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Synthesis of Zinc Oxide Nanoparticles for Antibacterial Application

S. V. Nikam* and B. T. Jadhav
Department of Nanoscience and Technology, Yashavantrao Chavan Institute of Science Satara
Corresponding author Email:sushamanikam12@gmail.com

ABSTRACT
In this study Zinc Oxide nanoparticle were synthesized by sol-gel process. With this method it is possible to control the particle size and reaction parameters can be maintained easily. For the synthesis of ZnO nanoparticles, zinc acetate dehydrate is used as a precursor and methanol as solvent. The sol was converted into gel by heating and finally into white coloured nanoparticles. Further ZnO nanoparticles were characterized by UV-Visible spectroscopy, XRD and SEM techniques. The synthesized nanoparticles can be have good antimicrobial activity and used as a antibacterial agent or in food preservative.
Keywords: *Sol gel method, Zinc Oxide Nanoparticles, antibacterial activity.*

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INTRODUCTION

Nanotechnology is described as a procedure which modifies the materials at the nanoscale and explores them to various distinguished programs for society [1]. In recent technology there has been an increase in application of metallic nanoparticles like gold and silver out of which gold nanoparticles are being widely utilized in most cancers remedy in the shape of gold Nano shells and Nano tubes [2]. In this article the synthesis of zinc oxide nanoparticles and their various characterizations were represented. Zinc oxide which belongs to II-VI institution of semiconductor crystallizes in three forms namely cubic, wurtzite and zinc blend. Zinc oxide nanoparticles have numerous programs inside the area of generation, medicinal drug, and engineering plastics, in coating applications semiconductor devices, etc. apart from those applications, the zinc oxide also are used in making cosmetics applications. Zinc oxide has a very extensive band gap because of which it can be explored to manyother packages like photo voltaic cell, electric generators and sun cells [3]. Due to non-toxicity Zinc oxide nanoparticles can be used as food preservative [4]. It has many anti-bacterial activities which are used for destroying sickness inflicting pathogens. In this paper we presented the synthesis mechanism of ZnO nanoparticles with the sol gel method, using zinc acetate dehydrate as a precursor.

MATERIAL AND METHODS:

For the synthesis of ZnO nanoparticles Sol gel method was used. It is inexpensive and performed at low temperature [5]. Sol gel method provide easy control over reaction parameters and hence one can optimize the size of synthesized nanoparticles with maintaining its high purity[6]. Zinc oxide nanoparticles were synthesized by sol gel method by using zinc acetate as precursor and methanol as a solvent. 14 gm Zinc acetate dehydrate was dissolved in 112 ml of methanol. The solution was stir for 10-15 min in magnetic stirrer at room temperature. Then it is subjected to gelation at 80°C with constant stirring for 30 min. Then temperature was maintained to 40°C and stir for 1:30 hr. The white precipitate was formed which indicate the formation of ZnO. It is filtered and annealed at 200°C for 4 hr.
The Synthesized materials were further characterized by using UV-Visible spectroscopy, XRD and SEM techniques.
Antibacterial assay: The antibacterial activity of synthesized Zinc oxide nanoparticles was investigated against Gram negative Escherichia coli. The nutrient agar plate was prepared and 0.1 ml of E. coli suspension was spread on plate with sterilized spreader. Wells were bored in each plate with the help of a sterilized borer. The 80 ml and 100 ml of synthesized nanoparticles were loaded into well and plate were kept into incubator for 24 h at 37°C. Zone of inhibition was observed on next day.

Table1: Concentration and zone of inhibition of ZnO Nanoparticles

Sr. No.	Concentration (µl)	ZnO Nanoparticle Zone of Inhibition (mm)
1	80	20
2	100	22

RESULTS AND DISCUSSIONS:

a) Optical Properties:

Optical properties are investigated by UV-vis spectroscopy technique. Following figure 1 shows the absorbance vs wavelength properties. It shows that optical band gap at 3.10 eV.

