Electronic Supplementary Information

One-step preparation of mirror-like NiS nanosheets on ITO for the efficient counter electrode of dye-sensitized solar cells

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Experimental

Synthesis of NiS CE: In a typical synthesis, 0.5 mmol of $NiCl_2 \cdot 6H_2O$, 1 mmol of D-penicillamine were dissolved in 40 mL of ethylene glycol under stirring for 10 min. The reaction mixture was then transferred into a Teflon-lined autoclave with 50 mL inner volume and a ITO substrate was dipped into it. The autoclave was then sealed and kept at 200 ^oC for 1 h in an electric oven. After cooling down to room temperature, the ITO substrate was washed several times with deionized water and ethanol, and dried at 70 ^oC. Then, the NiS CE was obtained. Transparent Pt CE was prepared by drop casting 5 mM H_2PtCl_6 isopropyl alcohol solution on a clean FTO and sintered at 400 ^oC for 20 min.

***Fabrication of the DSCs*:** Fabrication of the DSCs was executed by screen-printing method on FTO using the commercially available TiO_2 nanopowder (Sigma Aldrich, < 25 nm) with ethyl cellulose (10 wt%) and a solution compose of ethanol and α-terpineol (5 wt%), followed by calcination at 525 ^oC for 2 h. The thickness of TiO_2 film was about 12 μm. The electrode was dipped

into a solution containing 0.5 mM N719 dye in acetonitrile and isopropyl alcohol (v/v=1:1) for 24 h. After sensitization, the TiO_2 electrode was incorporated into a thin-layer, sandwiched solar cell with an active area of 0.25 cm^2 using NiS as CE. The performance of prepared transparent Pt CE was also measured for the comparison. These electrodes were separated by a polyethylene spacer (38 μm) to prevent short-circuiting. The electrolyte consisted of 0.05 M I_2, 0.1 M LiI and 0.6 M 1,2-dimethyl-3-n-propylimidazolium iodide in acetonitrile with 0.5 M 4-tertbutylpyridine.

Measurements of photovoltaic properties: The photovoltaic performance of solar cells was carried out using a source meter (Keithley 2400). A PEC-L11 AM 1.5 solar simulator (Peccell, with a 1000 W Xe lamp and an AM1.5 filter) was used as the light source (100 mW cm^{-2}). Action spectra of the monochromatic IPCE were collected using a PEC-S20 (Peccell). The incident light intensity was calibrated according to a standard for amorphous silicon solar cells that was produced by the Japan Quality Assurance Organization. XRD pattern was charactrerize by using X-ray diffraction instrument (Axios Petro, PANalytical, CoKα, λ=1.79021Å). X-ray photoelectron spectra (XPS) were recorded using a MUTILLAB 2000. SEM images were presented using an S4800 instrument (Hitachi) with an accelerated voltage of 5 kV, and EDS spectrum was measured with an accelerated voltage of 15kV. TEM images were taken using a Tecnai G2 F20 S-TWIN with an accelerated voltage of 200 kV. Current-Voltage curves (CV), electrochemical impedance spectroscopy (EIS) and Tafel polarization curves were conducted using an IM6 (Zahner). Diffuse reflection spectra (DRS) were investigated using a UV-Vis-NIR diffuse reflectance spectroscopy (Varian CARY 500) with $BaSO_4$ as the background.

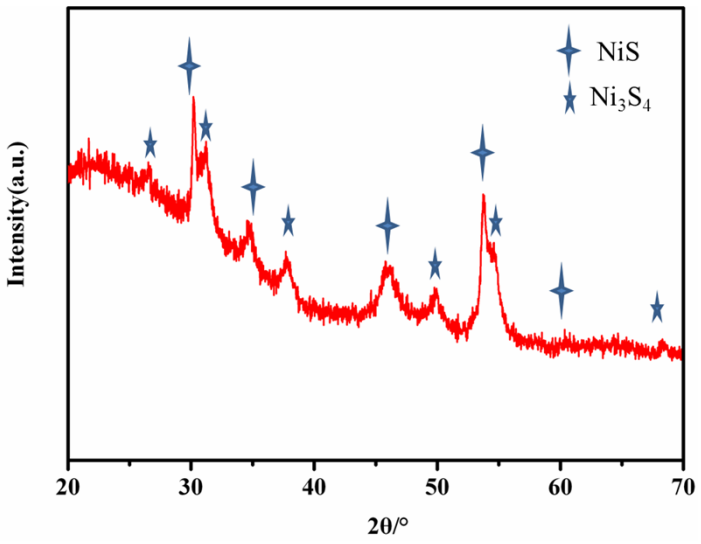

Fig.S1 XRD patterns of the product fabricated in ethylene glycol solution at 200 °C

