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An Experimentation Work on Sn-ZnO using Sol-gel and Characterization using XRD and AFM Patterns

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Abstract

Sn-doped Zinc oxide are here experimented in this work using sol-gel method. The sol is here constructed using the zinc-acetate dehydrate and tin chloride. Once the solution is prepared, the analysis is performed for XRD patterns at different temperature values. The intensity analysis is been performed for different annealing temperatures at different wavelength. The results show that as the temperature is increased, the intensity value of solution is also increased.

Keywords: *Sn-ZnO, Characterization, XRD Pattern.*

Introduction

Zinc Oxide is the semiconductor material that provides large exciton binding energy. It provides high conductivity with high transmittance. There are number of applications, such as crystal display, solar cell, heat mirrors etc, that are having the potential use of ZnO thin film. To achieve high quality standards in deposition of ZnO thin film under different evaporation techniques. One of such effective technique is sol-gel adopted by many researchers under the industry and application constraints. The characterization of the film is also analyzed under environmental and material based constraints such as temperature, low cost equipments, growth rate, suitability of deposition etc. Sn is considered as the most effective element that improves the opto-electrical properties of ZnO. It not only improves the crystal quality but also reduces the material based defects by providing the thermal annealing.

Sol-gel is an extensive approach that is been used for the characterization and deposition of different materials. It includes the material fabrication under the colloidal solution that includes the precursor for the integrated form. It convert the material to the discrete particles or the network polymers. Different metal alkoxides and the metal salts are defined under different forms to obtain the reaction analysis.

In this paper, the Sn-doped ZnO thin film characterization and deposition is evaluated by using the sol-gel approach. In this section, the basic introduction to the ZnO, its application areas and its characteristics exploration is done. The section also given a brief introduction to the sol gel approach. In section II, the work done by the earlier author under for the ZnO characterization under different substrate doping and characterization using different approaches is discussed. In section III, the experimentation adopted in this present work is discussed in detail. In section IV, the result analysis based on the proposed work is discussed under the XRD. In section V, the conclusion derived from the work is discussed.

Sn-ZnO Characterization and Deposition

Lot of work is already done on the exploration of the characterization of Zinc Oxide. Different authors defined the different doping elements for the exploration of characterization. This characterization is proposed by different authors using different approaches. In year 2009, Michal Byrczek has presented a chemical deposition approach for characterization of Zinc oxide thin film. Author defined the analysis under the low temperature and defined the descriptive zinc oxide nano crystals under the thin layer deposition. Author defined an investigation to provide the nanostructure growth under the gas sensitivity[1]. Another work on the sputtered aluminum doped zinc oxide was performed by Shang Chou Chang. Author defined the doping under different substrate so that the different type of AZO films under the surface morphology will be performed. Author defined the analysis under the rounded grain and uniform grain analysis. Author also performed the diffraction analysis under the XRD at different temperature values. Author performed the stress analysis approach under the sputtering process [2]. Another work on the electrical property exploration for zinc oxide channel was proposed by mamoru Furuta in year 2012. Author defined a solution based pressure deposition approach for the solution based dielectric stack formation and analysis. Author defined the material research to explore the component oxide insulators and semiconductors[3]. Another work on the physical

characteristics based exploration of Zinc oxide analysis was proposed by Hsin Chiang in year 2012. Author defined the spin coating method for the spin coding using the si substrate. Author performed the deposition using the sol gel approach and perform the analysis at different thickness levels[4]. Shang-Chou Chang defined the analysis on post annealing properties under the gallium and aluminum doped zinc oxide. Author performed the investigation under different characteristics like grain size, resistivity analysis and the higher figure analysis for the heating rate[5].

