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TiO_2 photocatalysis: progress from fundamentals to modification technology

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ABSTRACT

Heterogeneous photocatalysis is a promising method among advanced oxidation processes, which can be used for degradation of various organic pollutants in water and air. In heterogeneous photocatalysis, illumination of an oxide semiconductor, usually the anatage form of titanium dioxide, by UV radiation produces photo-excited electrons (e^-) and positively charged holes (h^+). In the aqueous phase, the illuminated surface is extensively regarded as a producer of hydroxyl radicals ($h^+ + OH^- = HO^{\cdot}$). These hydroxyl radicals, holes, and conduction-band electrons can degrade organic pollutants directly or indirectly. However, the massive recombination of these photo-generated charge carriers and large band gap of TiO_2 limits its overall photocatalytic efficiency. These limitations can be overcome by changing surface properties of titania by adding suitable electron scavengers in the reaction medium or by modifying its electronic band structure through strategies like metal ion/nonmetal atom doping, narrow band-gap semiconductor coupling, sensitization by organic dyes, etc. Based on recent studies reported in the literature, nonmetal ion doping and dye sensitization are very effective methods to extend the activating spectrum to visible radiation. This review emphasizes on the visible-light activation of TiO_2 and its application to environmental remediation.

Keywords: Heterogeneous photocatalysis; Mineralization; Doping; Dye sensitization; Composite semiconductor

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