Supporting Information

# Efficient Fiber-shaped Zinc Bromide Batteries and Dye-sensitized Solar Cells for Flexible Power Sources

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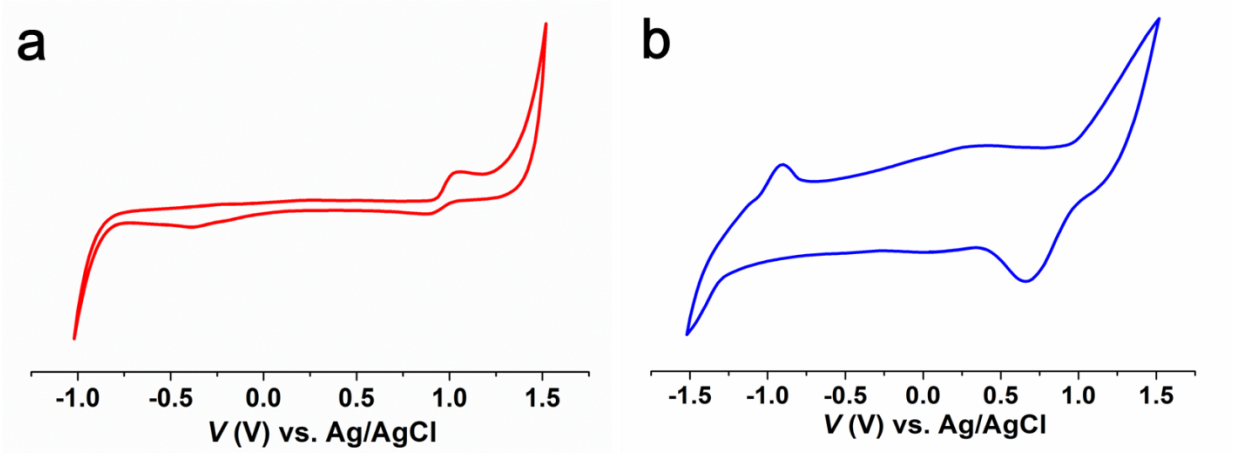


**Figure S1** Cyclic voltammetry of Pt wire (a) and carbon fiber (b) in diluted $ZnBr_2$ solution at 0.10 V/S. (The catholic peak at -1 V vs Ag+/Ag may reflect the reduction of $Zn^{2+}$.)

