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Supporting Information

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A Lightweight Polymer Solar Cell Textile that Functions when Illuminated from Either Side**

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Supplementary Information

Experimental section

Spinnable CNT arrays were synthesized by chemical vapour deposition with Fe (1.2 nm)/Al_2O_3 (3 nm) on a silicon substrate used as the catalyst at 740 ℃. The preparation process of the Fe/Al_2O_3 catalyst was described as below. Here the Fe/Al_2O_3 catalyst system was coated on silicon substrate by electron beam evaporation with rates of 0.5 and 2 Å/s for Fe and Al_2O_3, respectively. C_2H_4 was used as the carbon source, and a gas mixture of H_2 and Ar was used as the carrier gas. The flow rates of H_2, C_2H_4 and Ar were 30, 90 and 400 cm^3/min, respectively. Here the multi-walled CNT arrays showed a height of appropriately 230 μm. The aligned CNT sheet was then dry-drawn from the array. The thickness of the aligned CNT sheet was measured by Dektak 150 Step Profiler. Typically, the thickness of 100 layers of aligned CNT sheets was obtained and then divided by 100 to calculate the thickness of one layer of sheet.

Ti textile (100 mesh) woven from (diameter of 0.05 mm) were ordered from Alfa Aesar. Ammonium fluoride (NH_4F, 99.99%), titanium tetrachloride ($TiCl_4$, 99.99%) and isopropyl alcohol ($(CH_3)_2CHOH$, 99.9%) were obtained from Aladdin. Poly (3-hexylthiophene-2,5-diyl) (P3HT) and phenyl-C_{71}-butyric acid methyl ester (PCBM) were ordered from Sigma-Aldrich. PEDOT:PSS (PH1000) was obtained from Clevios. Ethylene glycol ($HOCH_2CH_2OH$, 99%) was obtained from Sinopharm Chemical Reagent Co., Ltd.

The detailed preparation of the Ti textile electrode is described below. The aligned TiO_2 nanotubes arrays were grown on the surface of the Ti textile by an electrochemical anodization method using 0.3 wt% NH_4F/ethylene glycol solution containing 8 wt% H_2O at a voltage of 60 V for 10 min. The anodization was performed by a two-electrode electrochemical cell with a Ti textile and Pt sheet as the anode and cathode, respectively. The resulting Ti textile was washed with deionized water to remove the residue, followed by annealing in air for 1 h at 500 ℃. The annealed Ti textile was then immersed into an aqueous solution of $TiCl_4$ (100 mM) for 30 min at 70 ℃, followed by annealing for 30 min at 450 ℃. The photoactive polymer layers were sequentially dip-coated onto the modified Ti textile. Typically, the modified Ti textile was infiltrated into a mixture solution of P3HT and PCBM in chlorobenzene (weight ratio of 1/0.8) with 25 mg/mL of P3HT in a glove box, followed by annealing for 10 min at 150 ℃. A mixture solution of PEDOT:PSS aqueous solution (PH1000) and 2-propanol (volume ratio of 4/1) was further coated on the outer surface, followed by annealing for 10 min at 150 ℃.

Transmittance spectra were recorded by a Shimadzu UV-2550 spectrophotometer. The resistances were measured with a Keithley 2400 source meter. The structures were characterized by scanning electron microscopy (Hitachi FE-SEM S-4800 operated at 1 kV). The energy conversion efficiency was obtained by recording J-V curves with a Keithley 2400 Source Meter under illumination (100 mW/cm^2) of simulated AM 1.5 solar light coming from a solar simulator (Oriel-Sol3A 94023 A equipped with a 450W Xe lamp and an AM1.5 filter).

