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Silver-Doped Magnetite Titanium Oxide Nanoparticles for Photocatalytic Degradation of Organic Pollutants

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Abstract : The global lack of clean water for human sanitation and other purposes has become an emerging dilemma for human beings. The presence of organic pollutants in wastewater produced by textile industries, leather manufacturing and chemical industries is an alarming matter for a safe environment and human health. For the last decades, conventional methods have been applied for the purification of water but due to industrialization these methods fall short. Advanced oxidation processes and their reliable application in degradation of many contaminants have been reported as a potential method to reduce and/or alleviate this problem. Lately it has been assumed that incorporation of some metal nanoparticles such as magnetite nanoparticles as photocatalyst for Fenton reaction which could improve the degradation efficiency of contaminants. Core/shell nanoparticles, are extensively studied because of their wide applications in the biomedical, drug delivery, electronics fields and water treatment. The current study is centred on the synthesis of silver-doped Fe3O4/SiO2/TiO2 photocatalyst. Magnetically separable Fe3O4@SiO2@TiO2 composite with core–shell structure were synthesized by the deposition of uniform anatase TiO2 NPs on Fe3O4@SiO2 by using titanium butoxide (TBOT) as titanium source. Then, the silver is doped on SiO2 layer by hydrothermal method. Integration of magnetic nanoparticles was suggested to avoid the post separation difficulties associated with the powder form of the TiO2 catalyst, increase of the surface area and adsorption properties. The morphology, structure, composition, and magnetism of the resulting composites were characterized and their photocatalytic activities were also evaluated. The results demonstrate that TiO2 NPs were uniformly deposited on the Fe3O4@SiO2 surface. The silver nanoparticles were also uniformly distributed on the surface of TiO2 nanoparticles. The aim of this work is to study the suitability of photocatalysis for the treatment of aqueous streams containing organic pollutants such as methylene blue which is selected as a model compound to represent one of the pollutants existing in wastewaters. Various factors such as initial pollutant concentration, photocatalyst dose and wastewater matrix were studied for their effect on the photocatalytic degradation of the organic model pollutants using the as synthesized catalysts and compared with the commercial titanium dioxide (Aeroxide P25). Photocatalysis was found to be a potential purification method for the studied pollutant also in an industrial wastewater matrix with the removal percentages of over 81 % within 15 minutes. Methylene blue was removed most efficiently and its removal consumed the least of energy in terms of the specific applied energy. The magnetic Ag/SiO2/TiO2 composites show high photocatalytic performance and can be recycled three times by magnetic separation without major loss of activity, which meant that they can be used as efficient and conveniently renewable photocatalyst.

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