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# The diffusion coefficient of lithium tantalite ($LiTaO_3$) with temperature variations on LAPAN-IPB satellite infra-red sensor

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**Abstract**

Lithium tantalate, which has chemical formula of LiTaO3, thin films have been grown on a p-type Si substrate (100) by using chemical solution deposition and spin coating techniques at speed of 3000 rpm for 30 seconds. $LiTaO_3$ thin films were made in concentration of 2.5M and at annealing temperatures of 550°C, 600°C, 650°C, 700°C, 750°C, and 800°C. The purpose of this study determines the diffusion coefficient of lithium tantalate ($LiTaO_3$) above the silicon substrate (100) on the p-type annealing temperature of 550°C, 600°C, 650°C, 700°C, 750°C and 800°C. These thin films were characterized by using LCR meter. The electrical conductivity values of LiTaO3 films were in the range of $10^{-6}$ - $10^{-5}$ S/cm, where the higher the electrical conductivity, the higher the light intensity. This indicates that the LiTaO3 films was a semiconductor material. In addition, the higher the energy that moves the particles leads to the faster the diffusion. The diffusion coefficients of Li-TaO3 films were in the range of 57 - 391 $nm^2$/s.


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*Keywords:* Lithium tantalate ($LiTaO_3$); electrical conductivity; diffusion coefficients

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## 1. Introduction

Ferroelectric materials, especially those based on a mixture of lithium tantalate ($LiTaO_3$), used for the needs of electronic devices. The role of ferroelectric materials $LiTaO_3$ very interesting to study because in practice it can be used as an infrared sensor. $LiTaO_3$ is the object studied intensively over the last few years because it has unique properties [3].

From some of the results of the study, $LiTaO_3$ is non-hygroscopic crystals that are not easily damaged optical properties, these properties that make the material $LiTaO_3$ superior to other materials [6]. Crystal imperfections or crystal defects caused by the vacancy of atoms in a crystal. Crystal defects in the form of atomic vacancies, providing an opportunity for infiltration of foreign atoms. Foreign atoms are also likely to occupy interstitial positions, especially if the size of the foreign atoms are smaller than the size of atoms parent material. This interstitial position makes it easy to move over to the foreign atoms or atom itself. Diffusion is an event where there is a transfer of material through another material. The material transfer takes place because of the atom or particle always moves by thermal agitation. Although the actual motion is the random movement without any particular direction, but overall there is a net direction in which the entropy increases. Diffusion is an irreversible process. In the gas phase and liquid, easy diffusion events occur; the solid phase diffusion also occur, although it takes longer [11].

In the crystal structure, the vacancy position allows atom adjacent atom moves fill the gap while he himself left the same place that he contents to be empty. The newly formed vacant positions will give the possibility to be filled by the atom next to it; and so on. This mechanism is the most likely mechanism for the occurrence of internal diffusion. Another possibility is the existence of atoms separated from the crystal lattice and into the interstitial atom and be easy to move. If the dimensions of the diffusing atom is much smaller than atomic dimensions of the material to be broken, interstitial diffusion easily takes place. This mechanism occurs for example if the carbon, nitrogen, oxygen, and hydrogen diffuses into the metal. The same thing happened on the diffusion of lithium tantalate ($LiTaO_3$) into the silicon crystal. The purpose of this study determines the diffusion coefficient of lithium tantalate ($LiTaO_3$) above the silicon substrate (100) on the p-type annealing temperature of 550°C, 600°C, 650°C, 700°C, 750°C and 800°C.

## 2. Experimental Method

Materials used in this study was powdered Lithium Acetate [$LiO_2C_2H_3$], powder Tantalum Oxide [Ta2O5], solvent 2-methoxyethanol [$C_3H_8O_2$], the Si substrate (100) p-type, deionized water, acetone PA [$CH_3COCH_3$, 58.06 g / mole], methanol PA [$CH_3OH$, 32.04 g / mole], the acid fluoride (HF), glass slide, silver paste, fine copper wire and aluminum foil. In this study $LiTaO_3$ thin films prepared by the method of chemical solution deposition (CSD) which has been developed for the growth of perovskite thin films. This method has the advantage that the procedure is simple, the cost is relatively economical, and get great results. Methods of chemical solution deposition (CSD) is a method of filmmaking by way of a chemical solution deposition on the substrate surface, then prepared with a spin coater at a speed of 3000 rpm for 30 seconds each hatching $LiTaO_3$ solution.

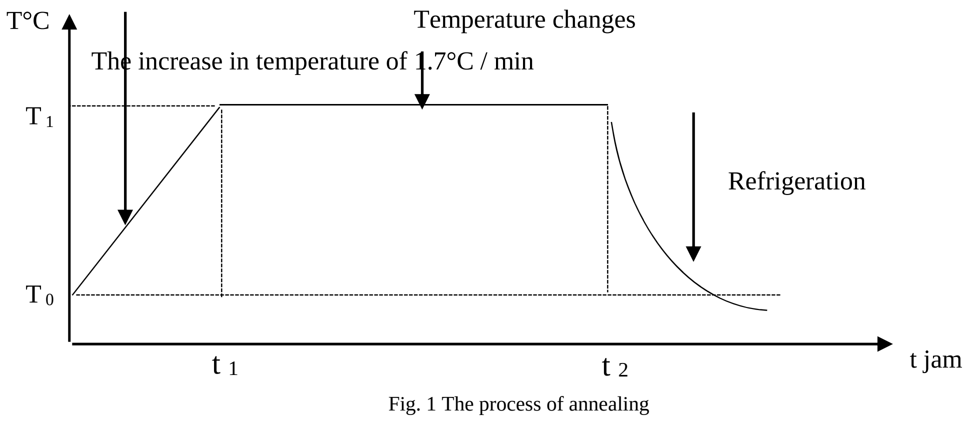


Fig. 1 The process of annealing