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Structural Optical properties of Zinc Oxide (ZnO) Nano Particles

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Abstract: ***Nano structured Zinc oxide (ZnO)materials have many applications in optics and photonics. ZnO nanoparticles were synthesized at room temperature by co-precipitation method. The structural properties of prepared powder is characterized by powder x-ray diffraction(XRD) , morphology is investigated using SEM. The evaluated average size of prepared powder was 16nm.The strain and dislocation density were also calculated using XRD studies. The SEM image shows the Stone-like morphology of the nanopowder, optical properties were also studied.***
Keywords: ZnO nanoparticles, stone like shaped, co-precipitation method, optical absorption.

I. INTRODUCTION

Zinc oxide (ZnO) is a n-type semiconductor material, has a band gap (3.3ev).It has variety of applications in the visible and near ultraviolet region[1,2]. been widely used in near uv emission, gas sensors , solar cells, LED's ,transparent conductor and piezoelectric applications[3].There are several methods of preparation of nano materials. In our present work ZnO nanoparticles are prepared by chemical co-precipitation method[4,5]which of low cost.ZnO exists as hexagonal wurtz structure with two lattice parameters a=0.324nm and c=0.5207nm(JCPDS card number :36-1451)[6]. The prepared sample was characterized by powder XRD,UV,SEM and EDS analyses and the results are discussed.This work is carried out to investigate the synthesis and characterization of ZnO nanoparticle[7]

II. EXPERIMENTAL DETAILS

Zinc nitrate (Sigma aldrich) is the chemical compound with formula ($Zn(NO_3)_2.6H_2O$) used as a precusor in preparing ZnO nanoparticle in chemical precipitate method[8] .in our present work NaOH is used to obtain precipitate, All the reagents are purchased from sigma Aldrich and used without further purification .for the synthesis of ZnO nanoparticle 0.5M ($Zn(NO_3)_2.6H_2O$) was dissolved in a mixed solvent of water 100ml and added to solution of 0.3M NaOH (150)ml under constant stirring at 80^0 c and evaporated for 4 hours .the product was dried at 500^0c for 4hr then grounded into a fine particles .the dried precursor powder was to obtain the ZnO particles.

During Stirring

$Zn(NO_3)_2.6H_2O+2NaOH \rightarrow Zn(OH_2)+2Na(NO_3)$

During Drying

$Zn(OH_2) \rightarrow ZnO+ H_2O$

The x-ray diffraction (XRD) was used to identify the crystalline phase and to estimate ceystalline size by Rigaku miniFlex 600. The morphology was characterized by field emission scanning electron microscopy (SEM), EDS images are taken from s-3400,25kv. The FT-IR spectrum of the sample is recordrd on shimadzu-IR Affinity IS FT-IR Spectrophometer in the range of 400-4000cm. The UV and Visible absorption spectroscopy is recorded by JASCO-V670 spectrophotometer is used to record optical absorption spectra of ZnO nanoparticle

III. RESULTS AND DISCUSSIONS:

A. XRD Pattern for ZnO Nanoparticle

The X-ray diffraction (XRD) was used to identify the crystalline phase and to estimate crystalline sizes. fig(1) shows the XRD morphology of ZnO nanoparticle.In our present study the diffraction peaks are observed at angles (2Θ) =37.09°

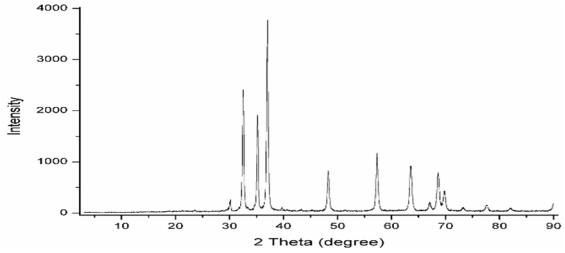

Fig 1: XRD Spectra of ZnO Nanoparticles

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The mean size of ZnO nanoparticle has been estimated from the FWHM and Debye-Scheer formula[9] $D=k\lambda/\beta\cos\theta$ where D is crystalline size, k=0.89 is the shape factor, d is the wavelength of x ray radiation ($1.5406A^0$) is the Bragg diffraction angle and b is full width at half maxima (FWHM).The dislocation density is used to determine the amount of defects present in the grown sample $\delta=1/D^2$

The characteristic peak located at $2\theta=37.09^{\circ}$ corresponding crystallite size is shown in below table 1.

Table 1: Average crystallite size of ZnO nano particles.

