Electronic Supplementary Material (ESI) for RSC Advances.

High-efficiency perovskite solar cells employing conjugated donor-acceptor co-polymer as a hole-transporting material

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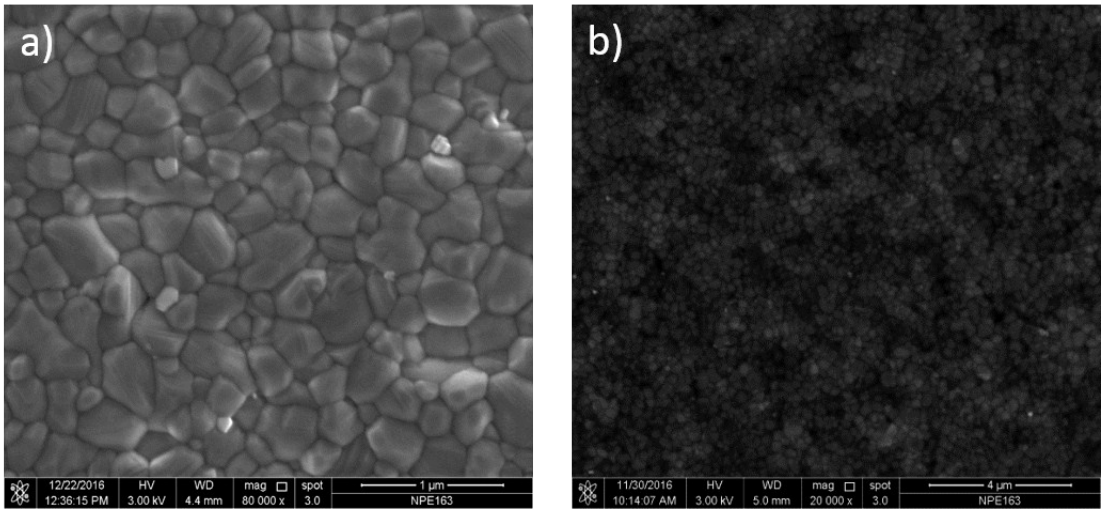

Fig. S1 Top-view SEM of (a) mix-ion perovskite film and (b) PCPDTBT:F4TCNQ film onto the perovskite.

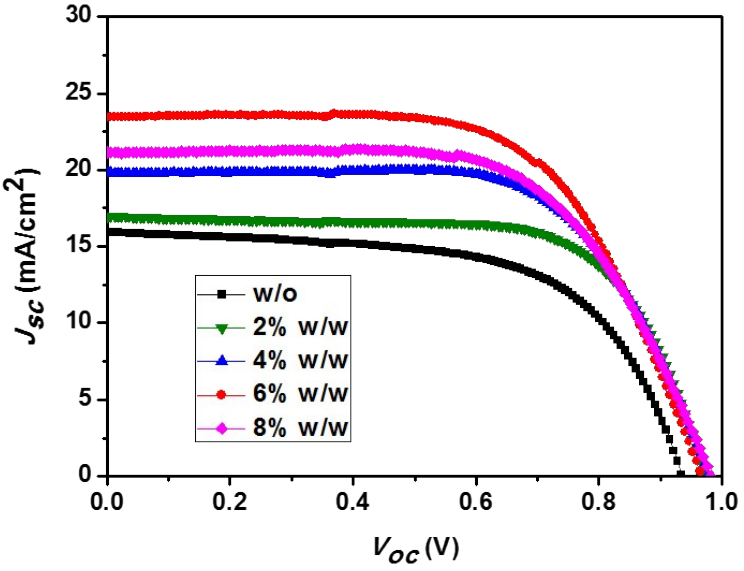

Fig. S2 *J*−*V* characteristics of the PSC devices based on PCPDTBT as HTMs with different doping levels of F4TCNQ measured under AM1.5 simulated sunlight (100 mW·cm^{-2} irradiance).

