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Synthesis and Characterization Studies of Pure Znoby Sol-Gel Method

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Abstract: *The pure ZnO nanoparticles were synthesized by Sol-Gel method. The synthesized samples are characterized by X-ray diffraction, energy dispersive x-ray (EDAX) analysis EDAX,UV-visible spectrometer, Scanning Electron Microscope. The XRD studies of the sample confirmed the formation of monoclinic structure and the particle size and lattice constants were analyzed. The XRD patterns show that the average particle size is in the range of 10nm for ZnO respectively. SEM results show Spherical shape for ZnO. A broad absorbance band from UV-Vis spectra is located at around 4.98eV. This is the simple synthesis method and they are used in optical and gas sensor applications, telecommunication cables, conductor wires, connector wires and automotive switches.*

Keywords: Znoby Sol-Gel Method

I. Introduction

Zinc oxide nanoparticles (ZnO-NPs) are common nanoparticles and widely used in many fields such as sunscreen products, cosmetics, pigments, industrial coatings, plastic additives, semiconductors, textiles, and antibacterial agents [1]. Nanoparticles are used as manipulation, sensing, and detection of biological structures and systems. The principal factors which make nanomaterials different from their bulk counterparts include an increase in their relative surface area and quantum effects, which affect their physical and chemical properties [2]

ZnO is an important metal oxides that could be easily grown, environmental friendly and of interest to many applications. It is suitable for industrial, technical and medical applications. Although there are already a number of researches on the preparation of ZnO nanostructures via aqueous techniques which include micro emulsion hydrothermal synthesis [3], direct deposition in aqueous solution [4], surfactant assisted hydrothermal orientation growth [5], alcohol solution refluxing [6] and simple chemical sol–gel process [7].

II. Experimental Details

2.1. Materials

Zinc acetate reagents included a oxalic acid are used for the synthesis Pure ZnO nanoparticles. All chemicals, double distilled water and reagents used were procured from Sigma-Aldrich (United States of America) and Merck (Germany) and were of analytical grade.

2.2. Sample Preparation

Zinc acetate were synthesized by employing a simple sol-gel method by using a oxalic acid. To prepare the zinc acetate nanoparticles, 1g of zinc acetate ($ZnC_4H_6O_4$) was dissolved in 20ml of ethanol. This solution was stirred using magnetic stirrer above 10 minutes and 1g of oxalic acid ($C_2H_2O_4$) was dissolved in another 20ml of ethanol. This solution was stirred using magnetic stirrer above 10 minutes. After the oxalic acid ($C_2H_2O_4$) solution was poured into the zinc acetate ($ZnC_4H_6O_4$) white gel agent was formed. The both zinc acetate and oxalic acid was stirred using magnetic stirrer ½ hours, aging for 12 hours and dried the sample at 100^0C for 24 hours. Finally zinc oxide nanoparticles were obtained.

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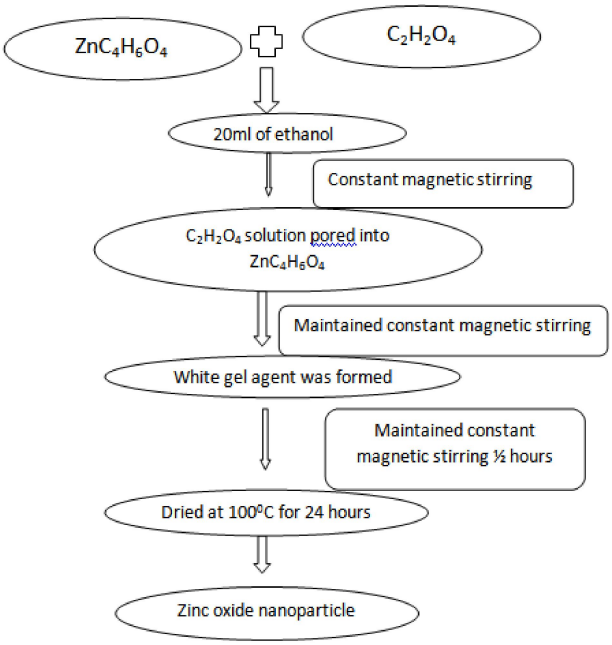
2.3 Flow Chart for Zinc Acetate Nanoparticels



III. Results and Discussion

3.1 Powder X-Ray Diffraction (XRD) Analysis

Powder XRD technique is used to identify the crystal structure, phase purity and grain size of the materials. The XRD patterns of nanoparticles ZnO shown in figure3.1. All the diffraction peaks appearing at corresponding 2θ values at 34.45, 36.29, 47.55, 62.86 and 68.01 are indexed to (110), (201),(212),(221) and (303).The results were matched with (JCPDS 36-1451) Giri et al. [9] reported similar peaks for zinc oxide nanoparticles. No other extra diffraction peaks of other phase are detected, indicating the phase purity and synthesized ZnOnano particle with monoclinic structure. Average grain size calculated using Debye –Schere's formula. Average grain size calculated for ZnO is 10nm.

$$D = K\lambda/\eta\cos\theta$$

Where λ is the X-ray wavelength (1.5418Å), η is the full width of the peaks in radians at half-maximum intensity; θ is the Bragg's angle and K the Scherer's constant (0.9). The estimated average diameter of pure ZnO Nanoparticles calcinated at 100°C is found to as 10nm respectively.

