[Electronic Supplementary Information]

Enhanced performance and mechanical durability of flexible solar cell from dry transfer of PEDOT:PSS with polymer nanoparticles

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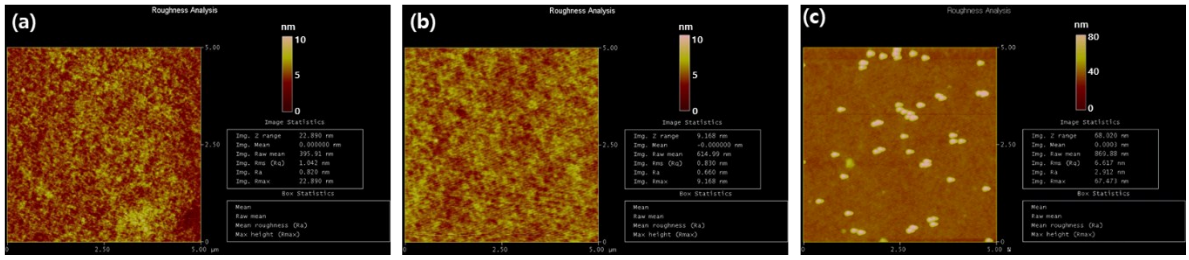


Figure S1. Two-dimensional AFM roughness analysis with RMS values: A) spin-coated PEDOT:PSS, B) transferred PEDOT:PSS and C) transferred PEDOT:PSS with PS NPs

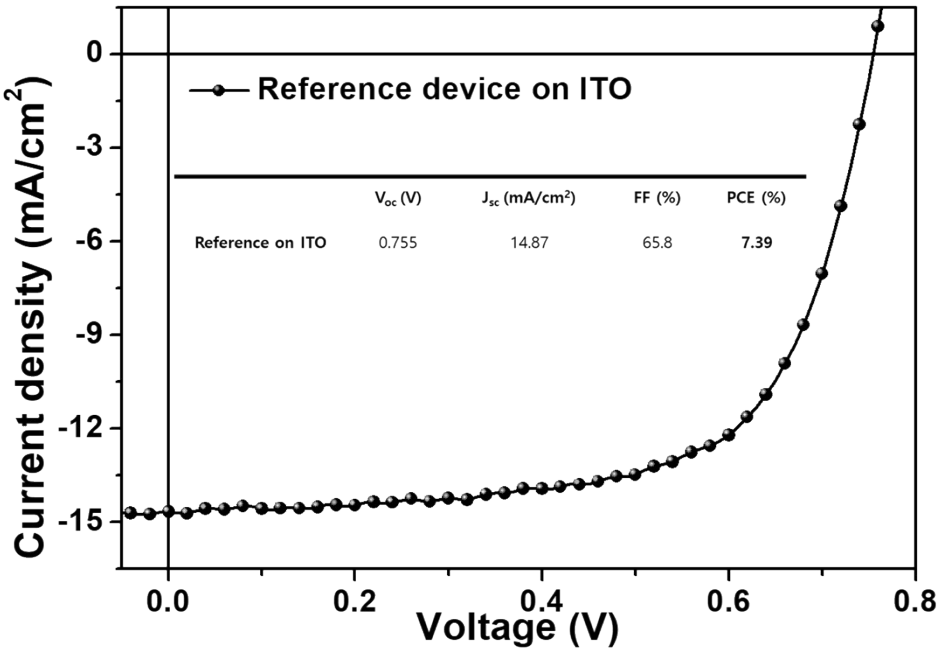


Figure S2. The J-V curve of the PTB7:$PC_{71}BM$-based reference device fabricated on ITO substrate with inserted photovoltaic parameters

