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The Optical Properties of SnO_2 Thin Layer With Dopan Zinc Using Solgel Technique

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Abstract

A thin layer of a material that is grown on the substrate surface with a size up to the nanometer scale. This study aims to determine the optical properties of SnO_2 thin film by doping Zn using sol-gel method. Variations in the concentration of the sol used 0.1, 0.2, and 0.3 M and Zn doping concentration of 0, 5, 10 and 20 % at 550°C annealing temperature. The characterization using UV - Vis Spectrophotometer, indicating reduced transmittance after being given dopants, for their absorption is shifted to shorter wavelengths, causing the energy band gap decreases with increasing sol concentration and doping Zn.

Keywords : *Optical properties, thin film, SnO_2, Zn, sol gel.*

1. Introduction

The development of science and technology more rapidly led to more varied innovations in various fields, especially electronics. Businesses that need to be done so as not to depend on other countries by making the independent Indonesian state so as to create an electronic device and be able to compete in the world of technology. An electronic device can be derived from a semiconductor material. Semiconductors are solid materials which have an energy band gap of 0.5 - 5.0 eV (between conductor and insulator) and made in the form of pellets, a layer of thick and thin layers. Electronic device may use a semiconductor material because it can alter the characteristics of a material such as optical properties, crystal structure, morphology and composition contained in the material.

Thin film technology is the development in the field of solid material that is widely used to achieve a thickness of 1µm [1]. Early development of the thin layer in 1852 by Groove with the development of the materials use, the method, as well as treatment given in a thin layer. It is became the basis of further research to develop the conducting transparent oxide, gas sensors, transistors and other electronic devices. Material that can be used in the synthesis of a thin layer of the material that has properties as a metal oxide material such as ZnO, SnO_2, TiO_2, In_2O_3, WO_3, ITO and many other materials. ZnO and TiO_2 is widely used because it shows good flexibility in the methods of synthesis and morphology of particles produced [2]. But has the disadvantage at the time of coating and stability are low in chemical processes and can affect the resistivity of the material of electronics. As with the doping material indium tin oxide absorption, transmittance decreases [3]. Absorption occurs because of the clumping of solute in a solution by the surface of the absorbent substance that forms a bond between the absorber. Absorption occurs due to the presence of compounds that undergo electronic transitions when exposed to light from a source. The transition is usually caused by electron transitions between electronic states in atoms or material. Electron transitions between energy levels in the atoms outside the great mass also involve ultraviolet energy. This corresponded to a total energy of wavelengths from ultraviolet to visible light even to the near infrared. Absorption of ultraviolet to visible light energy transition involves a fairly high (above 1 eV)[4]. Based on the description above, the authors analyze the characteristics of SnO_2 layers without doping, and given various concentration sol, Zn doping. Variations sol and doping concentration of Zn to get a variation of the optical properties of a thin layer of SnO_2 through absorption and transmittance testing include SnO_2 layer by doping Zn tested with UV-Vis spectrophotometer.

2. Materials And Methods

Thin layer sample preparation method used is the sol-gel spin coating deposition. The basic ingredients used in this study as C2H5OH, SnCl2.2H2O, and ZnCl2 in the form of a powder with a purity of 99.99% with heating 550oC. After the sample is finished in the heat, further samples SnO2 thin layer with Zn doping variation tested by UV-Vis Mini 1240SA (Shimadzu) with a wavelength of ultraviolet light to visible light through (300-800 nm) to determine the value of the transmittance and absobansi and analyze the band gap energy.

3. Result And Discussion

Testing samples of SnO2 thin layer with a metal doping Zn conducted to determine the transmittance, absorption and energy band gap on each individual sample. In SnO2 thin layer transmittance spectrum of 0.2 and 0.3 M showed a regular decrease with the addition of doping given Zn grown on the surface of the glass substrate. There are two parts of the first part of the curve transmittance 350 nm $\leq \lambda \leq$1500 nm and transmittance is between 80% and on the 290 nm $\leq \lambda \leq$350 nm which is the absorption area, the transmittance decreases (falls) [3]. The test results UV-Vis spectrophotometer can be seen in Figure 1 below.

Absorption of SnO_2 thin layer using metal doping Zn pada0,1 M; 0.2 M; and 0.3M with doping concentration variation of 0%, 5%, 10% and 20% can be seen in Figure 2 below:

The energy band gap in the semiconductor optical analysis using Tauc equation [2], which is a relation between the plot that shows the linearity, where extrapolation may be used in calculating the energy gap. Values energy band gap in the sol concentration of 0.1 M, 0.2 M and 0.3 M showed a significant decrease. This is due to the influence of density is changed in a thin layer, change the size of the crystal grains in thin layers and their quantum size effects [6]. Energy gap extrapolating results is the value obtained in Table 1.

