2 The *J-V* curves of OSCs under different measurement condition, a) without mask, b) with mask.

Table S1 Photovoltaic parameters of the OSCs measured with or without mask.

SVA	Spin-coating PDIN	Without mask				With mask			
		J_{SC} (mA cm^{-2})	V_{OC} (V)	FF (%)	PCE (%)	J_{SC} (mA cm^{-2})	V_{OC} (V)	FF (%)	PCE (%)
DCM	S-PDIN	27.48	0.84	56.30	13.00 (12.91±0.12)	18.74	0.82	72.74	11.17 (11.05±0.14)
	D-PDIN	19.09	0.84	70.82	11.36 (11.24±0.13)	18.79	0.82	74.39	11.46 (11.32±0.15)
CF	S-PDIN	26.33	0.85	56.36	12.61 (12.53±0.11)	18.45	0.83	72.38	11.08 (10.94±0.15)
	D-PDIN	18.76	0.85	68.14	10.86 (10.70±0.17)	18.37	0.83	72.90	11.11 (11.03±0.13)
--	S-PDIN	25.23	0.86	53.50	11.61(11.49±0.14)	18.12	0.84	67.42	10.26 (10.16±0.14)
	D-PDIN	18.68	0.86	64.95	10.43 (10.31±0.15)	18.35	0.84	67.25	10.36 (10.22±0.16)

Remarks: The average PCEs and standard deviations were calculated with 10 cells prepared from different batches.

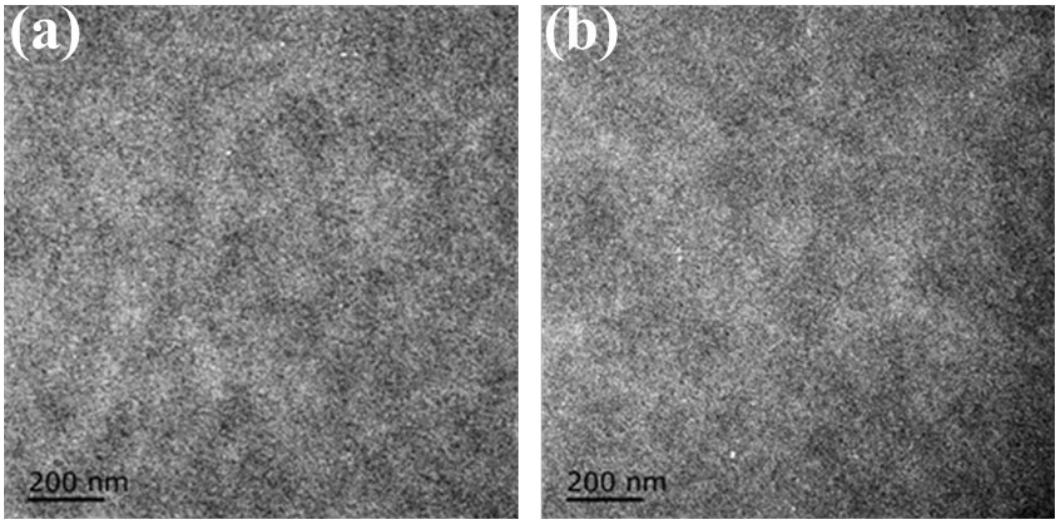

Fig. S3 TEM images of a) pristine blend films; b) blend films post-treated with methanol by SSC method.