

# Synergistic Effect of Ag and Cu Codoping on the Structural, Optical and Photocatalytic Performance of BiVO<sub>4</sub>

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## Research Article

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# Abstract

In this work, Ag or/and Cu doped BiVO<sub>4</sub> samples has been prepared successfully via hydrothermal and photoreduction method. Ag/Cu co-doped BiVO<sub>4</sub> exhibited high photocatalytic degradation efficiency in the degradation of methylene blue (MB) and displayed a significantly superior property compared to pure BiVO<sub>4</sub>, as well as only Ag or Cu doped BiVO<sub>4</sub> upon exposure to visible light source. Interestingly, we found that enhanced photocatalytic activity of Ag/Cu co-doped BiVO<sub>4</sub> arises from the synergistic effect between the Ag and Cu co-doped BiVO<sub>4</sub> with smaller crystalline size, improved photocatalytic reaction sites, improved life-time and enhanced separation of photogenerated charge carriers which are confirmed using different characterization techniques. The degradation of MB was mainly indicated by superoxide radical species as confirmed by the trapping experiment. Based on the collective results obtained an excellent photocatalytic activity in Ag/Cu co-doped BiVO<sub>4</sub> has been confirmed.

# Full Text

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# Figures

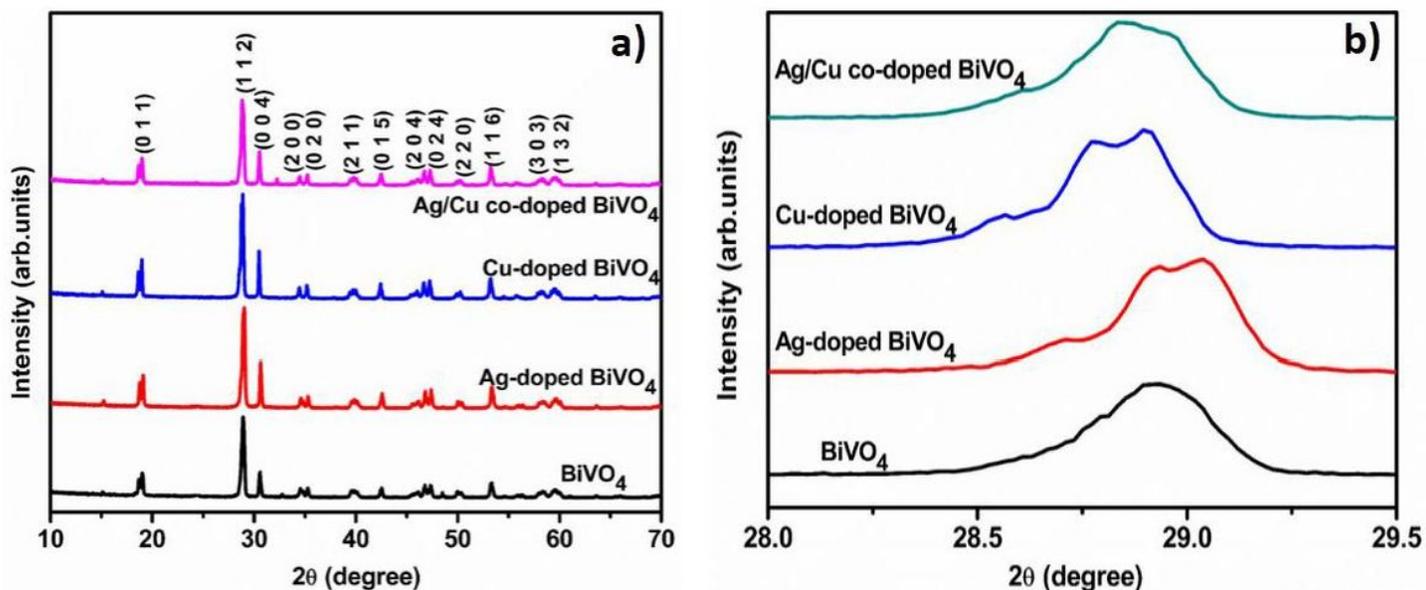
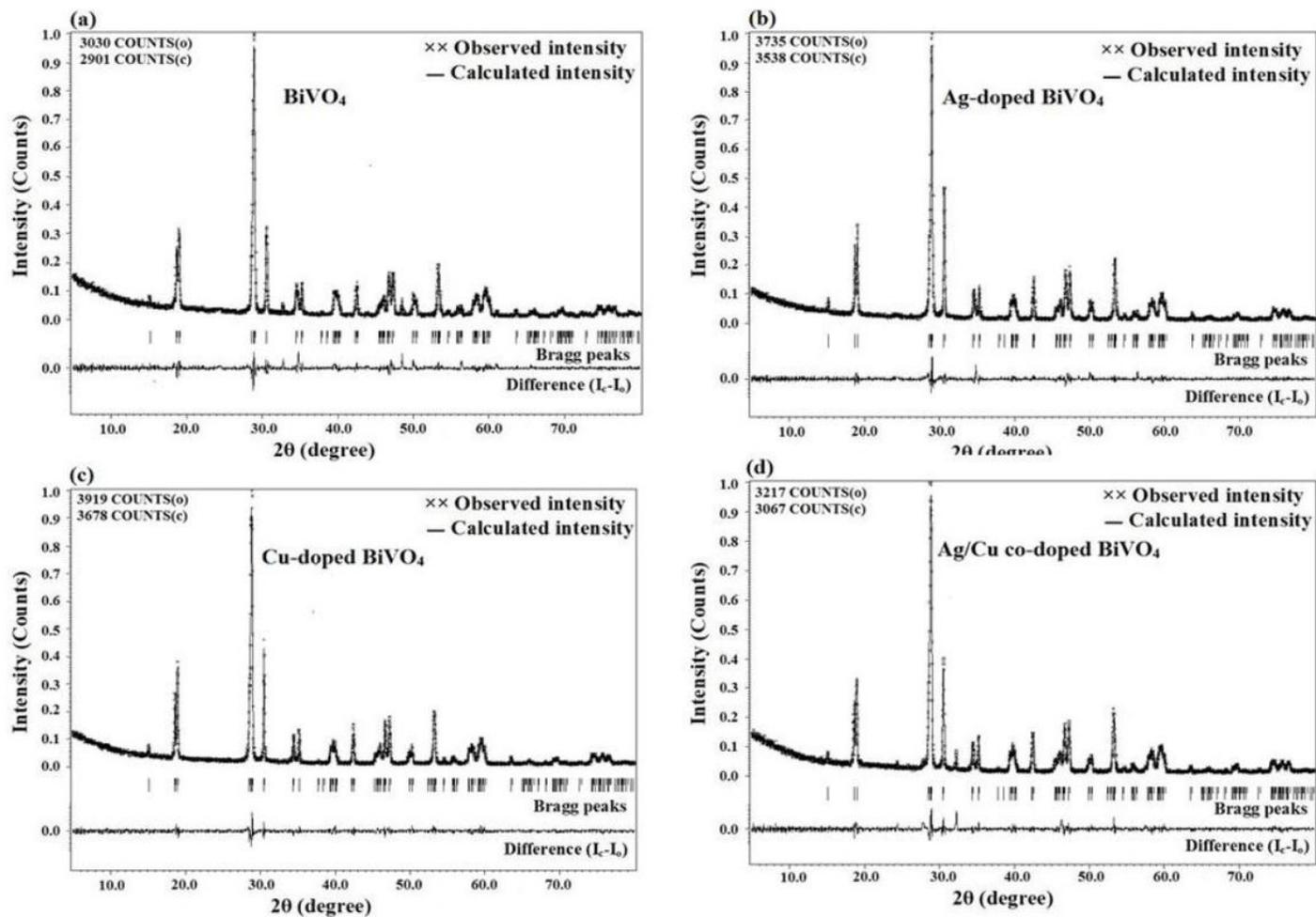