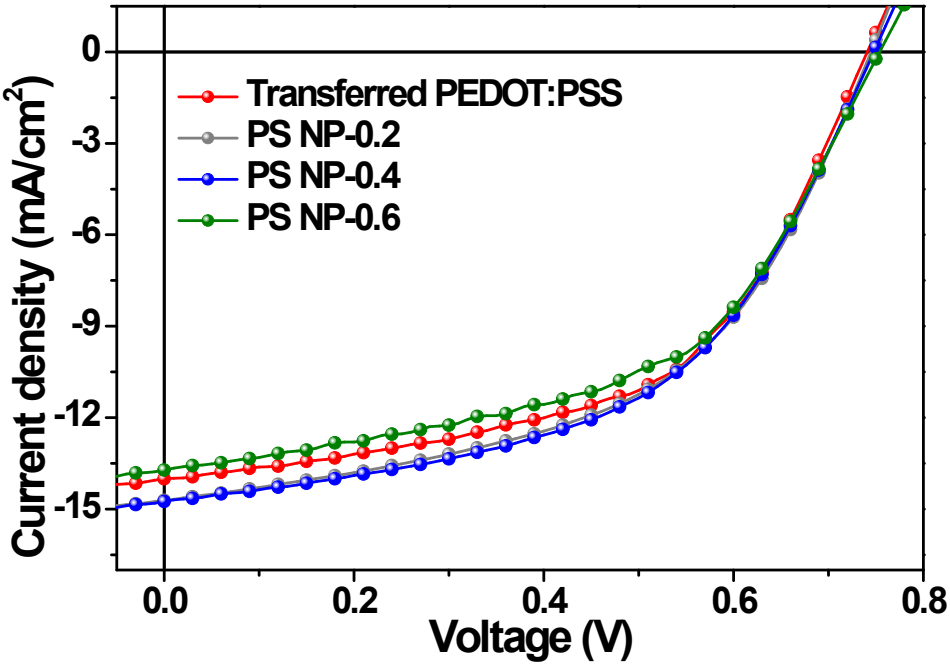


Figure S3. The J-V curve of the PTB7:$PC_{71}BM$-based device fabricated by transfer of PEDOT:PSS with different volume ratio of PS NPs

Table S1. Fitting parameter for the time-resolved photoluminescent (TRPL) decay curves of spin coated PEDOT:PSS, transferred PEDOT:PSS and transferred PEDOT:PSS with PS NPs

Sample	A_1 (%)	τ_1 (ns)	A_2 (%)	τ_2 (ns)	τ_{avg} (ns)
Spin-coated PEDOT:PSS	80.101	0.59853	19.899	0.20691	**0.5206**
Transferred PEDOT:PSS	79.263	0.54164	20.737	0.164	**0.4633**
Transferred PEDOT:PSS with PS NPs (ϕ 0.2)	84.68	0.48976	15.32	0.12666	**0.4341**

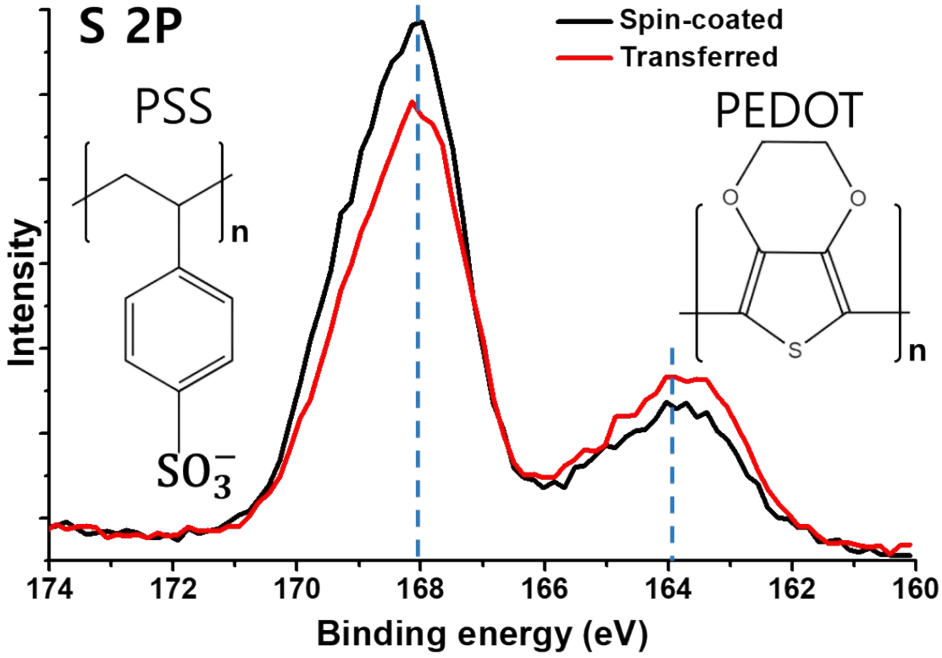


Figure S4. S2p XPS spectra of the PEDOT:PSS prepared by using different coating process.

