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Synthesis of Zinc Oxide Nanoparticle by Sol-Gel Method and Study its Characterization

Aditya Vishwakarma[1], Dr. Satya Pal Singh[2]
[1]*M.Sc Student,* [2]*Assistant Professor, Department of Physics and Material Science, Madan Mohan Malaviya University of Technology, Gorakhpur, India*

Abstract: ***Now a day the more interesting and attracting point in research area is synthesis of nanoparticles with specific properties. Due to unique properties of oxide of nanoparticles achieve great attention in research areas. It is widely used as solar energy conversion, catalysis, varistors, gas sensors, non linear optics etc. ZnO nanostructures obtained a great attention in the research area because ZnO has large band gap. There are many different methods for synthesis of ZnO nanoparticles such as sol-gel method, chemical vapor decomposition, thermal decomposition, hydrothermal method etc. Among this method sol-gel method is the best for the preparation of ZnO nanoparticle. Fabrication of nanomaterial by sol gel method is simple and also its have advantage to control the size of material and morphology study of the material. The main objective of this paper is synthesis of ZnO nanoparticle by sol-gel method and studies its characterization. In this zinc acetate used as precursor, methanol as solvent, NaOH used as medium. The obtained ZnO nanoparticles are homogeneous and consistent in size corresponds to the XRD result that exhibit good crystallinity .ZnO nanoparticles are successfully synthesized by sol gel method. The obtained ZnO nanoparticles are characterized by XRD, SEM, and UV-visible***

Keywords: Zinc Oxide nanoparticle, Sol-gel, XRD, SEM, UV-Visible

I. INTRODUCTION

ZnO is a member of II-VI semiconducting compounds and occurs naturally in mineral zincates. Zinc oxide nanoparticles play a great role in industrial areas. This is because it has some specific properties such as excellent heat resistance, low electron conductivity, anti bacteria and anti corrosion. The applications of zinc oxide nanoparticle are capacitors, protective over coating, photo printing, solar cells, electro photography and blue lasers diode and conductive thin films in LCDs.

J.N. Hasnidawani et al.,(2015) discuss the synthesis of ZnO nanostructures using Sol-gel method. It concludes that ZnO nanoparticle is successfully synthesized by sol gel method. It obtain nano rod like structure and particle nano size range 84.98nm.

S. Jurablu et al.,(2015) discuss about the synthesis of zinc oxide nanoparticle and study its structural and optical properties. It concludes that TEM and XRD result shows that ZnO has hexagonal wurtizite structure with mean grain size about 28nm. From SEM images it is clear that the shape of particles change as increasing in temperature. The UV-Visible result shows a wider band gap 3.49ev. Riyadh M. Alwan et al (2015) discuss the synthesis of ZnO nanoparticles via sol-gel route and their characterization. The ZnO nanoparticle characterized by SEM, TEM, XRD. This paper shows that particle size 58.3nm by XRD. From SEM analysis get particle size about 100-200nm at 80°C.

Sajjadi et al.,(2005) discuss about sol-gel process and its application in nanotechnology. It shows that sol- gel method is develop in may research areas. It is simple and best method. By sol – gel method , obtained very fine particles.

The main objective of this paper is synthesis of ZnO nanoparticle by sol-gel method and studies its characterization.

II. EXPERIMENTAL SECTION

In this experiment sol-gel technique is used. In this research the use of materials are Zinc acetate dihydrate, Sodium Hydroxide, methanol and distilled water. Zinc acetate dihydrate is used as precursor and methanol as a reagent. Distilled water is used as solvent. All chemical reagents in this experiment were obtained from commercial sources as guaranteed-grade and were used as received without further treatment. In this experiment sol-gel method is used for synthesized ZnO nanoparticle. In this experiment Zinc acetate dihydrate was used as zinc precursor as zinc precursor. Mixing 0.2M zinc acetate dihydrate in methanol at room temperature. After then mixing this solution ultrasonically at 25°C for 120 min. then we get clear and transparent sol with no precipitate and turbidity was obtained. Now 0.02 M of NaOH was added to the sol and stirred ultrasonically for 60 min. keep the sol undisturbed till white precipitates settle down at the bottom of the sol. After precipitation, the precipitate were filtered and washed with excess methanol to remove starting material. Precipitates were dried at 80°C for 15 min on hot plate. After this precipitates were annealed at 400°C for 30 min.

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III. RESULT AND DISCUSSION

A. SEM Analysis

SEM analysis shows the study of surface morphology of nanoparticles. Fig- 1 shows the sem images of ZnO nanoparticle. From SEM images, observe that the size of ZnO nanoparticles is 15 to 25 nm and spherical in shape.