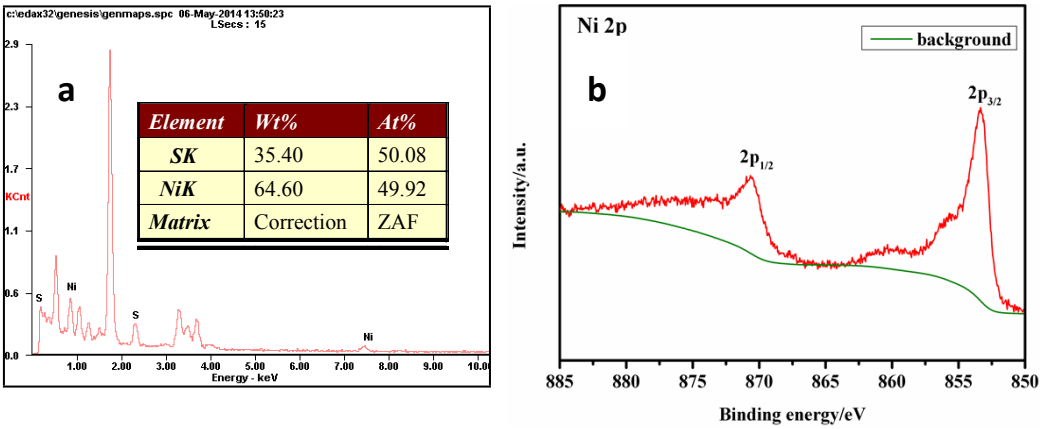

Fig.S2 (a) EDS spectrum and (b) XPS spectrum of as-prepared NiS on ITO glass substrate.

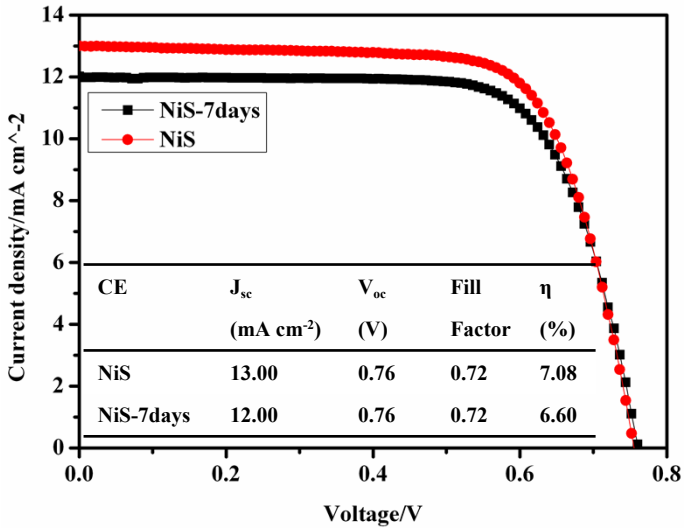

Fig. S3 Current-voltage characteristics of as-prepared NiS CE and NiS CE that aging for one week.

Long-term stability of as-prepared counter electrodes were also tested. In Fig. S3, after aging for one week, the NiS CE can still keep an efficiency of 6.60%, which is 93.2% of the efficiency for fresh as-prepared NiS CE.

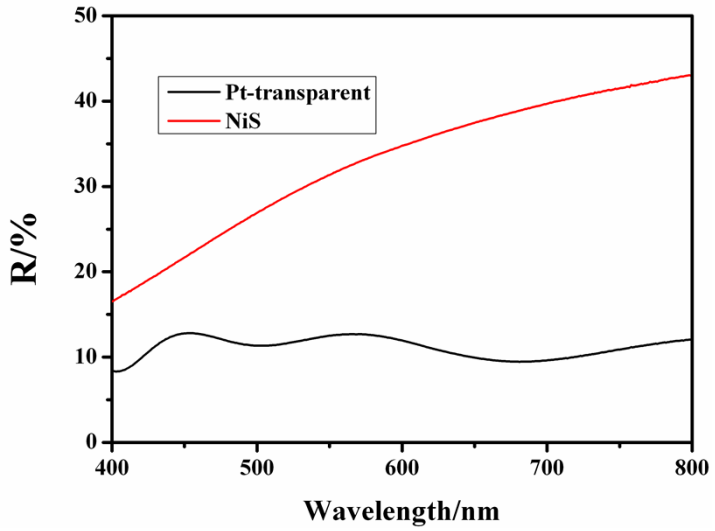

Fig. S4 Diffuse reflectance spectra of as-prepared NiS CE and transparent Pt CE