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Development of Visible Light Sensitive TiO_2 Photocatalysts and Their Sensitization Using Fe^{3+} Ions

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Titanium dioxide photocatalysts are promising substrates for photodegradation of pollutants in water and air, but show photocatalytic activities only under UV light. To utilize a wider range of incident wavelengths such as solar light, development of photocatalysts active under visible light is very important. Chemically modified titanium dioxide photocatalysts were prepared containing anatase phase with S (S^{4+}) substituted for some lattice Ti atoms or N substituted for some lattice O atoms. These catalysts showed strong absorption of visible light and high activities for degradation of 2-propanol in aqueous solution and partial oxidation of adamantane under irradiation at wavelengths longer than 440 nm. The oxidation states of the S and N atoms incorporated into the TiO_2 particles were determined to be mainly S^{4+} and N^{3-} from XPS spectra, respectively. The photocatalytic activities of S- or N-doped TiO_2 photocatalysts with adsorbed Fe^{3+} ions were markedly improved for oxidation of 2-propanol compared to those of S- or N-doped TiO_2 without Fe^{3+} ions under a wide range of incident wavelengths, including UV light and visible light. The photocatalytic activity reached maximum with 0.90 wt% Fe^{3+} ions adsorbed on S-doped TiO_2, and 0.36 wt% Fe^{3+} ions on N-doped TiO_2. Furthermore, redox treatment of S- or N-doped TiO_2 photocatalysts with adsorbed Fe^{3+} ions by reduction with $NaBH_4$ followed by air oxidation resulted in further improvements in photocatalytic activities. In this case, the optimum amounts of Fe^{3+} were 2.81 and 0.88 wt% on the surfaces of S- and N-doped TiO_2 photocatalysts, respectively.

Keywords: Photocatalyst, Titanium dioxide, Visible light, Sulfur-doped titanium dioxide, Nitrogen-doped titanium dioxide, Iron (III) cation

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