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The Effect of Temperature of the Output Performance of a Silicon Solar Cell

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Abstract

This work investigates the performance of silicon solar cell with changes in temperature. This was achieved by heating the cell through a thick silicon plate, which was provided by an electric heater and a constant distance of illumination with a 100 watts electric bulb. Results show that there is a direct proportionality between the output performance of the cell and the cell temperature. The cell has highest performance at the temperature of about43^0C . The series resistance(R_S) is found to be 121KΩ while the shunt resistance is 14.9KΩ at the temperature of about43^0C.

Keywords: Silicon Solar cell, Temperature, Series Resistance, Shunt resistance, Mean power

1.0 Introduction

Beside assisting in the reduction of environmental pollution, coupled with decrease in dependency on conventional power supply, Photovoltaic or solar cell production has been doubling every two years increase by an average of 48% each year since 2002 making the world fastest growing energy technology [1,2]. A solar cell on the other hand is a grid connected system which is now being seriously considered to supplement conventional power generation in many industrial countries.However, they have been extensively used in water treatment system, rural electrification, solar powered pumping, telecommunication and remote monitoring system, electric fences cathodic protection system for improving the quality of life in remote areas. However the cost of electric power to drive these systems and the high cost of maintaining conventional systems has limited their use. Alot of scientist have studied the variation in output of solar cell system with ambient temperature over the years [3,4]. Onimisi [5] has gone further to study the temperature dependence on the power output in copper oxide solar cells. He found that the cell suffers loss of power output with increase in the cell temperature.This temperature dependence is the main concern of this paper.

Despite the huge advantage given by this, it is observed that an increase in the cell temperature may affect the overall output of the cell performance thereby causing a setback in the overall aim of improving the performance of the cell.

This research study is aimed at assessing the performance of the cell at every 5^oC rise in temperature, so that researchers will be aware of the particular cell temperature that will give the best performance of the cell.

2.0 Material and Method

2.1 Material

The material used for this research include the following: A 6V(50mA) solar cell that consists of 3.0 volt silicon cells are connected in series. Connection wire for connection, lamp holder for holding the 100watts electric bulb used for illumination, volt meter and ammeter used to measure the voltage(0-1) and current(0-2v) respectively. Thermometer used to measure the surface temperature of the cell. Room heater was used to provide the temperature.

2.2 Method

Adopted for thisconsisting in heating the cell through a thick silicon plate, which was provided by an electric heater and a constant illumination with a 100 watts electric bulbto provide variation of temperature. The experiment was kick started at 25^0C and increased in step of 5^0C up to 100^0C. The solar cell was connected in series and parallel with a milliammeter and voltmeter respectively which to measure the current and a voltage (see Figure 1). Current and voltage and mean power at various temperature were recorded and tabulated.

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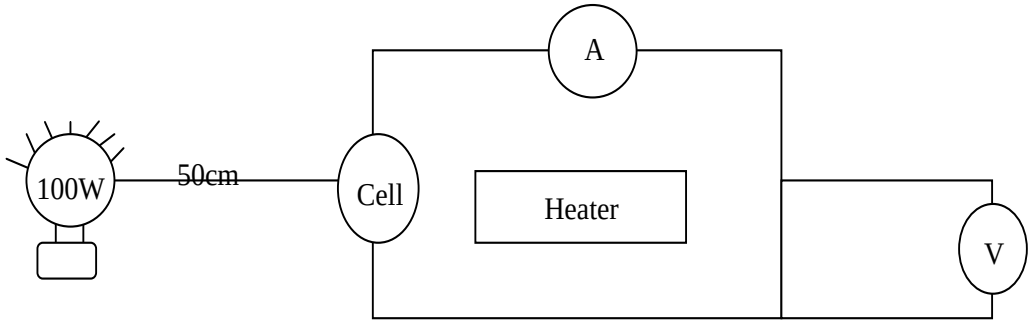

Figure 1: Circuit diagram used for the experiment

3.0 Results

The result of the experiment obtained at different temperatures is shown in figures 2-4.