Table 1. Energy band gap with different concentrations and varying concentrations of metal doping Zn

concentration sol	A thin layer sample	Energy gap
0,3 M	Pure SnO_2	3.291
	SnO_2 + Zn 5%	3.179
	SnO_2 + Zn 10%	3.177
	SnO_2 + Zn 20%	2.804
0,2 M	Pure SnO_2	3.292
	SnO_2 + Zn 5%	3.362
	SnO_2 + Zn 10%	2,000
	SnO_2 + Zn 20%	2.800
0,1 M	Pure SnO_2	3.471
	SnO_2 + Zn 5%	2.372
	SnO_2 + Zn 10%	2.254
	SnO_2 + Zn 20%	1.937

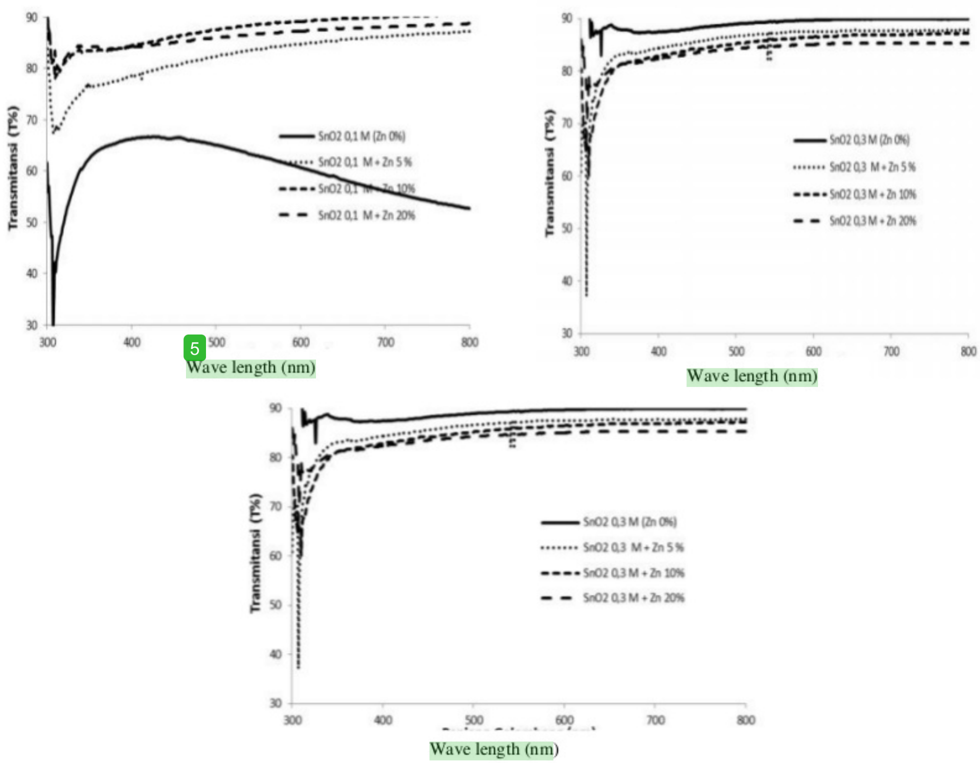

Figure 1. Graph transmittance with a concentration of 0.1 M sol (a), 0.2 M (b) and 0.3 M (c) with doping variation of 0%, 5%, 10% and 20%.

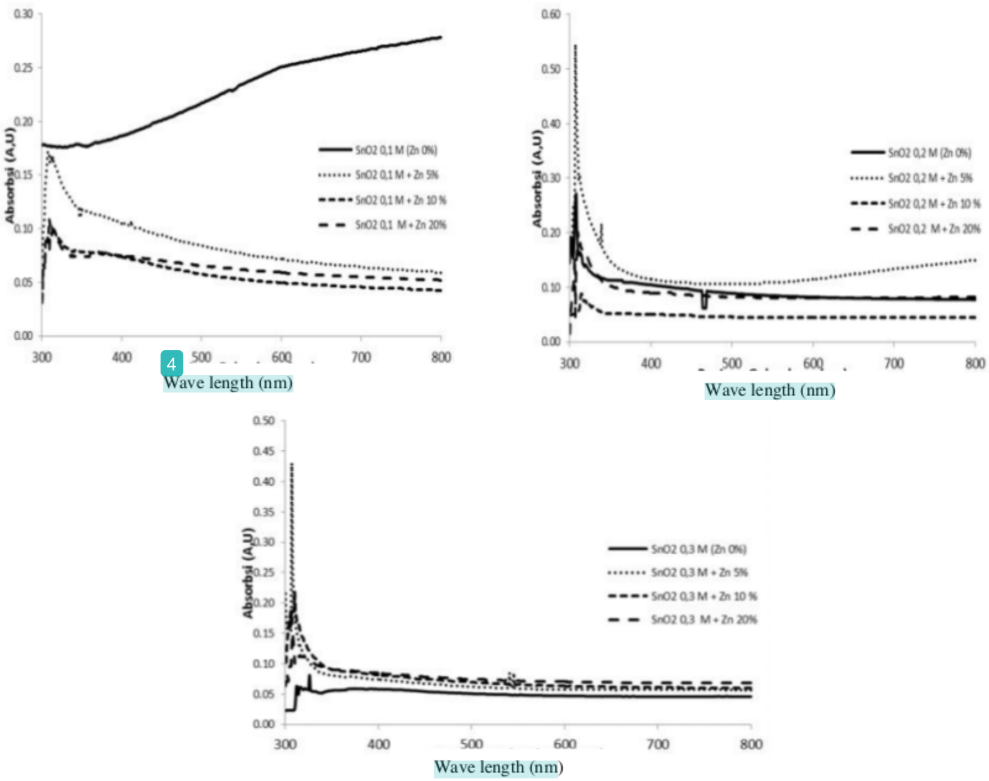

Figure 2. Absorption chart with sol concentration of 0.1 M (a), 0.2 M (b) and 0.3 M (c) with doping variation of 0%, 5%, 10% and 20%.

4. Conclusion

The optical properties of SnO_2 thin layer with a transmittance and energy band gap decreases with given variations of metal Zn doping concentration of 0%, 5%, 10% and 20%, but absorption increases with the doping given variation. In theory indicates the sample is a semiconductor

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