Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supplementary Materials

Facile synthesis of NiS nanowires via ion exchange reaction as efficient counter electrode for dye-sensitized solar cells

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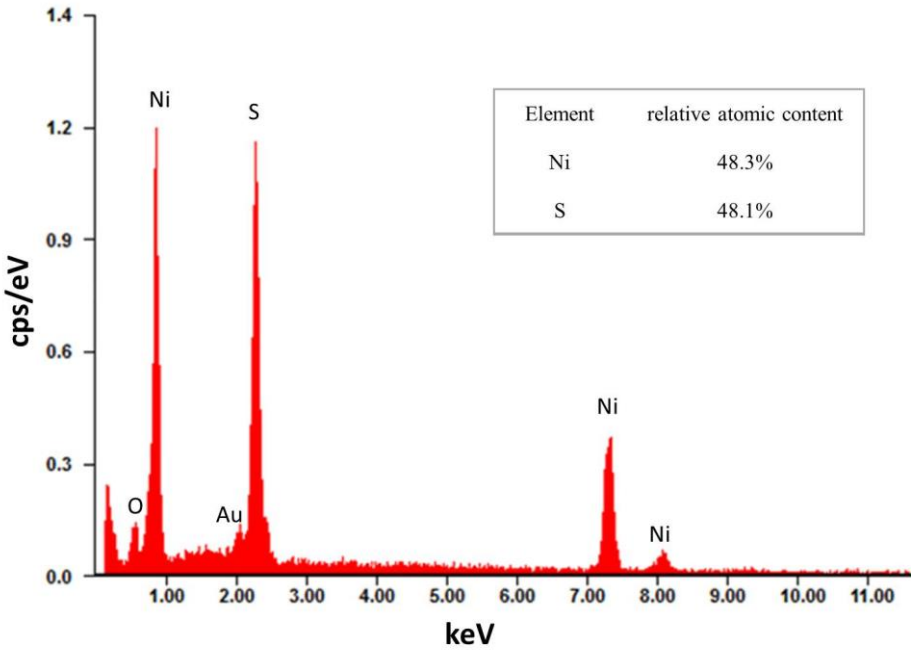

Fig. S1 EDS spectrum of nanoporous NiS-NWs-350.

The EDS spectrum (Fig S1) shows that the relative atomic content of Ni and S in the sample of 1D NiS nanowires is 48.3% and 48.1%, respectively, and the atomic ratio of S to Ni is close to 1:1,indicating that the obtained material is NiS.

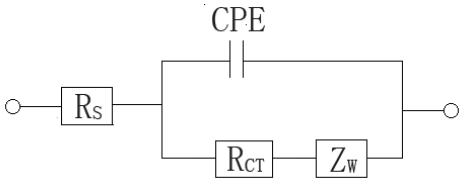

Fig. S2 Equivalent circuit of EIS for the CE-CE cell. R_s is a sheet resistance, CPE is a constant phase element, R_{CT} is a charge-transfer resistance, Z_W is Nernst diffusion impedance.

$Ni(SO_4)_{0.3}(OH)_{1.4}$ Nanobelts		NiS nanowires	
d(Å)	(h,k,l)	d(Å)	(h,k,l)
7.96	(1,0,0)	2.98	(1,0,0)
6.81	(0,0,2)	2.69	(0,0,2)
5.08	(1,0,2)	2.62	(1,0,1)
3.94	(2,0,0)	1.99	(1,0,2)
3.86	(1,0,3)	1.72	(1,1,0)
3.78	(2,0,1)	1.53	(1,0,3)
3.39	(0,0,4)	1.49	(2,0,0)
3.05	(2,0,-3)	1.44	(2,0,1)
2.94	(0,1,0)	1.34	(0,0,4)

TABLE S1 Corresponding main lattice parameters summarized from the XRD, illustrating the lattice shrink of the transaction from $Ni(SO_4)_{0.3}(OH)_{1.4}$ nanobelts precursor to NiS nanowires.

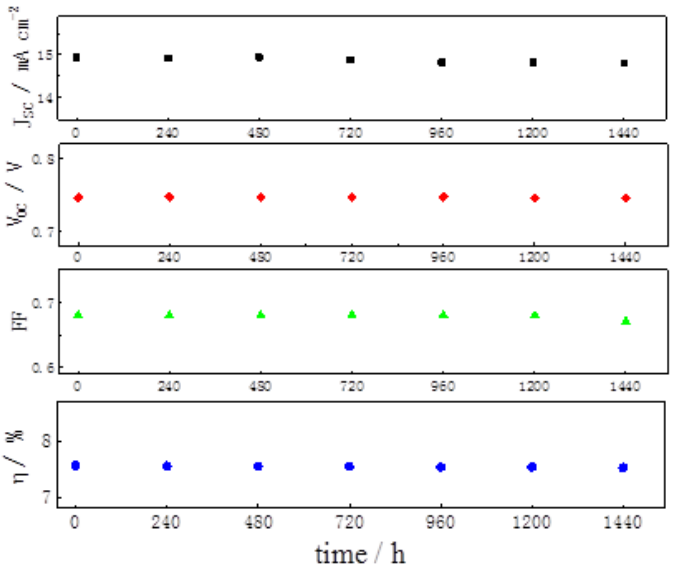

Fig. S3 Time/Efficiency plots. NiS nanowires 350°C sintered electrodes (NiS-NWs-350) were immersed into the iodine/tri-iodine containing electrolyte used in this paper, After different corrosion time, the electrodes were cleaned with ethanol, then using them as the counter electrode of DSSCs, we got the different parameters from the corresponding J-V curves. From the

plot we can see, the overall efficiency have no much decrease after 1440 hours of electrolyte corrosion, indicating the highly stability of NiS-NWs-350 in the iodine/tri-iodine containing electrolyte.