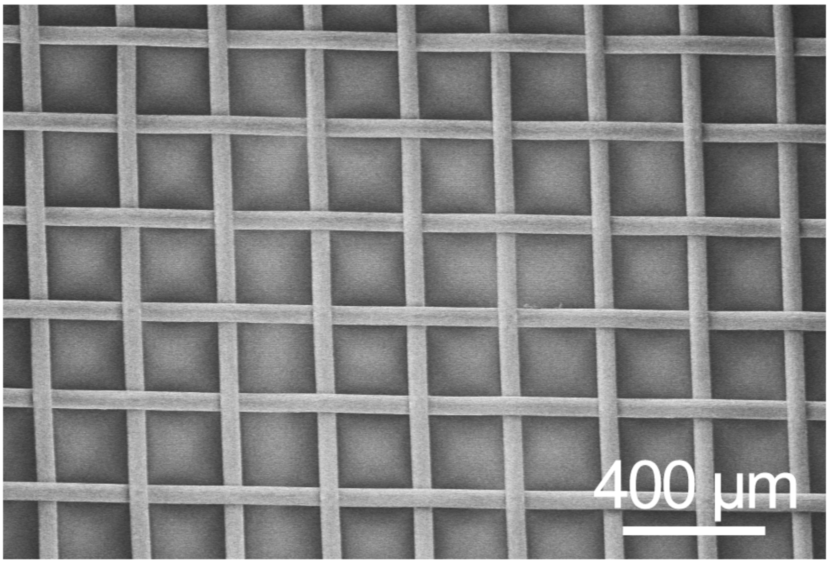

Figure S1. SEM image of the Ti textile.

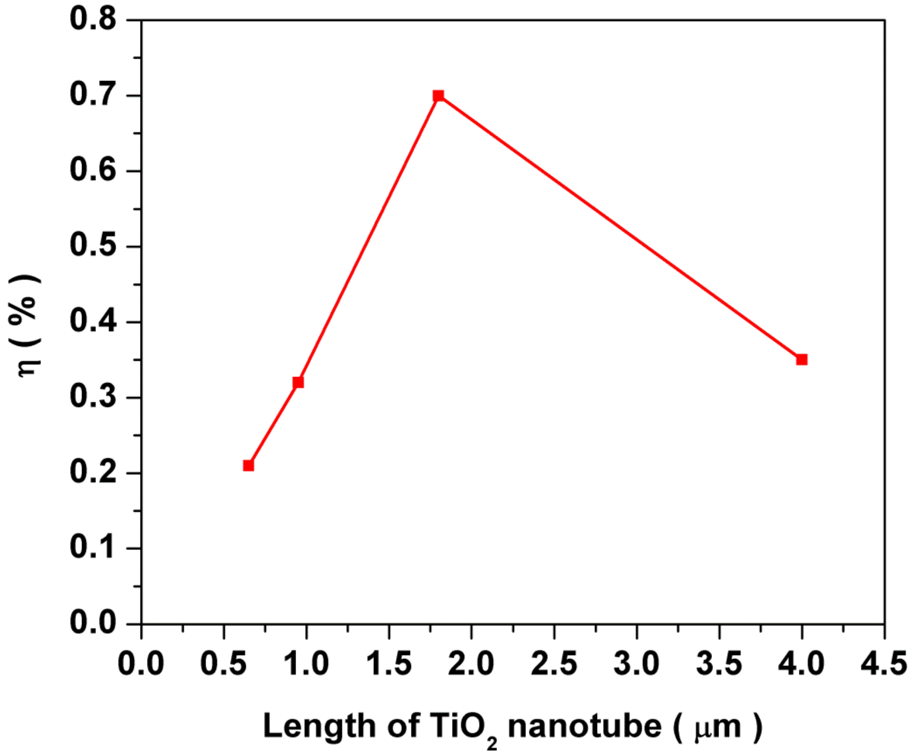

Figure S2. Dependence of energy conversion efficiency (η) on the length of TiO_2 nanotube.

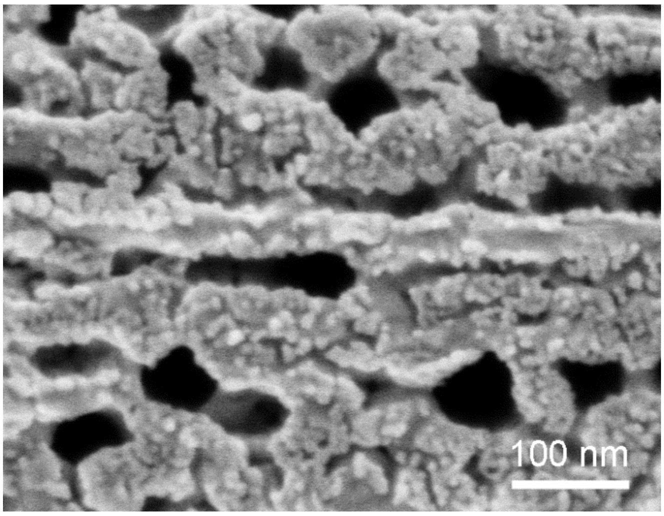

Figure S3. SEM image of aligned TiO_2 nanotubes after treated by $TiCl_4$ for 30 min.