Sample code	Position (2θ)	FWHM (β)	Crystallite Size (D)nm	Dislocation Density $\delta=1/D^2\times10^{15}$
ZnO	37.09	0.5215	16.79	3.5473

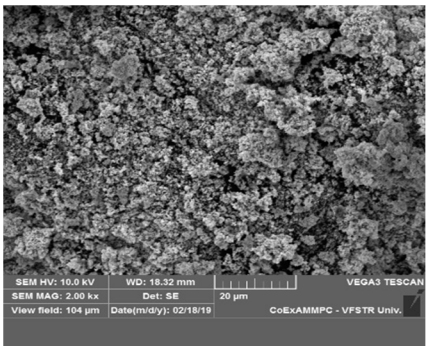

Fig 2: SEM image of ZnO nanoparticles

SEM is one of the promising technique for the topography study of the samples and it gives important information regarding the growth mechanism,shape and size of the particles.
Fig(2) shows the SEM images of the ZnO nanoparticle prepared by co-precipitation method. The ZnO nanoparticles formed were *STONE* like structure.

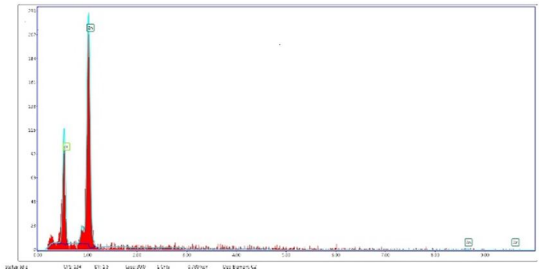

Fig:3.EDS of ZnO nanoparticle

The Energy dispersive spectroscopy (EDS) of ZnO nanoparticle confirms the existence of Zn and O with weight percent.

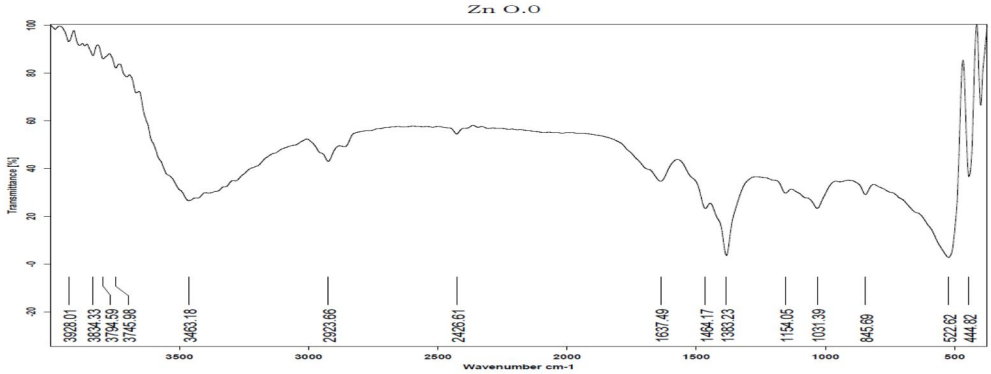

Fig 4:FT-IR spectra of ZnO nano Particles

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fig (4) shows that the FT-IR spectra of ZnO powder sample annealed at 500c shows a peak at 1637cm^{-1} which represent a symmetric c=o stretching of Zinc nitrate and another peak at 3463cm^{-1} which belong to O-H stretching of hydroxyl group. In addition 2 peaks at 522cm^{-1} and 2426cm^{-1} which are attributed due to stretching vibrations of Zn-O bonds[10]and CO2 on the metallic respectively are also observed[11].

UV-Vis Absorption Spectroscopy is widely used technique to examine the optical properties of nanosized particles.The absorption spectrum of ZnO nanopowder is shown in fig (5).It exhibits a strong absorption band at about 219nm[12].

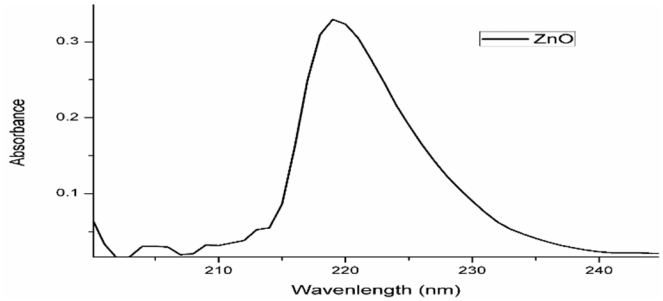

Fig .5: UV-Vis spectra of ZnO nanoparticles

IV. CONCLUSION

XRD pattern of synthesized ZnO nanoparticle confirms that the formation of ZnO from each precursor was a hexagonal wurtzite zinc oxide structure with characteristic peak at
$2\theta=37.09^{0}$. FT-IR spectra reveals the existence of various functional groups present in the prepared nanopowder. The morphology of prepared sample is analysed with the SEM images and found to be *STONE* like shape. The UV-Visible spectra of ZnO nanoparticle shows the sharp absorption edge observed around 219nm.

