Supporting Information

Boosting photocatalytic performance of (001) BiOI: enhance donor density and separation efficiency of the photogenerated electrons and holes

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EXPERIMENTAL SECTION

1. *Preparation of BiOI nanosheets*

$Bi(NO_3)_3$ (1 mmol) and KI (3 mmol) were dissolved in deionized water (15 mL) with continuous stirring at room temperature. After all of them were dissolved in water, NaOH (2 M) was dropped to adjust the pH at 6.0. Then the solution was poured into the Teflon-lined stainless autoclave (20 mL). The autoclave was put into the oven and heated to 160 °C for 2 h. Until the oven cool to the room temperature, the precipitates in autoclave were centrifuged and washed with water several times. The precipitates were dried at 60 °C overnight and the BiOI nanosheets were obtained. To obtain the R-BiOI nanosheets, 0.3 g BiOI nanosheets were dissolved in the 100 mL isopropanol and then ultrasound with differernt times (5, 10, 15, 20 h) at room temperature. The samples were heated at 300 °C for 1 h.

2. *Characterization*

The structural information of samples was carried out with the X-ray diffraction (XRD) measurements (a Broker's D8 ADVANCE powder X-ray diffractometer with

Cu K radiation (λ = 1.5418 Å)), X-ray photoelectron spectroscopy (XPS) measurements (ESCALab250 XPS system with Al K_α source and a charge neutralizer), Raman spectroscopy (Nicolet NXR 9650), and FT-IR measurement (Nicolet/Nexus 670). The morphology was studied by the field-emission SEM (JSM-6330F) and TEM (JEM2010-HR, 200 KV). The electron spin resonance measurement was performed in the X-band (9.45 GHz) with 5.00-G modulation amplitude and a magnetic field modulation of 100 kHz using a Bruker, A300–10–12 Bruker ESR spectrometer at 77 K. Absorption spectra of the samples were measured with a UV-Vis-NIR spectrophotometer (UV-Vis-NIR, Shimadzu UV-2450). Photoluminescence (PL) spectra were studied by a spectrometer (FLS920, EDINBURGH) with a 400 nm excitation wavelength. Photoelectrochemical measurements were studied by a three-electrode quartz cell. 0.1 M Na_2SO_4 solution (pH=7.0) was used as the electrolyte. The BiOI sample was used as the working electrode. The counter and reference electrode were Pt electrode and Ag/AgCl electrode, respectively. 300 W Xe arc lamp (PLS-SXE-300/300UV, Beijing Trusttech Co. Ltd.) was used as the illumination source. CHI 760D electrochemical workstation (CHI, Shanghai) was used to record the current densities.

3. *Photocatalytic activity test*

The photocatalytic activity of samples (0.1 g) was evaluated by removing HCHO at 500 ppm in a closed reactor (30 cm × 15 cm × 10 cm), which was made of polymeric glass and covered with Saint-Glass. A tungsten halogen lamp (100 W) with a UV cut of filter (420 nm) was used as the illumination source. It was vertically placed 20 cm above the reactor. The photo-catalytic reaction was kept at the temperature of 25 ^oC. The lamp was turned on after the adsorption−desorption equilibrium was achieved. An Agilent 7890A gas chromatograph with a TCD detector was used to analyze the products of the reaction. The HCHO conversion was calculated from the CO_2 content as follows:

$$HCHO\ conversion\ (\%) = [CO_2]_{out}/[HCHO]_{in} \times 100$$

$[CO_2]_{out}$ and $[HCHO]_{in}$ in the formula are the CO_2 concentration in the products and the HCHO concentration in the reactor, respectively.