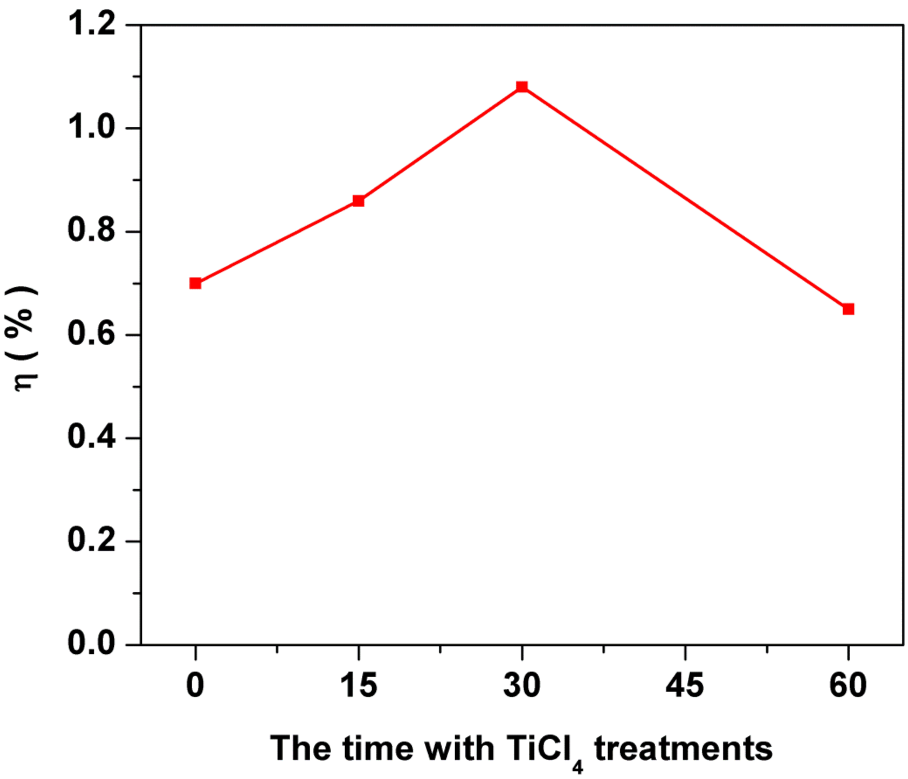

Figure S4. Energy conversion efficiencies without and with $TiCl_4$ treatments under the increasing growth time.

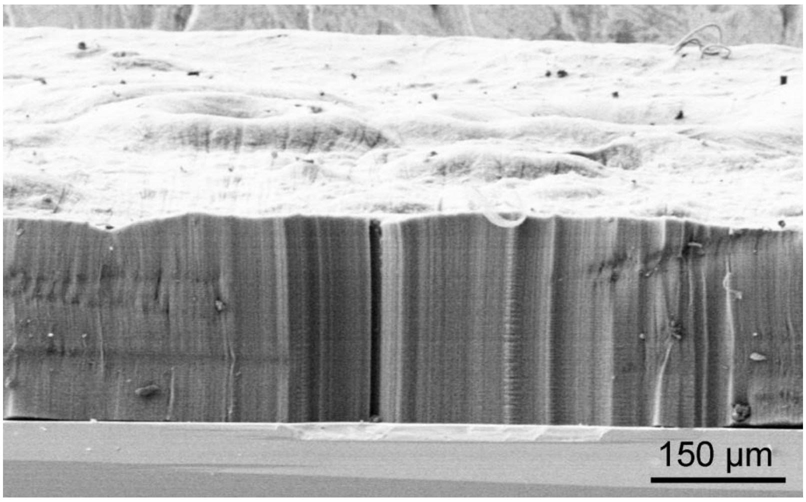

Figure S5. Scanning electron microscopy (SEM) image of a spinnable CNT array with a height of 230 μm.

