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Preliminary Study and Synthesis Thin Film of Antimony Tin Oxide (ATO) with Sol-Gel Spin Coating Technique

Syifa Azzahra [1*], Aris Doyan [1], Susilawati[1], Ahmad Harjono[1],Norma Ikraman[1], Zahid Ramdhan[1]

Master of Science education, Post Graduate Mataram University
Lombok Indonesia[12]
[*] *syifasarahzahra138@gmail.com*

Abstract

ATO tin films has been applied to the device optoelectronics, electronics, sensor and Laser UV. In this research have been synthesized a thin film of Antimony Tin Oxide (ATO) on a glass substrate by sol-gel spin coating technique using centrifuges. To making Sol-gel, this study using material salt of Tin (II) chloride dihydrate ($SnCl_2.2H_2O$), ethanol (C_2H_5OH), and Antimony (III) Chloride ($SbCl_3$), each of which serves as solutes and solvents. As the material sol, $SnCl_2.2H_2O$ salt dissolved in ethanol solution, at room temperature with stirred using a magnetic stirrer for three hours until completely dissolved with various persent doped antimony on tin oxide is 0, 5, 10, and 15%. In preparation dripped glass sol-gel material is approximately 0.05 ml, then spin using centrifuged for 30 second with rotation speed of 3000 rpm. Then the samples were heated in 350 ℃ for 10 minute to deposited films.

Keywords: *ATO, sol-gel technique*

1. Introduction

Tin Oxide is one of the material semiconductor that applications as solar cells, optoelectronic device, thin film resistors, antireflection coating, photochemical devices and electrically conductive glass. These properties are attracted the attention of scientist who have attempted to improve electrical performance by different experimental and simulated and methods [1,2]. For TCO application, in electronics for instance, a very high quality of the films is required, and we will show that high quality tin oxide layers, as far as the structure and morphology are concerned [3].

Semiconducting thin films of Tin oxide is usually “n” type and transparent in visible range which can be conductivite by contribution of some elements such as antimony, molybdenum [4,5]

A thin film of pure tin oxide or tin oxide by doping have been generated through a variety of different techniques, such as chemical vapor deposition (CVD), aerosol pyrolysis, sputtering, laser abration, dip coating and sol-gel spin coating. All of these techniques have advantages and disadvantages of each. Some of them need the equipment and how to work more complicated such as high pressure and vacuum conditions. For example, by sputtering method, adhesion between the film and the substrate is good, but it requires complicated equipment. While evaporation method, apparatus used is quite simple, but the outboard power atoms on the substrate surface is not too strong [6].

In previous studies have been quite many conducted research on doping antimony tin oxide such as investigated the characteristics of antimony doped tin oxide thin films by dip coating technique [7], discussed in proceeding that tin oxide cristaline structure remain the same after antimony addition [8], investigation of the properties of antimony doping on tin oxide materials for technological applications [9], and investigate the cristallinity,

microstructure, electrical properties [10].

The current study to synthesis and analyze various percent doped antimony on tin oxide and repeated the process of spin coating and heating. The various percent doped antimony on thin film of tin oxide is 0, 5, 10, and 15% whereas repeated the process of spin coating and heating is once, twice and three times. The purpose of this study were synthesize thin films of Tin Oxide, analyze the effect various percent doped antimony on thin film of tin oxide and repeated the process of spin coating and heating?

2. Materials and Methods

The substrate materials to use glass slide with dimensions (20 mm x 20 mm x 5 mm) were cleaned with two steps. Cleaned glass slide aims to remove oil and organic residues, which appear on glass surface. Step first of cleaned, the glass substrate in warn acetone bath for 10 minutes then remove and place in methanol for 5 minutes. Next, remove and rinse in aquades then dried by blower. Step second of cleaned, pour the aquades and 30% HCl solution. Futhermore, put the glass substrate into glass beaker and shake for 30 minutes then rinse in aquades and dry with blower. The glass substrate that is clean, then stored in plastic clip.

The precursor was prepared using $SnCl_2 \cdot 2H_2O$ (98%, Merck Co. Inc.) and $SbCl_3$ (99%, Merck Co. Inc.) as starting materials, and ethanol (99%, Merck Co. Inc.) was used as a solvent. The mixture was stirred for 3 hours at room temperature, to obtain a homogene solution with 1.0 M sol concentration. In this experiment, the solution of sol-gel with various percent doped antimony is 0, 5, 10, and 15%. Then maturation process of sol gel solution approximately one day.

