CoFe₂O₄/TiO₂ nanocatalysts for the photocatalytic degradation of Reactive Red 120 in aqueous solutions in the presence and absence of electron acceptors

Panneerselvam Sathishkumar, Ramalinga Viswanathan Mangalaraja, Sambandam Anandan, Muthupandian Ashokkumar

Nanomaterials and Solar Energy Conversion Lab, Department of Chemistry, National Institute of Technology, Trichy 620 015, India
Advanced Ceramics and Nanotechnology Laboratory, Department of Materials Engineering, Faculty of Engineering, University of Concepcion, Concepcion 407-0409, Chile
School of Chemistry, University of Melbourne, Vic 3010, Australia

CoFe₂O₄ and CoFe₂O₄/TiO₂ nanocatalysts were prepared with more stable rutile phase of TiO₂. CoFe₂O₄/TiO₂ nanocatalyst was found to be suitable for the visible light induced photocatalytic degradation of RR120. Enhanced photocatalytic degradation of RR120 was observed by the addition of electron acceptors.

Magnetic CoFe₂O₄ and CoFe₂O₄/TiO₂ nanocatalysts were prepared by a co-precipitation method in which CoFe₂O₄ induced the formation of thermodynamically more stable rutile phase of TiO₂. The structural and elemental analyses confirmed the formation of CoFe₂O₄ and CoFe₂O₄/TiO₂ nanocatalysts and the specific atomic ratios of Ti, Co, Fe, and O in these catalysts. The presence of Co²⁺ and Fe³⁺ cations in its oxide forms on the surface of TiO₂ led to visible light absorption in the wavelength range 550–650 nm. The band gap calculated by Tauc approach showed 3.2, 1.1 and 2.8 eV for TiO₂, CoFe₂O₄ and CoFe₂O₄/TiO₂ nanocatalysts, respectively. The photocatalytic degradation of Reactive Red 120 (RR120) was studied by varying its concentration and the amount of nanocatalyst in order to attain a maximum degradation. The role of electron acceptors in the photocatalytic degradation of RR120 was studied in the presence of the magnetic nanocatalysts.

1. Introduction

Metal-oxide nanoparticles have been extensively utilized in various applications [1–8], including advanced oxidation processes (AOPs), due to their interesting physicochemical properties [9–12]. AOPs are promising techniques for the degradation of organic pollutants in aqueous environment. Among the various AOPs, heterogeneous photocatalytic degradation of organic contaminants in the presence of nanostructured semiconductor (e.g., TiO₂) materials attained the maximum efficiency of mineralization [13]. TiO₂ is chemically and biologically inert. Nevertheless, the separation of TiO₂ from the heterogeneous solution is found to be very diffi-