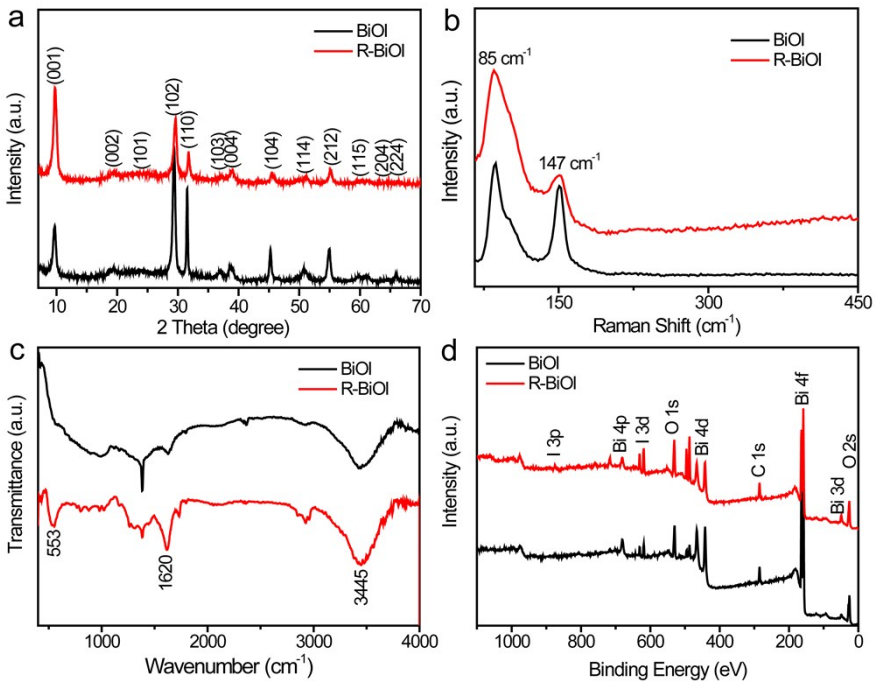


Fig. S1 Characterization of the BiOI and R-BiOI nanosheets. (a) XRD profiles (b) Raman spectra (c) FT-IR spectra and (d) XPS survey spectra.

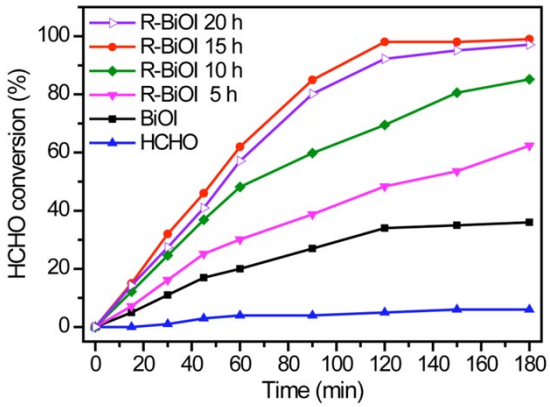


Fig.S2 Photocatalytic performance of BiOI and R-BiOI samples for degradation of HCHO under visible light irradiation.

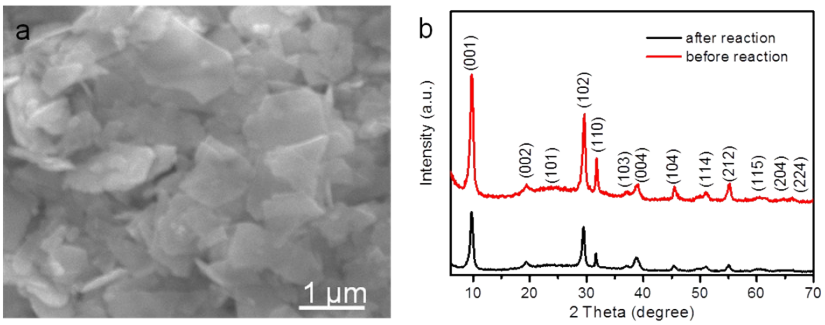


Fig. S3 (a) SEM image of R-BiOI nanosheets after 5cycles. (b) XRD of R-BiOI nanosheets before and after reaction.

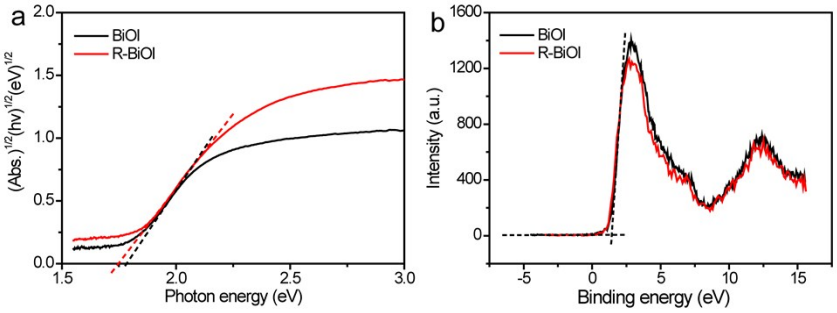
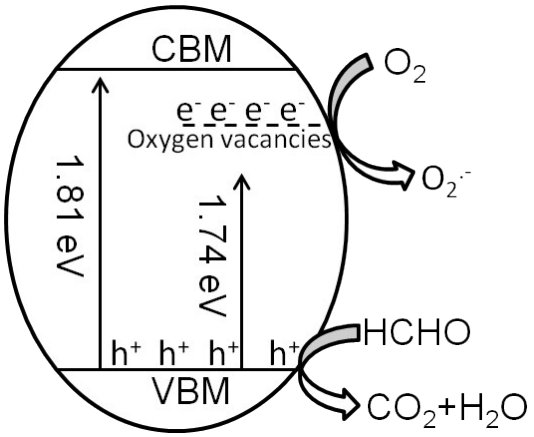


Fig. S4 (a) plots of the $(\alpha h\nu)^{1/2}$ vs photon energy ($h\nu$) and (b) Valence band comparison of BiOI and R-BiOI.



Scheme S1 Photocatalytic mechanism scheme of R-BiOI catalysts under visible light irradiation.