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A simple synthesis of CuO NPs for photocatalytic applications and theirs structural and optical properties.

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Abstract

In this study, the copper nanoparticles were synthesized by simple co-precipitation method which were obtained by heating at 80°C for photocatalytic application. The microstructural characterization of the nanopowder obtained was performed using X-ray diffraction (XRD), SEM, EDS, and Infrared Spectroscopy (IR). The optical properties of nanoparticles were studied by UV-Visible spectroscopy. XRD studies demonstrated that the formation of CuO monoclinic phase and the average grain size of CuO crystallite were found to be 30 nm. The FTIR spectral analysis showed the characteristics peaks of Cu-O bond. The EDAX result indicated that there were no other elemental impurities present in the prepared CuO nanoparticles. SEM images indicate the morphology as a three-dimensional flower-like structure was successfully prepared for subsequent degradation of methylene blue (MB). With regard to the optical proprieties, the value of the bandgap energy equals 1.34 eV.

Keywords: CuO NPs; X-ray diffraction; SEM; FTIR; and Optical properties; Photocatalytic.

1. Introduction

In recent years, transition metal oxides (TMOs) have attracted considerable interest due to their potential applications such as supercapacitors, sensors, solar cells, photocatalysis and electrochromic devices [1-6]. Among them, Copper nanoparticles and copper oxide with these two stable forms precisely: tenorite (CuO) and cuprite (Cu2O) with band gaps of 1.2-1.9 eV and 2.0-2.2 eV respectively have aroused a great interest in the scientific community worldwide [7, 8]. These two oxides have a p-type semiconductor character due to the presence of copper gaps in their crystallographic structure. These oxides have three main advantages which are : (i) low cost, (ii) less toxicity, (iii) high stability [9-14].

The CuO NPs have different morphologies such as: nanoflowers, nanowires, hollow spheres and octahedra nanorods [15-17], in addition to its crystalline/amorphous nanoparticles facilitates the separation of electron-hole pairs offering an electron transfer surface[18]. Due to their direct electron channels and efficient electron-hole separation during the photocatalytic process, they have attracted a considerable attention in photocatalytic applications[19].

There were many studies about the photocatalytic removal of methylene violet and methylene blue in the presence of CuO nanoparticles wich were prepared by hydrothermally [20]. It was found that CuO nanoparticles reduced by 96% and 89% of methylene violet and methylene blue respectivly dye in 180 minutes [21]. Other studies demensteated the photocatalytic efficiency to remove methylene blue and methylene orange dyes by flower-like CuO microspheres through the reflux condensation technique[15-17].

Several methods are used to synthesize copper oxide nanoparticles such as thermal deposition, electrodeposition, reactive sputtering, microwave-assisted route, facile wet chemical and hydrothermal routes [22-24]. Among these methods, is the co- precipitation chemical method which is simple, economical and allows to obtain large scale nanostructures for many semiconductor nanoparticles.

In this study, copper oxide nanoparticles were obtained by co- precipitation method. These nanoparticles were studied by different characterization techniques such as: X-ray diffraction, SEM scanning electron microscopy, energy-dispersive X-ray spectroscopy (EDX), UV-vis spectroscopy and infrared absorption spectroscopy. The manufacturing of CuO NPs was conducted to investigate the photocatalytic degradation of MB.

2. Experimental section

2.1. Preparation of CuO nanoparticles

CuO NP is obtained by an easy chemical co-precipitation method, a very simple process whose low-temperature synthesis parameters and reduced costs make it the preferred choice compared to other techniques [25], was obtained by the interaction of ammonia with the sulfate solution.

In this experiment, 1.95 g of CuSO4-5H2O was dissolved completely in 100 ml of deionized water. Then, a solution of NH3-H2O (64 ml, 0.26 M) was added rapidly to the CuSO4 solution and stirred for 30 minutes, and then a solution of NaOH (24 ml, 1.4 M) was added at a flow rate of 2 ml/min, controlling the reaction temperature in a water bath at 80 °C. Finally, the CuO