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Phasor diagrams of thin film of $LiTaO_3$ as applied infrared sensors on satellite of LAPAN-IPB

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Abstract

Thin film had been manufactured to determine Phasor diagram Thin Film as an application of infrared sensor on the LAPAN IPB satellite. Phasor diagram could be stated as a quantity of vector, which rotated on its starting point that could be described as a vector which its rotational angle was equal to its phase angle on the horizontal axis (X axis). The thin film was manufactured by CSD (*chemical solution deposition*) Method and Spin coating technique with annealing temperature 600°C and a rotational speed of 3000 rpm for 30 seconds. The test by LCR meter in 600 KHZ – 1 MHZ resulted in value of inductance (L), capacitance (C), resistance (R), and impedance (Z). From the result of LCR metre calculation, Phasor diagram is acquired. The electrical characteristics of thin film $LiTaO_3$ at 600,700 and 900 kHz frequency have capacitative Phasor diagram, while at 800,1000 kHz frequency it has inductive Phasor diagram. The result of this study is the information of electrical characteristics of thin film $LiTaO_3$ to support sensor data of satellite sensors.

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Keywords: thin film of $LiTaO_3$; LCR meter; Phasor diagrams; infrared sensor; satellite.

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1. Introduction

Technological development has occurred in many countries, especially in developed countries which have conducted a long research on the latest technology. One of the technologies which explored by the researchers is the Material Science. Science and technology of thin layers (Thin Film) plays an important role in the high-tech industry that will be the main focus of companies' competitiveness in the future [1]. Thin layer technology (Thin Film) plays an important role in high-tech industries for manufacturing products, therefore a high quality and efficient products will be produced. While the main study of thin layers already exist in microelectronics, such as the number of most applications that thrive on communications, optical electronics, and other various coatings.

In the period of last 30 years studies of thin films mainly crystal $LiTaO_3$ and its characteristics as a ferroelectric material and pyroelectric has became the main focus. $LiTaO_3$ ferroelectric crystals have an excellent ferroelectric and pyroelectric characteristics. A good $LiTaO_3$ ferroelectric characteristics is used on electronical devices and optical devices. Also, $LiTaO_3$ material is widely used on a high temperature transducers, lasers, electronic filters, and non-linear optical crystals [2]. As a material with its own advantages and good characteristics in ferroelectric and pyroelectric, Ferroelectric material is the material which has a special characteristics as spontaneously polarized dialectric and the ability to change the direction of its internal electricity. The polarization which is caused by the terrain work resulting on the asymmetry of ferroelectric crystal structure and it occurs spontaneously [3, 4]. To measure the properties of a material a dialectric tool LCR Meter is used [5].

2. Methods

In this research a method LiTaO3 Chemical Solution Deposition (CSD) was used to create a thin layer. The reason for using this method was because this method had several advantages and benefits such as stoichiometry control, homogeneity, it could be made at relatively low temperatures and relatively low cost [6]. CSD method is a method of making thin film layer by means of chemical solutions deposed over the prepared substrate using a spin coating at a certain rotation speed. $LiTaO_3$ film layer formed by doping with La_2O_3 and then synthesized by the method of Chemical Solution Deposition (CSD). One of the ingredients to make a photodiode is silicon, since silicon has a distinctive characteristics, it has become the material that mostly made for the photodiode. Silicon can be used at a wavelength of 400-1000 nm, with a low interference (noise), and a small response time [7]. Several methods are widely used in the manufacture of thin film such as by solid state reaction [8], molten salt [9], the polymeric precursor method [10] Sol-gel or Chemical Solution Deposition (CSD) [11], metal organic chemical vapor deposition [12], combustion methods [13], the Czochralski method [14] and liquid phase epitaxy [15] pyrosol process [16].

3. Experimental

First, the used substrate, p-type (100), was cut into 1x1 cm pieces, then the cutted substrate pieces were cleaned by deionized water for 10 minutes, then the surface of the silicon was drained. To speed up the drying process, a hot plate with temperature 100°C was used for 1 hour. A thin layer of the film would be formed by $LiTaO_3$ powder (tantalum oxide of lithium acetic acid) and 2.5 ml dissolved 2-metoxiethanol [11, 17]. *Second*, the growth of $LiTaO_3$ films on the surface of the reactor using cutting CSD was spinned at speed of 3000 RPM [11, 17]. The surface of the Spin Cutting disc was cleaned, then the silicon substrate which had been cut was placed on the surface of the Spin cutting disc. The substrate was attached on its top with 1/3 section was closed and 2/3 section opened then spin cutting was activated for 30 seconds at 3000 RPM along with 3 drops dripping $LiTaO_3$ solution on the substrate for 30 seconds. *Finally*, substrate was put on the hot plate to reduce the evaporation of existing solution on the substrate [11,17]

The result of the $LiTaO_3$ thin films growth, which were heated over a hot plate, were continued to annealing process which aimed to accelerate the rate of diffusion solution substrate $LiTaO_3$ on silicon. Annealing rate process was conducted constantly at 1.7°C/min by using a furnace-type brands vulcane TM 3-130 [11]. The heating process was started from temperature 27°C and a constantly rise at 1.7°C/minute until the annealing temperature of 600°C for 8 hours. The thickness of thin film which was increased, was also calculated before and after the annealing process with volumetric method [11]. After the process of the growth and annealing was completed, the next process