SIMULATION ON THE EFFECT OF N-LAYER THIN FILM THICKNESS ON EFFICIENCY OF SILICON –BASED SOLAR CELL USING SILVACO TCAD TOOLS

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UNIVERSITI TEKNOLOGI MARA

KAMARUZZAMAN BIN MAT RANI

Faculty of Electrical Engineering

UNIVERSITI TEKNOLOGI MARA

40450 SHAH ALAM

SELANGOR, MALAYSIA

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ABSTRACT

This report presents the "Simulation on the Effect of N-Layer Thin Film Thickness on Silicon-Based Solar Cell" in order to obtain the optimum conversion efficiency of solar cell when a different material types on n-layer thin film was used. This report establishes a novel method in which to use Silvaco's physically-based device simulator, Athena and Atlas to model the effects of n-layer thin film thickness on solar cell output characteristics. A virtual model representing a single junction silicon solar cell with was created in Atlas. The resulting output characteristics of the virtual solar cell, illuminated with a simulated Air Mass Zero (AM0) solar spectrum, were compared to published experimental measurements for Silicon-based solar cells of the same dimensions. The virtual solar cell demonstrated a good correlation between the measured and virtual solar cell output characteristics and accurate representation of the spectral response. Complete Athena and Atlas programs are included in appendices. This report has focused on the use of Silicon as solar cell substrate with different variations on n-layer thin film thickness in order to achieve high efficiency energy conversion with low production cost. The findings of this project show that n-GaAs/p-Si solar cell has performed the highest efficiency with 15.87% at the thickness of n-layer is 0.5µm. The n-layer of solar cell should be thin enough to increase the life time of minority carrier. Hence the optimum n-layer thin film thickness of 0.5µm has increased the short circuit current, spectral response as well the efficiency of solar cell. The result of this research has proven that Gallium Arsenic (GaAs) is the best material to be n-layer for p-n junction solar cell with Silicon substrate that has achieved high efficiency energy conversion.

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

The present growing interest in photovoltaic conversion is a consequence of the concern to identify future sources of energy that will be inexpensive as well as consistent with the maintenance and safety of the environment. Traditional sources of energy-fossil fuels such as coal, petroleum, and natural gas are running out as presently foreseeable rates of use are projected into the near future [1]. The inconsistent energy provides from sun is free, limitless, and environmentally friendly source of renewable energy. The rate of solar energy reaches a unit of area in space in the region of the Earth's orbit is approximately 1,400 W/m^2 which referred as the solar constant [2]. The conversion of solar energy can be categorized into two ways, directly and indirectly. Direct solar energy conversion involves only one transformation into a usable form like the case of photovoltaic cell produces electricity directly from solar energy. Meanwhile, indirect solar energy conversion involves more than one transformation to reach a usable form, for example, vegetation uses photosynthesis to convert solar energy to chemical energy, which can later be burned as fuel to generate electricity [3].

A photovoltaic array or solar panel was constructed in order to provide enough useful electrical energy from the solar. A solar panel is a linked collection of photovoltaic modules, which are in turn made of multiple interconnected solar cells. The cells convert solar energy into direct current electricity via the photovoltaic effect. Most solar arrays use an inverter to convert the direct current power produced by the modules into alternating current that can plug into the existing infrastructure to power lights, motors, and other loads. The modules in a solar array are usually first connected in series to obtain the desired voltage; the individual strings are then connected in parallel to allow the system to produce more current [4].