Supporting Information

3D porous ZnO-SnS p-n heterojunction for visible light driven photocatalysis

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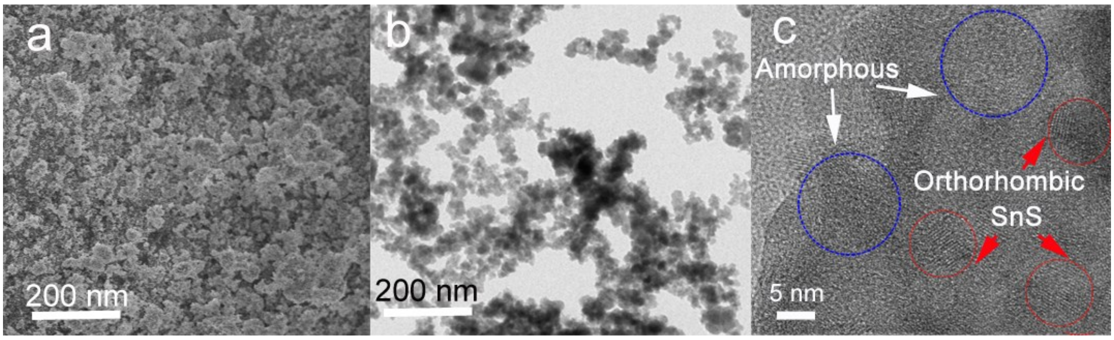

Fig. S1. (a) SEM, (b) TEM and (c) HRTEM images of SnS.

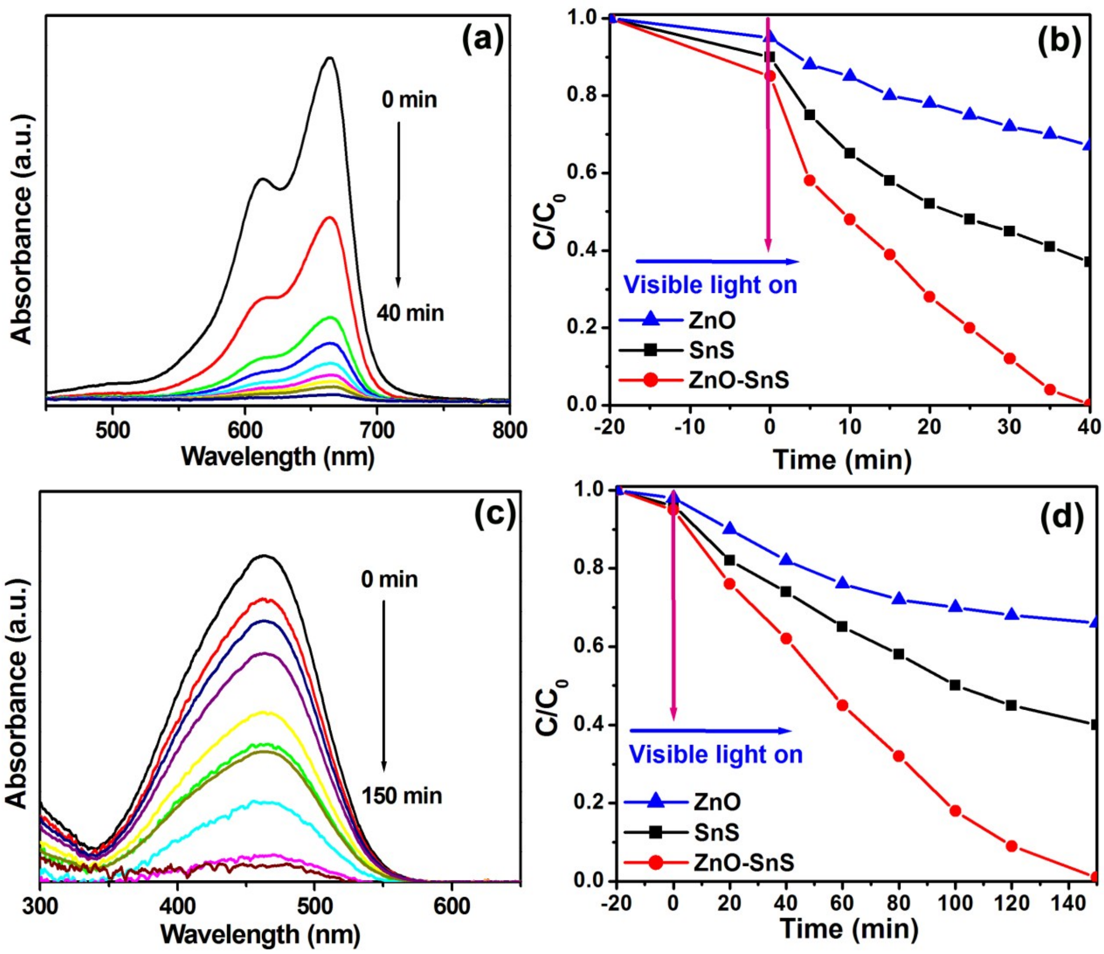

Fig. S2. Absorption curves of (a) MB solution and (c) MO solution, photocatalytic degradation curves of (b) MB solution and (d) MO solution with 3D porous ZnO-SnS heterojunction as catalyst under visible light, confirming its higher photocatalytic activity for cationic dye. (wavelength of incident light: λ > 420 nm, 10 mg of photocatalyst in 25 mL of 1 × 10^{-5} M MB/MO aqueous solution, and 300 W xenon lamp as the light source).

