Enhanced visible photocatalytic activity of $BiVO_4$@β-$AgVO_3$ composite synthesized by an in-situ growth method

Yanmei Yang,[a] Yuanyuan Liu,*[a] Baibiao Huang,*[a] Rui Zhang,[b] Ying Dai,[b] Xiaoyan Qin[a] and Xiaoyang Zhang[a]

[a] State key lab of crystal materials, Shandong university, Jinan, China, 250100.
Email: bbhuang@sdu.edu.cn（Baibiao Huang）, yyliu@sdu.edu.cn （Yuanyuan Liu）
[b] School of physics, Shandong university, Jinan, China, 250100.

Experimental section

Materials

$AgNO_3$, NH_4VO_3, $Bi(NO_3)_3 \cdot 5H_2O$ and $NH_3 \cdot H_2O$ (25-28%) were analytical reagent grade and used as received without further purification.

Synthesis of β-$AgVO_3$ nanowires, $BiVO_4$@β-$AgVO_3$ composites and $BiVO_4$

1. Synthesis of β-$AgVO_3$ nanowires

1mmol NH_4VO_3 was dissolved in 60 mL deionized water under stirring to obtain a transparent solution. Then, 1mmol $AgNO_3$ was added into the above solution and stirred for 2min. The pH value of the solution was adjusted to 8-8.2 by using $NH_3 \cdot H_2O$ (25-28%) and the mixture was transferred into a 100 mL Teflon-lined stainless vessel and heated at 180 ^oC for 12h. The brown β-$AgVO_3$ nanowires were washed several times with deionized water and ethanol, dried in an oven at 60^oC for 6h.

2. Synthesis of $BiVO_4$@β-$AgVO_3$ composites

0.2g as-prepared β-$AgVO_3$ nanowires were dispersed in 75 mL deionized water. Then, a certain amount of $Bi(NO_3)_3 \cdot 5H_2O$ was added under stirring and ultrasonication to obtain an uniform mixture which was transferred into a 100 mL Teflon-lined stainless vessel and heated at 160 ^oC for 12h. The final samples were washed several times with deionized water and ethanol, and dried in an oven at 60 ^oC for 6h. $BiVO_4$@β-$AgVO_3$ composites with different molar amounts of $BiVO_4$ were obtained: 5%, 10%, 15%, 20%, and the samples prepared were denoted as $BiVO_4$@β-$AgVO_3$-5%, $BiVO_4$@β-$AgVO_3$-10%, $BiVO_4$@β-$AgVO_3$-15%, $BiVO_4$@β-$AgVO_3$-20%, respectively.

3. Synthesis of $BiVO_4$

For comparison, $BiVO_4$ was prepared using equimolar NH_4VO_3 and $Bi(NO_3)_3 \cdot 5H_2O$ through the above process, and the other conditions are the same as that in 2.

Characterization

XRD patterns of the as-prepared samples were recorded on an X-ray diffractometer (XRD Bruker D8-advanced X-ray powder diffractometer with Cu-Ka radiation λ=1.5418 A˚). The morphology and microstructure were determined by scanning electron microscopy (SEM Hitachi S-4800 microscope) and high-resolution transmission electron microscopy (HR-TEM JEOL JEM-2100 instrument). The diffuse reflectance spectra (DRS) were measured using a UV/visible

spectrophotometer (UV-2550, Shimadzu). The Brunauer–Emmett–Teller (BET) surface areas were measured with a Micromeritics ASAP 2020 apparatus at liquid nitrogen temperature. The TOC (total organic carbon) before and after photocatalysis by $BiVO_4$@β-$AgVO_3$-15% was evaluated by TOC-V CPH (Shimadzu).

Photocatalytic evalution

Photocatalytic activies of β-$AgVO_3$, $BiVO_4$ and $BiVO_4$@β-$AgVO_3$ composites were evaluated by the degradation of rhodamine B (RhB) under visible light irradiation of a 300 W Xe arc lamp (PLS-SXE300, Beijing Trusttech Co. Ltd.) with UV cutoff filter (providing visible light with $\lambda >$ 420 nm). Typically, RhB is a potentially toxic and carcinogenic pollutant and extensively used to characterize the photocatalytic activities of materials in photocatalysis research. In a typical process, 0.1g of as-prepared samples were added to 100 mL RhB solution (10mg·L^{-1}). After being dispersed in an ultrasonic bath, the mixture was kept under stirring for 1 h in the dark to reach adsorption equilibrium and exposed to the visible light irradiation. 5 mL solution was taken out from the reaction beaker at given time intervals and centrifuged to remove the suspension. Then the RhB degradation concentration was measured by a Shimadzu UV2550 recording spectrophotometer.

