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Synthesis and characterization of ZnO/CNT nanocomposite

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Abstract - *In this study, a novel nanocomposite based on ZnO/CNT has been successfully synthesized. Zinc acetate and Sodium hydroxide were used as a starting material for the preparation of ZnO nanoparticles via the hydrothermal method and producing nanocomposite by mixing with CNT. The obtained materials were characterized by X-ray diffraction analysis (XRD), UV-Visible spectrometer, Fourier transform infrared spectrometry (FTIR), and Field Emission Scanning Electron Microscope (FESEM) and Energy-dispersive X-ray spectroscopy (EDX) analysis. The morphology and particle size of the ZnO/CNT nanocomposite was studied FESEM and XRD analyses. According to XRD analysis, the size of nanoparticles was found to be in the range of 30-39 nm. The EDX analysis proved the presence of Zn, O, and CNT elements within ZnO/CNT nanocomposite.*

Key Words: **hydrothermal, CNT, nanocomposite, FESEM, *morphology***

1.INTRODUCTION

The synthesis of ZnO and ZnO based nanocomposite has been the subject of extensive research in the last decade [1]. ZnO has wide application in field emission, gas sensors, ceramics, solar cells, biosensors, antimicrobial, textiles, catalysis, environmental protection, biotechnology etc. in recent years; it has been found that ZnO can be synthesized by various techniques [2, 3]. Hydrothermal method is one of the most important methods for the synthesis of ZnO nanoparticles. In the hydrothermal process, the morphology and size also can be controlled by adjusting the reaction temperature, concentration of precursors and time [4, 5]. In several researches, ZnO nanoparticles were successfully attached on the surface of CNTs [6]. CNTs have a highly porous and hollow structure, large specific surface area, significant electronic and conductive properties and a very versatile surface that can be modified to improve adsorption properties [7]. In this study, a novel nanocomposite based on ZnO/CNT has been successfully synthesized by hydrothermal method. The structures of the nanocomposite were characterized by using XRD, FTIR, and FESEM with EDX. The optical properties were investigated using UV-Vis spectrophotometer.

2. EXPERIMENTAL DETAILS

Zinc acetate as the precursor, NaOH as a precipitating agent, and CNT were purchased from Sigma-Aldrich. In the synthesis of ZnO/CNT nanocomposite, the aqueous solution (0.2 M) of zinc acetate dissolved in distilled water. A solution of (0.4 M) of NaOH was added drop wise into it at room temperature under vigorous stirring. Then a certain amount of purified CNTs were completely dispersed in distilled water ultrasonically, and were added and completely dissolved in the first suspension. These solutions were transferred into the autoclave and maintained at the temperature 200^0C for 6 hours under autogenously pressure. The obtained precipitate was centrifuged, washed, the resulting product then dried in air in an oven at 80^0C. The obtained samples were placed in air at 200^0C and the resultant powder was crushed in grinding furnace to get ZnO/CNT nanocomposite.

3. RESULT AND DISCUSSION

3.1 XRD analysis

The XRD form of ZnO/CNT nanocomposite obtained from the hydrothermal process were as shown in Fig (1). The peaks at 2θ values of 31.72^0, 34.38^0, 36.22^0, 47.48^0, 56.54^0, 62.82^0, 66.36^0 corresponded to the crystal planes of (100), (002), (101), (102), (110), (103) and (112) of ZnO nanoparticles. The prominent peak about $2\theta = 26^0$ can be attributed to the (0 0 2) reflection of CNT. The particle average size was calculated by the Scherrer formula and found to be in the range of 39 nm.

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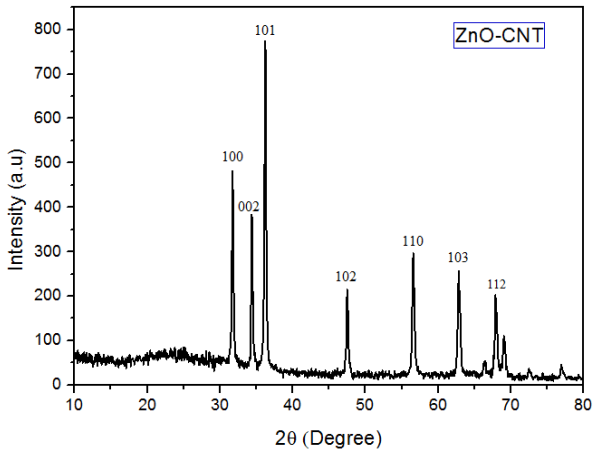

Fig-1: XRD pattern of ZnO/CNT nanocomposite

3.2 UV-Vis Absorption spectra

Figs. (2a&b) shows the UV-Vis spectra and the band gap of ZnO/CNT nanocomposite obtained by hydrothermal method. ZnO shows the absorption peaks at 205 nm. The band gaps of ZnO/CNT were found to be 3.3 eV.

