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Preparation and Characterization of Cd Doped ZnO Nanoparticle by Combustion Method

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Abstract: ***Cadmium doped Zinc oxide nanopowder was synthesized by simple and inexpensive combustion technique using zinc nitrate and glycine. We found that in the combustion process nitrate ions acted as an oxidant. The powder XRD analysis confirms the crystallinity of the synthesized sample with crystallite size of 50 nm for the various doping concentration of 1%, 3%, 5%. The absorbance near UV region decreases with increase in dopant concentration. It is evident that from the photoluminescence spectrum, the PL intensity increases with increase in Cd dopant.***

Keywords: Zinc oxide, nano particle, combustion, Glycine

1. Introduction

Zinc oxide (ZnO) nano structured material was broadly researched due to its wide band gap (3.3 eV) with high exciton binding energy (60 meV) [1-4]. In recent decade it has been widely used in many applications such as functional devices, thermoelectric materials, UV protection, photocatalysis, field emission displays, solar cells etc. due to their excellent physical and chemical properties [2-4]. Recently, several researchers [1-2] have found that combustion technique is capable of producing ultra-fine powders of metal oxide nanopowder in a shorter time and at a lower calcinations temperature with improved powder characteristics[5-11].In the present study, we synthesize Cd doped ZnO via simple combustion method and the work was focussed to reveal the optical and PL property of the synthesized material.

2. Experimental Procedure

Zinc oxide (ZnO)nanoparticlewas synthesized by a simple combustion method which allows efficient synthesis of nano-size materials. Glycineacts as a fuel material and zinc nitratewas served as a precursor and oxidiser to synthesize ZnO nanopowder. The dopant Cd is added to zinc nitrate with required molar ratio and glycine is also added along with it, in a molar ratio of 0.9:1(zinc nitrate+Cd :glycine) and stirred well for 80 minutes in 100ml double distilled water. The obtained solution is heated (‑150 °C) till combustion reaction occurs.The resultant powder was collected and dried at 80°C in oven and it was utilized for further characterization.

3. Results And Discussion

3.1 Powder X-Ray Diffraction

The powder x-ray diffraction pattern of the synthesized sample (Cd doped ZnO) was recorded using powder x-ray diffraction system. X-ray diffraction was recorded for the sample by means of a slowly moving radiation detector in the range of 10°-70° where monochromatic wavelength of 1.5405 Å (Cu) was used. The figure 3.1 shows the x-ray diffraction patterns of pure and doped zinc oxide nanocrystals.