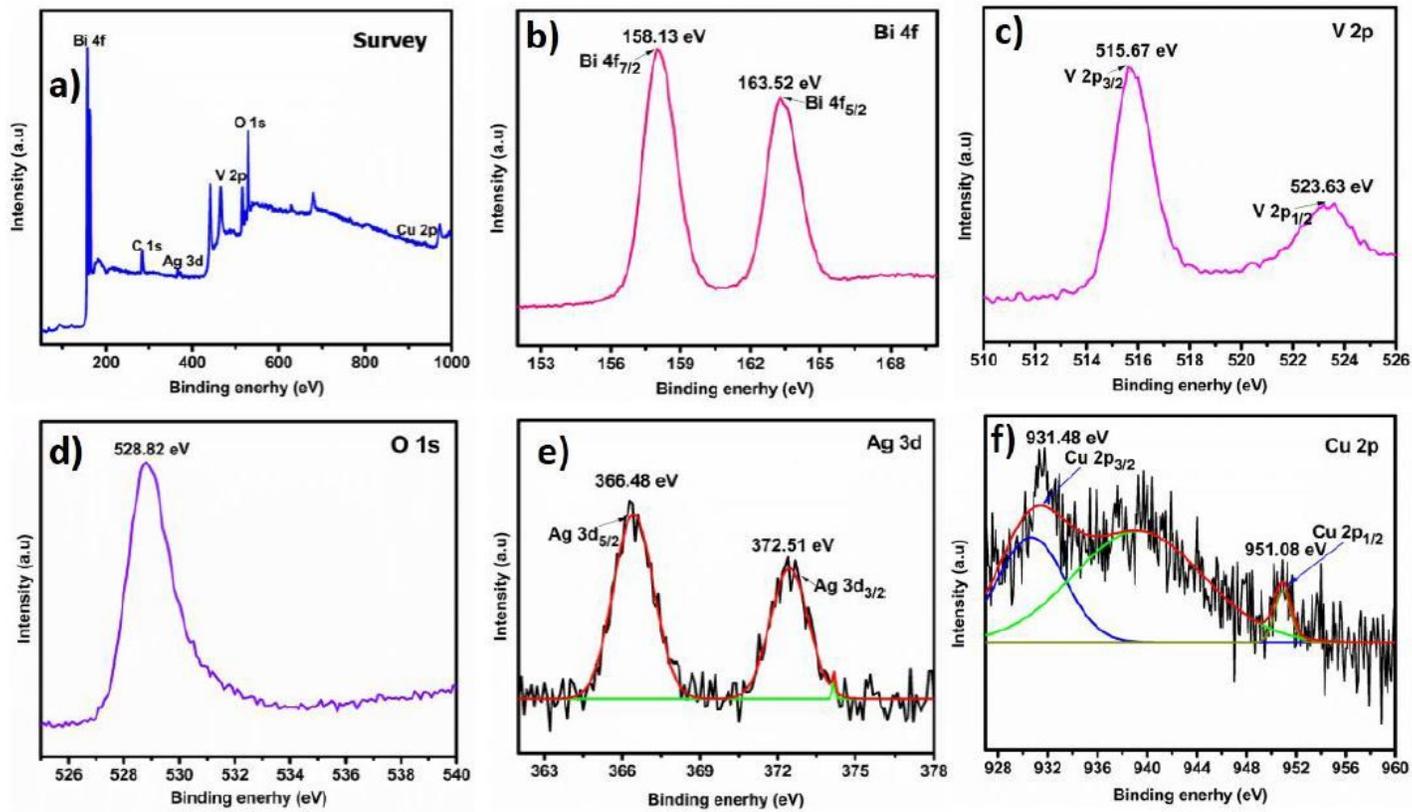
Figure 1

(a) XRD patterns and (b) Magnified peaks of (1 1 2) planes in the range of 2θ from 280 of BiVO<sub>4</sub>, Ag-doped BiVO<sub>4</sub>, Cu-doped BiVO<sub>4</sub> and Ag/Cu co-doped BiVO<sub>4</sub>.