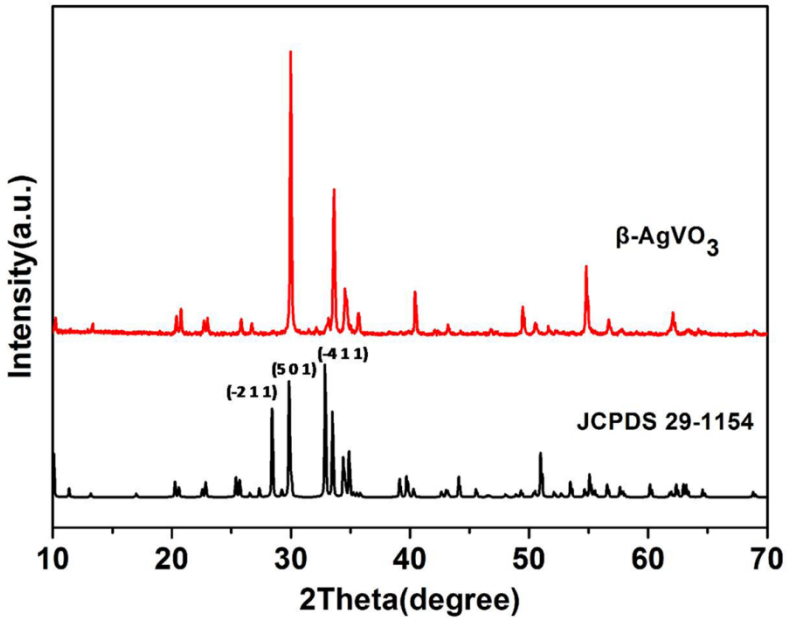

Fig. S1 XRD patterns of as-prepared β-$AgVO_3$

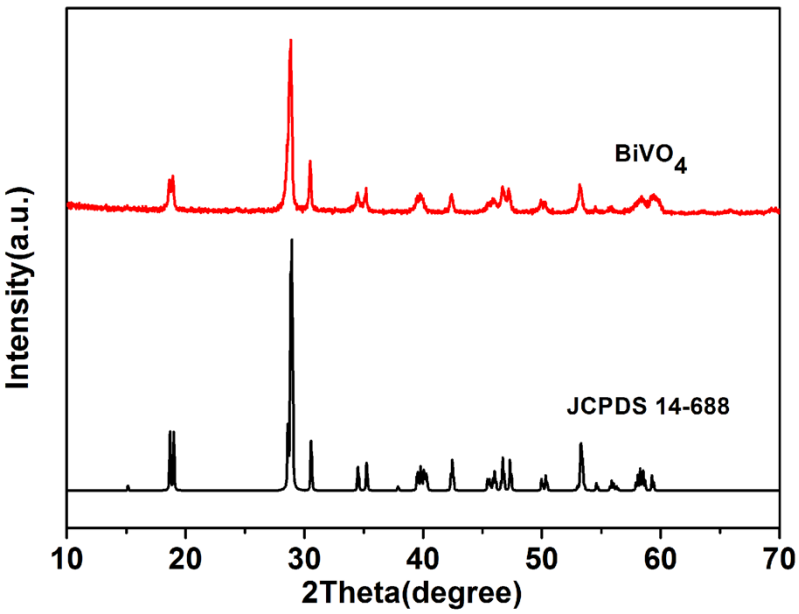

Fig. S2 XRD patterns of as-prepared $BiVO_4$

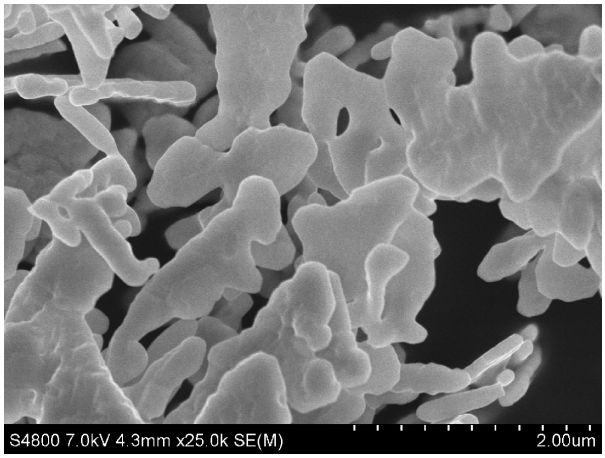

Fig. S3 SEM image of $BiVO_4$