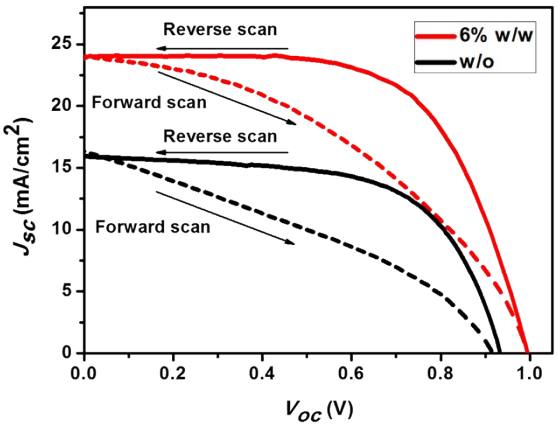

Fig. S3 *J*−*V* characteristics of the PSC devices based on PCPDTBT with and without F4TCNQ as HTMs measured at different scan directions under AM1.5 simulated sunlight (100 mW·cm^{-2} irradiance).

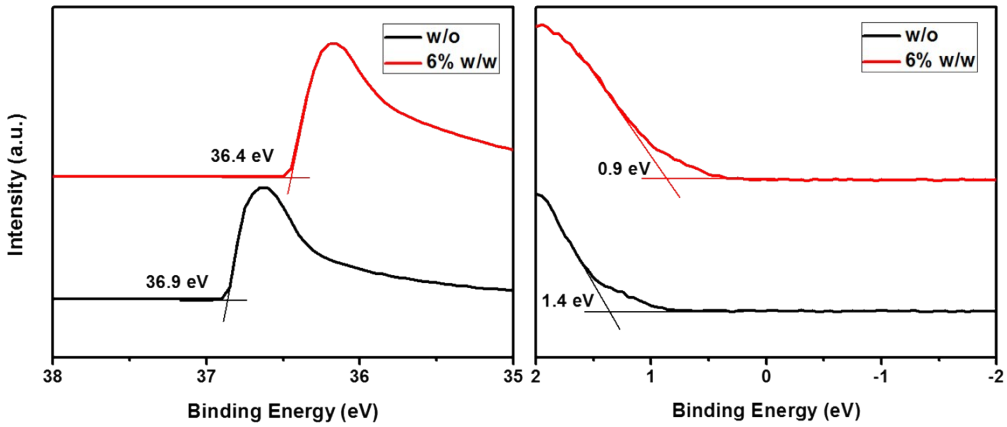

Fig. S4 UPS spectra in the cutoff (left) and onset (right) energy regions for pristine PCPDTBT (black) and F4TCNQ doped PCPDTBT (red) films.

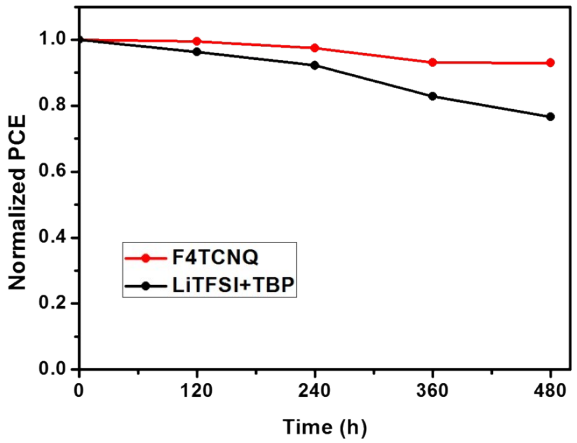

Fig. S5 PCE variations based on PSCs with spiro-OMeTAD with F4TCNQ (6% w/w) or LiTFSI and TBP as HTMs measured under AM1.5 simulated sunlight (100 mW·cm^{-2} irradiance). The devices were stored without encapsulation at ambient condition with humidity at ~30% in the dark.

Table S1 Photovoltaic parameters of PSC devices using PCPDTBT with and without doping F4TCNQ as HTMs measured at different scans under AM1.5 simulated sunlight (100 mW·cm^{-2} irradiance).

Doping ratio	*Scan directions*	*V_{oc} (V)*	*J_{sc} (mA/cm^2)*	*FF*	*PCE (%)*
6% w/w	Reverse	0.99	24.0	0.64	15.1
	Forward	0.99	24.0	0.43	10.2
w/o	Reverse	0.93	15.9	0.62	9.2
	Forward	0.92	16.3	0.35	5.2