EVALUATION OF $CuFe_2O_4/TiO_2$ HETEROJUNCTIONS IN THE PHOTOCATALYTIC DEGRADATION OF REACTIVE YELLOW BF-4G DYE

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The textile industry is one of the largest consumers of water and a significant generator of effluents with a high pollutant load, especially due to the intensive use of synthetic dyes. These dyes are composed of molecules that are difficult to degrade, which is attributed to their structural complexity, including aromatic rings, amine groups, azo groups, and metallic ions (Konwar, 2020, Azanaw et al., 2022). Among the various dyes used, reactive dyes, such as reactive yellow BF-4G, are widely employed for their durability and resistance to washing. However, these dyes present a significant environmental challenge, as they are highly soluble in water and resistant to degradation, leading to the contamination of water resources. Conventional wastewater treatment methods are generally ineffective in the complete removal of these dyes, underscoring the need for the development of more efficient technologies (Fadzil et al., 2022).

Among the emerging technologies, Advanced Oxidation Processes (AOPs) have demonstrated high efficiency in the degradation of organic contaminants due to the generation of transient oxidizing species, such as the hydroxyl radical ($HO^{\bullet}$), which is capable of oxidizing and decomposing a wide range of compounds (Tufail et al., 2020). TiO_2 is a widely studied material in heterogeneous photocatalysis, but it faces limitations related to its difficult separation from the reaction medium and its inability to be efficiently activated by visible radiation (Matamala-Troncoso et al., 2023). In order to overcome these deficiencies, this study investigated the formation of heterojunctions between magnetic copper ferrite nanoparticles and TiO_2, synthesized via the polymeric precursor method, in different mass ratios of $CuFe_2O_4$ and TiO_2.

The reactions under visible radiation were carried out using a 250 W/D PRO Osram HQI-T halogen lamp (emission in the range of 300 to 800 nm), while the reactions under ultraviolet radiation employed an 80 W mercury vapor lamp (Osram) with a quartz bulb. In the X-ray diffraction patterns, the copper ferrite sample exhibited three crystalline phases: ferrite, hematite, and cupric oxide. For TiO_2, the anatase and rutile polymorphs were observed. In the $CuFe_2O_4/TiO_2$ heterojunctions, the presence of all five crystalline phases was identified. It was noted that the association with ferrite stabilized the anatase phase, delaying its transition to rutile. Moreover, the increase in ferrite content resulted in a decrease in the crystallite size of

the TiO_2 polymorphs, which contributed, at least in part, to the improvement in photocatalytic activity.

The heterojunction with the highest ferrite content ($CuFe_2O_4/TiO_2$ mass ratio of 2:1) exhibited the best performance in the photocatalytic degradation of the BF-4G dye, completely eliminating the dye after 60 minutes of adsorption, followed by 90 minutes of photocatalytic treatment under ultraviolet radiation, in the presence of hydrogen peroxide (Fig. 1a). This sample maintained its activity after five consecutive degradation cycles, being easily recovered and reused (Fig. 1b). The formation of hydroxyl radical species was confirmed as one of the main mechanisms of the dye's photocatalytic degradation.

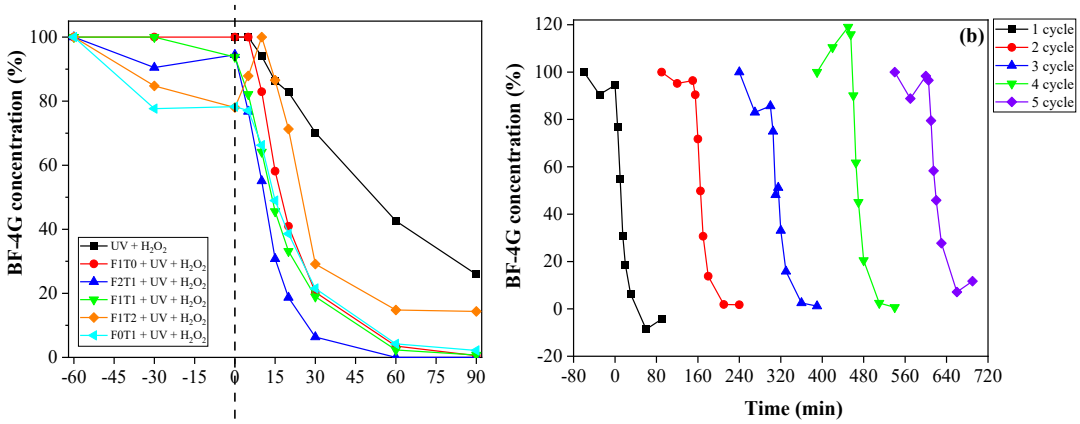

Figure 1. (a) Influence of the radiation source on the photocatalytic degradation tests of the reactive yellow dye BF-4G in aqueous medium. (b) Evaluation of the reuse of the F2T1 photocatalyst in five sequential cycles of degradation of the reactive yellow dye BF-4G in aqueous medium.

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