Ming-Zhi Yang defined a work on the fabrication on zinc oxide under the semiconductor process. Author defined a sensitive film based analysis so that the absorption at room temperature[6]. Mansoureh Mirhendi presented a work on the chemical reaction analysis and decomposition of zic acetate and the hot injection approach. Author defined the high zic bacteria analysis so that the ultrasonic so that the negative bacterium will be obtained to perform the deposition under different temperature level. Author defined the analysis by XRD[7]. Praramate Mongkolserm presented a sol gel based deposition approach on tin toped Zinc oxide. Author defined the analysis under the UV light. Author defined the grain analysis for Sn-doped ZnO film upon the UV light illuminations[8]. M. Benhaliliba defined a zinc oxide film fabrication onto a glass substrate performed the spin coating. Author performed the analysis under XRD based crystallization and structural analysis. Author defined the work on Sn-doped-ZnO films[9]. Another work on the ZnO characterization and deposition using sol gel was presented by S. Ilican. Author defined the spin coating method at the different rotation rates. Author defined the Zinc acetate dehydrate and the material solvement analysis under the crystal structure and orientation under XRD patterns[10]..

Experimentation

In this section, the experimentation of the Sn-ZnO characterization and the deposition using the sol-gel approach is explored. In this experimentation, zinc acetate dehydrate (Zn(CH3COO)2.2H2O) is taken as the initial material. Later on the some solvement and stabilizers are applied on it. 2-methoxyethanol is considered here as the solvement and monoethanolamine is considered as the stabilizer in this work. Tin chloride(SnCl4) is considered as the dopant source of tin. Once the solution is obtained after the solvement and stabilizing process, Zinc Acetate dehydrates is dissolved in the mixture. This solution is maintained at room temperature. Later on, the molor ratio of MEA:Zn(CH3COO)2) was maintained 1.0. The concentration of the zinc acetate is taken for 0.5M. Later on the stirring process is applied on 60C for 2 hours so that the homogenous solution will be constructed. This solution is then considered as the coating solution after applying the cooling to room temperature. The coating process takes 2 days after the preparation of the solution and after this it becomes more stable.

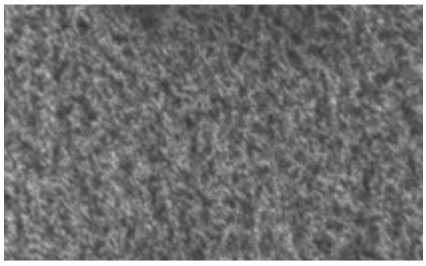
The solution is later on dropped under the glass substrate at room temperature, when the solution is rotated at high speed at 1000 rpm for about 30 sec. This deposition process is performed under spin coating. Later on the heating at 150C is applied for 10 mins to dry the thin film. With this process, the evolution of the solvent is performed and the organic residuals are removed. This coating procedure is repeated on the dry solution for 3 times until the thickness of the film in not reduced to 200nm. This process is annealed in air at 400, 500 and 600C for 1 hour.

The work is also analyzed under different characterization techniques. The confirmation of pure ZnO phase is verified under XRD analysis. The shape and the morphology based particle analysis is studied under the SEM pictures. The particles are attended under the nano range of the studied by taking the TEM picture so that the sampling is performed under the sharp peak in XRD. The decomposition of the sample and the absorption is performed under the property analysis. XRD pattern gives the crystalline solid based formation so that the identification will be done effectively. To determine the structure and the atom pack under the crystalline state so that the inter atomic distance and angle based analysis.

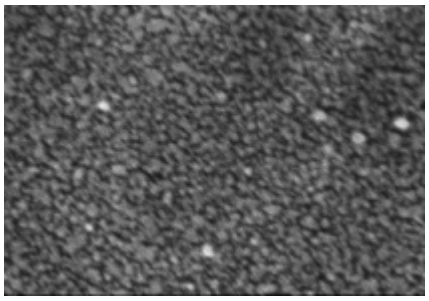
Results and Discussion

The results are here obtained in the form of SEM images of undoped and doped ZnO thin films on glass substrate at room temperature. The surface morphology obtained from the obtained process is shown in these images under the annealing and doping process. The observation of structure of SEM is performed for all films. This annealing process is applied on different temperatures called 400C, 500C and 600C for different size particles. The results images from the solution process is shown in figure 1.

