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Synthesized Doped TiO2 Photocatalysts for Mineralization of Quinalphos from Aqueous Streams

Authors : Nidhi Sharotri, Dhiraj Sud

Abstract : Water pollution by pesticides constitutes a serious ecological problem due to their potential toxicity and bioaccumulation. The widespread use of pesticides in industry and agriculture along with their resistance to natural decomposition, biodegradation, chemical and photochemical degradation under typical environmental conditions has resulted in the emergence of these chemicals and their transformed products in natural water. Among AOP's, heterogeneous photocatalysis using TiO2 as photocatalyst appears as the most emerging destructive technology for mineralization of the pollutant in aquatic streams. Among the various semiconductors (TiO2, ZnO, CdS, FeTiO3, MnTiO3, SrTiO2 and SnO2), TiO2 has proven to be the most efficient photocatalyst for environmental applications due to its biological and chemical inertness, high photo reactivity, non-toxicity, and photo stability. Semiconductor photocatalysts are characterized by an electronic band structure in which valence band and conduction band are separated by a band gap, i.e. a region of forbidden energy. Semiconductor based photocatalysts produces e-/h+ pairs which have been employed for degradation of organic pollutants. The present paper focuses on modification of TiO2 photocatalyst in order to shift its absorption edge towards longer wavelength to make it active under natural light. Semiconductor TiO2 photocatalysts was prepared by doping with anion (N), cation (Mn) and double doped (Mn, N) using greener approach. Titanium isopropoxide is used as titania precursor and ethanedithiol, hydroxyl amine hydrochloride, manganous chloride as sulphur, nitrogen and manganese precursors respectively. Synthesized doped TiO2 nanomaterials are characterized for surface morphology (SEM, TEM), crystallinity (XRD) and optical properties (absorption spectra and band gap). EPR data confirms the substitutional incorporation of Mn2+ in TiO2 lattice. The doping influences the phase transformation of rutile and anatase phase crystal and thereby the absorption spectrum changes were observed. The effect of variation of reaction parameters such as solvent, reaction time and calcination temperature on the yield, surface morphology and optical properties was also investigated. The TEM studies show the particle size of nanomaterials varies from 10-50 nm. The calculated band gap of nanomaterials varies from 2.30-2.60 eV. The photocatalytic degradation of organic pollutant organophosphate pesticide (Quinalphos) has been investigated by studying the changes in UV absorption spectrum and the promising results were obtained under visible light. The complete mineralization of quinalphos has occurred as no intermediates were recorded after 8 hrs of degradation confirmed from the HPLC studies.

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