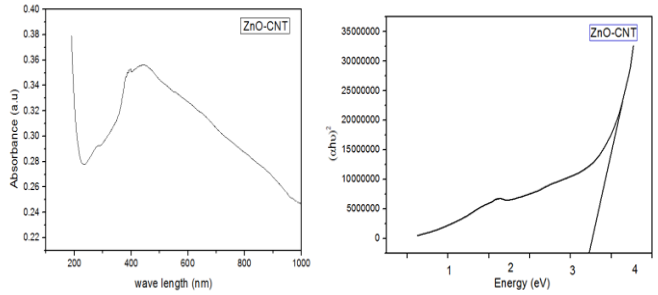

Fig.2. UV-absorption spectra (a) band gap (b)

3.3 FTIR Analysis

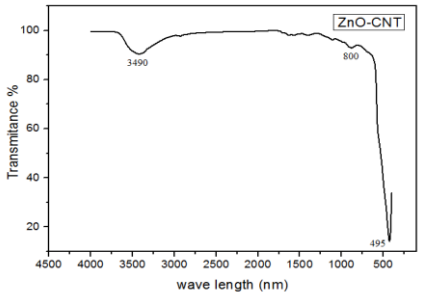

Fig-3: FTIR spectrum of ZnO/CNT nanocomposite

Fig.3 represents the FTIR spectrum of ZnO/CNT nanocomposite recorded in the range of 4000 -500 cm^{-1}. The band located near 495 cm^{-1} can be attributed to the Zn-O stretching mode. The band at 3200 cm^{-1} to 3600 cm^{-1} corresponds to the stretching vibration of -OH bond. These stretching vibrations correspond to the water molecule bound on the surface of the sample.

3.4 FESEM/EDAX Analysis

Fig. (4a) shows the FESEM pattern of ZnO/CNT nanocomposite. The shape of the ZnO nanoparticle obtained is granular and well dispersed. The CNT nanotubes are the flake like structures.

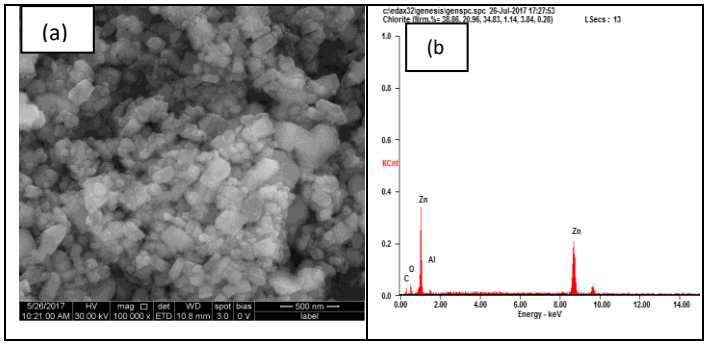

Fig-4: FESEM (a) and EDAX (b) spectrum of ZnO/CNT

Fig. 4(b) shows the EDAX spectrum of ZnO/CNT nanocomposite. The given sample was examined by EDAX spectrum and Zinc, Oxygen, and carbon signals have been detected, suggesting that the nanocomposite is made up of Zn (64.56 %), O (10.06 %) and CNT (23.44%).

4. CONCLUSION

ZnO-CNT has been successfully synthesized using the hydrothermal method. UV-Vis absorption spectra confirmed the result of wavelength 205 nm and the band gap of ZnO-CNT were found to be 3.3 eV. The morphology and particle size of the ZnO/CNT nanocomposite was studied FESEM and XRD analyses. The shape of the ZnO nanoparticle obtained is granular and well dispersed. The CNT nanotubes are the flake like structures. The XRD confirm the result of the average crystalline size of ZnO-CNT was found to be 39 nm. The EDX analysis proved the presence of Zn, O, and CNT elements within ZnO/CNT nanocomposite.

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