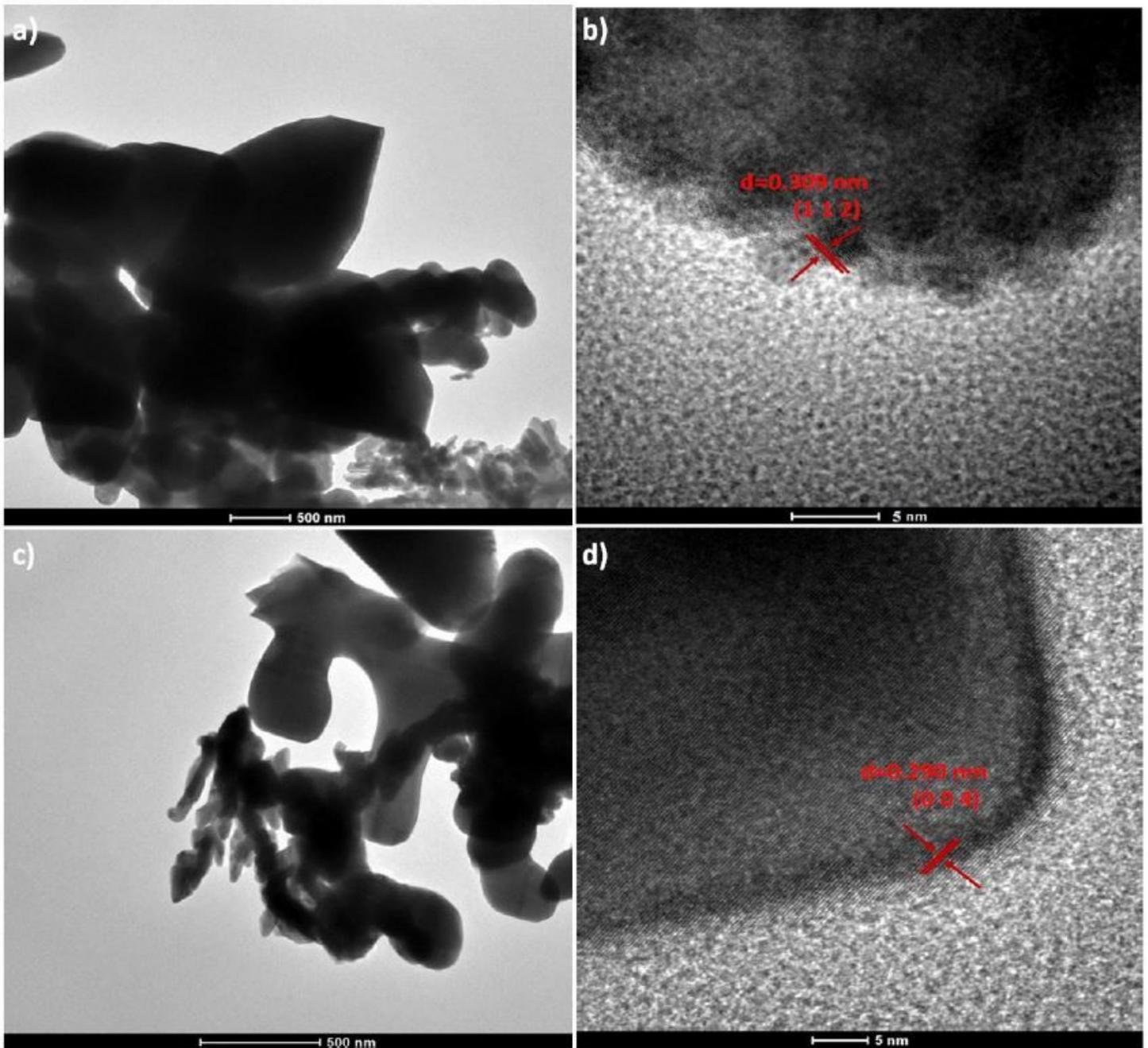
**Figure 2**

Rietveld refinement graphs of (a) BiVO<sub>4</sub>, (b) Ag-doped BiVO<sub>4</sub>, (c) Cu-doped BiVO<sub>4</sub> and (d) Ag/Cu co-doped BiVO<sub>4</sub>.