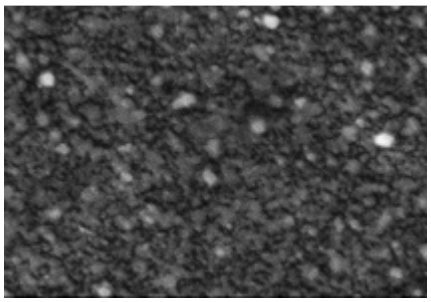
Figure 1: SEM images



(a) Undoped Annealed at 400C



(b) Undoped Annealed at 500C

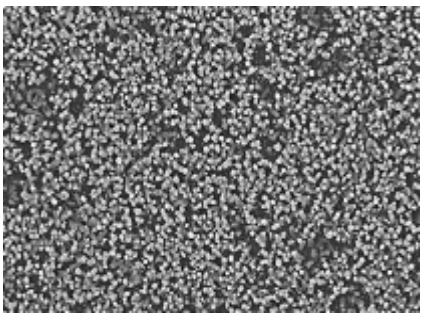


(c) Undoped Annealed at 600C

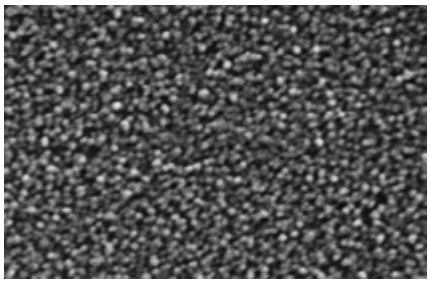
Here figure 1 is showing the SEM images un doped ZnO thin film under different temperature. Figure 1(a) is showing results of annealing process at 400C, 1(b) is showing for annealing process at 500C and 1(c) is showing the annealing process at 600C.

The doping to the solution is applied using Sn. The SEM images obtained from the Sn-doped ZnO is shown in figure 2. The results showing the outcome for different annealing temperatures.

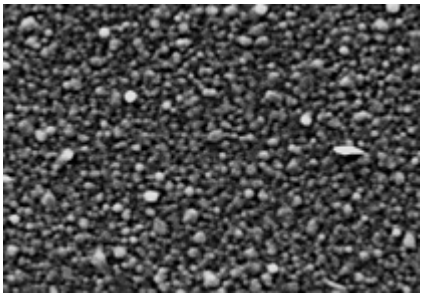
Figure 2 : Doped SEM Images



(a) Sn-Doped Annealed at 400C



(b) Sn-Doped Annealed at 500C

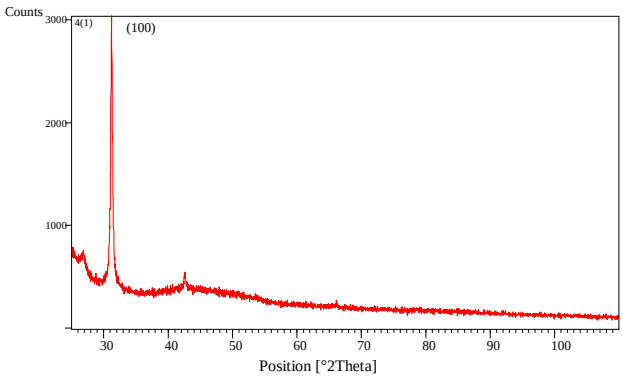


(c) Sn-Doped Annealing at 600C

Here the outcome of the SEM images for the annealing process on the doped thin film is shown. Figure 2(a) showing the outcome after the annealing at 400C for Sn-ZnO. Figure 2(b) is showing results for 500C and 2(c) is showing results for 600C.

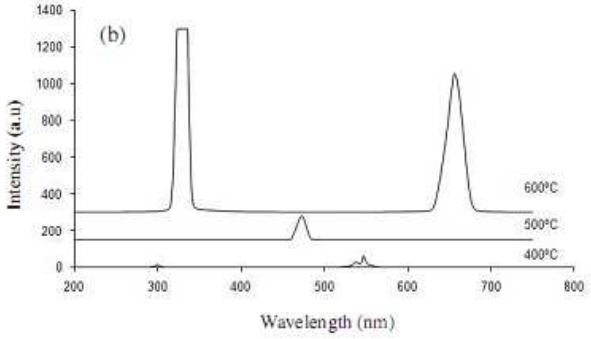
The XRD patterns of Sn-doped ZnO films are presented in this work. The work is prepared for ZnO nanoparticles under the oxygen vacancies. The Sn-ZnO thin film destroy the crystalline of thin film. This crystalline is considered as unvaporized water drops are migrated at high temperature. The annealing is applied at 400C,500C and 600C. The results for the XRD pattern is shown in figure 3.

