Characterization of Deposition of ZnO using Sol-Gel approach

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Abstract: ZnO is the semiconducting material used in many applications under the opto-electrical properties. The characterization and the deposition of the Zinc Oxide thin film is performed using the sol gel method under different temperature values. The experimentation of the methodology is performed in this work. The result analysis of the work is been performed under XRD pattern at different temperature values.

Keywords: ZnO, Characterization, XRD Pattern

I. Introduction

ZnO (Zinc Oxide) is been focused by different researchers as the effective semiconductor materials because of multi-functionalities due to novel nonlinear optical properties. The application area of ZnO includes the nanostructure and micro-structure analysis with inclusion of non-toxicity under low cost and quantum size effect. ZnO is more effective in different functional areas with larger free exciton binding energy up to room temperature. The application areas of ZnO include the ultraviolet detectors, thin film transistors, gas sensors, varistors, thin film solar cells etc. There are different fabrication methods under which the analysis of the thin film is under different temperature values for different property based changes. These approaches include the vapor phase processing for chemical vapor deposition. One of such approach is sol-gel process. The deposition process of the ZnO thin film is defined by different researchers under the nano-structured substances so that the device performance is been improved. Another parameters that effects of the surface under different substrates includes the optical loss minimization as well as the enhancement of the material under the active region analysis. The objectives of these solution process is to reduce the cost of the surface generation under the property setup along with doping process with specific substances.

In this paper, the exploration of the properties and the ZnO thin film is defined in this section. This section includes the description of ZnO, its application and its basic characterization and deposition approaches. In section II, the deposition process using sol-gel is described. The work description includes the contribution of different authors. In section III, the experimentation work is defined using sol-gel approach under different substrate. In section IV, the results obtained from the work are discussed. In section V, the conclusion of the work is described.

II. ZnO using Sol-Gel

There are number of researchers that defined the work on ZnO characterization and its deposition. Some of the work done by the researchers is defined in this section. In year 2011, Peter A. Hersh has defined the characterization on Zinc-Tin Oxide with effect of structural analysis with CIGS PV devices. Author defined the work on device structure analysis for undoped ZnO as well as ZTO(Zinc-Tin Oxide alloys). Author defined the tuning and optimization process under the composition of ZTO with the definition of Fermi Level and alignment. The obtained results from the system shows the efficiency and optimization has been improved[1]. Another work on Zinc Tin Oxide to suppress the negative bias illumination was defined by Chang-Kyu in year 2013. Author defined the work on photo-bias instability for ZTO using thin film transistors. Author defined attribute analysis for valance band offset between TiOx and ZTO[2]. Another work on the characterization and synthesizised of mechnochemical processing was defined by Sharipah Nadzirah in year 2012. Author defined the work on ZnO under the mechnochemical process. Author defined the investigation for the under the concentration of Zn dopoant for properties analysis of SnO2. An optimality is also considered for the crystalline size and the effective generation so that the visibility of the system will be estimated effectively. The results shows that the volume samples are decreased so that the energy gap will improved with the increasing Zn concentration[3]. Another work on properties exploration of ZnO was defined by Kyungsoo Jan in year 2013. Author defined the work on the crystallinity of the electrical properties for Indium-Tin-Zinc Oxide. Author
defined the analysis on the effects analysis for carrier concentration. Author presented the field-effect mobility under ratio analysis so that effective frame rate for the display will be obtained with ultra high resolution[4]. A work on the improvement with photo-bias stability for Zinc Tin oxide based Thin film transistor for the carrier blocking layer. Author defined the analysis on different property types including the morphological, electrical and structural property analysis. Author defined the work on ZTO with gate-stack of silicon nitrate. Author defined the physical property analysis so that the enhancement in the stability will be obtained under the valence band-off structure under the amorphous nature of thermal films[5]. Another work on the study of different kind of properties for ZnO was performed by Amit Kumar Srivastava in year 2011. Author defined the work under high temperature and low resistivity with subsequent annealing in air and vacuum. Author defined the work in annealing environment under the filling processes of cation site for Zinc solution stage[6]. Another work on structural and optical property exploration and analysis was proposed by P. Muthukumar. The obtained fibers are defined under the uniform free and strong adherent analysis under different substrate XRD, EDAX, SEM with optical properties analysis[7]. In year 2010, Sharul Ashikhin Kumarunddin has defined the sol-gel technique for the deposition and the characterization. In this paper, spin coating and its fabrication for ZnO film on glass substrates is defined. The fabrication of the ZnO films was investigated for the structural analysis so that the examination on the properties will be done effectively. Author defined the characterization of ZnO for ultra violet visible spectroscopy. The experimentation has explored the effects of exploration[8].