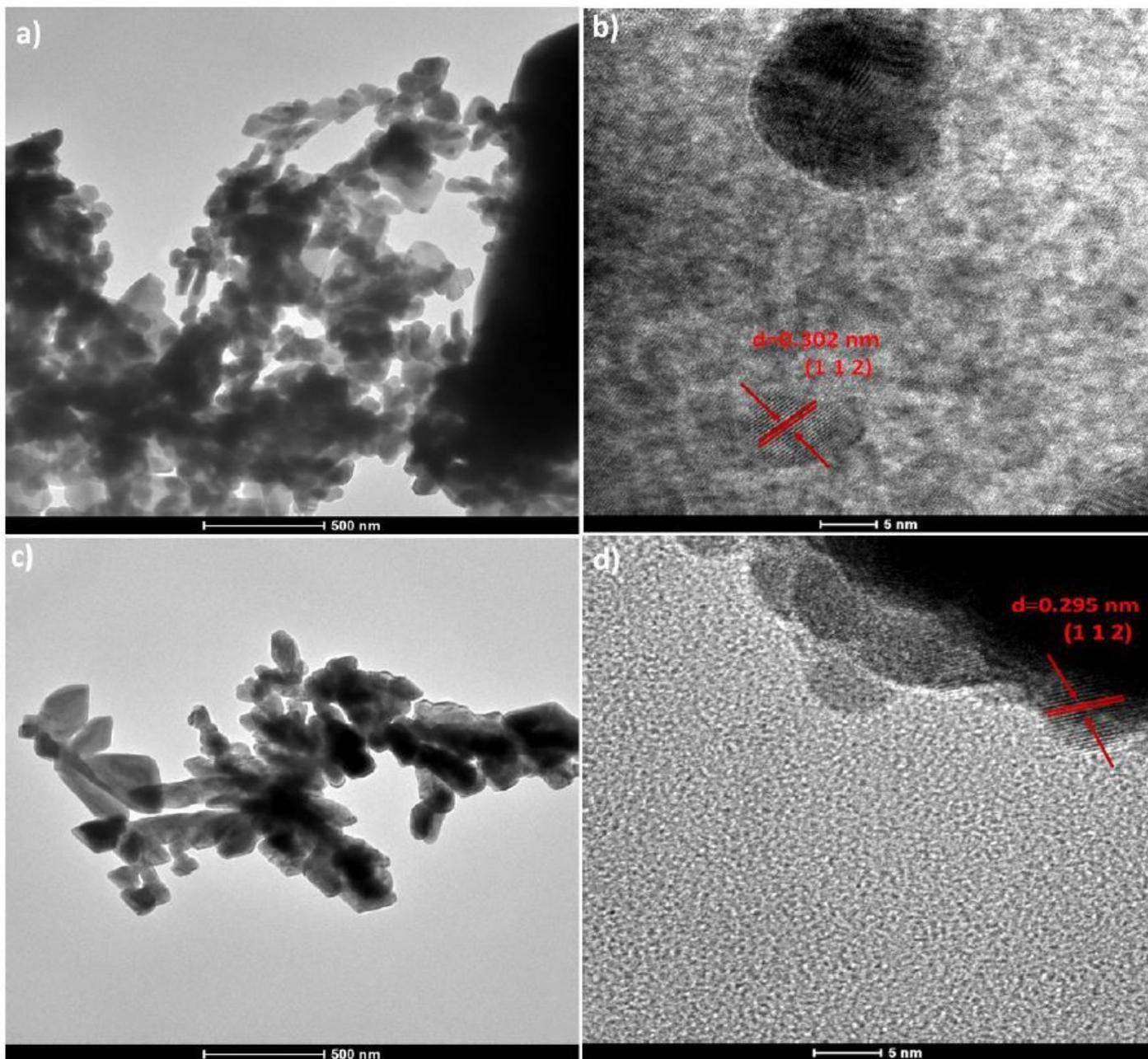
**Figure 3**

XPS spectra of the as prepared Ag/Cu co-doped BiVO<sub>4</sub> sample (a) Survey spectrum, (b) Bi 4f, (c) V 2p, (d) O 1s, (e) Ag 3d and (f) Cu 2p.



**Figure 4**

(a and b) TEM and HRTEM image of BiVO<sub>4</sub> and (c and d) TEM and HRTEM image of Ag/Cu co-doped BiVO<sub>4</sub>.



**Figure 5**

(a and b) TEM and HRTEM image of Ag-doped BiVO<sub>4</sub> and (c and d) TEM and HRTEM image of Cu-doped BiVO<sub>4</sub>.