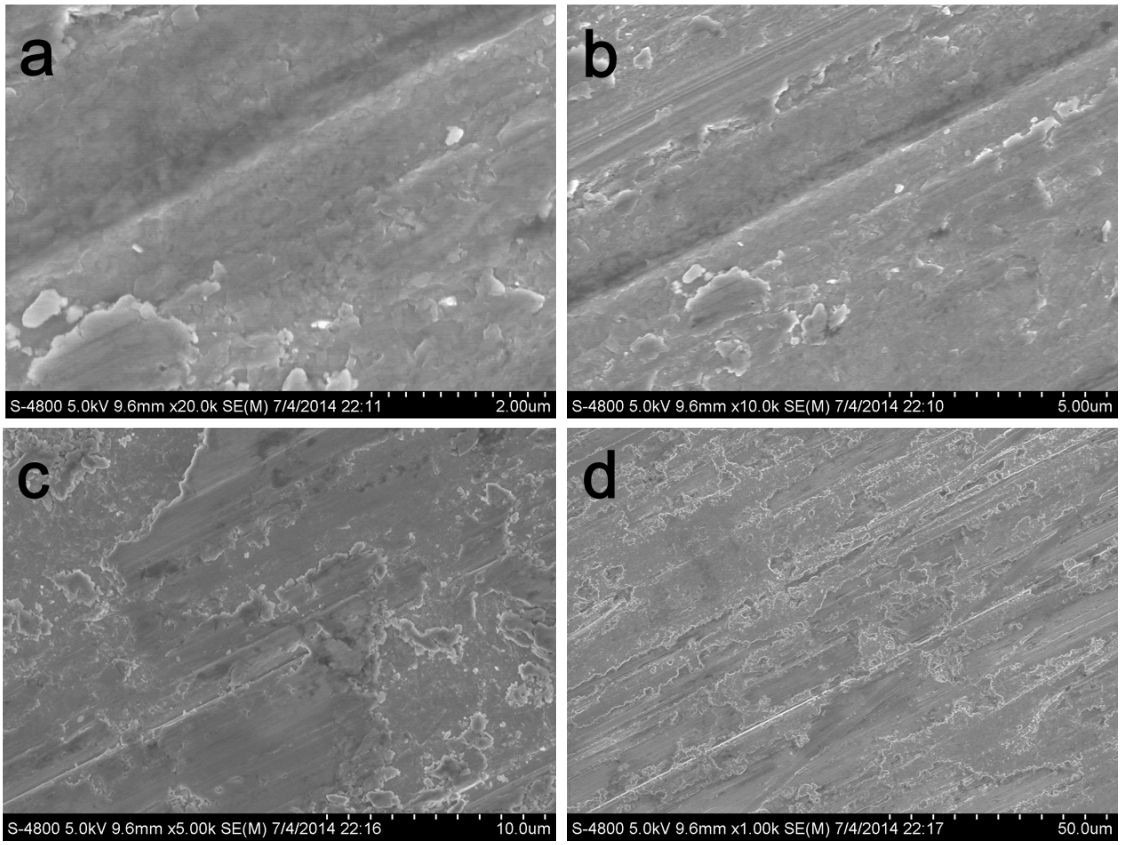


**Figure S2** Surface morphology of the polished Zn strip.

**Table S1** FB parameters under different charge/discharge current densities

| I (mA) | J (mA/mL) | J (A/g Pt) | CE | VE | EE | $Q_v$ (mA h/mL) | $E_v$ (mW h/mL) | $P_v$ (mW/mL) | $Q_d$ (mA h/g) | $E_d$ (mW h/g) | $P_d$ (mW/g) | $Q_l$ (mA h/cm) | $E_l$ (mW h/cm) | $P_l$ (mW/cm) | $Q_{pt}$ (A h/g) | $E_{pt}$ (W h/g) | $P_{pt}$ (W/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 11.11 | 1.56 | 0.86 | 0.80 | 0.69 | 19.15 | 28.37 | 16.46 | 4.84 | 7.17 | 4.16 | 1.92 | 2.84 | 1.65 | 2.69 | 3.99 | 2.31 |
| 20 | 22.22 | 3.13 | 0.86 | 0.76 | 0.65 | 19.01 | 27.79 | 32.49 | 4.80 | 7.02 | 8.21 | 1.90 | 2.78 | 3.25 | 2.67 | 3.91 | 4.57 |
| 40 | 44.44 | 6.25 | 0.93 | 0.66 | 0.61 | 9.48 | 13.16 | 61.69 | 2.40 | 3.33 | 15.59 | 0.95 | 1.32 | 6.17 | 1.33 | 1.85 | 8.68 |
| 50 | 55.56 | 7.81 | 0.94 | 0.64 | 0.60 | 6.27 | 8.52 | 75.54 | 1.58 | 2.15 | 19.09 | 0.63 | 0.85 | 7.55 | 0.88 | 1.20 | 10.62 |

The flexible FB weighs 3.56 g and is 9.0 cm long. It contains a 0.9 mL electrolyte and a 6.4 mg Pt electrode.


**Figure S3** After the charge/discharge cycles with a current of 40 mA (~ 40 mA/mL), inner layer of the FB remains "orange" and can drive a motor for more than 20 minutes.

