Supporting Information

Flexibly Assembled and Readily Detachable Photovoltaics

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Experimental section

Materials and Reagents: Chlorobenzene (99.8%), tetrabutyl titanate (97%), 4-tert-butylpyridine (96%), lithium bis(trifluoromethylsulphonyl)imide (99%), acetonitrile (99.8%) and PbI_2 (99%) were all purchased from Sigma-Aldrich. Dimethyl sulfoxide (99.7%, superdry), anhydrous alcohol (99.7%), N,N-dimethylformamide (99.8%, superdry), and 2-propanol (99.7%)were purchased from J&K Scientific Ltd. TiO_2 paste was purchased from Dyesol (30 NRD) and Fluorine-doped tin oxide (FTO, 15 Ω/sq) was purchased from Yingkou OPV Tech New Energy Co., Ltd,. Spiro-OMeTAD and CH_3NH_3I were purchased from Borun New Material Technology Co., Ltd and Xi'an Polymer Light Technology Corp, respectively.

PEDOT:PSS dispersion preparation: 40 mg solid PEDOT:PSS was dispersed into 5 ml 2-propanol, and 100 μL TBP and 60 μL Li salt were added. Then, the mixture was ball-milled for 5 h to achieve homogeneous dispersion.

Fabrication of photoanode: Firstly, FTO glass was patterned by etching with Zn powder and HCl solution, Then the FTO glass cleaned by deionized water and rinsed sequentially with deionized water, isopropanol and deionized water, finnaly dried with clean dry air. TiO_2 organic sol was prepared by dissolving 16.5 mL of diethanolamine and 68 mL of tetrabutyl titanate in 210 mL anhydrous alcohol for TiO_2 compact layer. Under ambient the mixture was stirred for 1 h (Solution A). A mixture of 3.6 mL H_2O and 100 mL ethanol (Solution B) was added dropwise into Solution A under stirring, then the solution was aged for 24 h at room temperature, finally diluted into 0.25 M

before used. TiO_2 organic sol was spin coated on cleaned FTO at 3000 rpm for 30 s for compact TiO_2 underlayer, followed by a sintering process in a furnace at 450°C for 30 min. A commercial TiO_2 paste diluted in ethanol (1:6, weight ratio) was spin coated at 5000 rpm for 30 s on compact TiO_2 underlayer preparing mesoporous TiO_2 layer. The layer was dryed at 125 °C then heated to 500 °C for 30 min and cooled to room temperature. To prepare $CH_3NH_3PbI_3$ layer, 181.8 mg CH_3NH_3I and 577.5 mg of PbI_2 was dissolved in 1mL mixture solution consistingof DMF and DMSO (4:1, volume ratio). Precursor solution was stirring at 60 °C for 2 h . Then, The perovskite solution was spin-coated on the mesoporous TiO_2 film in a two-step program; first at 1000 rpm for 10 s and then at 5000 rpm for 30 s. During the second step, the spinning substrate was poured with 250 µL of chlorobenzene 15 s prior the end of the program. The substrates were then annealed at 85 ^oC for 20 min in a glove box. HTM precursor was prepared by dissolving 72.3 mg spiro-OMeTAD, 17.5 mL lithium bis(trifluoromethylsulphonyl)imide and 28.8 mL 4-tert-butylpyridine, acetonitrile solution (520 mg mL^{-1}) in 1 ml chlorobenzene. Then, HTM layer was deposited atop perovskite by spin coating at 3000 rpm for 30 s. Finally 250 µl PEDOT:PSS precursor was sprayed on the HTM layer under 90 °C on a hotplate.

Fabrication of CE and S-PSCs: FTO glass was sprayed with 500 µl PEDOT:PSS precursor under 90 °C on a hotplate. For fabrication of S-PSCs, photoanode and CE were simply stacked together without extra processing.

Characterization: Sample microscopic morphologies were characterized by scanning electron microscopy (SEM, FEI QUANTA 450). Linear sweep voltammetry (LSV) curves of FTO/PEDOT:PSS/PEDOT:PSS/FTO and FTO/TL-PEDOT:PSS/TL-PEDOT:PSS/FTO were measured using a Keithley 2601 source. The contact angle was measured with an optical CA meter (OCA20, Dataphysics) at room temperature. Electrochemical impedance spectroscopy (EIS) measurements were conducted with an electrochemical workstation (Zennium Zahner, Germany) in dark, under a 0.3 V forward biasand with a 20 mV amplitude of AC perturbation ranging from 100 mHz to 1 MHz. *J–V* curves of PSCs were obtained using a Keithley 2450 source meter scanning the devices at 0.2 V/s under simulated AM 1.5 G illumination (100 mW cm^{-2}, Solar3A,

Newport), with a mask of 0.07065 cm^2.

