Electronic Supplementary Information

Controllable growth of SnS_2/SnO_2 heterostructured nanoplates via a hydrothermal-assisted self-hydrolysis process and their visible-light-driven photocatalytic reduction of Cr(VI)

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Experimental section

1.1. Synthesis of SnS_2 NPs

In a typical synthesis, SnS_2 NPs were prepared via a modified hydrothermal method.[1] Briefly, 1.05 g of tin tetrachloride pentahydrate ($SnCl_4 \cdot 5H_2O$) and 1.5 g of thiourea (TU) were first dissolved in 35 mL of distilled water with the assistance of ultrasonication for 10 min. The mixture was transferred into a 50 mL of Teflon-lined stainless steel autoclave and heated at 180 ^{0}C for 10 h. The resulting yellow products were collected by centrifugation, washed with distilled water and ethanol for several times before drying at 80 ^{0}C for 8 h.

1.2. Synthesis of SnS_2/SnO_2 HNPs

In a typical synthesis, 20 mg of the as-prepared SnS_2 precursor was dissolved in 35 mL of aqueous solution containing 300 mg of citric acid with the assistance of ultrasonication for 5 min. The resulting mixture was transferred into a 50 mL of Teflon-lined stainless steel autoclave and heated at 180 ^{0}C for certain durations. The final products were collected by centrifugation, washed with ethanol and distilled water, and then dried in a vacuum at 80 ºC for 8 h. A series of samples prepared with the different reaction time (0, 2, 5, 10, 14, and 24h) in the hydrothermal process were denoted as pure SnS_2, H-2, H-5, H-10, H-14 and H-24, respectively.

1.3. Characterization

Powder X-ray diffraction (XRD) measurements on all the samples were performed with a Philips PW3040/60 X-ray diffractometer using Cu Kα radiation, with a scanning rate of 0.06 deg s^{-1}. Scanning electron microscopy (SEM) was performed with a Hitachi S-4800 scanning electron micro-analyzer, using an accelerating voltage of 15 kV. Transmission electron microscopy (TEM) and high-resolution transmission electron microscopy (HRTEM) were conducted at 200 kV on a JEM-2100F field emission TEM. Samples for TEM measurements were prepared by dispersing the products in ethanol and placing several drops of the suspension on holey carbon films supported by copper grids. UV-vis diffuse reflectance spectra (UV-vis DRS) of the as-prepared samples were measured over the range of 200-800 nm using a Thermo Nicolet Evolution 500 UV-vis spectrophotometer equipped with an integrating sphere attachment. The absorption spectra were measured using a PerkinElmer Lambda 900 UV-vis spectrophotometer at room temperature.

1.4. Photocatalytic test

Photocatalytic activities of pure SnS_2 and SnS_2/SnO_2 HNPs were evaluated by the photocatalytic reduction of Cr(VI) under visible-light irradiation using a 500 W Xe lamp with a 420 nm cut-off filter. The reaction cell was placed in a sealed black box with the top opened and the cutoff filter was placed to provide visible-light irradiation. In a typical process, 20 mg of the photocatalyst was added into 20 mL of Cr(VI) solution (10 mg L^{-1}) which were prepared by dissolving $K_2Cr_2O_7$ into distilled water. After being dispersed in an ultrasonic bath for 5 min, the solution was stirred for 2 h in the dark in order to reach adsorption equilibrium between the catalyst and the solution, and then exposed to visible-light irradiation for certain time. The photocatalysts were removed by centrifugation at given time intervals, and the Cr(VI) concentration was measured by a colorimetrical method at 540 nm using the UV-vis spectroscopy.[2,3]

REFERENCES:

1 J. M. Ma, D. N. Lei, L. Mei, X. C. Duan, Q. H. Li, T. H. Wang and W. J. Zheng, *CrystEngComm,* 2012, **14**, 832-836.

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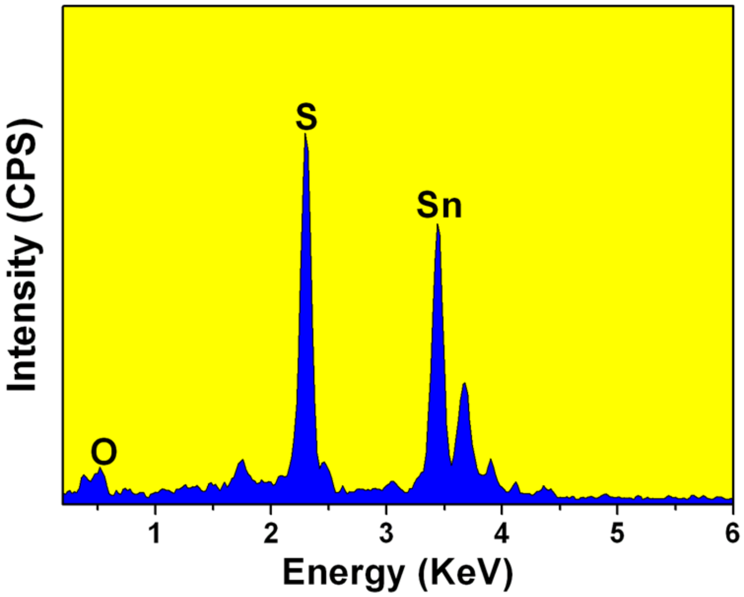


Fig. S1 EDS spectrum of the as-prepared sample H-5.

