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Enhanced photocatalytic degradation of caffeine as a model pharmaceutical pollutant by Ag-ZnO-Al_2O_3 nanocomposite

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ABSTRACT

In this paper, an Ag-ZnO-Al_2O_3 nanocomposite with enhanced photocatalytic activity has been obtained by calcination of an Ag-loaded zinc/aluminum layered double hydroxide (LDH). First, LDH materials intercalated by carbonates ions (Zn-Al-CO_3) were synthesized by the co-precipitation method at a Zn/Al molar ratio of 3 and were calcined at different temperatures (300, 400, 500, 600, 800, and 1000°C). Thereafter, in order to increase photocatalytic activity, catalysts obtained at optimal temperature were doped by Ag noble metal with various amounts (1, 3, and 5 wt %) using a ceramic process. Samples were characterized by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), and scanning electron microscopy coupled to energy dispersive X-ray spectroscopy (SEM/EDX). The photocatalytic activity was evaluated for the degradation of caffeine as a model of pharmaceutical pollutant in aqueous solutions under UV irradiation. The effect of irradiation time, initial concentration of caffeine, catalyst dosage, solution pH, and reuse were investigated. The Ag-doped calcined LDH materials showed significantly higher photocatalytic activity compared with undoped and standard Degussa P-25 titanium dioxide. The photocatalytic degradation of caffeine was increased with an increase in the Ag-loaded amounts. The photocatalyst showed high stability after three regeneration cycles.

Keywords: Ag-ZnO-Al_2O_3; Mixed oxides; Photocatalytic activity; Caffeine; Pharmaceutical pollutants

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