

# Structural and Optical Characterization of ZnO thin films by Sol- Gel Method

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**Abstract**— In this work the effects of annealing temperature on structural and optical properties of ZnO thin films were discussed in detail. ZnO thin films have been prepared on to glass substrate by spin coating method. Zinc acetate dihydrate, isopropyl alcohol and diethanolamine were used as starting material, solvent and stabilizer respectively. The prepared films were annealed at different temperature from 350°C to 550°C. The crystal structure and orientation of the films were investigated by using X-ray diffraction (XRD). The Scherrer formula was used to calculate the grain size of the films. From UV spectra the optical energy band gap was evaluated (3.27 eV-3.31eV). The surface morphology of the film was analysed by Scanning Electron Microscope (SEM).

**Index Terms**— ZnO thin films, sol-gel, structure, optical properties.

## I. INTRODUCTION

ZnO thin film is a n type semiconducting material with a wide direct band gap energy of 3.36 eV [1]. Due to its large exciton binding energy of about 60 meV they can be used as transparent electrodes in displays and metal oxide semiconductor in optoelectronic devices. ZnO is an excellent piezoelectric materials mainly used in surface acoustic waves components and piezoelectric devices. According to the preparation of ZnO thin films already various preparation techniques are available in literature such as spray pyrolysis [2,3], chemical vapour deposition [4], sputtering [5] pulsed laser deposition [6], Sol-gel method [7,8] etc. Among these techniques Sol-gel spin coating is one of the simple methods, because this technique has distinct advantages such as easy control of chemical composition, low cost and lower crystallization temperature. In this work the effect of different annealing temperature on structural, morphological and optical properties of ZnO thin films were reported.

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## II. EXPERIMENTAL

### A. Preparation

ZnO thin films were deposited by Sol-gel Spin coating method on to glass substrates. Zinc acetate dehydrate isopropanol and Diethanolamine (DEA) were used as a starting material, solvent and stabilizer respectively. The molar ratio of DEA to Zinc acetate dehydrate was maintained at 1.0 and the concentration of Zinc acetate was 0.5M.

Zinc acetate dehydrate was first dissolved in a mixture of isopropanol and DEA at room temperature. The solution was stirred at 60°C for 1 hr to yield a clear homogeneous solution which served as the precursor solution. The precursor solution was dropped on to glass substrates which were rotated at 3000 rpm for 30s. After they were deposited by spin coating, the films were preheated at 200°C for 10 minutes to evaporate the solvent and to remove organic residuals. The procedure from coating to drying was repeated several times. The films were then annealed at different temperatures from 350°C - 550°C for 1 hr.

The orientation and structural parameters of the films were determined by Xray diffractometer. The film thickness was measured by Thickness profilometer. The surface morphology of the film was analysed by scanning Electron microscope (SEM). Optical transmittance and band gap energy were estimated using UV-Vis, Spectra.

## III. RESULTS AND DISCUSSION

### A. Crystal structure of ZnO thin film.

The crystal structure and orientation of the ZnO thin films were investigated by Xray diffractometer. Fig 1 shows the XRD spectra of ZnO thin films annealed at different temperature. Diffraction peaks belonging to (100) (002) and (101) planes were observed in all the ZnO thin films. The XRD patterns of all the samples indicated the enhanced intensities of the peaks corresponding to (101) plane, indicating preferential orientation along C-axis and, shows that the films are wurtzite structure. The presence of prominent peaks shows the film is polycrystalline in nature.

# Optical And Structural Characterization Of Thin Films

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