

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 dihydrate isopropanol and Diethanolamine (DEA) were used as a starting material, solvent and stabilizer respectively. The molar ratio of DEA to Zinc acetate dihydrate was maintained at 1.0 and the concentration of Zinc acetate was 0.5M.

Zinc acetate dihydrate 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

Lauren Gardner



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Optical Properties and Structural Characterization of Ceramic Crystals, Pellets, and Laser-ablation-deposited Thin Films Mona P. Moret,1996 **Handbook of Nanoscale Optics and Electronics** ,2010-05-25 With the increasing demand for smaller faster and more highly integrated optical and electronic devices as well as extremely sensitive detectors for biomedical and environmental applications a field called nano optics or nano photonics electronics is emerging studying the many promising optical properties of nanostructures Like nanotechnology itself it is a rapidly evolving and changing field but because of strong research activity in optical communication and related devices combined with the intensive work on nanotechnology nano optics is shaping up fast to be a field with a promising future This book serves as a one stop review of modern nano optical photonic and nano electronic techniques applications and developments Provides overview of the field of Nano optics photonics and electronics detailing practical examples of photonic technology in a wide range of applications Discusses photonic systems and devices with mathematical rigor precise enough for design purposes A one stop review of modern nano optical photonic and nano electronic techniques applications and developments Nanostructures & Nanomaterials Guozhong Cao,2004 This important book focuses on the synthesis and fabrication of nanostructures and nanomaterials but also includes properties and applications of nanostructures and nanomaterials particularly inorganic nanomaterials It provides balanced and comprehensive coverage of the fundamentals and processing techniques with regard to synthesis characterization properties and applications of nanostructures and nanomaterials Both chemical processing and lithographic techniques are presented in a systematic and coherent manner for the synthesis and fabrication of 0 D 1 D and 2 D nanostructures as well as special nanomaterials such as carbon nanotubes and ordered mesoporous oxides The book will serve as a general introduction to nanomaterials and nanotechnology for teaching and self study purposes *Chemical Abstracts* ,2002 *SiC, Natural and Synthetic Diamond and Related Materials* A.A. Gippius,R. Helbig,J.P.F. Sellschop,1992-04-24 This volume addresses the burgeoning field of wide band gap materials The 64 contributed and invited papers will do much to stimulate the well justified ongoing work both theoretical and experimental in this area The high standard of the papers attests to the significant progress that has been made in this field as well as reporting on the challenging problems that still remain to be solved **Non-destructive Characterization Techniques for Rapid Optical and Structural Analysis of Dielectric Thin Films** N. K. Sahoo,K. V. S. R. Apparao,1993 *Thermophysical Properties of Materials and Devices* P. Predeep,Prasanth A. Pillai,A. S. Prasad,2008-05-01 NCTP 07 was the fourth in a series of biannual conferences on thermophysical properties being organized by the prestigious Thermophysical Society of India The first Asian Thermophysical conference was held in Guwahati University in 1994 the second in the Rajasthan University Jaipur and the third in the University of Goa All papers have been peer reviewed These Conferences are designed to be unique forums for the exchange of ideas and the newest technical information on thermophysical properties as well as materials

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Proceedings of the 2nd International Conference of Nanotechnology for Environmental Protection and Clean Energy Production Smail Hamamda, Abdelmalek Zahaf, Yurii Sementsov, Serhii Nedilko, Kateryna Ivanenko, 2024-06-01 This proceedings book covers the latest research and advancements in nanotechnology for environmental protection and clean energy production It encompasses a wide range of topics including physical chemical nanomaterials science nanoscale physics nanocomposites and nanomaterials applications solids and structures renewable energy nanoparticles and metallic and polymer materials While focusing on scientific advancements this book highlights the practical applications of nanotechnology in environmental protection and clean energy production It bridges the gap between theory and real world implementation making it a valuable resource for researchers students and professionals seeking practical insights and solutions

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