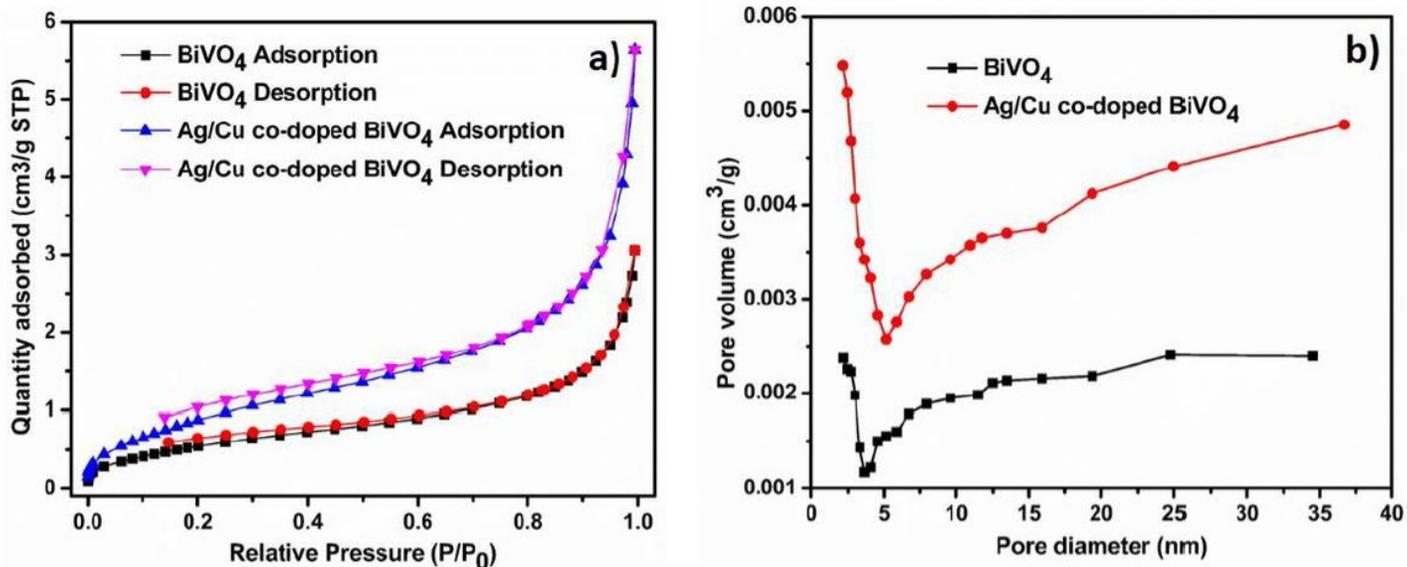


Figure 6

(a) Nitrogen adsorption isotherm curves of BiVO<sub>4</sub> and Ag/Cu co-doped BiVO<sub>4</sub> and (b) The corresponding pore size distribution calculated by the BJH method from the desorption branch of BiVO<sub>4</sub> and Ag/Cu co-doped BiVO<sub>4</sub>.

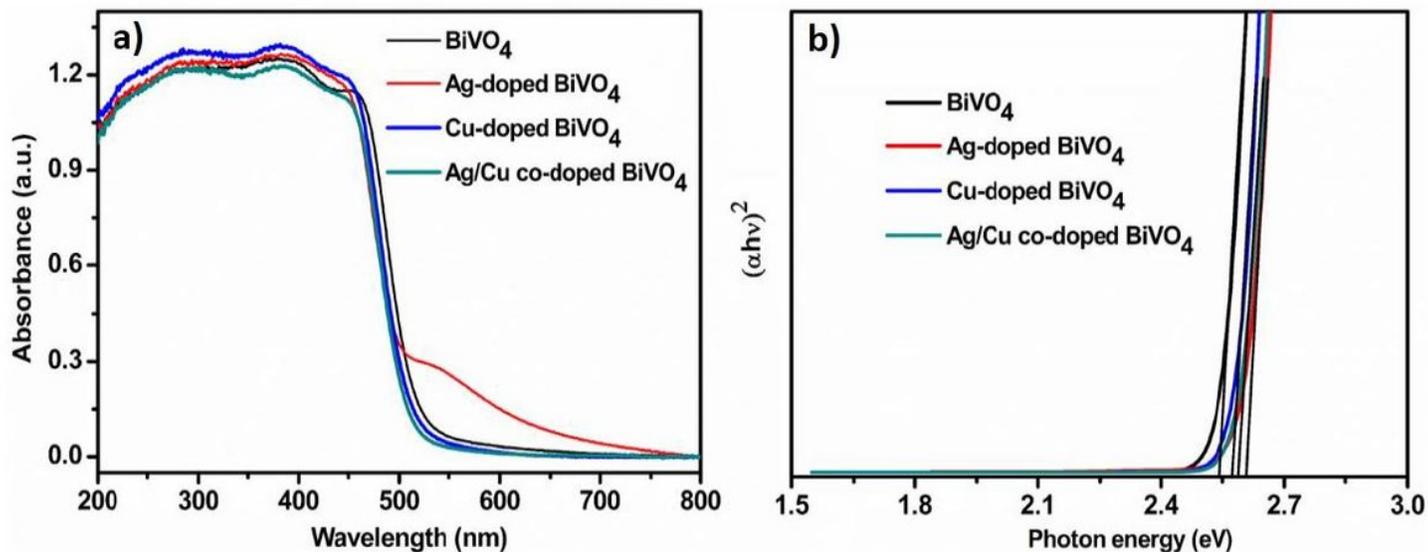


Figure 7

(a) UV-vis DRS spectra and (b) the plots of  $(\alpha h\nu)^2$  versus photon energy ( $h\nu$ ) for the band gap energies of BiVO<sub>4</sub>, Ag-doped BiVO<sub>4</sub>, Cu-doped BiVO<sub>4</sub> and Ag/Cu co-doped BiVO<sub>4</sub>.

