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# SYNTHESIS AND CHARACTERIZATION OF ZNO NANOPARTICLES WITH ZINC CHLORIDE AS ZINC SOURCE

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## ABSTRACT

*ZnO nanoparticles Synthesized by precipitating Zinc Chloride have been characterized Optically and Structurally. XRD is used for the structural characterization where the lattice constant was determined as a=b=3.2492Å, c=5.20661 Å with hexagonal structure and crystallite size as~*$5.3689nm$*. UV-vis spectrometer was used to obtain UV-vis absorption spectrum where excitonic peaks were obtained at wavelength of 277 nm and 235 nm.*

**Keywords:** ZnO, nanoparticles, UV-vis , XRD, Lattice Constant

## INTRODUCTION

Ultrafine semiconductors particles are of great scientific interest as they are effectively a bridge between bulk materials and atomic or molecular structures. They possess special properties such as a large surface to volume ratio, increased activity, special electronic properties and unexpected optical properties as they are small enough to confine their electrons and produce quantum effects. During the past decade a considerable effort has been spent in the preparation and investigation of the family of II-VI nanoscale semiconductors due to their fundamental electronic and optical properties. Various methods for the production of II-VI nanocrystals with narrow size distribution have been reported (Yu Zhao et al., 2004) (Tsuzuki T and Mccormick P.G., 1999; Jiang C et al., 2007). Among all the II-VI compounds, ZnO is attracting tremendous attention due to its interesting properties like wide direct band gap of 3.3eV at room temperature and high exciton bonding energy of 60meV(Shriwas Ashtaputre et al., 2005) Zinc Oxide is widely used in a number of application like varistors(Rana etal., 2010) UV lasers, gas sensors, photoprinting, electrochemical nanodevice, sunscreen lotion cosmetics and medicated creams(Ravichandrika., et al 2012)due to its several properties such as good transparency, high electron mobility, strong room temperature luminescence .Different types of techniques have been used to synthesize ZnO such as sputtering, spray pyrolysis (Abdelkader Djelloul et al.,2008) Solvothermal (Wang et al., 2005) Hydrothermal (Ni YH et al., 2005) ,Ball milling method (Lemine et al, 2010) and Wet Chemical method (Satyarana et al 2012; Shah and Al-shahry,2009; Singh et al,2012) was reported to be simple and easy in producing high yield, high purity ZnO at room temperature. In this paper ZnO nanoparticles are produced synthesized from $ZnCl_2$ using the wet chemical method at room temperature.

## EXPERIMENTAL PROCEDURE

Zinc oxide nanoparticles were synthesized by wet chemical method using Zinc Chloride and Sodium Hydroxide as precursors. The concentration ratio between the Zinc chloride and sodium hydroxide was determined using the chemical equation formula shown below:

$$ZnCl_2 + 2NaOH \rightarrow Zn(OH)_2 + 2NaCl$$

Hence, 0.4M aqueous methanol solution of zinc chloride was kept under constant stirring using magnetic stirrer to completely dissolve the zinc chloride and 0.8M aqueous methanol solution of sodium hydroxide was also prepared in the same way and kept under stirring. The speed of stirring the Zinc chloride was increased after its complete dissolution and 0.8M aqueous solution of sodium hydroxide was added for 20mins in drops. The colorless solution obtained after complete addition of addition of NaOH was allowed to be under constant stirring for 2hrs and later sealed and kept overnight. After the whole process Zinc hydroxide with some unknown impurities assumed settled at the bottom and the excess mother liquor obtained on top was removed. The remaining solution was centrifuged for 5mins and the precipitate obtained was washed five times with deionized water and methanol to remove the by products which were bound with the Zinc hydroxide and then dried in air atmosphere at about 400°C. After drying Zn $(OH)_2$ is completely converted to into ZnO explained by the equation below.

$$Zn(OH)_2 \rightarrow ZnO + H_2O$$

**Characterization of the Zno Nanoparticles.**

The prepared ZnO nanoparticles were characterized for their optical and Nano structural properties. X-ray diffraction pattern for the ZnO nanoparticles was recorded using an X-ray diffractometer (MD-10) using CuKa radiation of wavelength λ=1.5406 in the scan range 2θ=20˚-90˚. The optical absorption spectra of ZnO dispersed in water were recorded using UV-VIS Spectrophotometer (GENESYS 10s v1.200 2L7H311008).