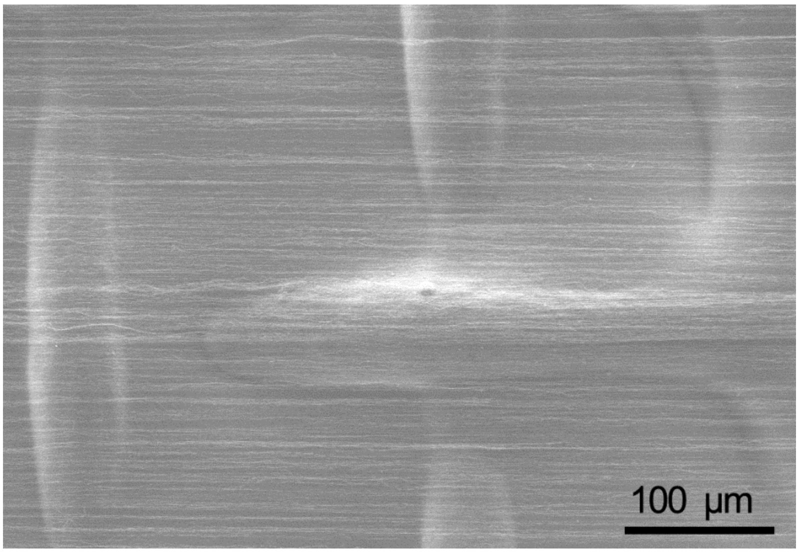

Figure S6. The aligned CNT sheet closely attached on the surface of the Ti textile.

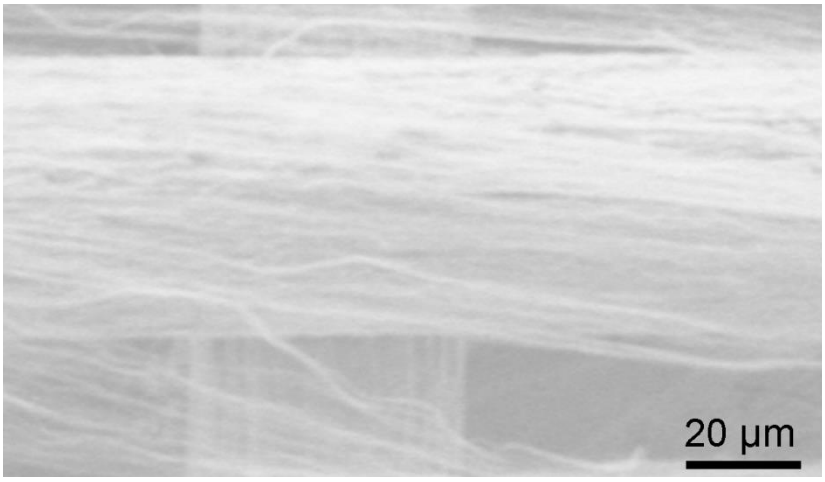

Figure S7. The aligned CNT sheet closely attached on the surface of the Ti textile.

