

DESIGN AND OPTIMIZATION OF A HETERO-JUNCTION SOLAR CELL USING SILVACO SOFTWARE PACKAGES

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ABSTRACT

In this paper, the design and optimization of a hetero-junction solar cell, utilizing a simulation using Silvaco software packages have been demonstrated. This paper has investigated the design of a hetero-junction solar cell. In this study, a hetero-junction of GaAs/AlGaAs solar cell and a single p-n junction Si solar cell were simulated. Firstly, fundamentals of solar cell operation and performance have been presented. The basic advantage and operation of hetero-junction solar cells were discussed. Then, the important design issues have also been discussed. 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 both simulations of the hetero-junction of GaAs/AlGaAs solar cell and a single p-n junction Si solar cell were analyzed to compare their performances. Then, the paper was concluded with an argument that the design of hetero-junction solar cells will be improved in the future and the technology can become a feasible widespread power source. Finally, the future design improvements have been suggested.

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"Excellence is never an accident; it is always the result of high intention, sincere efforts, intelligent direction, skillful execution and the vision to see obstacles as opportunities."

Muhammad Fairuz Osman

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CHAPTER 1

INTRODUCTION

1.1 Overview

One of the biggest challenges mankind will face today is how to supply the increasing need for energy. With the shortage of fossil fuels these days, it is needed to consider renewable sources of energy such as photovoltaic devices. Photovoltaic devices are a promising technology that directly takes the advantage of the ultimate source of power, the Sun.

When exposed to light, solar cells are capable of producing electricity without any harmful effect to the environment or device, which means they can generate power for many years while requiring only minimal maintenance and operational costs. Currently the wide-spread use of photovoltaic devices over other energy sources is limited by the relatively high cost and low efficiency of solar cells.

Hetero-junction solar cells are a new technology that offers a higher efficiency compared to traditional solar cells made of a single layer of semiconductor material. Depending on the particular technology, hetero-junction solar cells are capable of generating much more power under the same conditions as traditional solar cells made of silicon.

This paper will investigate the design of hetero-junction solar cells. First, fundamentals of solar cell operation and performance will be presented. The basic advantage and operation of hetero-junction solar cells will be discussed. Then, the paper will discuss important design issues.