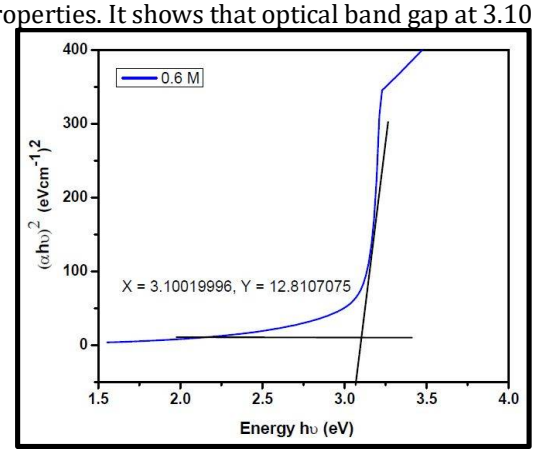

Figure: 1. Optical absorbance spectra of ZnO Nanoparticles

b) Structural properties:

The structural properties of ZnO are investigated by using XRD analysis. Fig. 2 Demonstrates the XRD patterns of ZnO powder in the 2θ range from 20°-80°. XRD pattern shows that particles are polycrystallines with hexagonal Wurtzite structure. XRD pattern shows diffraction peak at (002), (101), (100), (110). The crystallite size was calculated from the plane (002) diffraction peak using Scherer formula:

$$D = \frac{0.9\lambda}{\beta \cos \theta}$$

D is the grain size in a particular orientation, λ is the X-ray wavelength, θ is the diffraction angle corresponding to the particular orientation, β is the width at half maximum intensity (FWHM) of the peak.Crystallite size obtained was 16.93nm.

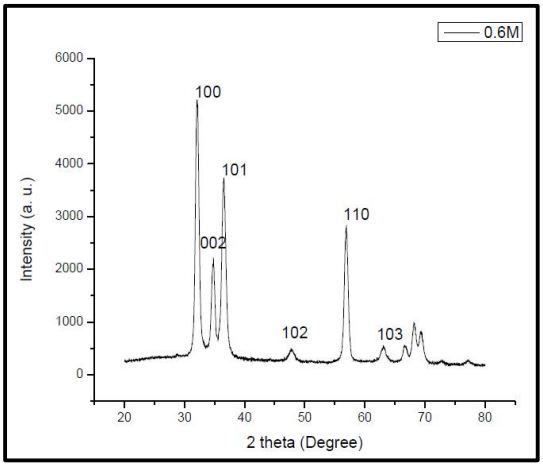

Figure 2: XRD pattern of ZnO nanoparticle.

c) Morphological properties:

Morphological properties of ZnO thin film were investigated by using Scanning Electron microscopy. It shows spherical and uniform distribution of ZnO nanoparticles.

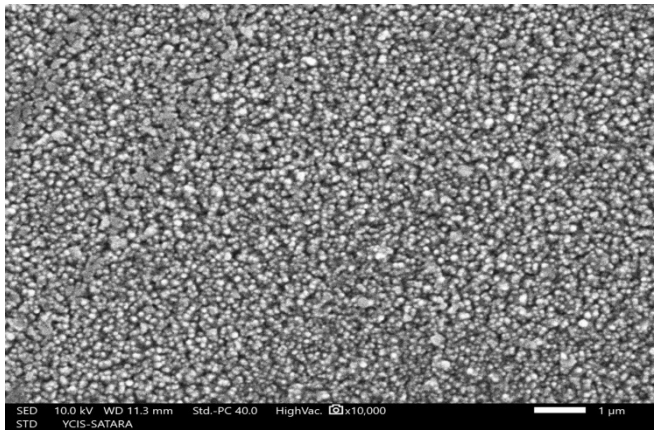

Figure 3: SEM image of ZnO nanoparticles.

CONCLUSION

Zinc oxide nanoparticles were successfully synthesized by sol-gel method using zinc Zinc acetate dehydrate as a precursor and methanol as a solvent material. The UV-Visible spectra shows ZnO nanoparticle with wide energy band gap 3.10 eV. XRD will reflect hexagonal Wurtzite structure and particle size is of 16nm. The antibacterial activity of ZnO nanoparticles was studied against Gram negative bacteria showed that ZnO nanoparticles were potential antibacterial agent for Gram negative Escherichia coli. Zinc Oxide due to its non-toxic in nature and potential antibacterial properties can be used as a food preservative.

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