

Synthesis of Nanoparticles and Thin Film of $\text{Cu}_2\text{ZnSnS}_4$ by Hydrothermal Method and Its Application as Congo Red Photocatalyst

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Abstract : The textile, food and pharmaceutical industries are expanding daily worldwide, and they are located within the most polluting industries due to the fact that wastewater is discharged into watercourses with high concentrations of dyes and traces of drugs. Many of these compounds are stable to light and biodegradation, being considered as emerging organic contaminants. Advanced oxidation processes (AOPs) emerge as an effective alternative for the removal and elimination of this type of contaminants. Heterogeneous photocatalysis has been extensively studied as it is an efficient, low-cost and durable method. As the main photocatalyst, TiO_2 has been used for the degradation of a large number of dyes and drugs. The disadvantage of TiO_2 is its absorption in the UV region of the solar spectrum. On the other hand, quaternary chalcogenides based on $\text{Cu}_2\text{SnZnX}_4$ ($X = \text{S}, \text{Se}$) are a possible alternative due to their narrow bandgap (ca. between 0.8 to 1.5 eV depending on the phase considered), low cost, an abundance of its constituent elements in the earth's crust and its low toxicity. The objective of this research was to synthesize $\text{Cu}_2\text{SnZnS}_4$ (CZTS) through of a low-cost hydrothermal method and evaluate it as a potential photo-catalyst in the photo-degradation process of Congo Red. The synthesis of the nanoparticle in suspension and film onto fluorine-doped tin oxide coated glass (FTO) was carried out using a mixture of: 2 mmol CuCl_2 , 1 mmol ZnCl_2 , 1 mmol SnCl_2 and 4 mmol $\text{CH}_4\text{N}_2\text{S}$ in a Teflon reactor at 180°C for 72 h. Characterization was performed through scanning electron microscopy (SEM), X-ray diffraction (XRD) and UV VIS spectroscopy. Photo-degradation monitoring was carried out employing a UV VIS spectrophotometer. The results show that photodegradation of 55% of the dye can be obtained after 4h of exposure to polychromatic light, it should be noted that the Congo Red dye is being studied for the first time.

Keywords : CZTS, hydrothermal, photocatalysis, dye

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