Sonochemical synthesis of metal oxides/sulfides and their composites for the sonophotocatalytic degradation of organic pollutants

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Photocatalysis is based on redox reactions, which take place at the surface of a semiconductor material under UV or visible light irradiation. The photocatalyst activity depends on its ability to create electron-hole pairs, which are then taking part in a redox reaction. These electron-hole pairs generate hydroxyl and superoxide radicals, which can undergo secondary reactions (Vaitsis et al. 2020). By doping TiO_2 with metal ions the photocatalytic efficiency can be enhanced in order to push the initiation of TiO_2 to longer wavelengths (anatase band gap, 3.2 eV) (Hunge et al. 2018, Serpone et al. 2012). Another similar semiconductor with a wide band gap (Eg=3.3 eV at 300 K) is zinc oxide. Its compounds have been very attractive due to possible synergistic effects on photocatalytic activity (Stucchi et al. 2018).

Advanced oxidation processes (AOPs) are based on the production of $OH^{\bullet}$ radicals to sufficiently oxidize wastewater, organic pollutant streams, and toxic effluent from industrial, pharmaceutical and municipal wastes. Through the implementation of such procedures, the treatment of such waste leads to products that are less toxic and possess fewer pollutants. The mechanism produces $OH^{\bullet}$ radicals and other reactive species such as superoxide anions and hydrogen peroxide (Maroudas et al. 2020). Finally, combined AOPs implementations are favored through the literature as an efficient solution in addressing the issue of global environmental waste management (Pandis et al. 2022).

In the present work, the solid phase catalysts of TiO_2, ZnO, CdS, ZnS, CdS-TiO_2, CdS-ZnO, ZnS-TiO_2 and ZnS-ZnO were synthesized sonochemically. The degradation of organic pollutants was investigated via ultrasound irradiation at low (20 kHz) and high frequencies (860 kHz), photocatalysis (UV) and Fenton/Photo-Fenton reaction, along with their combinations in order to examine their synergy. It has been observed that the CdS catalyst has a remarkable photocatalytic effect, whereas as transition elements, Zn and Ti oxides have a beneficial effect on cadmium sulfide with respect to its photocatalytic property.

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