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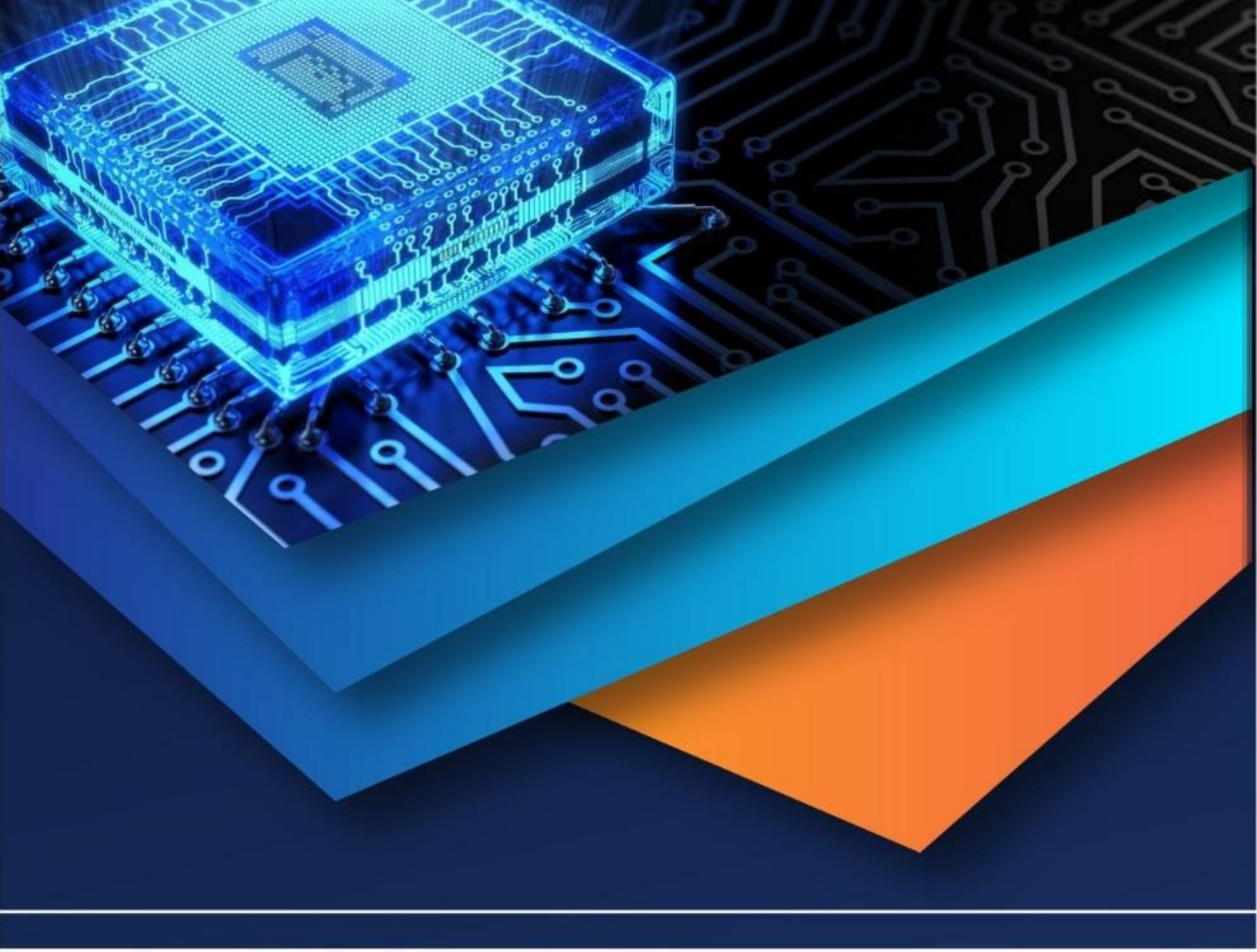

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