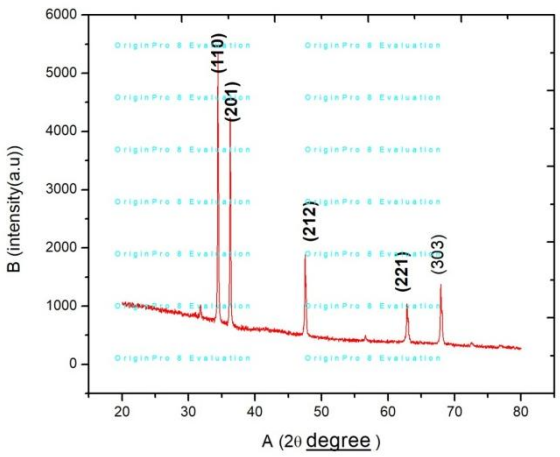


Figure 3.1: XRD pattern for pure Zinc oxide Nanoparticles

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3.2 EDAX

The element analysis of ZnO nanoparticles was carried out by energy dispersive -ray (EDAX) analysis .Figure 3.2 shows typical EDAX spectrum of ZnO nanoparticles. The presence of ZnO without contamination by any other element was confirmed by EDAX spectrum analysis.

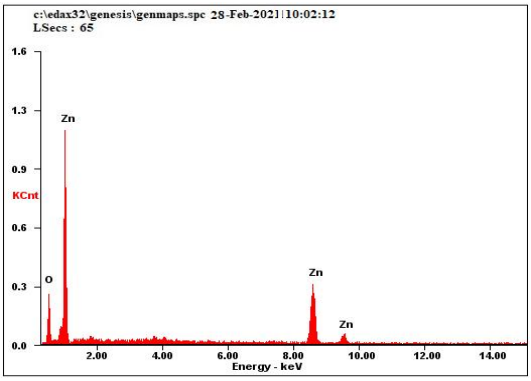

Figure 3.2: EDAX pattern for pure ZnO Nanoparticles

3.3 UV-Visible Sectroscopy

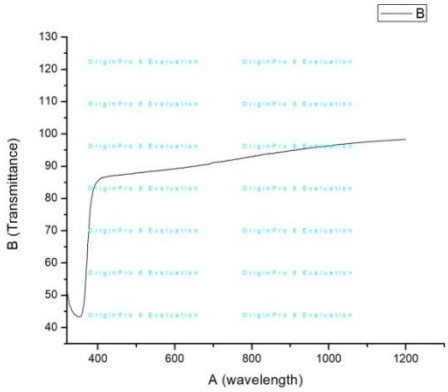

Figure 3.3: V- pattern for pure ZnO Nanoparticles

The band gap of the prepared sample ZnO nanoparticles were determined by using UV visible studies. From the UV spectrum the optical band gap of ZnO nanoparticles was found to be 4.98eV.

3.4 SEM Analysis

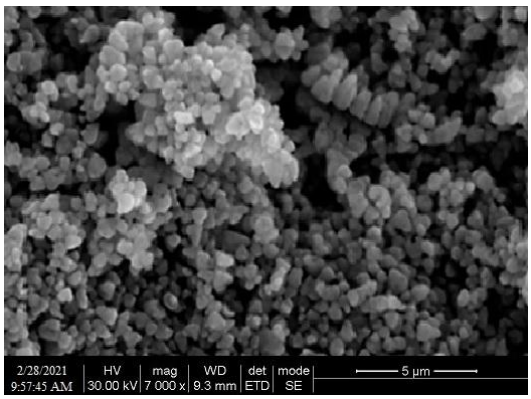

Figure 3.4: SEM pattern for pure ZnO Nanoparticles

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The size and morphology of the synthesized ZnO nanoparticles are visualized by Scanning Electron Microscope using ZEISS SCAN instrument for different magnification. The SEM image of ZnO nanoparticles are shown in fig 3.4.The ZnO nanoparticles are showing Spherical like shape (Kenanakis et al 2018).

IV. Conclusion

- Well crystalline zinc oxide was successfully synthesized by sol-gel method.
- Synthesized nanoparticles were further characterized by different characterization techniques
- Powder X-Ray diffraction analysis confirmed the crystal structure, Phase purity and Grain size of the nanoparticles. The average size of the synthesized nanoparticles is 10 nm.
- EDAX is used to analyze high purity and chemical composition of ZnO nanoparticles.
- UV-VIS Spectroscopy is used to analyze the band gap energy of synthesized nanoparticles and value is4.98eV.
- SEM image of ZnO reveals the well crystallized particles with spherical like morphology.

Data Availability

The data used to support the findings of this study are included within the article. More information could be obtained from the authors upon request.

Conflicts Of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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