Preparation of NiS particles. 0.02 mol $NiSO_4 \cdot 5H_20$ and 0.028 mol NaOH were added to 50 ml deionized water respectively, and then the two solutions were quickly mixed under vigorous stirring, forming a green suspension. Then 0.015 mol Na2S resolved in 100 ml deionized water was added dropwise to the green suspension under vigorously stirring, at 90 °C and stirred for 1 h to make the mixture homogeneous. The mixture was transferred into a polytetrafluoroethylene autoclave, and heated at 150 °C for 3 h, with freedom cooling to room temperature. The resulting precipitate containing NiS particles was washed with toluene, ethanol and deionized water respectively. This method to compose NiS particles is similar with the ion-exchange strategy to compose the NiS nanowires in this article, just omit the step of forming Ni(SO4)0.3(OH)1.4 nanobelts. The SEM of the prepared NiS particles were shown in Fig S4.

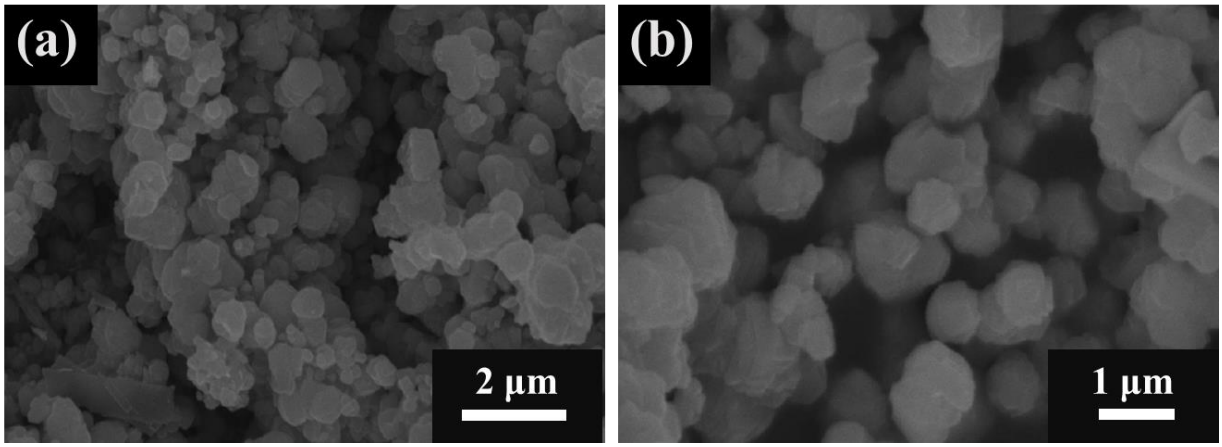

Fig. S4 SEM of NiS particles (a,b)

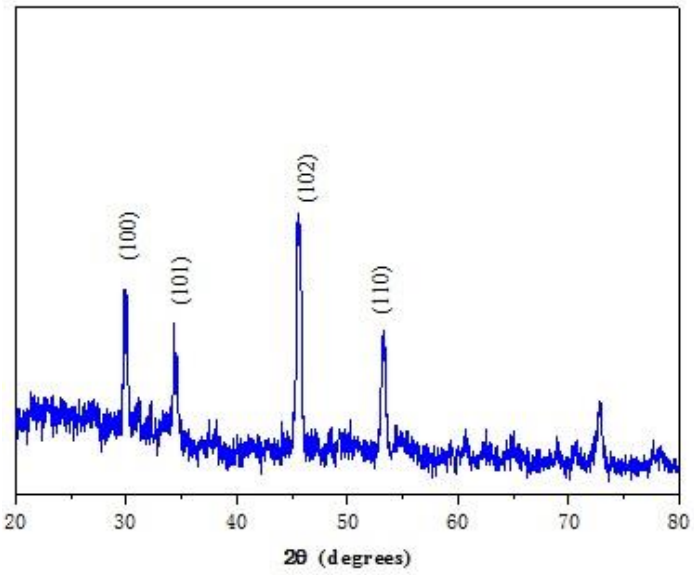

Fig. S5 XRD patterns of NiS particles

As shown in Fig. S5, and the diffraction characteristic peaks of NiS particles is similar with of

the NiS-NWs, which indicates that the prepared NiS particles obtain the same crystal structure of NiS-NWs.

Table S2 BET specific surface area of NiS-NWs and NiS-particles.

sample	S_{BET} (m^2/g)
NiS NWs	62.4
NiS particles	7.5

The BET specific surface area (S_{BET}) of the samples were measured using a TriStar-3000 (Micromeritics Inc, American). The NiS-NWs show the large specific surface area, the S_{BET} up to 62.4 m^2/g. The NiS-particles show a relative small S_{BET} of 7.5 m^2/g.

Table S3 Sheet resistance of NiS-NWs and NiS-particles with different film thickness.

sample	sheet resistance （Ω/□）
NiS-NWs（10μm thickness film）	94.8
NiS-particles（10μm thickness film）	349.6
NiS-NWs（30μm thickness film）	32.2
NiS-particles （30μm thickness film）	108.5

We measured a series of sheet resistance of NiS-NWs and NiS-particles with different film thickness by four probes method using Keithley-2612 source meter. The samples were coated on the surface of insulating glass with the doctor scraping method. The sesults show that, compared with the NiS-particles, the NiS-NWs can let the film obtain relative better conductivity. These datas also can support the explanation that 1-D nanostructure easily forms a tightly connected electron transfer path, resulting in a convenient transfer of electrons and a higher film conductivity.