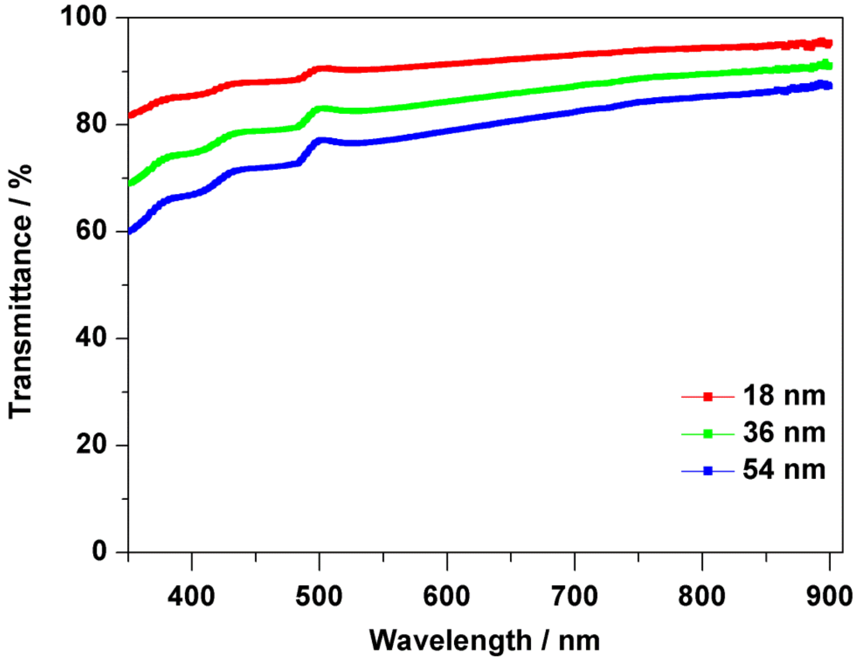

Figure S8. Dependence of optical transmittance on wavelength for aligned CNT sheets with increasing thicknesses from 18 and 36 to 54 nm.

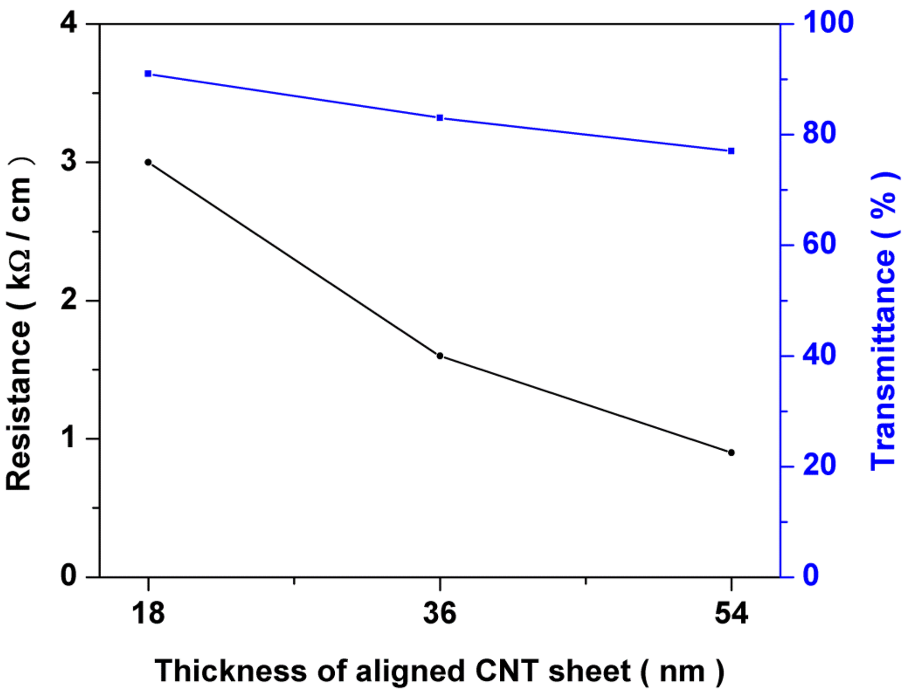

Figure S9. Resistances and transmittances of the aligned CNT sheets at thicknesses of 18, 36 and 54 nm.

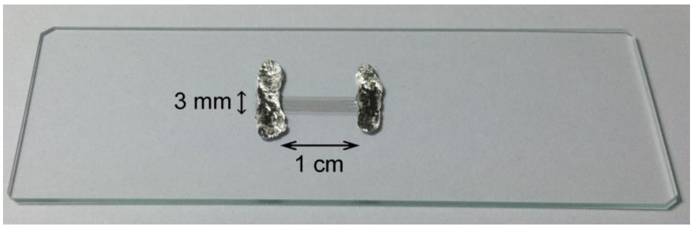

Figure S10. Photograph of the aligned CNT sheet paved onto the glass with the two ends connected to indium by an ultrasonic soldering mate. The resistance was measured by a Keithley 2400 source meter, and the contact resistance is negligible through the use of indium.

