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Abstract

Studies on Photocatalytic Degradation of Methylene Blue Using TiO_2—Transition Metal Oxides Heterojunctions †

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One of the sources of water pollution is the wastewater generated from the textile industry. This type of wastewater contains different organic dyestuffs. Methylene blue (MB) is one of the most widely used industrial dyes, with UV-Vis spectroscopic characteristics dominated by sharp and intense bands, which made it the most common dye used to test the performance of newly photocatalytic materials [1]. Residual water containing organic dyes discharged from textiles dyeing plants into natural water effluents are harmful and, through decomposition, are able to form highly toxic and carcinogenic compounds. Several techniques have been used for wastewater treatment in the past, including oxidation, anaerobic treatment, and filtration through the membranes, ultrafiltration, reverse osmosis and coagulation. But these methods convert dye pollutants into secondary pollutants that are not environmentally friendly [2]. This study presents an alternative method for decontamination using TiO_2 photocatalysts with metal-oxide heterojunctions for application in the depollution of water effluents contaminated with textile dyes.

The nanoparticles developed in this study were based on hybrid photocatalysts based on TiO_2 with transition metal-oxide heterojunctions, using cobalt, copper, cadmium and lead acetates, ferric chloride as metal oxide precursors and titanium dioxide. Reactions were performed using a Discover 2.0 Microwave Flow Reactor at a temperature of around 160 °C and at 300 W. The obtained samples underwent characterization using modern analytical methods to ensure that the photocatalysts possessed the desired properties. The photocatalytic properties of the synthesized materials were assessed by separately mixing the metal-oxide photocatalysts with a styrene–acrylic film-forming material [3]. The resulting materials were deposited onto glass plates and immersed in a vessel containing water contaminated with methylene blue dye. The reaction vessel was illuminated using a Xenon arc lamp, and degradation of the chromophore was monitored using UV-Vis absorption spectroscopy.

Characterization of the titanium dioxide photocatalysts doped with various transition metal oxides was performed via Scanning Electron Microscopy (SEM) and it was seen that morphology of the particles remain unchanged. Through Brunauer–Emmett–Teller (BET) analysis, it was observed that textural properties of the photocatalysts are relatively similar (pore diameters around 10 nm, and specific area of about 50 m^2/g). Using UV-VIS diffuse reflectance measurements, it was determined that the smallest band gap was recorded in the case of TiO_2/FeOOH photocatalyst. The obtained materials presented adequate properties and they showed good results regarding the photocatalytic activity.

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The synthesized materials have the potential to be used in efficient water depollution process through photocatalytic methods.

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