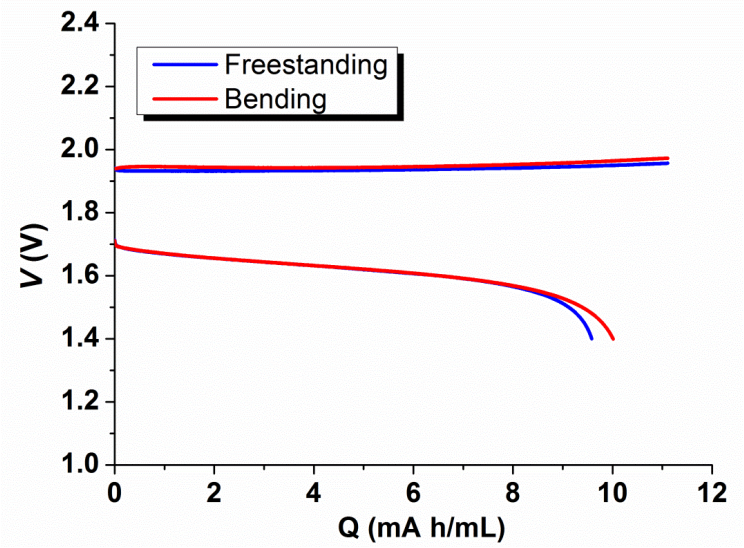


**Figure S4** Typical charge/discharge curves of the flexible FB in freestanding and bending states at 20 mA/mL with a constant charging capacity of 11.11 mA h.

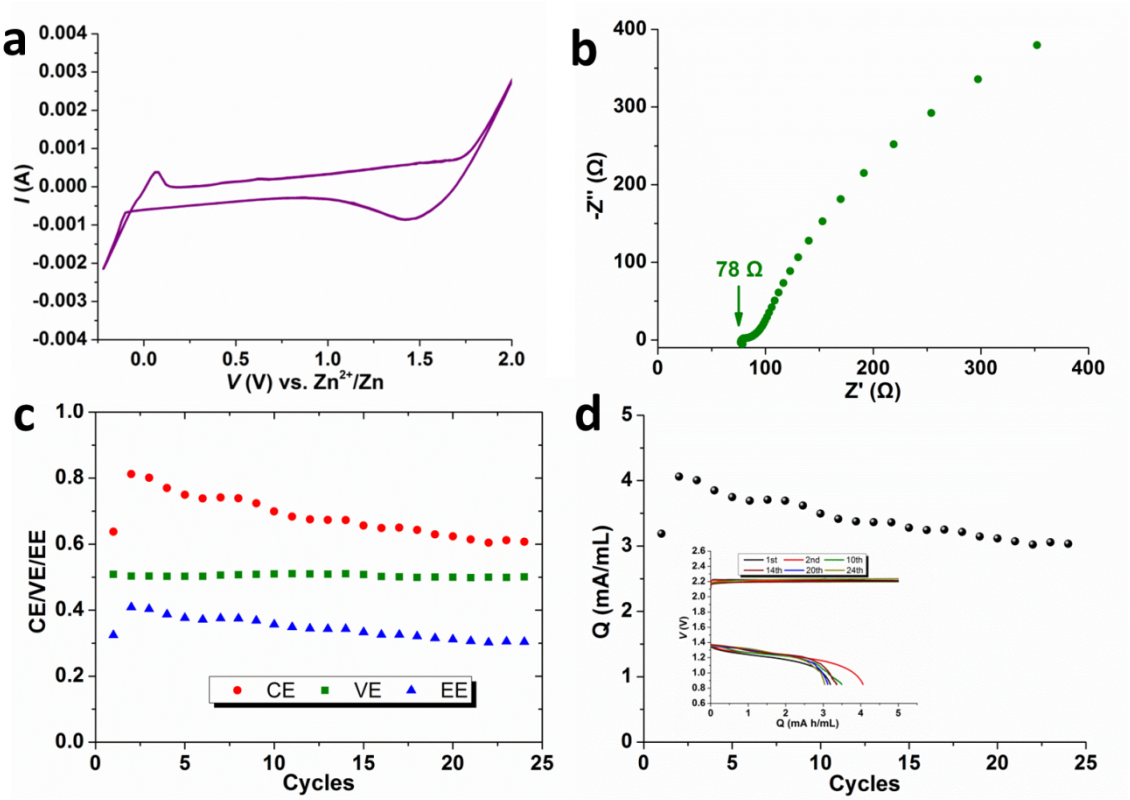


**Figure S5** (a) Current responses of a typical all CF-based flexible battery (Cathode: 6.0 mg; electrolyte: 1.0 mL; weight: 2.74 g; length: 10.0 cm) to a linear voltage scan at 0.10 V/S at a range of -0.2 V−2.0 V (versus $Zn^{2+}/Zn$); (b) Nyquist plots of the fresh device; (c) CE, VE, and EE of the flexible battery with a constant charging capacity of 5 mA h at 5 mA/mL (0.50 mA/cm); (d) cycle stability of the flexible battery with a constant charging capacity of 5 mA h at 5 mA/mL. Inset: Typical charge/discharge curves.

