Supplementary Information

Quantum-sized $BiVO_4$ Modified TiO_2 Microflower Composite Heterostructure: Efficient Production of Hydroxyl Radicals towards Visible Light-Driven Degradation of Gaseous Toluene

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Synthesis of $BiVO_4$ Nanoparticle All of the chemical reagents were of analytical grade and used without further purification. $BiVO_4$ Nanoparticle was prepared according to the previously reported method.[1] In a typical synthesis, 5 mmol $Bi(NO_3)_3 \cdot 5H_2O$ and 5 mmol NH_4VO_3 were added to 90 mL distilled water. Subsequently, 1 g polyethylene glycol 20000, as surfactant, was added into the above solution. The pH value of the suspension was adjusted to about 7 by dilute ammonia. Then the mixture was stirred for 1 h at room temperature and then exposed to high-intensity ultrasonic irradiation at room temperature for about 30 min. The yellow precipitates were collected, washed with de-ionized water and absolute ethanol repeatedly, and then dried at 60 °C for overnight. The final obtained powders were calcined at 450 °C for 2 h at a ramp rate of 1 °C/min.

Synthesis of Nano-$BiVO_4/TiO_2$ Composite 15 mg $BiVO_4$ nanoparticle, 200 mg TiO_2 microflower and 60 mL cyclohexane were added into a 100 mL beaker and the mixture was sonicated for about 30 min. The dispersion was vigorously stirred for about 2 h at room temperature, and then stirred at 80 °C in an oil bath pot to evaporate the cyclohexane. Finally, the prepared product was collected for further characterization.

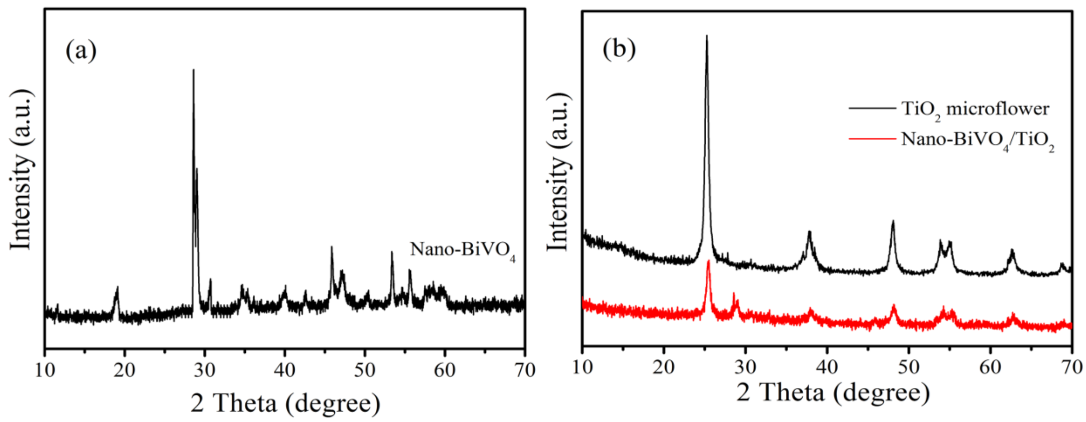

Figure S1 XRD patterns of the $BiVO_4$ nanoparticle (a), TiO_2 microflower and nano-$BiVO_4/TiO_2$ composite (b).

Figure S1 displays the XRD patterns of the $BiVO_4$ nanoparticle and nano-$BiVO_4/TiO_2$ composites. In Figure S1a, the XRD pattern of highly crystalline $BiVO_4$ matches well with pure monoclinic $BiVO_4$ (JCPDS No. 14-0688). From Figure S1b, it can be seen that there is diffraction peak at 2θ about 28.94° of $BiVO_4$ in the nano-$BiVO_4/TiO_2$ composites, which indicates that $BiVO_4$ nanoparticle combines successfully with TiO_2 microflower.

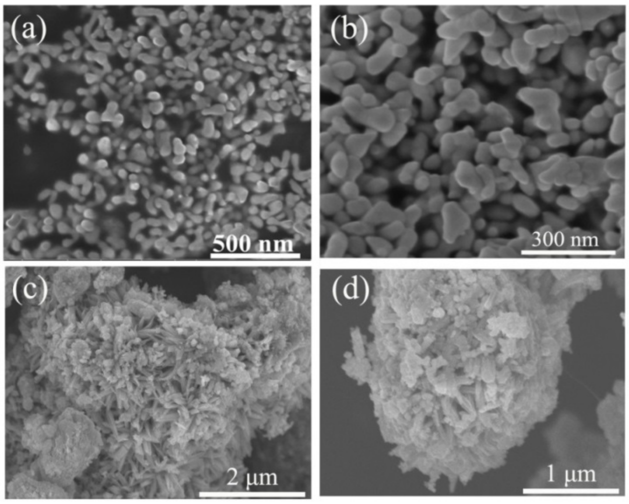

Figure S2. Typical SEM images of the as-prepared $BiVO_4$ nanoparticle (a, b) and nano-$BiVO_4/TiO_2$ composite (c, d).

Figure S2 displays the scanning electron microscopy (SEM) images of the $BiVO_4$ nanoparticle and nano-$BiVO_4/TiO_2$ composite. As shown in Figure S2 (a, b) the as-prepared $BiVO_4$ nanoparticle has an average size of 100 nm. The typical SEM images of the resultant nano-$BiVO_4/TiO_2$ composite are displayed in Figure S2 (c, d). It can be seen that the $BiVO_4$ nanoparticle has been uniformly deposited onto the surfaces of TiO_2 microflower.

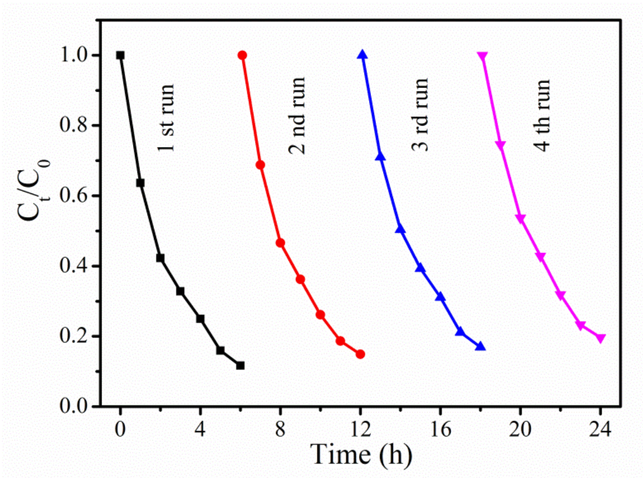

Figure S3. Cycle runs of Q-$BiVO_4/TiO_2$ composite for degradation of toluene under visible-light irradiation ($\lambda > 400$ nm).

Recyclability of Q-$BiVO_4/TiO_2$ composite. For evaluating the photochemical stability and durability of the Q-$BiVO_4/TiO_2$ composite, the additional experiments have been carried out to degrade toluene under visible light cycled for four times. After each run, the photocatalysts was collected and washed by absolute ethanol repeatedly. Afterward, the photocatalysts were dried in vacuum at 60 °C for 6 h and for the next recycle reaction. As shown in Figure S3, there is no distinct activity decay after four recycling runs, which indicates that Q-$BiVO_4$/TiO_2 composite has high stability in the photocatalytic process under visible-light irradiation.

Reference

1 M. Shang, W. Wang, L. Zhou, S. Sun and W. Yin, *Journal of Hazardous Materials*, 2009, **172**, 338–344.