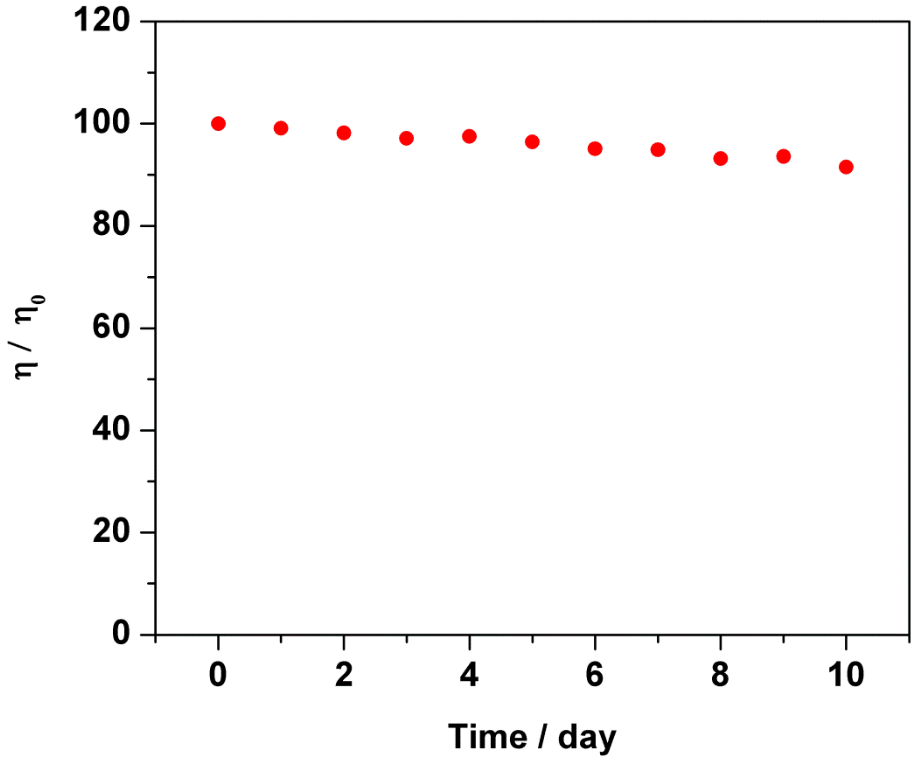

Figure S11. Energy conversion efficiencies of the PSC textile stored in argon for a period of ten days.

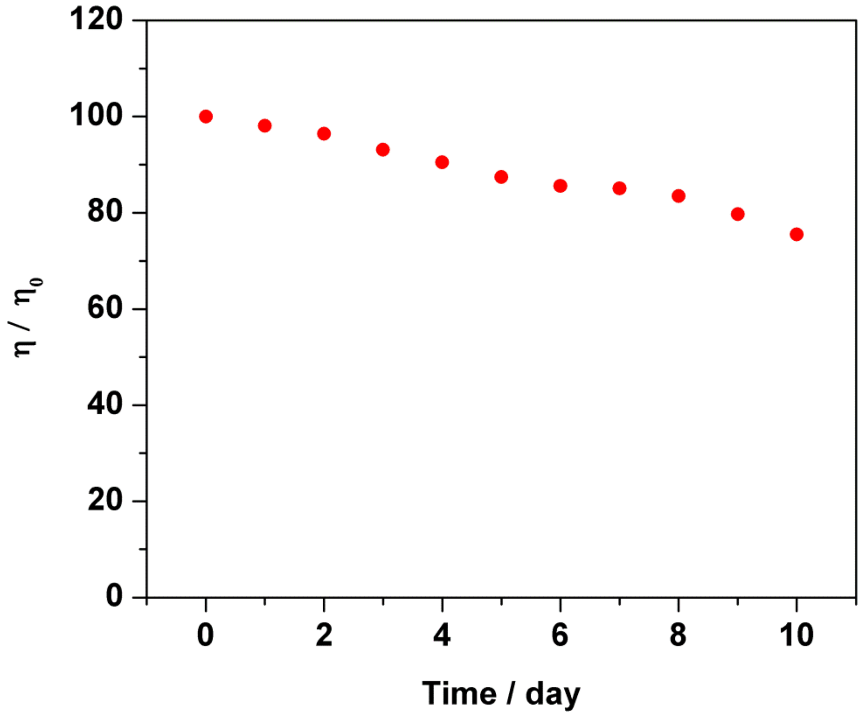

Figure S12. Energy conversion efficiencies of the PSC textile stored in air for a period of ten days.