Photocatalytic activity of nano-ZnO loaded with Ag and Fe immobilized on ZSM-5

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Abstract

Photocatalysts zinc oxide (ZnO)/ZSM-5, Fe–ZnO/ZSM-5, Ag–ZnO/ZSM-5, and Ag–Fe–ZnO/ZSM-5 were successfully prepared using sol–gel method. The synthesized photocatalysts were characterized by X-ray diffraction, Brunauer–Emmett–Teller, scanning electron microscopy, transmission electron microscopy, energy-dispersive X-ray spectroscopy, and diffuse reflectance spectroscopy measurements. Photocatalytic activities of the photocatalysts were evaluated by the removal of Rhodamine B and Reactive Red 6B from aqueous solutions under ultraviolet (UV) or visible irradiation. The results show that the size of nano-ZnO on ZSM-5 surface was ~10 nm. Fe and Ag co-loaded nano-ZnO/ZSM-5 effectively suppressed the recombination of photogenerated holes and electrons and reduced the band-gap energy. The photocatalytic process followed first-order kinetics with >0.98 $R^2$. The best Fe- and Ag-loaded amounts were 0.6% and 1%, respectively, exhibiting 80% Rhodamine B removal at 320 min and 100% Reactive Red 6B removal at 280 min under UV irradiation. Ag–Fe–ZnO/ZSM-5 expressed an outstanding photocatalytic performance under visible-light irradiation with 67% Rhodamine B removal at 320 and 0.0034 min$^{-1}$ reaction rate constant. Ag–Fe–ZnO/ZSM-5 was used three times without any inactivation.

Keywords: Ag loaded; Fe loaded; Nano-ZnO/ZSM-5; Photocatalytic activity; Rhodamine B

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