Table S1. Photovoltaic parameters of stacking structured PSCs with and without Spiro-OMeTAD

	J_{sc} (mA cm^{-2})	V_{oc} (V)	FF	PCE (%)
With Spiro-OMeTAD	7.24	0.35	0.47	1.17
Without Spiro-OMeTAD	17.89	0.77	0.61	8.39

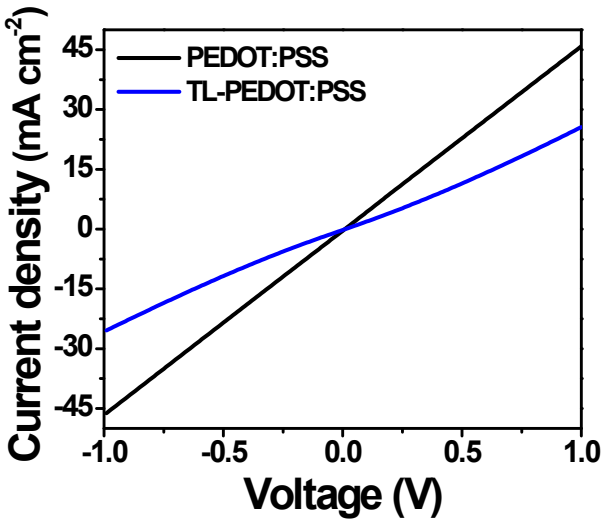

Fig. S1. Linear sweep voltammetry curves of FTO/PEDOT:PSS/PEDOT:PSS/FTO and FTO/TL-PEDOT:PSS/TL-PEDOT:PSS/FTO

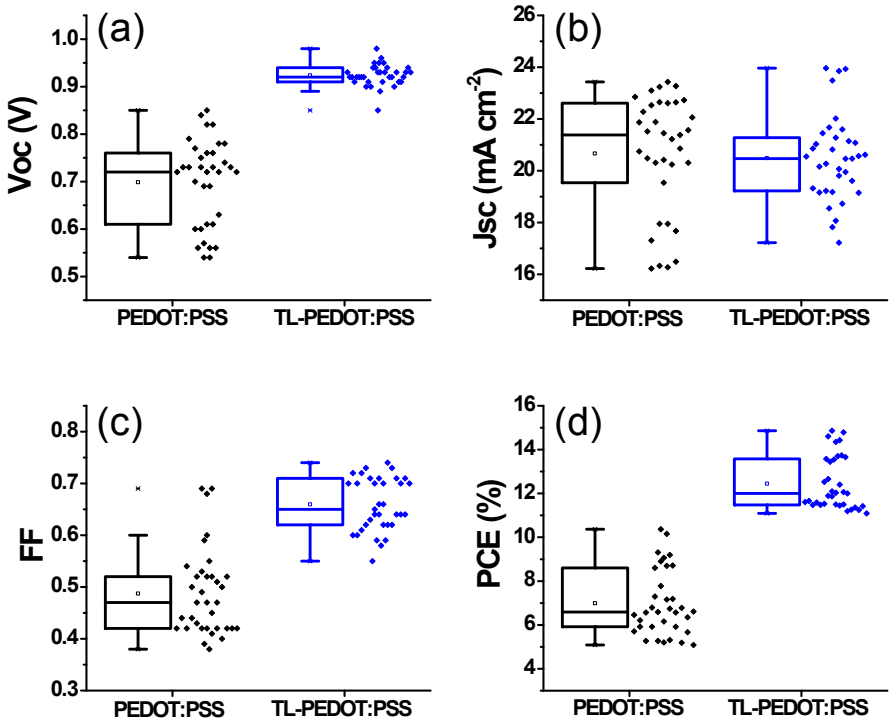

Fig. S2. Box charts exhibiting the statistical features of (a) J_{SC}, (b) V_{OC}, (c) FF and (d) PCE of all the cells.

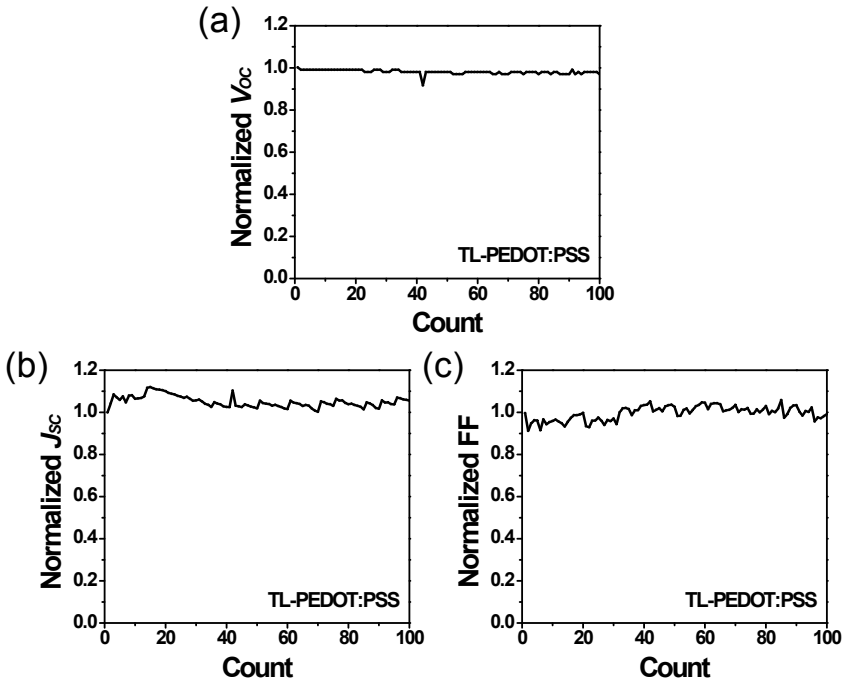

Fig. S3 Normalized values of (a) V_{OC}, (b) J_{SC}, and (c) FF of PSCs after repeated detachment stability test.