Electronic Supplementary Information (ESI):

From Wire to Vein: Wet-Process Fabrication of Light-weight Reticulation Photoanodes for Dye-sensitized Solar Cells

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Experimetal Methods

1 Materials and Methods

Different fiber substrates were employed, such as Cu wire (0.20 mm), and nonconductive polymer fibers, namely, polybutylene terephthalate (PBT, φ=0.26 mm), polyethylene terephthalate (PET, φ=0.20 mm), polypropylene (PP, φ=0.20 mm), and polyamide (PA, φ=0.20 mm). For comparison, Fe and Ti wires were used as conductive substrates of the photoanode. PET meshes (150#) and commercially-bought leaf veins were also used. All substrates were cleaned with deionized water and then dried in a vacuum.

All substrates were cleaned with deionized water and then dried in a vacuum. A Ni layer was then deposited via chemical plating.[18-20] Prior to Ni plating, the fiber substrate was dipped in a $PdCl_2$ solution (6.1×10^{-3} M) for 40 min at 50 °C and then in an HCl solution (10%) for 1 min at 25 °C. Afterward, it was dipped in a Ni-plating solution (pH = 7.5) for 40 min at 80 °C. The Ni-plating solution consisted of $NiSO_4$ (0.057 M), trisodium citrate (TSC, 0.051 M), and hypophosphite (0.29 M).

The wire was cleaned with deionized water and then dried. Afterward, the wire was dipped into a solution of zinc acetate and hexamethylene tetramine and then taken out. A layer of ZnO nanoseeds formed on the substrates after heating at 200 °C. The process was then repeated six times. ZnO-nanorod arrays were then grown on the substrates in a solution of zinc acetate and hexamethylene tetramine at 95 °C for 10h.[17,21–23] The electrode was then cleaned with deionized water and dried in a vacuum. A common way to increase the length of wet-grown ZnO nanorod is to refresh the synthesis solution for many times. However, it would bring in more uncontrollable defects, especially for more complex substrate structures, which will result a large fluctuation of the performance. For better comparison between different substrates, we did not refresh the synthesis solution.

Prior to testing, the as-prepared working electrodes were sensitized in a N719 ethanol solution (Solaronix, Switzerland) for 20 h..

2 Photoelectrochemical Test

The photoelectrochemical tests were conducted using an electrochemical working station (CHI660D, Shanghai Chenhua, China). The light source was a xenon lamp, and the photo-intensity, which was calibrated by a standard Si solar cell, was determined as 100 mA/cm^2. During the testing, the working electrode was directly assembled on the Pt foil (99.9 %). The electrolyte consisted of lithium iodide (0.5 M, AR), iodine (0.05M, AR), lithium perchlorate (0.05 M, AR), and 4-tert-butylpyridine (0.5 M, AR) in acetonitrile (AR) [13]. To prepare CuI solid-type fiber-shaped DSSCs, CuI was deposited on the fiber photoanode by dropwise dripping a CuI/CH_3CN solution at approximately 110 °C,[24] An Au wire (diameter = 30 μm, pitch = 0.75 mm) was used as the counter electrode. The effective area was calculated using the projected area of the photo-anode. The active length of the fiber equals to the part where ZnO coated. Besides, there is no mirror or any thing reflective at the back-side of the cell. For vein-shaped electrode, the active area was measured on optical photos via a fractal-image-processing software. And, the average value of more than 3 photos was employed.

3 Characterization

Morphology was characterized using scanning electron microscopy (SEM) (S-570, Hitachi, Japan). Electrochemical impedance spectroscopy (EIS) was also performed using an electrochemical working station (CHI660D, Shanghai Chenhua, China) at an open-circuit voltage under dark.

4 XRD results for ZnO with different [Zn^{2+}]

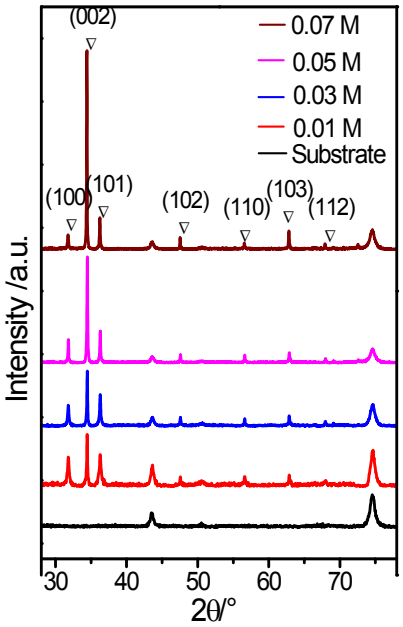

Fig. S1. X-ray diffraction results of the ZnO nanoarrays with different [Zn^{2+}]

5 EIS results for Cu electrode

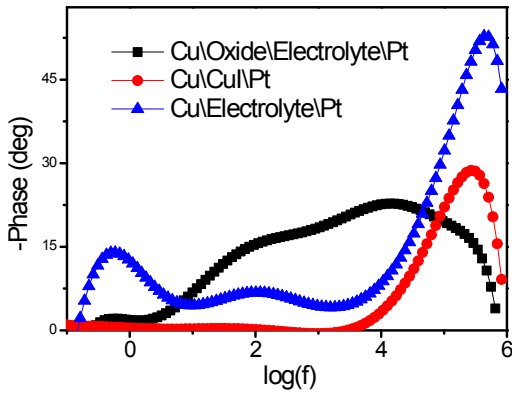

Fig. S2. EIS results for Cu electrode (Cu\Oxide\Electrolyte\Pt: Cu electrode was heated in air for 1h; Cu\CuI\Pt: CuI was directly deposited on Cu;)

6 Adsorption amount of Dye on different ZnO electrodes

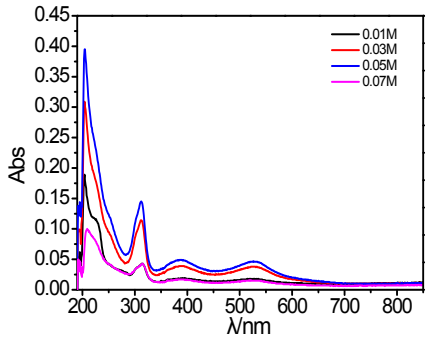

Fig. S3. UV-Vis of dye solutions desorbed from photoanodes with different ZnO via ethanol (ZnO are grown from reaction solutions with different [Zn^{2+}]: 0.01M, 0.03M, 0.05M, 0.07M)