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Synthesis of uncapped and graphite-capped ZnO nanostructures and their chromaticity and photocatalytic degradation of methylene blue for photonic emitting device and wastewater treatment applications

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ABSTRACT

ZnO and graphite-capped ZnO nanostructures was synthesized via microwave treatment (420 W for 1 min) followed by a calcination (500 °C for 2 hrs). The formation of the aforementioned compounds, and their physico-chemical features were studied using XRD, ATR-FTIR, FE-SEM/EDX, UV–visible absorption, photoluminescence, chromaticity, and photodegradation characteristics. The effect of graphite on crystal structure, morphology, light absorption/emission, chromaticity, and photocatalytic activity of ZnO was thoroughly investigated. XRD analysis confirmed the hexagonal wurtzite phase in both ZnO and graphite capped-ZnO materials. FT-IR and EDS analysis were performed to confirm the formation of aforementioned compounds. The methylene blue (MB) photo-degradation efficiency of ZnO and graphite-capped ZnO under UV light irradiation was determined as 94 and 97 %, respectively. The finding results would be suitable in photosensing displays and wastewater treatment applications.

1. Introduction

The development of diverse chemical and textile industries results in the release of a variety of toxic substances. These toxic substances are admixture in the water, causing water pollution throughout the country. In order to resolve the water pollution, water purification technology has much attention. Pollutants can be removed or degraded from water by introducing water purification technologies such as physico-chemical (biodegradation, chemical oxidation, and adsorption) and photo-catalytic methods [1]. Except photocatalysis, the aforementioned pollutant removal process from water has been a challenging task due to several reaction steps, incomplete degradation, and high equipment cost. Here, we used the synthesized graphite-capped ZnO nanostructures as a photocatalyst to degrade MB solution under UV light irradiation.

Numerous studies are available on the photocatalytic characteristics of ZnO-carbon source (g-C_3N_4, reduced graphene oxide, graphene)-based nanocomposites [2–5]. However, the reported synthesis process is tedious and having multiple reaction steps and conditions. Hence, a simple synthesis route for production of ZnO-carbon-based composites with photocatalytic applications needs to be developed.

Few researchers reported the graphite admixture in ZnO nano-structures by various chemical synthesis routes to explore the photo-catalytic performance [1,6–8]. The above-mentioned literature reports exhibit relatively higher photodegradation activity than pure ZnO. The reason for selecting graphite includes its high surface area/electrical conductivity and semiconducting properties [9]. When the aforemen-tioned properties of graphite are admixture with the nontoxic, eco-friendly, and wide optical band gap of ZnO material, the unique

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