STUDY ON THE SILICON BASED HETERO-JUNCTION STRUCTURE SOLAR CELL BY USING SILVACO TCAD

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UNIVERSITI TEKNOLOGI MARA

AZARYNA BINTI NOH
FACULTY OF ELECTRICAL ENGINEERING
UNIVERITI TEKNOLOGI MARA
40450 SHAH ALAM
SELANGOR, MALAYSIA

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ABSTRACT

In this paper, the study on the silicon based hetero-junction structure solar cell using Silvaco software packages has been demonstrated. In this study, hetero-junction of n-GaAs/n-Si/p-Si, n-AlGaAs/n-Si/p-Si, n-InP/n-Si/p-Si, and n-InGaAs/n-Si/p-Si solar cells were simulated. Firstly, fundamentals of solar cell operation, performance and designs issues have been presented. The simulation of the solar cells using Silvaco TCAD Tools consisted of processes simulation of constructing solar devices in ATHENA and simulation of electrical characteristics of solar devices in ATLAS. The results from all simulations of the hetero-junction of solar cells were analyzed to compare their performances. Then, the paper was concluded with an argument that the hetero-junction of n-GaAs/n-Si/p-Si solar cell would provide better performance and efficiency over the others heterojunction solar cells. Finally, the future design improvements have been suggested.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 Overview

One of the today's biggest challenges is how to supply our increasing need for energy. The existence of an "energy source" crisis has become all too clear during this seventh decade of the twentieth century. A frequently mentioned solution to the problem of obtaining an adequate source of energy for the future is the use of photovoltaic, or solar cell, conversion of the energy contained in sunlight. Photovoltaic generation offers a way of helping to meet the increasing worldwide demand for electricity without accelerating the depletion of our finite resources of fossil fuels, adding to the contamination of the atmosphere or building hundreds of nuclear power stations.

In 1839, E. Becquerel observed a photovoltaic (a voltage that depends on light) when sunlight was allowed to shine on one electrode in an electrolytic solution [1]. The modern solar cell is an electronic device, fabricated from semiconductors, that converts a fraction of the energy contained in sunlight directly to electrical energy. To understand how solar cell work and to be able to design and construct energy conversion system using solar cells requires a background covering such diverse areas as: the nature of solar radiation, semiconductor physics, quantum mechanics, the techniques of energy storage, optics, heat flow in materials, the technology of semiconductor device fabrication, and the economic of energy flow.

Solar cells today are mostly made of silicon, one of the most common elements on earth. They do their job silently and there are no moving parts to wear out. They do not pollute atmosphere and they leave behind no harmful waste product. The crystalline silicon solar cell has considerable advantage of being based on a well-established semiconductor technology, which have been developed over many years for electronic components such as diodes, transistors and microchips. Solar cell performance is treated