Table S1. Composition of the as-prepared SnS_2/SnO_2 HNPs.

Samples	Atomic (%) S K	Atomic (%) O K	Molar ratio $SnS_2 : SnO_2$
H-2	49.17	21.27	2.31
H-5	36.88	33.18	1.11
H-10	17.27	56.55	0.30
H-14	4.03	72.62	0.06
H-24	0.50	76.37	0.01

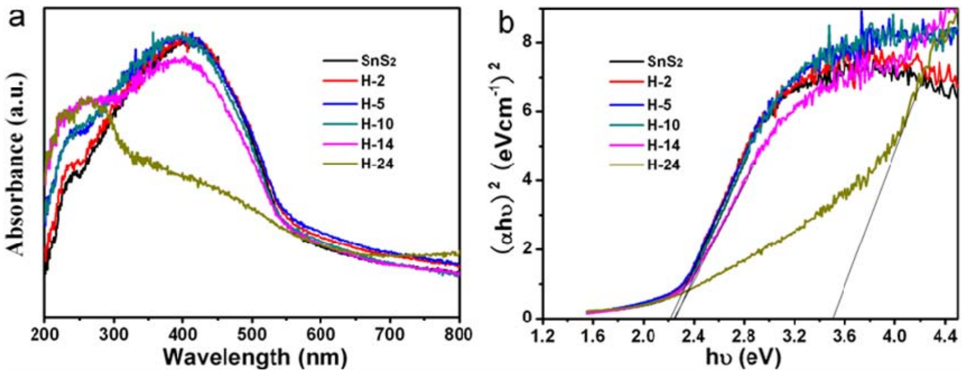


Fig. S2 (a) UV-vis DRS spectra, and (b) plots of $(\alpha h\upsilon)^2$ against $(h\upsilon)$ of the as-prepared pure SnS_2 NPs and SnS_2/SnO_2 HNPs.

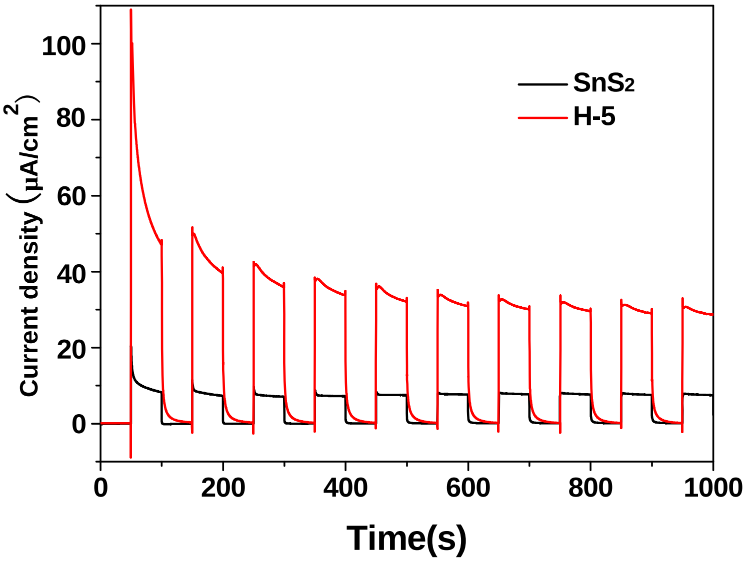
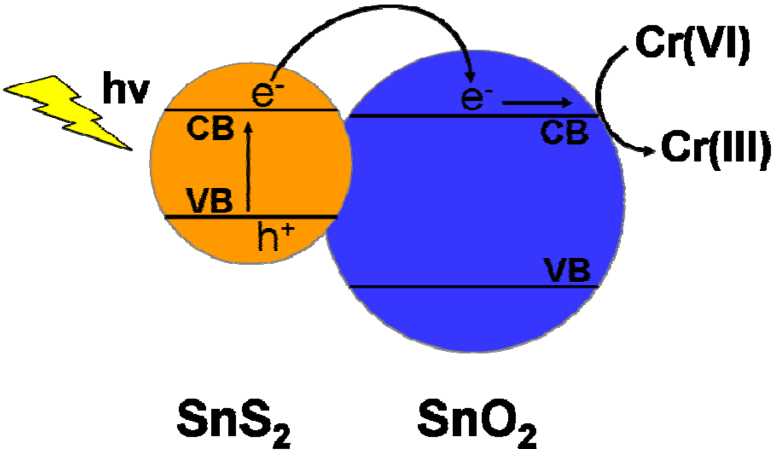


Fig. S3. Photocurrent response of the as-prepared pure SnS_2 nanoplates and SnS_2/SnO_2 heterostructured nanoplates (sample H-5) under visible-light illumination.



Scheme S1. Schematic diagram representing the charge-transfer process in the SnS_2/SnO_2 HNPs.

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