The sol gel materials were deposited on a glass substrate with driped 0.05 ml. Using a centrifuges, spin coating method with a rotation speed of 3000 rpm for 30 seconds. The as-deposited films were heating for 5 minutes on temperature 350°C. In this study, the process of spin coating and heating with various repeated is once, twice and three times.

3. Result And Discussion

Materials used in research synthesis of Tin Oxide salt with a thin layer of sol-gel method that is: Salt tin (II) chloride dehydrate ($SnCl_2.4H_2O$) with M = 225,53 g/mol, Ethanol C_2H_5OH with M = 46,07 g/mol and Salt antimony (III) chloride ($SbCl_3$) with M = 228,1 g/mol.

The work was performed in a clean room and room temperature which hydrolysis and condensation reaction as follows respectively:

$$M(OR)_4 + xH_2O \rightarrow M(OH)_{4-x}OH_x + xROH \quad (1)$$

$$M(OH)_{4-x}OH_x + M(OR)_4 \rightarrow (OR)_{4-x}MO_xM(OR)_{4-x} + xROH \quad (2)$$

Solution of sol-gel with various percent doped antimony that have been synthesized are stored in small bottles as figure 1.

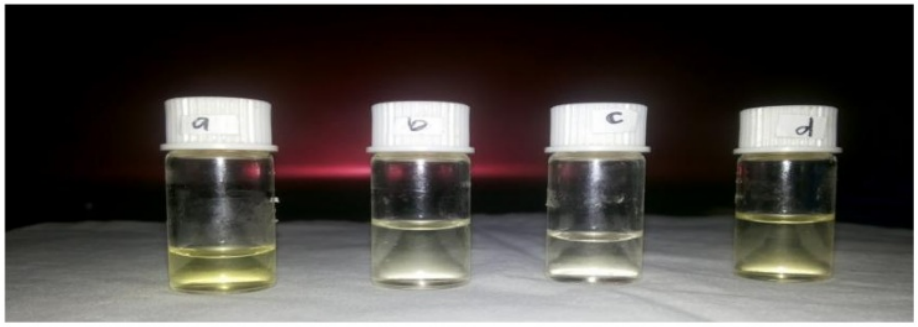

Figure 1. Solution of sol-gel-varying doping antimony a (0%), b (5%), c (10%) and d (15%)

For result deposition solution of sol-gel-varying doping antimony on the glass substrate as figure 2.

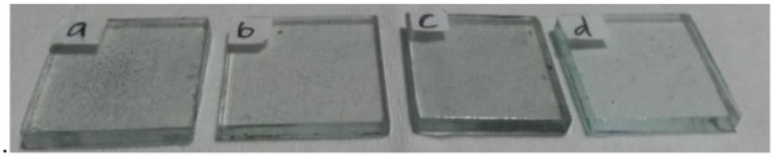

Figure 2. Results deposition solution of sol-gel-varying doping antimony a (0%), b (5%), c (10%) and d (15%) for heating 350 ℃

Furthemore the result deposition doping antimony D (15%) with various repeated the process of spin coating and heating 350 ℃ as figure 3.

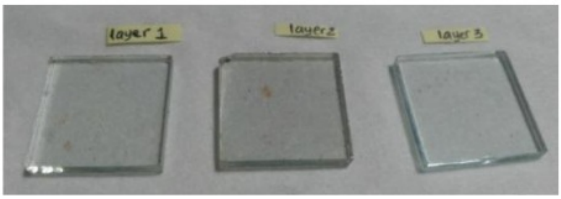

Figure 3. Results deposition solution doping antimony D (15%) with various repeated the process of spin coating and heating 350 ℃ : (layer 1) once, (layer 2) twice and (layer 3) three times

4. Conclusion

This research have been synthesized a thin film of tin oxide on glass slide by technique os sol-gel spin coating. To making sol-gel, used base material such as salt tin (II) chloride dehydrate (material prekursor) and ethanol, each of which serves as solutes and solvent. As the material sol, $SnCl_2.2H_2O$ salt dissolved in ethanol solution, at room temperature with stirred using a magnetic stirrer for three hours until completely dissolved with various persent doped antimony on tin oxide is 0, 5, 10, and 15%. In preparation dripped glass sol-gel

material is approximately 0.05 ml, then spin using centrifuged for 30 second with rotation speed of 3000 rpm. Then the samples were heated in 350 ℃ for 10 minute to deposited films.

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