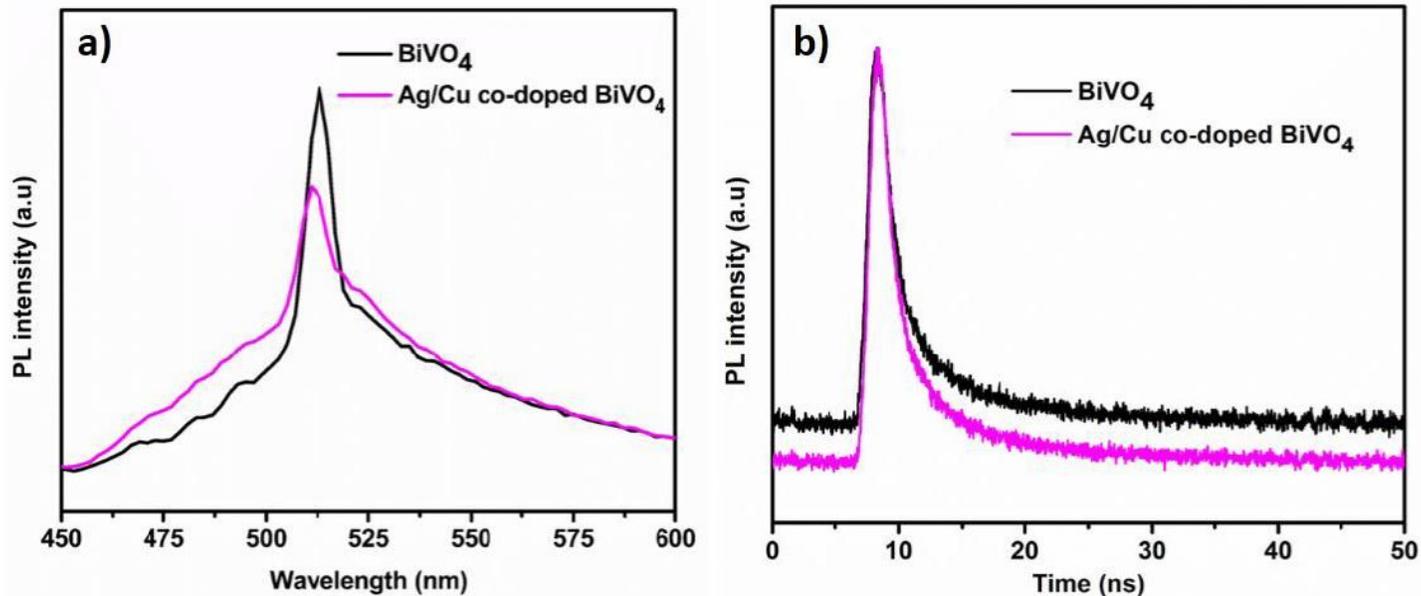


Figure 8

(a) The photoluminescence (PL) spectra and (b) The time resolved PL (TRPL) spectra of BiVO<sub>4</sub> and Ag/Cu co-doped BiVO<sub>4</sub>.