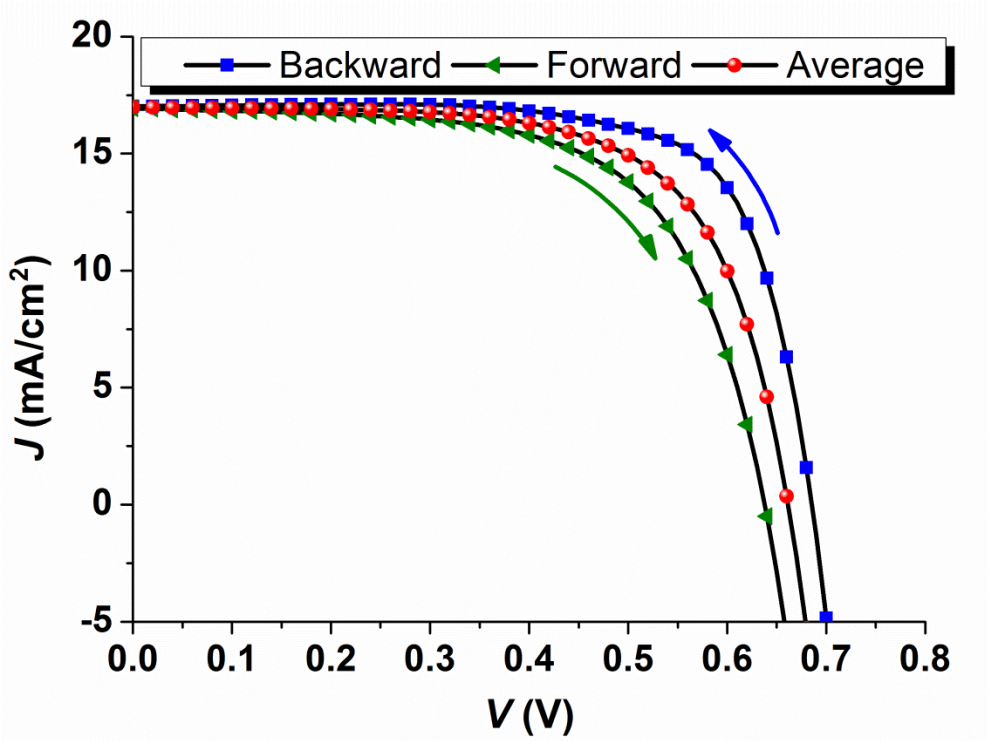


**Figure S6** Current–voltage curves of the efficient FDSC under the forward and backward tests, as well as their average.

**Table S2** Photovoltaic parameters of the efficient FDSC

| Case | $I_{SC}$ (mA) | $J_{SC}$ (mA/cm$^2$)* | $V_{OC}$ (V) | *FF* | $\eta$ (%) |
|---|---|---|---|---|---|
| Forward | 0.559 | 16.92 | 0.638 | 0.641 | 6.92 |
| Backward | 0.562 | 17.03 | 0.685 | 0.728 | 8.49 |
| Average | 0.560 | 16.97 | 0.661 | 0.667 | 7.48 |

* The illumination area of the FDSC is 0.033 cm$^2$.

