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ZnO Nanoparticles Synthesis by Sol-gel Method and Characterization

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Abstract

Background/Objective: ZnO nanoparticle synthesis by sol gel method and its characterization to find out the morphology of the particles.
Methods/Statistical analysis: Sol-gel technique was used to prepare zinc oxide nanoparticles. The characterization was done by X-Ray diffractive (XRD), UV- Visible spectroscopy and field emission scanning electron microscopy (FE-SEM). X-Ray diffraction (XRD) was used to find out the particle size and FE-SEM image was used to determine its morphology.
Findings: pH 9 offers better morphology and good crystalline nature. The morphology can be changed by varying the solvent ratio.
Improvements/ Application: Gas sensor application

Keywords: ZnO Nanoparticle, XRD, FE-SEM, U.V Visible, Sol gel method.

1. Introduction

Zinc oxide (ZnO) is a versatile material [1] and synthetically produced on commercial scale. This water insoluble inorganic powder is used in ceramics, cement, paints etc. ZnO having lot of desirable properties such as high electron mobility, wider band gap, and exhibits luminescence at room temperature. The wide band gap of 3.3ev finds use in varied application such as electronic devices, biomedical field and sensor field [2].

Recently, the density functional perturbation theory (DFPT) methods was used to compute the response properties directly without the need for multiple ground–state calculations [3,4] also nano colorants exhibited excellent chromatic properties attributed to the nano scale effects of homogeneous [5]. Different methods are used in the synthesis of ZnO nano powder viz. sol gel method [6], hydrothermal or solvothermal method [7, 8], micro – emulsion method [9], precipitation method [10], and physical vapor deposition [11]. But compared to all, sol gel method provides high purity and quality with homogenous distributions of nano powder. The morphology can be changed by varying the solvent ratio [12, 13]. ZnO powder application including performances of tapered POF coated with seeded ZnO nanostructures for better efficiency compared to silica microfiber [14, 15].

In this work we are using simplest and cost effective sol gel method to prepare the ZnO nano particles. Zinc acetate was the precursor and Isopropyl alcohol (IPA) as the solvent. Finally, the optical properties were studied by UV- Visible spectra and crystallinity by FE- SEM image; particle size is measured by X-Ray diffraction.

2. Method

The preparation was carried out in room temperature. 2 Mole of Zinc acetate (Zn $(CH_3COO)_2.2H_2O$), and 1 Mole of Sodium Hydroxide pellet (in deionized water) was dissolved in 100 mL of Isopropyl alcohol. The solution was magnetic stirred at room temperature, and then the few drops of Ammonia solution was added and again stirred for 3 hours at room temperature to get pH 9. Then filtered and washed with D.I water and then dried at 50^0c for an hour. The dried gel form then calcined at 200^0C for four hours by using a muffle furnace. The structure morphology of the prepared ZnO nanoparticle was characterized by powder X-ray diffraction (X Pert Powder XRD System, Spectris Technologies Pvt. Ltd). The UV-Vis absorption (LAB INDIA Instruments Pvt. Ltd, U.V 3000+ Mode) measurement was measured over the range of 200-800 nm.

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3. Results and Discussion

I. U.V Visible spectrum

The UV-Vis spectra of ZnO nanoparticles measured in the range of 200-800 nm are shown in Figure 1 (LAB INDIA Instruments Pvt. Ltd, U.V 3000+ Mode). The absorbance at 202 nm shows a blue shift, it should be due to the confinement effect. The particles size was 17 nm as calculated through powder x-ray diffraction method.

II. XRD Studies

The X- Ray diffraction (X Pert Powder XRD System, Spectris Technologies Pvt. Ltd) is shown in Figure 2. The prominent peaks at pH 9 (100), (002), (101), (102), and (110), correspond to the standard structure of zincite phase reported in JCPDS File Card No.89-1397. No diffraction peaks from any impurities were observed, revealing a high purity of the ZnO nanostructures under current synthetic conditions. Thus, at pH 9 purity crystalline can be obtained. The particle size was calculated by using scherrer formula found to be 17nm.