III. Experimentation

In this section, the experimentation of the ZnO characterization and the deposition using the sol-gel approach is explored. The synthesis process defined in this work is based on the Zinc Acetate dehydrate to obtain the high purity up to 99%. To obtain this purity level the triethanolamine is been used as along with surfactant. The substrate used in this deposition is Ethanol and ammonium hydroxide to obtain the homogeneity in the solution substrate. The work as about to make a stochiometric solution under the Zinc oxide nano-particles.

In this experiment, 100ml of water is added with 30 ml TEA and later on ethanol is included in the solution in a continuous drop wise form. This continuous stirring is included to obtain the homogenous solution. The drop count of the ethanol is performed upto 2ml that provided the homogenous solution. This zinc oxide solution quantity is 2gm. Now under the stoichiometry, 30 ml of water is added with 20 ml of tea and again a drop wise inclusion of the ethanol is performed to attain the homogeneity. This drop wise inclusion is performed for 2 to 3 hours and it results the 2gm batch of zinc oxide. Later on, 5.39 gm of zinc acetate di-hydrate is mixed with 50 ml of water and the solution process is been performed under the continuous stirring to attain the homogenous solution. This solution is kept under the heating and stirring environment for 20 minutes. later on 10 ml of distil water is included during the stirring operation. It results the formation of bulky solution of white color. The solution is filtered in a filtered paper and drying is performed at 95 C temperatures for 8 hours. It results the white powder when the solution is placed at very high temperature for 4 hours. The ZnO under the zinc acetate and dehydrate precursor using the sol-gel process is defined under four main stages called solution, hydrolysis, polymerization and the transformation. Based on this formation the zinc acetate dihydrate precursor was first solvated in the ethanol substrate and the hydroxylation is performed. Based on this process, the removal of the intercalated acetate ions is obtained. The equational representation of the process is shown as under

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\text{Zn(OAc)}^+ \rightarrow 2\text{Zn}^{2+} + (\text{OAc})
\]

\[
\text{Zn}^{2+} + 2\text{OH}^- = > \text{Zn(OH)}^+ \rightarrow \text{ZnO} + \text{H}_2\text{O}
\]

The activity solvemen under the influence analysis with the reacting progress and the product. Ethanol has the smaller size and the active OH. The splition of the zinc hydroxide splits into the Zn2+ and OH- anion under the reaction analysis is performed. 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 interatomic distance and angle based analysis.

IV. Results and Discussion

The XRD based diffraction pattern for high temperature analysis. The temperature considered in this work is 500 C, 700 C and 900 C. The process is performed on the ZnO phase hexagonal structure under the pattern analysis with cell structure analysis with the lattice parametric formation and the exploration. It includes the deviation of the parameters under the presence of various defect points such as zinc antisties, oxygen vacancies and the extended defect analysis. The XRD shows the crystal quality is improved along with stronger and sharper. It performs the crystal quality analysis under the improved and the variation of peak height wand the FWHM with different annealing temperature. Peak height obtained at 500 C is 105 and the FWHM obtained is 0.2755. The height based analysis under the temperature effect is shown in figure 1.
The obtained results in terms of FWHM under different annealing temperature is shown in figure 2. The XRD on the ZnO were broadened and the the dependent on the Miller indices so that the crystal planes are defined. The temperature crystalline of the particles is increased under the particle becomes bigger.

The smaller particles based lower temperature is favorable. It also includes the samples calcined at high temperature of 900 C where the fine peaks are obtained. The cauterization results at different temperature are shown in figure 3,4,5.

As we can see, in figure 3, the XRD pattern based ZnO characterization results at 500 C are shown. Here the X axis represents the theta value to define the rotational vector and y axis represents the intensity value.
As we can see, in figure 4, the XRD pattern based ZnO characterization results at 700 C are shown. Here the X axis represents the theta value to define the rotational vector and y axis represents the intensity value.

**Figure 5: ZnO characterization XRD Pattern analysis at 900 C**

As we can see, in figure 5, the XRD pattern based ZnO characterization results at 900 C are shown.

**Figure 6: SEM image for ZnO**

Here figure 6 is showing the SEM morphology result of the synthesized nano ZnO particles. Figure is showing the formation of spherical ZnO nanoparticles and the change in morphology under defined temperature.

The UV-Visible is defined to determine the band-gap energy under the absorption coefficient. It includes the transition to the photon energies along with standard relation specification. The UV report of the sample at 700 and 900 is shown in the figure 7.

**Figure 7: UV Report of sample taken under different Temperatures.**
In this paper, the characterization and deposition of ZnO is performed using sol-gel approach. The analysis of the work is done under the XRD pattern analysis. In this paper, the experimentation of the work is defined as well as the results obtained from the solution are described.

VI. References

[8] Sharul Ashikin Kamaruddin, "Zinc oxide films prepared by sol–gel spin coating technique".

VI. Acknowledgments

The heading of the Acknowledgment section and the References section must not be numbered.