Figure 3 : XRD pattern results on Sn-ZnO



Here in figure 3, the XRD pattern results of Sn-ZnO is shown. Here X-axis represents the wavelength and y axis represents the intensity value. The figure shows that as the wavelength is increased the intensity value is decreased.

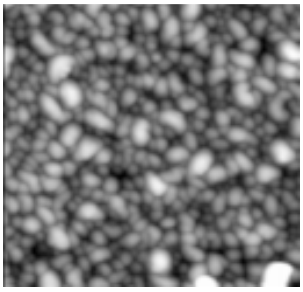
Figure 4: Spectra of Sn-ZnO at different temperatures



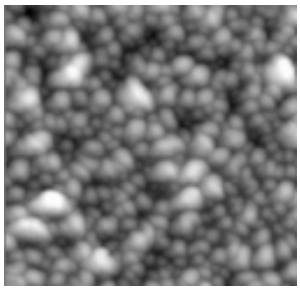
Here figure 4 is showing the results for different temperature values. Figure shows, as the temperature is increased, the intensity is increased.

To perform the observation of the Sn-doped-ZnO film using AFM (Atomic Force Microscopy), the film is deposited on micro array sensor platform. After this deposition process, the annealing over the solution is performed at high 500C and 700C in synthetic air for about 12 hours. The effect of the deposition process is here shown in the form of AFM images as shown in figure 5. Here figure 5(a) showing the AFM image is showing the annealing result of Sn-doped-ZnO at 500C and figure 5(b) is showing the result for annealing process at 700C.

Figure 5: Doped AFM Images



(a) Sn-Doped Annealing at 500C



(b) Sn-Doped Annealing at 700C

Conclusion

In this paper, the characterization and deposition of Sn-ZnO is performed using sol-gel approach. The analysis of the work is done under the XRD pattern analysis. The analysis is here performed at different temperature values. In this paper, the experimentation of the work is defined as well as the results obtained from the solution are described.

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References

[1] Michal Byrczek," The growth of zinc oxide nanocrystals on the zinc oxide thin film by chemical bath deposition", 2009 International Students and Young Scientists Workshop "Photonics and Microsysterns", 978-1-4244-4303-1109 ©2009 IEEE

[2] Shang-Chou Chang, "Some Special Phenomena Observed From In-Line Sputtered Aluminum Doped Zinc Oxide Films".

[3] Mamoru Furuta," Electrical Properties of the Thin-Film Transistor With an Indium–Gallium–Zinc Oxide Channel and an Aluminium Oxide Gate Dielectric Stack Formed by Solution-Based Atmospheric Pressure Deposition", IEEE ELECTRON DEVICE LETTERS 0741-3106 © 2012 IEEE

[4] Hsin-Chiang You," The Transistor Characteristics of Zinc Oxide Active Layer with Different Thickness of Zinc Oxide Thin-film", 2012 International Symposium on Computer, Consumer and Control 978-0-7695-4655-1/12 © 2012 IEEE

[5] Shang-Chou Chang," Heating Rate of Post-annealing on Microstructure/Electrical/Optical

Properties of Gallium and Aluminum Co-doped Zinc Oxide Films", ISBN: 978-1-4673-1638-5

[6] Ming-Zhi Yang," Fabrication of an ammonia microsensor based on zinc oxide".

[7] Mansoureh Mirhendi," Production of nano zinc, zinc sulphide and nanocomplex of magnetite zinc oxide by Brevundimonas diminuta and Pseudomonas stutzeri", ISSN 1751-8741

[8] Praramate Mongkolserm," Influence of Tin Doping on the Photocatalytic Activity of Zinc Oxide Thin Films under UV Light".

[9] M. Benhaliliba," Spin coated (Mx, Zn1-x O), M= Sn, Al nanofibers investigation".

[10] S. ILICAN," Preparation and characterization of ZnO thin films deposited by sol-gel spin coating method", JOURNAL OF OPTOELECTRONICS AND ADVANCED MATERIALS