Design and synthesis of bandgap tailored porous Ag/NiO nanocomposite: an effective visible light active photocatalyst for degradation of organic pollutants

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Abstract

In this work, a series of novel visible light driven Ag/NiO nanocomposites were synthesized via a facile one-pot hydrothermal method. The phase structure, morphology and optical properties of the as-prepared materials were characterized by various tools including X-ray powder diffraction, X-ray photoelectron spectroscopy, scanning electron microscopy, high resolution transmission electron microscopy, energy dispersive X-ray analysis with mapping, the Brunauer–Emmett–Teller surface area, UV–Vis diffuse reflectance spectroscopy and photoluminescence spectroscopy. Ag/NiO nanocomposites have strong visible-light absorption and narrow energy bandgap of 2.55–3.01 eV, and exhibit excellent photocatalytic activity than pure NiO on the degradation of sunset yellow (SY) and tartrazine under visible light irradiation. The incorporation of Ag into NiO can decrease the bandgap, enhance the photoinduced interfacial charge transfer, and therefore increase the charge separation efficiency during the photocatalytic process. In addition, the Ag nanoparticles served as an electron trap site and prolong lifetime of the charge separation state. Among the series of synthesized Ag/NiO nanocomposites, (5%) Ag/NiO nanocomposite display higher separation of photo-induced charge carriers, which could be mainly responsible for the outstanding photocatalytic activity. The radicals trapping experimental results revealed that photogenerated $O_2^{\cdot-}$ and $^{\cdot}OH$ radicals were the main reactive species for the degradation of SY. These combined effects endowed the Ag/NiO nanocomposite system with the ever-increasing photocatalytic efficiency and enhanced stability in degradation reaction process.