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Hydrothermal synthesis of novel $BiVO_4/Ag_3VO_4$ composite with high visible-light-induced photocatalytic activity

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A hydrothermal process is utilized to synthesize silver orthovanadate (Ag_3VO_4, AVO), bismuth orthovanadate ($BiVO_4$, BVO) and $BiVO_4/Ag_3VO_4$ composite (BVO/AVO). The precursors of AVO were silver nitrate ($AgNO_3$) and sodium orthovanadate (Na_3VO_4), and those of BVO were bismuth nitrate ($Bi(NO_3)_3$) and ammonium metavanadate (NH_4VO_3). The Bi/Ag molar ratio in the BVO/AVO preparation was 1/3. The effects of heating time (6, 12 and 24 hours) and temperature (393, 433 and 473K) on the synthesis of AVO were elucidated. C.I. Reactive Red 2 (RR2) was used as the parent compound in evaluating the photocatalytic activity of all prepared photocatalysis. The optimal experimental conditions for synthesizing AVO by the hydrothermal method included initial heating at 393K for six hours. A 400 W Xe lamp was used as the light source. A quartz appliance that was filled with 2 M $NaNO_2$ solution was placed on the top of the photo-reactor to filter out the ultraviolent (UV) and to provide visible-light (Vis). The rates of RR2 photodegradation by all photocatalysis under UV and Vis irradiation followed a pseudo-first-order kinetic model. The RR2 photodegradation rate constants in the UV/AVO, Vis/AVO, UV/BVO, Vis/BVO, UV/BVO/AVO, Vis/BVO/AVO and solar/BVO/AVO systems were 1.43, 0.03, 0.55, 0.16, 5.06, 2.39 and 2.48 hr^{-1}, respectively. BVO/AVO exhibited the highest photocatalytic activity of all the prepared photocatalysis. This investigation suggested that the coupling of BVO greatly inhibited the recombination of photo-generated electron-hole pairs in AVO, revealing that the separation of photo-generated electron-hole pairs in BVO/AVO was more efficient than that in AVO. Adding isopropanol to the RR2 solution slightly reduced the rate of RR2 photodegradation but adding Cr (VI) and EDTA-2Na markedly slowed RR2 photodegradation. The experimental results suggested that the photogenerated holes and superoxide radicals were the main oxidative species for RR2 photodegradation in AVO and BVO/AVO systems.

Biography

Chung-Hsin Wu has received a Doctorate in Environmental Engineering from National Taiwan University, in 1999 and joined the Faculty of Chemical and Materials Engineering at National Kaohsiung University of Science and Technology, in 2010 as a Professor. His research interest includes treatment processes for contaminated waters and hazardous chemicals, for which seven Taiwan patents have been issued. Currently, he is working on the synthesis of novel photocatalysis. He has reviewed over 300 papers submitted for publication to various journals and, has authored over 100 journal papers and 80 conference presentations and seminars.

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