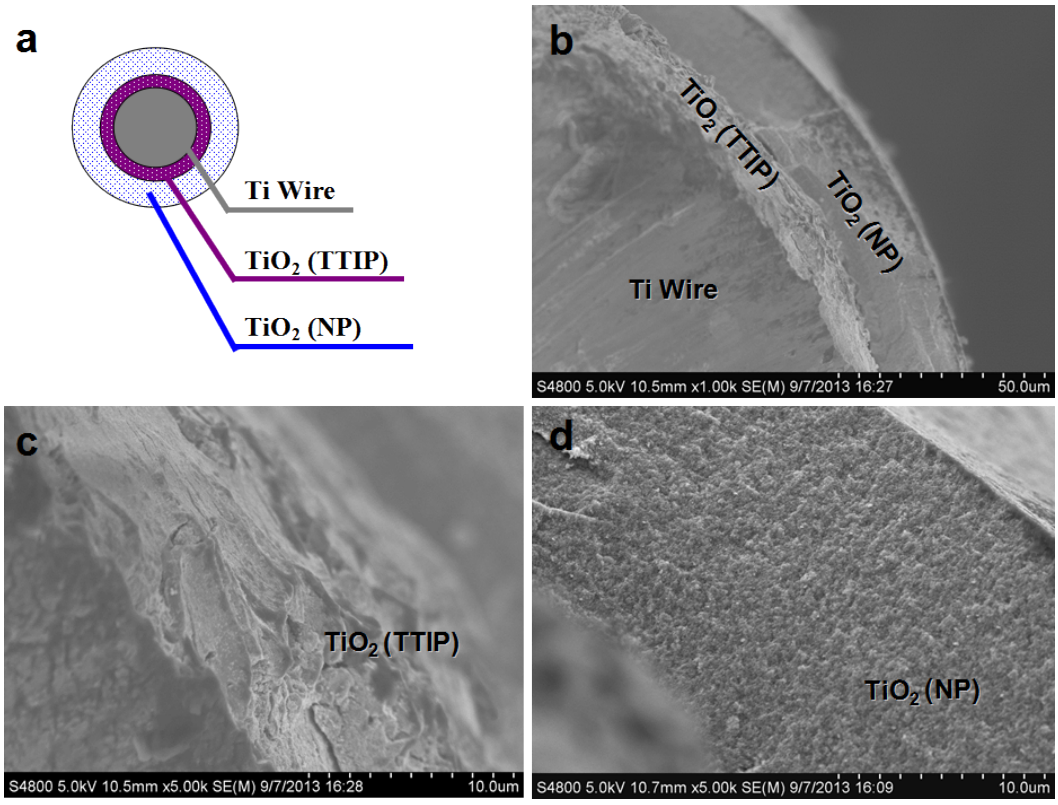


**Figure S7** (a) Schematic diagram of the Ti wire-supported $TiO_2$ bilayer structure. Field emission scanning electron microscopy images of: (b) cross-section of the as-prepared structure; (c) enlarged $TiO_2$ layer constructed from titanium tetraisopropoxide (TTIP); and d) enlarged $TiO_2$ nanoparticle layer generated from a home-made $TiO_2$ colloid.