III. FE-SEM Image

The Field emission scanning electron microscopy (FESEM) (JSM-6500F) image (Figure 3), demonstrates the production of microsphere-like hierarchical structures of ZnO and observed as numerous randomly oriented nano sphere.

4. Conclusion

The preparation of ZnO nano particle is achieved by simplest and cost effective sol gel method. Zinc acetate was the precursor and Isopropyl Alcohol (IPA) as the solvent. Finally, the optical properties were studied by UV-Visible spectra, the crystallinity by FE- SEM image and particle size measured by X-Ray diffraction. The calculated average particle size is 17nm at calcination temperature of 200^0C for four hours. This nanoparticle is applicable for gas sensor and sun screen products.

5. Acknowledgment

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Figure 1. UV -Vis spectra of ZnO nanoparticles

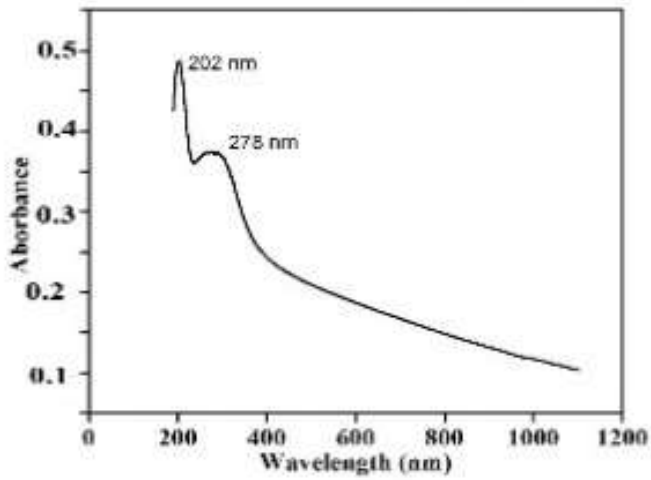

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Figure 2. XRD pattern of ZnO nanoparticles

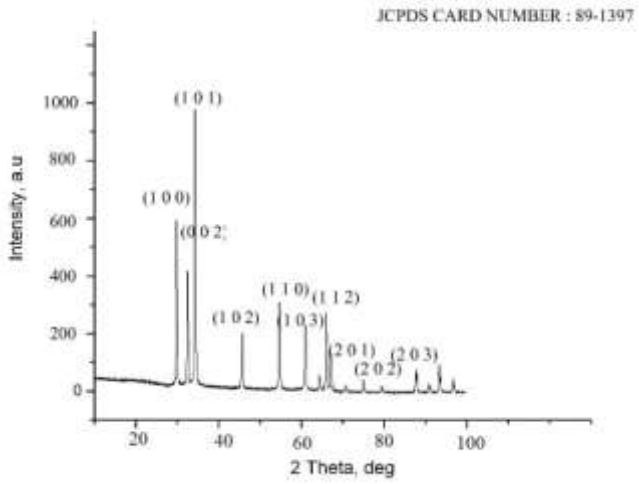
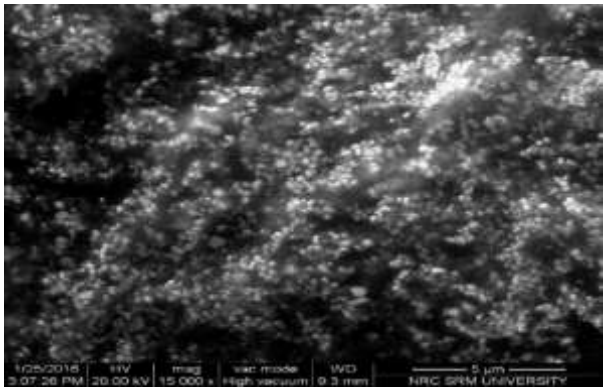


Figure 3. FESEM image of ZnO Nanoparticle



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