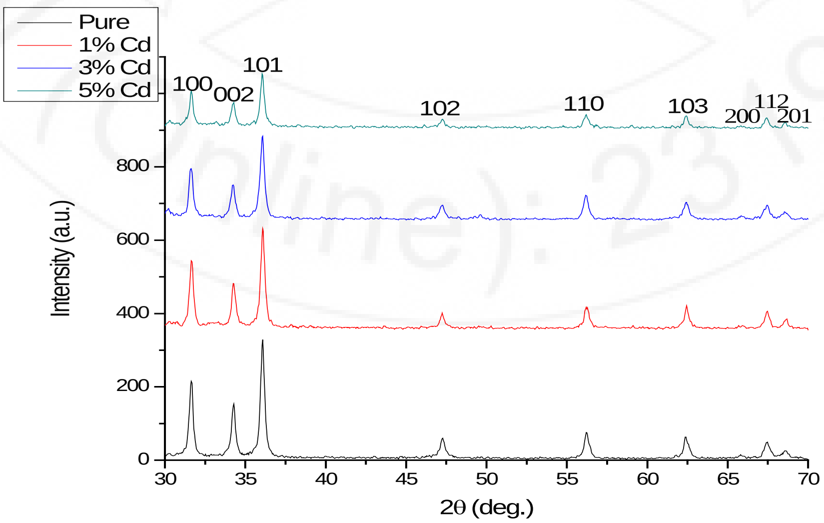

Figure 3.1: X-ray diffraction pattern of the pure and Cd doped ZnO

The peaks of the x-ray diffraction pattern can be compared with the standard available data for the confirmation of the structure, with the use of JCPDS (Joint Committee on Powder Diffraction Standards) card no. 36-1451. Thus the observed patterns reveal the presence of hexagonal phase with zincite structure. The crystalline sizes were approximately estimated to be 50 nm by using the Scherrer equation from the full-width at half maximum (FWHM) of diffraction peaks. The diffraction pattern of zinc oxide is observed between the 2θ values of 30° and 70°. The peak intensity of ZnO decreases with ratio of Cd dopant increases 0 to 5 mol %. Therefore, ZnO nano structures crystalline nature decreases with Cd dopant.

3.2 UV-Vis Spectroscopy

The UV-Vis absorbance of the sample was measured using a Cary 5E UV-Vis Spectrophotometer. The observed spectrum is shown in figure 3.2.The UV-VIS spectrum shows that the absorbance is high below 380 nm wavelength region, and the dopant decreases the absorbance of ZnO considerably. After 380 nm the absorbance of pure ZnO is less compared with Cd doped ZnO and the absorbance increases with increase in dopant concentration.

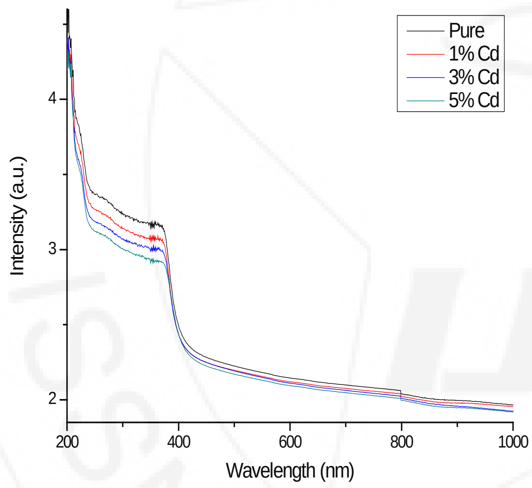

Figure 3.2: UV-Vis Absorbance spectrum ofthe pure and Cd doped ZnO

3.3 Photoluminescence spectroscopy

The photoluminescence (PL) spectrum of Cd doped zinc oxide is obtained from the use of a PL spectrometer. The spectrum of pure and doped ZnO is shown in the figure 3.3. Photoluminescence (PL) spectra of Cadmium doped ZnO nano structures are measured with an excitation wavelength of 270 nm, the intensity of PL emission is found to be increasing with increase in Cd dopant. ZnO has been doped with Cd to narrow the band gap. The band gap of ZnO nanocrystals could be tuned in the range of 2.25-3.22 eV by the use of Cd ions as dopants.

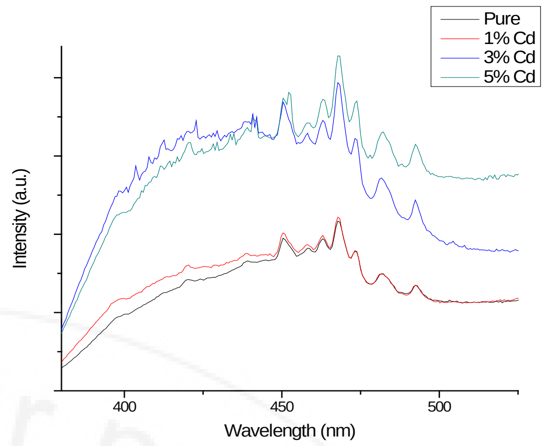

Figure 3.3: PL Emission spectra of the pure and Cd doped ZnO

4. Conclusion

Cadmium doped Zinc oxide nanopowder was synthesized by simple and inexpensive combustion technique using zinc nitrate and glycine. We found that in the combustion process nitrate ions acted as an oxidant. The powder XRD analysis confirms the crystallinity of the synthesized sample with crystallite size of 50 nm for the various doping concentration of 1%, 3%, 5%. The absorbance near UV region decreases with increase in dopant concentration. It is evident that from the photoluminescence spectrum, the PL intensity increases with increase in Cd dopant.

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