Synthesis, characterization and application of bismuth and boron Co-doped TiO₂: A visible light active photocatalyst

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ABSTRACT

Bismuth and Boron co-doped TiO₂ nanoparticles were successfully prepared by a modified sol–gel method. The products were characterized with various spectroscopic and analytical techniques to determine their structural, morphological, light absorption and photocatalytic properties. The results reveal that all the samples consist of highly crystalline anatase with mesoporous structures. The experimental results further indicate that Bi and B species have been doped into the crystal lattice of TiO₂ with Bi substituting Ti in the form of Bi³⁺ and B doped in the form of substitutional (O) and interstitial B. Bi–B–TiO₂ degraded 2, 4-DCP and AO7 under visible light effectively. Bi species enhanced visible light harvesting, e⁻/h⁺ separation and mobility.

1. Introduction

Employing Titania (TiO₂) as a photocatalyst in degradation of organic and inorganic pollutants in air and water offers a viable approach for solving environmental pollution problems. This is due to its unique properties which include high oxidizing capacity, low cost, non-toxicity, chemical robustness and high photostability [1–4]. However, practical application of this great substance is impeded by its high recombination rate of photo induced charge carriers and wide band gap (3.2 eV for anatase polymorph). TiO₂ only shows photo-response to UV light, hence making it more costly to use it because of the need for a UV light source. A more cost effective way will be the use of renewable energy (solar energy) for the purpose of environmental clean up due to its abundance and environmental friendliness. However, its larger portion is comprised of low energy light (~45%) which cannot be utilized by TiO₂. In order to address the above mentioned drawbacks in the use of TiO₂ in environmental remediation application, numerous attempts in research have been done to induce visible light absorption in TiO₂ for efficient utilization of solar energy as well as improvement in charge carrier separation. These methods include dye sensitization [5,6], metal doping [7,8], non-metal doping [9–12], composites with other semiconductors [13,14] and surface metallization [15–21]. Although dye sensitization and surface metallization of TiO₂ induced visible light absorption in TiO₂, their use