Applications of Metal doped-Ferrite Bismuth as Reusable Magnetic Nanoparticles for Fast Removal of Organics under Visible Light Irradiation

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Pure $BiFeO_3$ magnetic nanoparticle (BFO MNPs), Ba-doped BFO MNPs, Cu-doped BFO MNPs, and Cu-Ba co-doped BFO MNPs as visible-light driven photocatalysts have been successfully synthesized via a simple and rapid sol-gel method at a low temperature and with rapid calcination. Metal loading (Ba^{2+}, Cu^{2+}) in BFO MNPs brought a distorted structure of BFO MNPs, consisting of small, randomly oriented and non-uniform grains, increased surface area and improved magnetic and photocatalytic activities. Metal doping into pure BFO greatly increased magnetic saturation at least 3.0 emu/g and significantly decreased the band-gap energy until 1.7 eV, as compared to 2.1 emu/g and 2.1 eV, respectively, for pure BFO MNPs. The decrease in the band-gap energy of metal-doped BFO MNPs along with oxygen vacancy, and the increase in ferromagneticity and surface area, compared with pure BFO MNPs, led to a marked increase in the photocatalytic activity of the nanomaterials. The metal doped BFO MNPs showed great photocatalytic degradation of volatile organic compounds (VOCs) and phenolic compounds under visible light irradiation. It was identified that both $Fe^{3+}/Fe^{2+}$and Cu^{+}/Cu^{2+} pairs in synthesized nanomaterials greatly promoted the heterogeneous decomposition of H_2O_2 to ·OH and $S_2O_8^{2-}$to $SO_4^{-\bullet}$. Thus the enhanced photocatalytic degradation of organics removal is due to the improved photocatalytic and photo-Fenton catalytic activities. The high degradation efficiency of organics along with high reduction in chemical oxygen demand (COD), total organic carbon (TOC) and high concentration of carbon dioxide (CO_2), proved the high mineralization efficiency of whole organic pollutants under visible light irradiation. After photodegradation, the whole nanoparticles were easily separated from aqueous solutions by applying an external magnetic field. The identified major intermediates of photodegradation enabled to predict the proposed organics degradation pathway. The nano catalysts did not exhibit significant loss of photocatalytic activity after their successive using.

Keywords: Visible light; Photo-degradation; Metal doped $BiFeO_3$; Magnetic nanoparticle