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# Structural, Optical and Photoluminescence Studies on Cd-Doped ZnO Nanoparticles: Synthesized by Polyol Method

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**Abstract:** ***Cd-doped ZnO nanoparticles were synthesized by Polyol method and subsequently have been characterized by their Structure, Optical and Photoluminescence. XRD and PSA results revealed the formation of Cd-doped ZnO nanoparticles with an average crystallite size of 50 nm and average particle size of 246nm. From Zeta Potential measurements the Zeta Potential was found to be -29.2 eV indicating the stability of prepared nanoparticles. From Uv-Vis studies, it is found that the absorption of undoped ZnO is less compared with Cd- doped ZnO and the absorbance increases with increase in dopant concentration. Photoluminescence studies revealed that the samples are with high structural and optical quality.***

**Keywords:** Cd-doped ZnO nanoparticles, Polyol method, Structure, Optical and Photoluminescence**.**

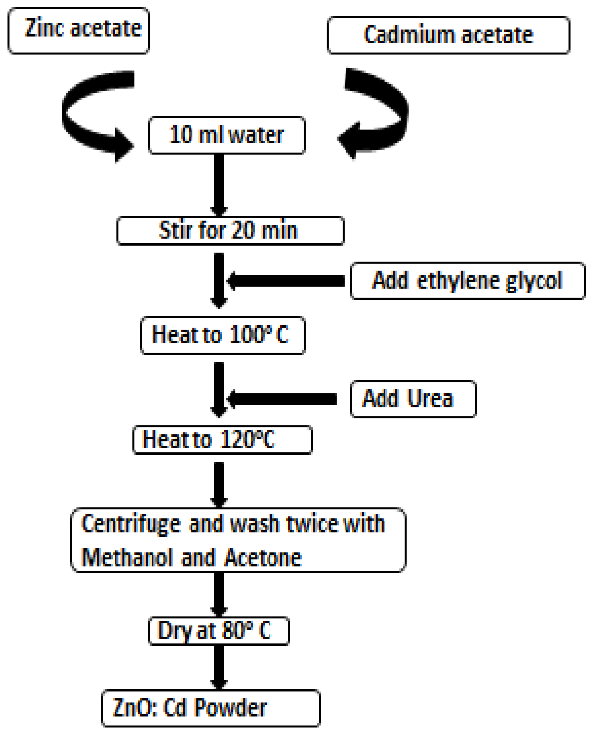
## 1. Introduction

Zinc oxide (ZnO) nano structured materials have attracted great attention during the past two decades,due to their optimized optical, electrical and gas sensing properties.ZnO is a typical II-VI compound semiconductor, with a direct band gap of 3.2 eV at room temperature and 60 MeV as excitonic binding energy, is a very good luminescent material used in displays,photo detectors, light emitting diodes, Ultraviolet and visible lasers, Solar cells components, piezoelectric devices and other such devices[1-3]. ZnO doped with various kinds of elements has recently been reported to have a higher electrical conductivity, and thus, is also expected to be used as a transparent conductive oxide [3].Recently, a no of techniques such as reverse micelle, hydrothermal, sol-gel, polyol and wet chemical methods have been used for the synthesis of ZnO nanoparticles, however among all the polyol method is one of the more widely recognized methods due to its several advantages like soft chemistry, easy to handle and requiring no special or expensive equipment.[5]. In the present study, we have synthesized Cd doped ZnO by simple Polyol method and the work was focussed to reveal the structural, optical and PL properties of the synthesized material.

## 2. Experimental Procedure

Cd-doped ZnO Nano particles were synthesized by a simple and low cost Polyol method using Zinc acetate, Cadmium acetate as starting materials. Ethylene glycol was used as a solvent and stabilizing ligand. First, an accurate weighed amount of Zinc acetate and cadmium acetate are added in 10 ml double distilled water and stirred well for 20 minutes. After that 20 ml of ethylene glycol was added to the solution. Solution was shaken and kept under stirring. A thermometer was used to measure the temperature. When the temperature was raised to 100$^{o}$C, around 2 gm. of urea was added and temperature was raised further to 120$^{o}$C and maintained at this temperature for 2 hours. The precipitate obtained after 2 h of reaction was cooled, centrifuged, washed twice with methanol, and twice with acetone. The precipitate was dried overnight under ambient conditions.

## 3. Flowchart For The Preparation Of Cd-Doped Zno Nanoparticles



# 4. Results and Discussion

## 4.1 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 Ǻ (Cu) was used. The figure 3.1 shows the x -ray diffraction pattern of Cd doped zinc oxide nanomaterial.

