

**STUDY ON THE EFFECT OF FILM THICKNESS ON
THE CONVERSION EFFICIENCY OF THE TANDEM SOLAR CELL
USING SILVACO TCAD**

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ABSTRACT

Analysis on the effect of film thickness on the conversion efficiency of the tandem solar cell using Silvaco TCAD was conducted in this paper. Several parameters such as thickness, short circuit current (I_{sc}), open circuit voltage (V_{oc}) were investigated and the ATHENA/ATLAS profile for tandem solar cell structure was developed to help understanding the effect of thickness of the tandem solar cell on its conversion efficiency (%). 2 samples of tandem solar cell were developed in this paper which includes fully crystalline silicon (Si) tandem solar cell and combination of crystalline silicon solar cell with gallium arsenide (GaAs). The cutline to extract the net doping of tandem solar cell in TONY PLOT with photogeneration current was done for investigating the dependence of the thickness to the conversion efficiency. From both samples, 3 parameters were varied which are (1) thickness, (2) ion implantation energy and (3) dose concentration. Each of the experiments were obtained 10 readings of I_{sc} and V_{oc} . Then, the values of efficiency were calculated using conversion efficiency solar cell formula.

All simulation was done by using SILVACO TCAD.

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The Final Year Degree Project is a major component of the undergraduate degree course in Electrical Engineering. The main objective is to develop problem solving, analysis, synthesis and evaluation skills in the field of Electrical Engineering. While working on the project, students would also be able to develop personal and social skills such as time management, self confidence and interaction. The evaluation of the Final Year Degree Project indirectly provides the students with training and communication skills.

This final project report is written as part of evaluation on the Final Year Project to ensure the standard and the quality of the Final Year Degree Project. The purpose of the report is to present a clear logical report on the completed project work and to establish the significant outcomes of the work done.

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Technically solar cell is one of the alternative energy that has a good developed potential since it is renewable, clean and safe compare to fossil energy [1]. For example nonrenewable source such as petroleum or uranium, can contribute to pollution and dangerous for humans, animals and also environments. Unfortunately, the cost material to produce a good conversion efficiency solar cell is high [2]. This encouraged many researchers to find other material or methods to produce a low cost solar cell without sacrifice its conversion efficiency.

One type of solar cell that had been developed is tandem solar cell. Tandem solar cell was developed decades ago to achieve high conversion efficiency. Mostly tandem solar cell was used in aerospace especially for satellite as main power source [3].

In words, tandem is means an arrangements two or more objects behind another. Basically tandem solar cell has an arrangement of several layer of n-layer with p-layer. In patent tandem solar cell, there are 3 layers which are upper, middle/intermediate and bottom/lower. An upper solar cell has a higher energy band gap compare other middle and bottom solar cell since it absorbed wavelength incident first. Middle solar cell has a higher energy band gap compare the bottom solar cell [4].

The thickness of solar cell is an important issue. It is only that a larger amount of precious material is needed for a thicker cell; a thinner cell could tolerate less optimal material properties. However before it can be achieved, type of materials that used in develop the solar cell is also need to be considered. Their drawback when became thinner are the very small mobility and diffusion length of electrons and holes [5].

Solar cell operated short and open condition. V_{oc} is the maximum possible voltage delivered by a solar cell. At this voltage the current is zero. I_{sc} is the current that flows when there is no external field applied, and charges are just drifting because of the internal field,