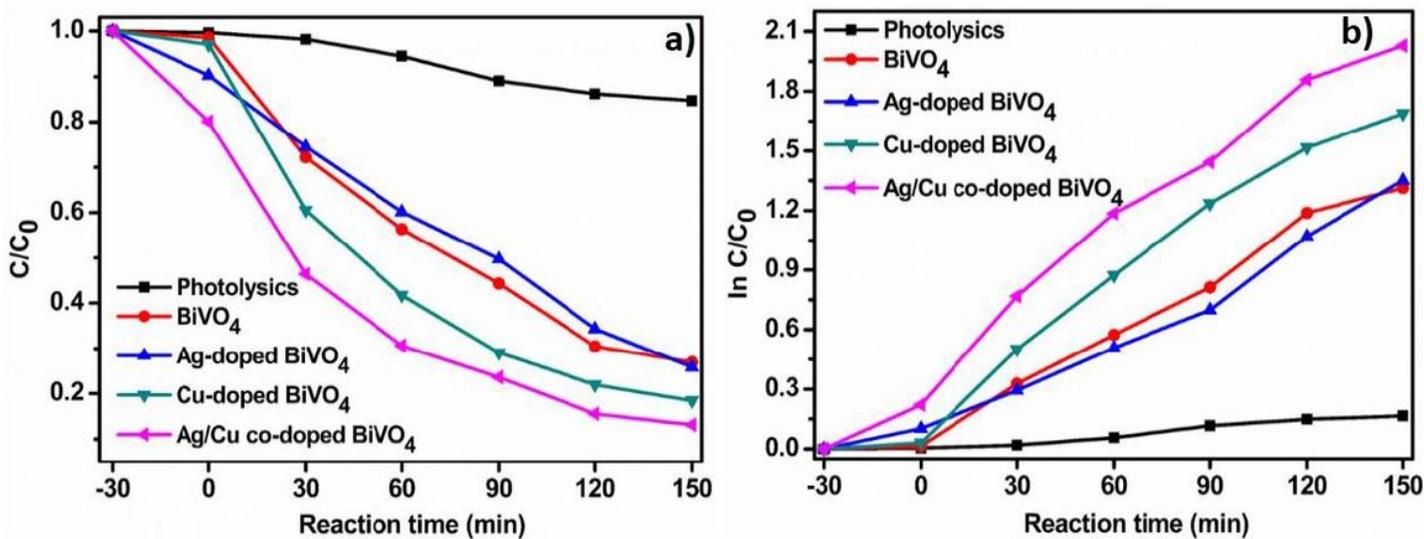


Figure 9

(a) Photocatalytic degradation curves of methylene blue (MB) under visible light irradiation and (b) pseudo-first order kinetic model fit of the photocatalytic degradation kinetic curves of methylene blue (MB) for BiVO<sub>4</sub>, Ag-doped BiVO<sub>4</sub>, Cu-doped BiVO<sub>4</sub> and Ag/Cu co-doped BiVO<sub>4</sub>.

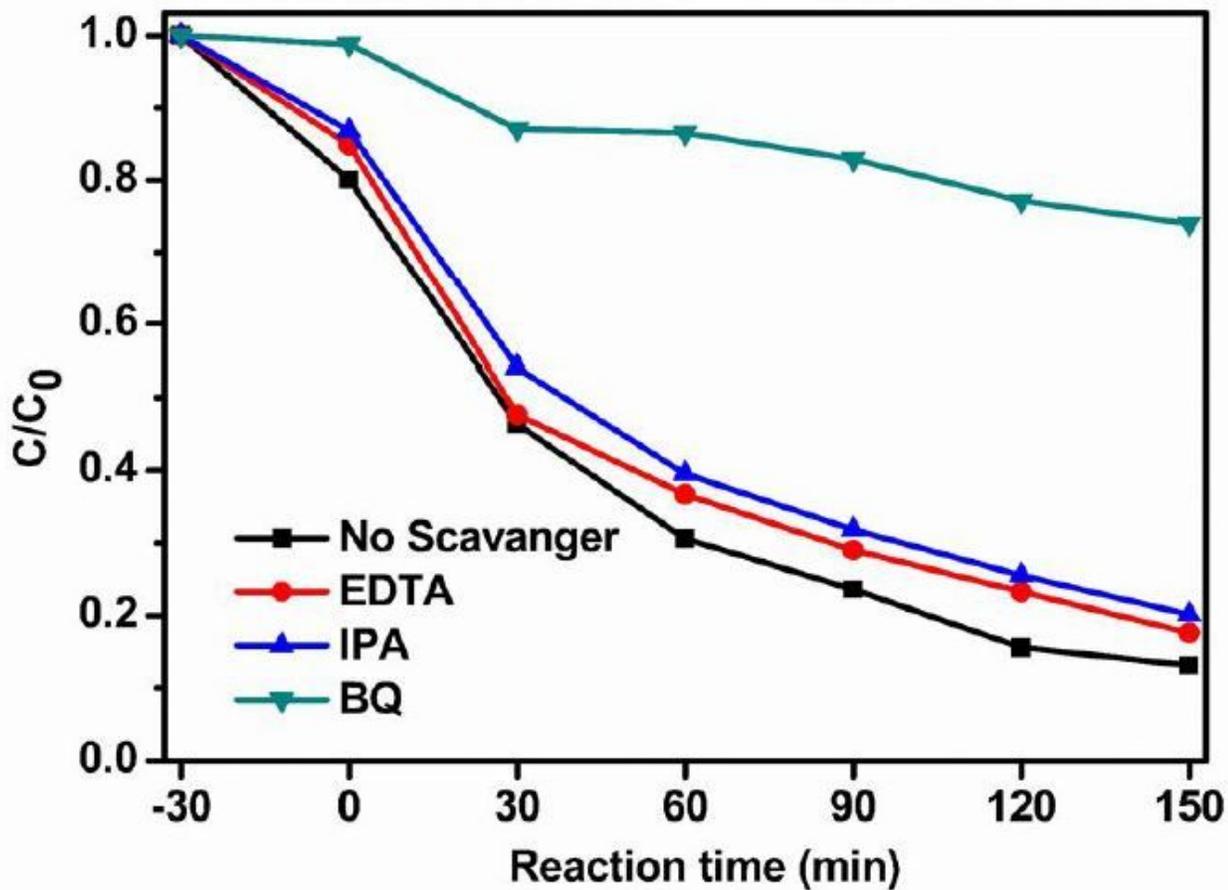


Figure 10

Trapping experiment of active species during the photocatalytic degradation of methylene blue (MB) over Ag/Cu co-doped BiVO<sub>4</sub> under visible light irradiation.