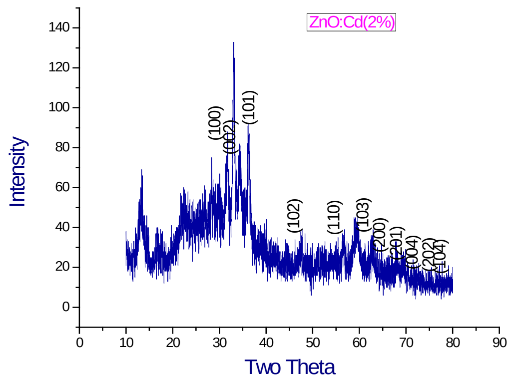



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**Figure 3.1:** X-ray diffraction pattern of the pure and Cd doped ZnO

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.79-0206.The major diffraction peaks shifted slightly towards smaller angles may suggest that $Cd^{+2}$ ions would uniformly substitute into ZnO lattice. Thus the observed patterns reveal the presence of hexagonal phase with wurtzite structure which is a stable phase of ZnO is conserved when Cd is doped.[6].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.

## 3.2.Particle size and zeta potential measurements

Particle size and zeta potentials were measured using Nanopartica SZ-100 (Horiba) by using dynamic light scattering technique (DLS).In general, the particles whose zeta potential (either positive or negative) is >30eVare considered to be stable. The present experimental PSA results for synthesized nanoparticles revealed the formation of Cd-doped ZnO nanoparticles with an average particle size of 246 nm. From Zeta Potential measurements the Zeta Potential was found to be - 29.2 eV indicating the stability of prepared nanoparticles.

## 3.3UV-Vis Spectroscopy

The UV-Vis absorbance of the sample was measured using a LABINDIA UV 3092 UV-Vis Spectrophotometer. The observed spectrum is shown in figure 3.2.The UV-VIS spectrum shows that the absorbance is high below 305 nm wavelength region, and the dopant increases the absorbance of ZnO considerably. After 305 nm the absorbance of pure ZnO is less compared with Cd doped ZnO .The cut off wavelength 208 nm is observed when 2 mol % of Cd is doped into ZnO. This could be a suggestable doping to get good absorption results in the entire UV-Visible spectrum.

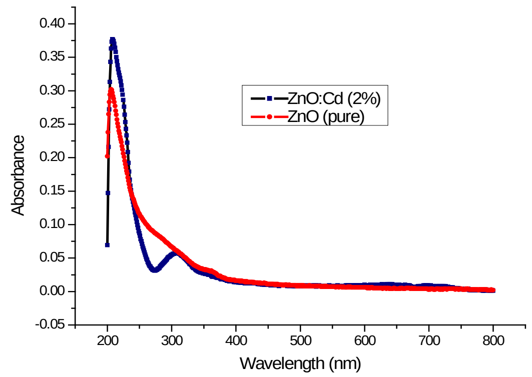


**Figure 3.3:** UV-Vis Absorbance spectrum ofthe pure and Cd doped ZnO

## 3.4 Photoluminescence spectroscopy

The photoluminescence (PL) spectrum of Cd doped zinc oxide is obtained from the use of a PL spectrometer. Room temperature PL spectrum of pure and Cd doped ZnO nanoparticles is shown in the figure 3.4.

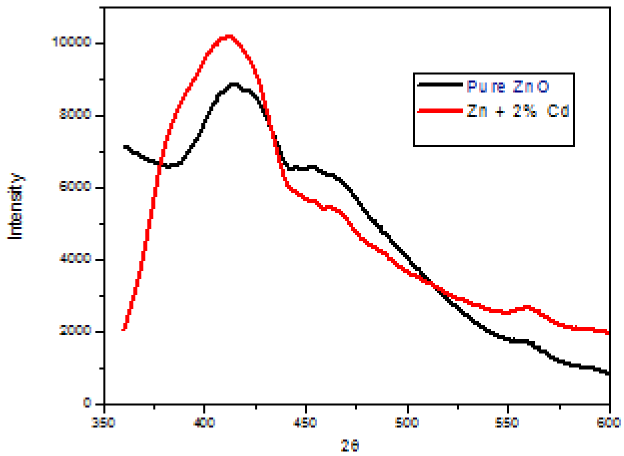


**Figure 3.4:** PL Emission spectra of the pure and Cd doped ZnO

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. High Photoluminescence (PL) is observed when 2 mol% of Cd is doped into ZnO. This could be attributed to the high purity and perfect crystallinity of the synthesized nanoparticles. ZnO has been doped with Cd to narrow the band gap. The band gap of ZnO nanomaterial could be tuned in the range of 2.25-3.22 eV by the use of Cd ions as dopants.

## 4. Conclusion

Cadmium doped Zinc oxide nanoparticles were synthesized by simple and inexpensive Polyol technique using zinc acetate, Cadmium acetate and ethylene glycol. When the synthesis temperature was 150- 170 $^{o}$Cin the polyol process, we obtained Cd-doped ZnO nanoparticles not only with a small size but also with good absorption in the Ultraviolet and Vis regions. The powder XRD and PSA analysis confirms the crystallinity of the synthesized sample with an average crystallite size of 50 nm and average particle size of 246 nm for the doping concentration of 2%. The photoluminescence spectrum reveals the fact that the Cd dopant increases areasonable PL intensity. These results showed a great promise for the Cd-doped ZnO nanopowders with applications in optoelectronic devices.

## 5. Acknowledgements

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