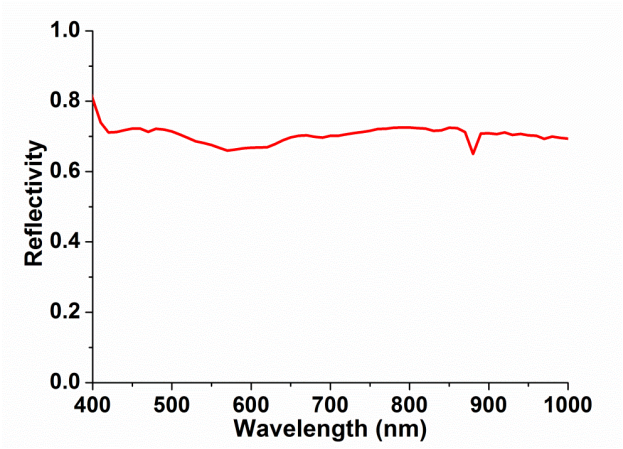


**Figure S8** Reflectivity of commercial A4 paper.

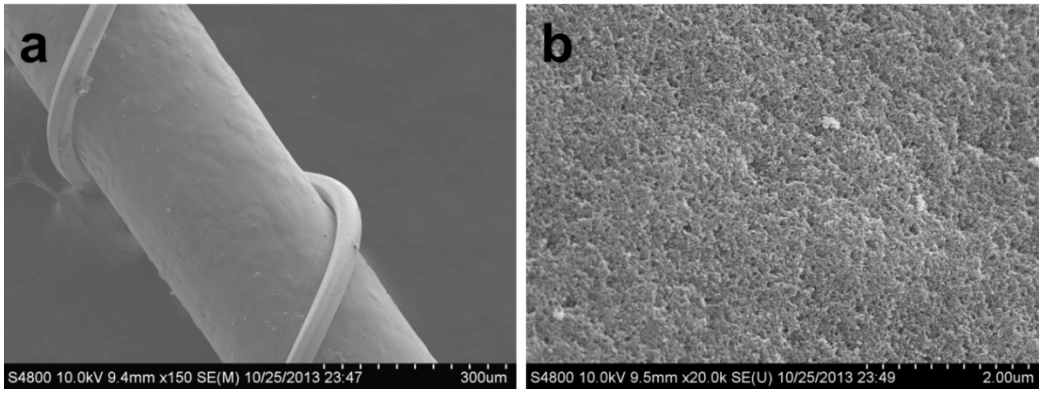


**Figure S9** Morphology of the original fiber photoanode. No cracks were observed on the electrode.

**Table S3** Photovoltaic parameters of the flexible solar device with four FDSCs in series

| $I_{SC}$ (mA) | $J_{SC}$ (mA/cm$^2$) | $V_{OC}$ (V) | *FF* | *P* (mW/g) | $\eta$ (%) |
|---|---|---|---|---|---|
| 3.93 | 4.23 | 3.14 | 0.701 | 2.96 | 9.32 |

Illumination area: 4 × 8.00 cm × 290 μm; weight: 2.92 g.

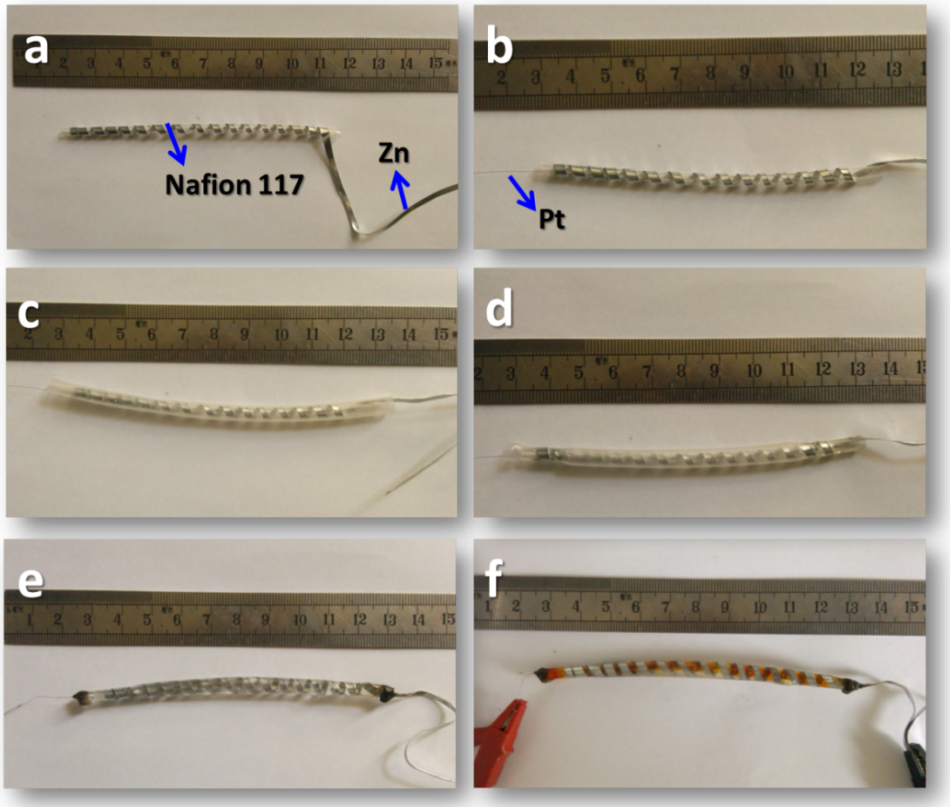


**Figure S10** Preparation of the flexible battery: a) Pretreated Nafion 117 proton exchange membrane is rolled into a cylinder and fixed with a helically-wound Zn strip (0.2 cm-0.3 cm wide). The cylinder is immersed in the original $ZnBr_2$ solution for 24 h. b) Twisted Pt wires are thrust into the Zn-surrounded cylinder. c, d) Electrodes are embedded in a heat-shrinkable tube (~10.5 cm) through heating. e, f) $ZnBr_2$ solution (2.00 M, approximately 1 mL) was injected into the tube and fixed with melton polyethylene. This device is ready for charge/discharge cycles.

