Visible light responsive Fe-ZnS/Nickel foam photocatalyst with enhanced photocatalytic activity and stability

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S1. Preparation of Fe-doped ZnS decorated on nickel foam

S1.1. Fe-doped ZnS

Fe-doped ZnS catalyst was synthesized under microwave irradiation following the same method published in our previous work.[1] The chemical composition of the catalyst determined with ICP-MS and IC was $Zn_{0.9\pm0.08}Fe_{0.1\pm0.02}S$. Briefly, 50 mL zinc acetate (0.009 mol·L^{-1}), 50 mL ferric nitrate (0.001 mol·L^{-1}) and 50 mL sodium sulfide (0.01 mol·L^{-1}) were mixed into a 250 mL round flask, with pH adjusted to the appropriately (5.0). Then, the mixed solution was transferred into a microwave oven immediately and microwaved for 10 min under the power of 150 W with magnetic stirring. When the reaction was finished, the mixed solution was placed at room temperature for cooling. Afterwards, the mixture was centrifuged at 4,000 rpm for 10 min, and then the supernatant was discarded. The precipitate was washed by ethanol and distilled water for two times, respectively. Finally, the resulting solid was dried in vacuum oven at 60 °C for 5 h, and ground into powders for storage.

S1.2. Fe-doped ZnS decorated on nickel foam

The hybridization of ZnFeS and nickel foam was achieved using a coupling method because of its low cost and controllability. A large sheet of raw porous nickel foam with a thickness of 3 mm was cut into small rectangular pieces of 15 mm× 30 mm. The photo of the raw nickel foam was shown in Figure S1.

Step one (pretreatment of nickel foam): the nickel foam was washed with soap and clean water with ultrasound for 3 min, respectively. Then the foam was separately soaked in 10% sodium hydroxide and hot water for 10 s. Finally, the foam was put in boiling water for 3 min for disinfecting, and placed at room temperature for 12 h.

Step two (preparation of silane solution): 85 mL deionized water was taken into a 100 mL beaker, and mixed with 5 mL Bis-(3-[triethoxysilyl]-propyl)-tetrasulfide. After appropriate treatment, lower aqueous phase solution was spared.

Step three (decorating ZnFeS catalyst onto nickel foam): a certain amount of ZnFeS particles were added in the silane solution and ultrasonic dispersed for 10 min.

The pretreated nickel foam was soaked into the suspension for 20 min, dried with nitrogen after taken out, and solidified at 100 °C for 1 h.

Fig. S1 Photo of the raw nickel foam.

S2. The loading amount of ZnFeS/nickel foam

The elemental distribution of the hybrid catalyst was performed using both Ion Chromatography (IC) on a Dionex AS50 and inductively coupled plasma mass spectrometry (ICP-MS) on a Perkin Elmer Optima NexIon^{TM} 300D. For the elemental distribution, 50 mg of the powder catalyst were digested by adding 2 mL HNO_3 (67–70%, V/V) and 1 mL H_2O_2 (30 wt% in H_2O). Then the suspension was heated on a hotplate at 150 °C for 20 min with a watch glass covering the beaker. The metal concentrations were measured three times to confirm the significance.

The loading amount (w%) was calculated by gravimetry through following equation:

$$w = \frac{m_1}{m_1 + m_0} \times 100\% \quad (1)$$

where m_1 and m_0 are the weights of ZnFeS and nickel foam, respectively.

In application of nickel foam as the catalyst substrate, the loading amount of ZnFeS/nickel foam reached 2.2 wt% by a combination of microwave irradiation synthesis and coupling method.

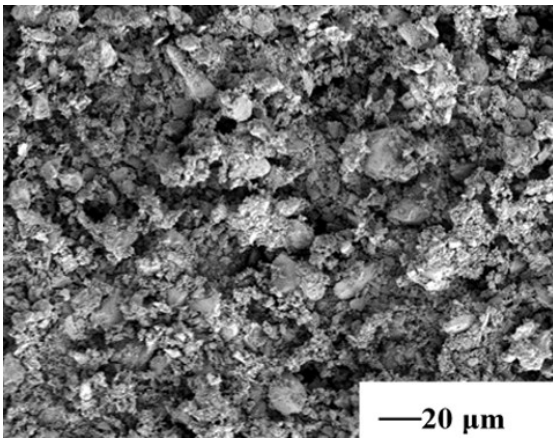

Fig. S2 SEM images of ZnFeS catalysts (20 μm).

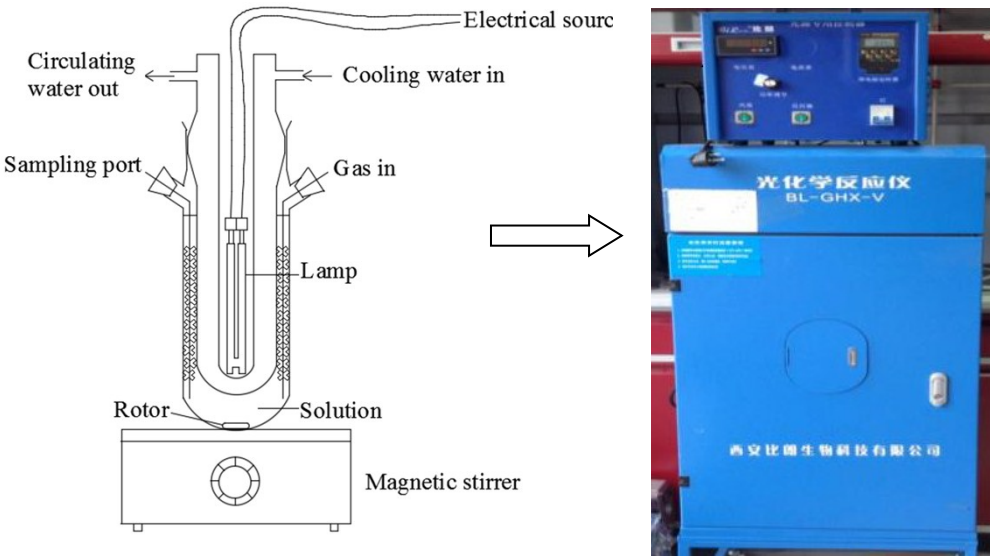

Fig. S3 Schematic diagram of experimental setup.

Notes and references

1 G. S. Zhang, Y. N. Xue, R. Su, Q. Wang, W. Zhang, Y. Yuan and P. Wang, *Journal of Photochemistry and Photobiology A: Chemistry*, 2016, doi:10.1016/j.jphotochem.2016.1006.1004.