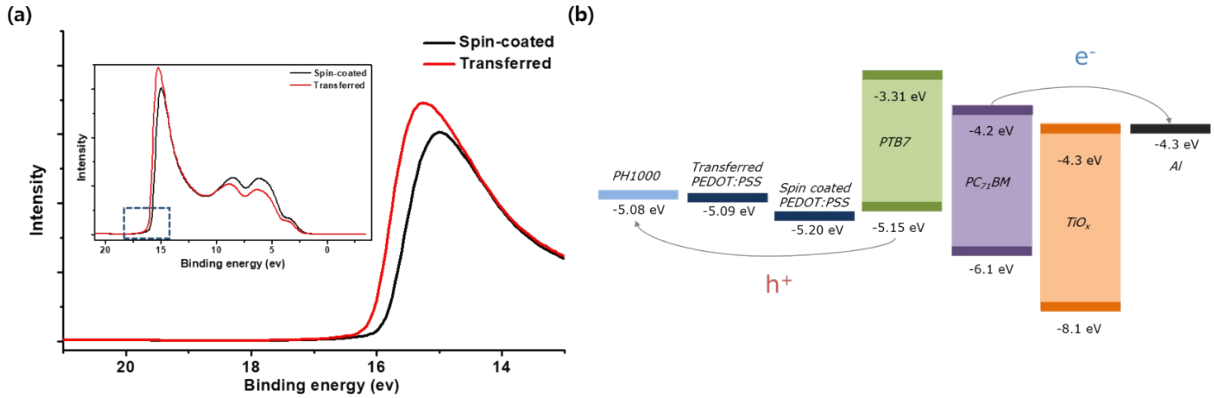


Figure S5. (a) UPS spectra of the PEDOT:PSS prepared by spin coating and stamping transfer process. (b) Schematic energy band diagram with two different work functions of spin-coated and transferred PEDOT:PSS.

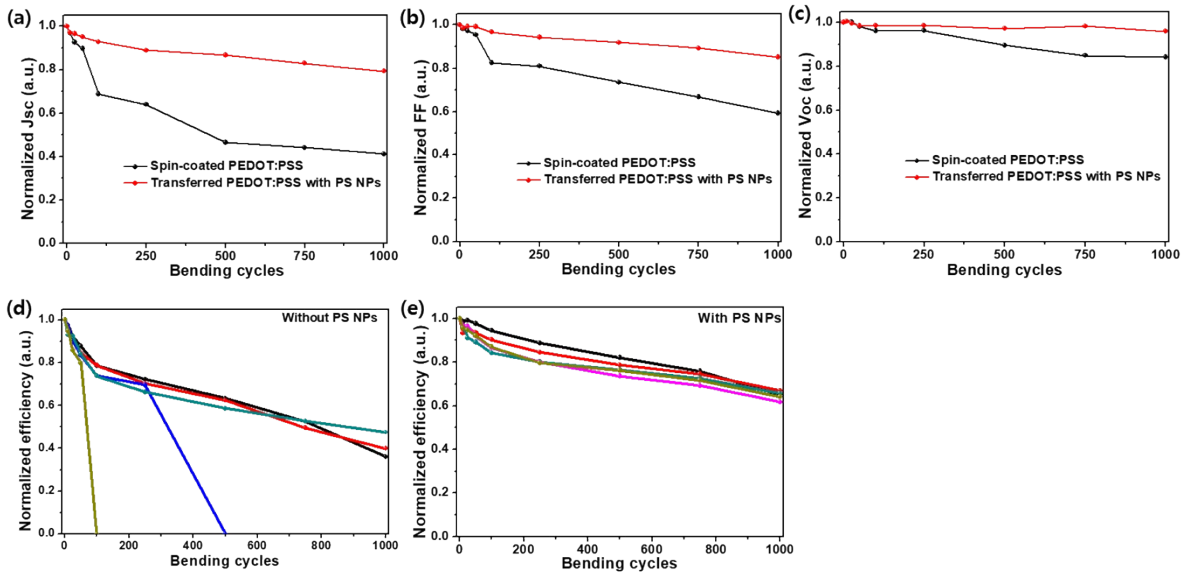
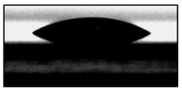


Figure S6. Normalized values of (a) J_{sc}, (b) FF, and (c) V_{oc} as functions of storage time. (d) and (e) show the normalized efficiencies of the flexible device without or with PS NPs as a function of bending cycles for each sample.

Table S2. Contact angles with liquid droplets of water and ethylene glycol. The calculated surface energy values of spin-coated PEDOT:PSS and transferred PEDOT:PSS with PS NPs.

Sample	Contact angle (deg)		Surface energy ($mJ\ m^{-2}$)
	Water	Ethylene glycol	γ^{total}
Spin-coated PEDOT:PSS	 11.92°	 15.26 °	86.136
Transferred PEDOT:PSS with PS NPs (ϕ 0.4)	 27.27 °	 30.13 °	81.332

Surface energy values were calculated by using the following equation with measured contact angle values.

$$\gamma_{LV}(1+\cos\theta) = 2\sqrt{\gamma_{SV}^{d}\gamma_{LV}^{d}} + 2\sqrt{\gamma_{SV}^{p}\gamma_{LV}^{p}}$$

Here, γ^{d} and γ^{p} mean dispersion and polar forces, and values of γ_{LV} were listed below

$$\gamma_{W}^{d} = 21.8mJ\ m^{-2}\ and\ \ \gamma_{w}^{p} = 51mJ\ m^{-2}$$

$$\gamma_{EG}^{d} = 29.3mJ\ m^{-2}\ and\ \ \gamma_{EG}^{p} = 47.3mJ\ m^{-2}$$