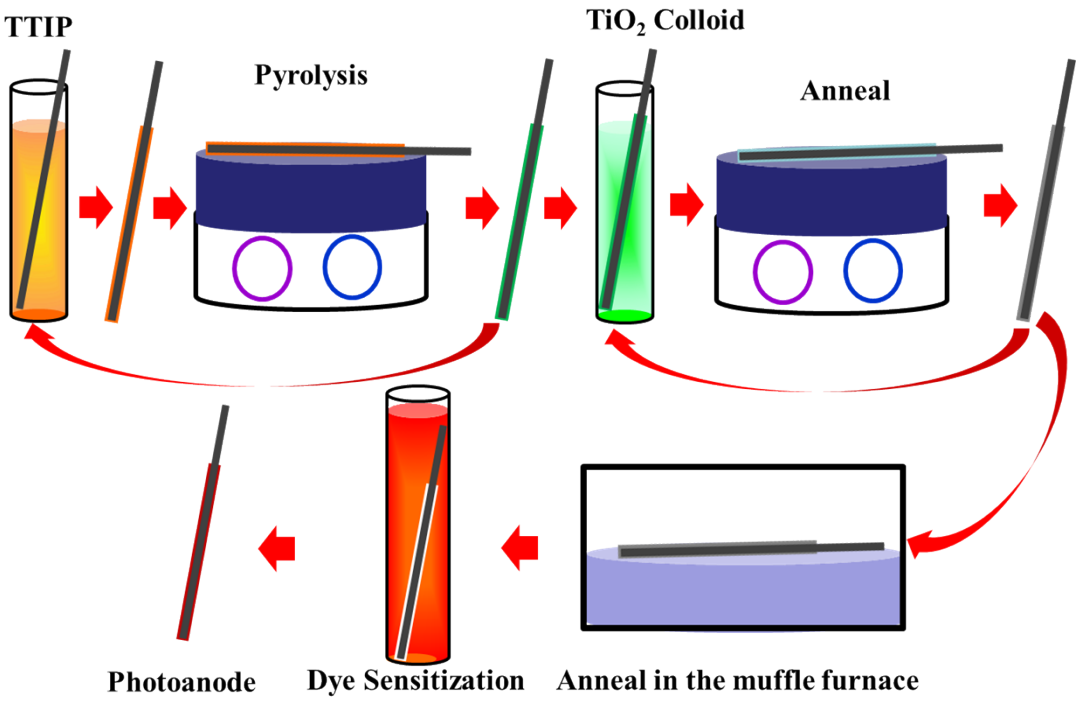


**Figure S11** Preparation of the fiber-based photoanode with $TiO_2$ bilayer. 1) A clean, polished Ti wire is coated with titanium tetraisopropoxide (TTIP) and pyrolyzed at 400 °C for 1 min. This procedure is repeated several times until a compact $TiO_2$ film of certain microns is produced. 2) A home-made $TiO_2$ colloid is dip-coated and annealed for 30 s. This procedure is repeated until the target nanoparticle film thickness is reached. 3) The as-prepared structure is annealed in a muffle furnace at 400 °C for another 30 min. 4) The Ti wire-supported $TiO_2$ bilayer is sensitized with N719 ethanol solution for 12 h to form the photoanode.

(D. Zou et al, *Nano Energy*, **2013**, 2, 537-544; *J. Power Sources* **2014**, 247, 249-255.)

**Video I**: The flexible battery can drive a motor.

**Video II**: The FDSC device is flexible.

**Video III**: A single flexible FDSC can drive a motor.