## RESULTS AND DISCUSSIONS

The functionalized particles were characterized by the following techniques.

### UV-VIS Spectroscopy

Figure1 shows the uv-vis absorption spectrum of ZnO sample. The sample shows excitonic peaks with the same absorbance intensity at wavelength of 277nm and 235nm. For ZnO OF wide band Gap of 3.37eV, an absorption peak is expected at $\sim 358nm$. Thus there is a strong blue shift in the absorption spectra of the ZnO sample indicating that particles must be smaller than the bohr radius of exciton which is for ZnO. Though more excitonic peaks were noticed with absorbance intensity very close to that of 277nm at wavelength of 262nm and 364nm.

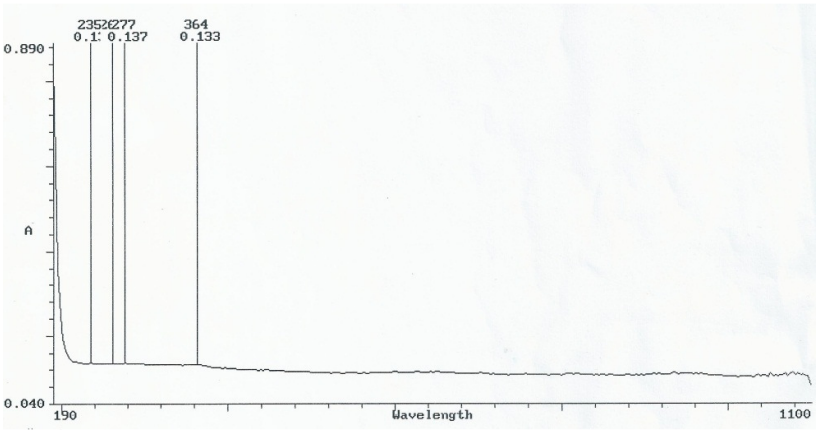


Figure1: UV-vis spectrum of the synthesized ZnO powder.

## X-RAY Diffraction Technique

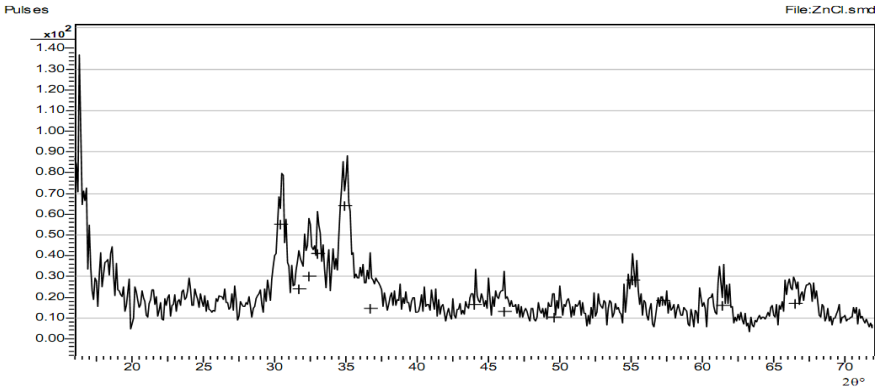


Figure2: X-RD pattern obtained for the ZnO powder

From the X-ray diffraction pattern shown above the average crystal size of the ZnO nanoparticles as calculated using Scherrer formula was$\sim 5.3689nm$. The peaks at scattering angles $(2\theta)$of $31.64°, 34.85°, 36.65°$ ,46.1 $and$ 57.12 which corresponds to (100), (002), (101) (102) (110) and (200) crystal plane respectively. It also shows that the particle has a hexagonal phase (wurtzite structure) with lattice constants a = b = 3.2492 $\AA$, c = 5.20661 Å .

## CONCLUSION

**ZnO** has been synthesized from zinc chloride using sodium hydroxide as the precipitant. The structural and optical analysis has been done using XRD and UV-VIS spectroscopy which reveals hexagonal structure with crystal size of $\sim 5.3689nm$ and excitonic absorption peak at 277nm and 235nm wavelength respectively.

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