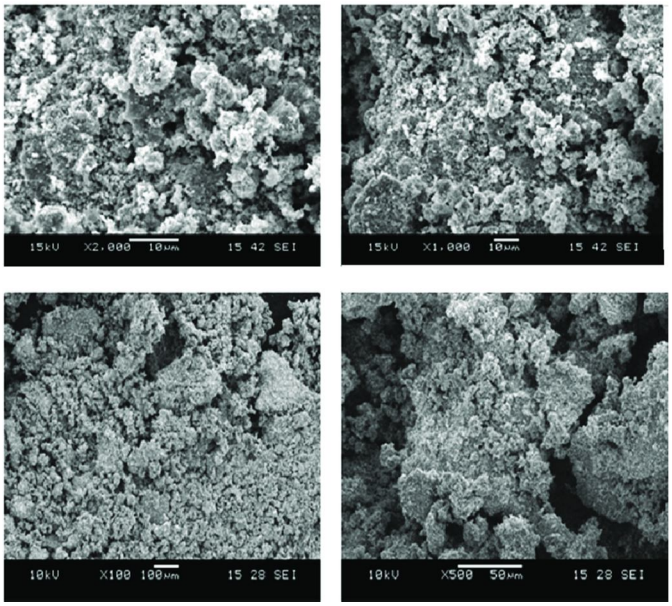

Fig -1 SEM images of ZnO nanoparticle (Above fig is reproduce from reference [13])

B. XRD Analysis

Figure-2shows the typical XRD pattern of ZnO nanoparticles in this work.XRD analysis determined the phase's presence in nanopowder. From the XRD pattern analysis, we determined peak intensity, position and full-width at half maximum (FWHM) data. The mean size of the ordered ZnO nanoparticles has been estimated from the full width at half maximum (FWHM) using Debye-Sherrer formula according to following equation:

$$D=0.89\lambda/b\cos\theta$$

Where 0.89 is the shape factor, λ is the x-ray wavelength, b is the line broadening at half the maximum intensity (FWHM) in radians, and θ is the Bragg angle.

From the result (Figure 2) the peaks were identified at 31.77∘, 34.44°, 36.28°, 47.60°, 56.52°, 62.88°, and 67.96°.

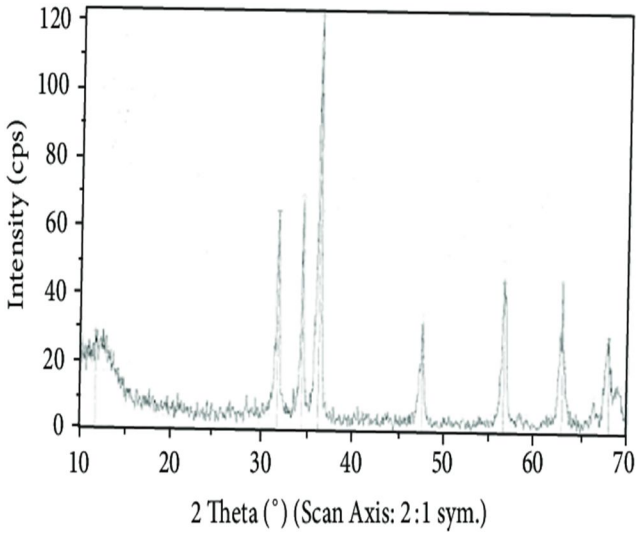

Fig -2 XRD pattern of ZnO nanoparticle (Above fig reproduce from reference [13])

C. UV-Visible

UV-Visible gives the bandgap of nanoparticles. Figure 3 shows the UV-Visible spectrum. Spectrum result shows the maximum peaks at 235nm. Therefore the ban gap wavelength of ZnO is 235nm. The actual band gap wavelength of ZnO nanoparticle is 388nm which is higher than 235nm which may be due to agglomeration and settling of nanoparticles in a cuvette which cause decreasing the absorption of radiation.