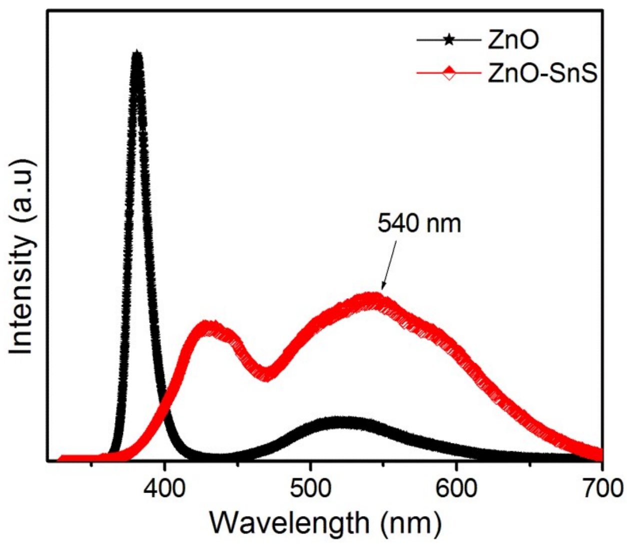

Fig. S3. PL spectra of ZnO and ZnO-SnS, indicating the existence of V_o in ZnO-SnS attributed to its green emission at 540 nm.

Table S1. The degradation efficiency of different conduct experiments under various conditions.

Conduct experiments	Feed ratios of ZnO, citric acid and SnS	Catalyst amount (mg)	Efficiency
1	8.0:2.0:1.0	2.5	90%
2	4.0:2.0:1.0	5	90%
3	4.0:1.0:2.0	5	95%
4	4.0:1.0:1.0	10	98%
5	2.0:1.0:1.0	10	96%
6	1.0:1.0:1.0	10	85%

Table S2. The efficiency and rate constants of different catalysts for the degradation of RhB under visible light.

Photocatalyst	Efficiency	Degradation constant (k/min^{-1})
ZnO	10%	$2 \pm (0.13) \times 10^{-3}$
flower like ZnO	22%	$5 \pm (0.13) \times 10^{-3}$
SnS	68%	$2 \pm (0.15) \times 10^{-2}$
3D porous ZnO-SnS	98%	$5 \pm (0.20) \times 10^{-2}$

Table S3. Comparison of photocatalytic degradation performance in other references with this work.

Catalyst used and amount	Concentration and volume of pullutant	Visible light source	Degradation time (min)	Application and efficiency	Prepare method	References
3D porous ZnO-SnS (10 mg)	RhB 25 mL (10^{-5} M)	300 W Xe light	80	98%	Solution method	This work
Porous ZnO/SnS heterojunction (200 mg)	Ciprofloxacin 300 mL (40 mg L^{-1})	200 W quartz tungsten-halogen lamp	360	80%	Microwave assisted	1
Sn doped ZnO microspheres (100 mg)	MB 50 mL (10 mg L^{-1})	300 W Xe lamp	100	98%	Precursor method	2
SnS (20 mg)	RhB 100 mL (8 mg L^{-1})	500 W Xe lamp	180	100%	Template-free polyol refluxing process	3
Hierarchical SnS nanostructures (20 mg)	RhB 100 mL (8 mg L^{-1})	500 W Xe lamp	180	55%	Polyol refluxing process	4
SnS nanorods (45 mg)	Trypan blue 50 mL (10^{-5} M)	Sunlight	240	95%	One pot method	5
SnS nanocrystal (2mg)	MB 2 mL (0.008 mg L^{-1})	300 W Xe lamp AM1.5G solar simulator	25	100%	Solution method	6
ZnO/In_2S_3 core/shell nanorod (20 mg)	RhB 80 mL (10^{-5} M)	500 W Xe lamp	100	85%	Surface functionalization	7

Catalyst used and amount	Concentration and volume of pullutant	Visible light source	Degradation time (min)	Application and efficiency	Prepare method	References
Au-ZnO heteronanostr-uctures (Si substrates of area 0.5 cm^2)	RhB 10 mL (5×10^{-6} M)	100 W bulb	180	99%	Flame spray pyrolysis process	8
ZnO/CdS (20 mg)	RhB 80 mL (10^{-5} M)	Simulated solar radiation	100	100%	Surface functionalization route	9
ZnO/ZnS core-shell nanostructures (50 mg)	RhB 100 mL (3 mg L^{-1})	500 W Xe lamp	25	90%	Microwave-assisted rapid route	10
SnS nanoparticles (70 mg)	MB 50 mL (1.4 g L^{-1})	45 W high-pressure Hg lamp	45	50%	Sonochemical route	11
TiO_2/SnS combined powders (50 mg)	Methyl orange 100 mL (5×10^{-6} M)	LED light	300	100%	Sol-gel method	12
Bi_2WO_6/SnS heterostructures (80 mg)	RhB 80 mL (1.0×10^{-5} M)	500 W Xe lamp	90	85%	Precipitation method	13
ZnS/SnS/A-FA nanorods (10 mg)	Congo red 50 mL (12 ppm)	UV light	150	100%	Wet chemical method	14
ZnS/SnS/Ag_2S (10 mg)	Congo red 50 mL (12 ppm)	Direct sunlight illumination	100	100%	Wet chemical method	15

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