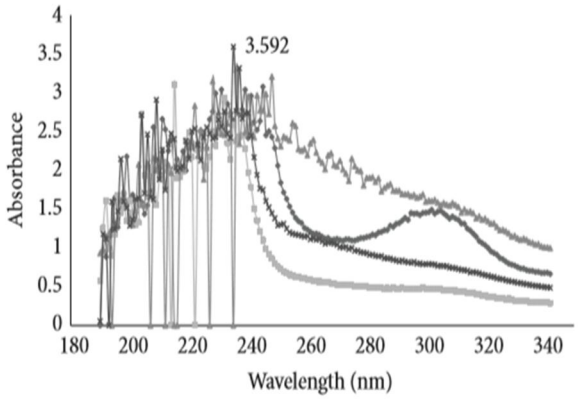

Fig-3 UV-Visible spectrum of ZnO nanoparticle (Above fig reproduce from reference [13])

IV. CONCLUSION

The ZnO nanoparticle obtained successfully via sol-gel method. The ZnO nanoparticle is successfully characterized such as SEM, XRD and UV-Visible. From the SEM analysis, the size of nanoparticles in the range 15nm to 25 nm. And also show that it is spherical in shape. XRD analysis result shows average nano-size range about 81.28nm to 84.98nm using Scherrer's equation. From UV- Visible spectrum result shows the bandgap wavelength is about 235nm.

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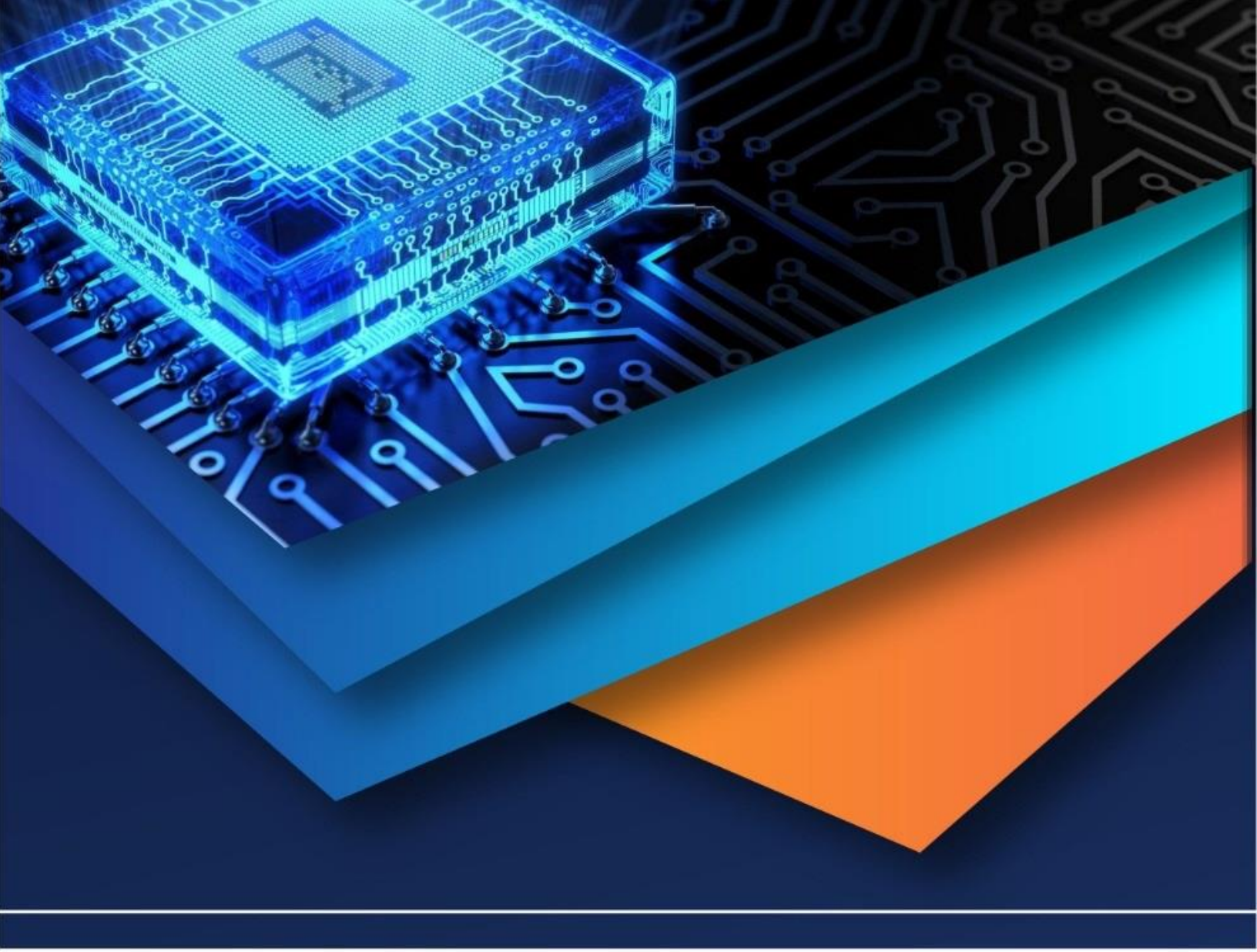

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