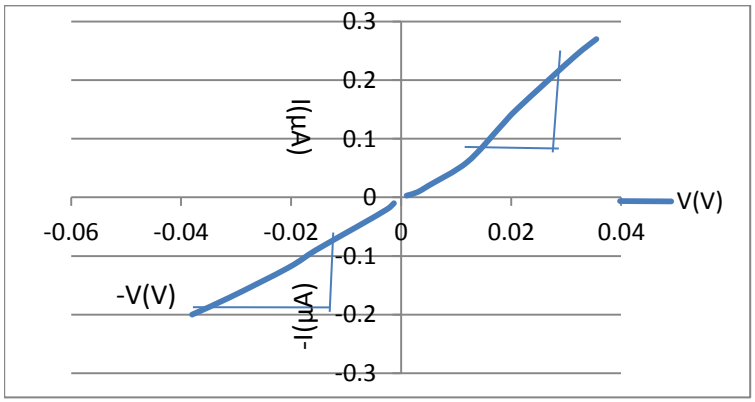

Figure 2: A graph of current against voltage

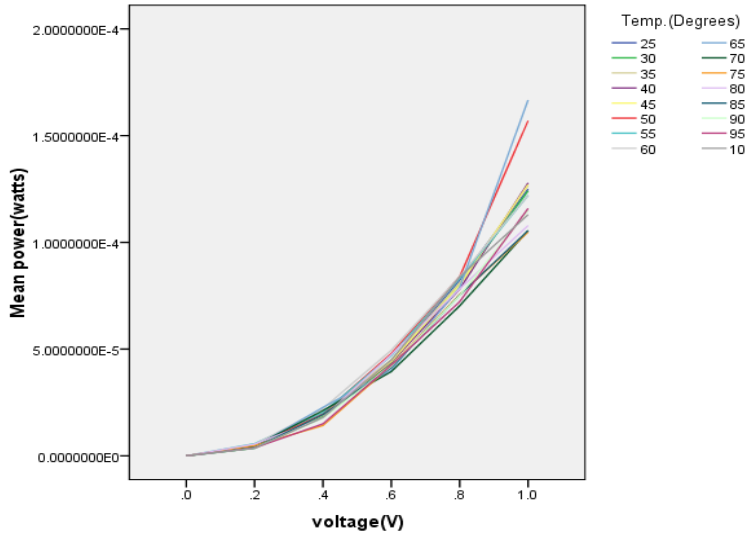

Figure 3: A graph of mean power against voltage

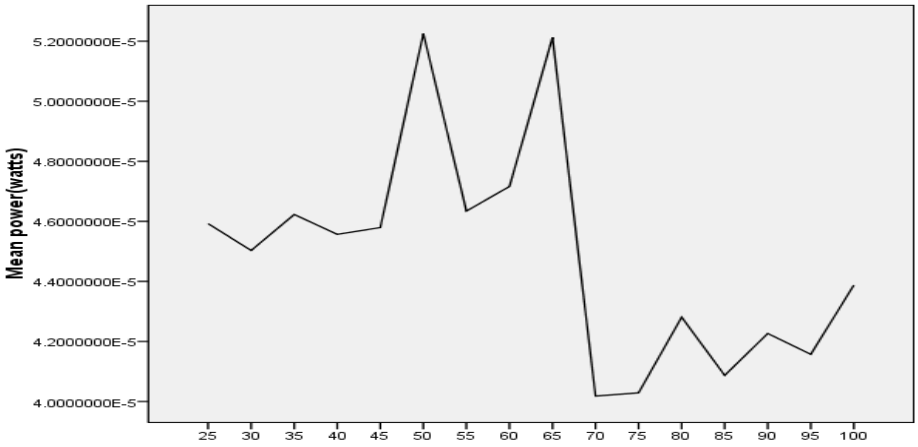

Figure 4: A graph of mean power against temperature

4.0 Results and Discussion

Figure1 is the circuit diagram out of the experiment. Figure 2 is a plot of current verses voltage. It is observed that the series resistance R_s is large and the shunt resistance(R_{sh}) is small. The more the efficiency of the cell, the smaller the series resistance (R_s). This compares favourably with the result obtained by Ali and Musa [6] who observed that the series resistance R_s is very large while the shunt resistance(R_{sh}) is small. In this work we also observed that increase in the series resistance decreases the efficiency of the cell and increase in shunt resistance increases the efficiency of the cell. Similar observation was reported by Ali and Musa [6]. Figure 3 is a plot of mean power verses voltage. The upper most curves is at the temperature of 25^0C,the lowest curve is at the temperature $100^0C$and the other curves are between the temperatures of 30^0C and 95^0C. It is observed that as the temperature increases the voltage increases and current and power decrease. This is as a result of decrease in carrier mobility which caused a decrease in the conductivity. This alsocomparesfavourably with the result obtained by Onimisi [5] who had observed that the cell suffered loss of power output with increase in the cell temperature. In this work we also observed that at a lower temperature the power output is high and low at higher temperature. Similar observation was reported by Onimisi [5].Figure 4 is a plot of mean powr verses temperature. It is observed that as the temperature increases power output decreases. This is as a result of dependency of Fermi level on temperature and because of the creation of electron capture by the vibration of impurity ions of the crystals particularly the doping element. This is compares favourably with the result obtained by Sanusi et al [3] who had observed that there is direct proportionality between the power output performance of the system and the ambient temperature.In this work we also observed that there is direct proportionality between the power output performance of the cell and the cell temperature. The cell has the highest output performance at a temperature of about43^0CSimilar observation was also reported by Sanusi et al [3].

5.0 Conclusion

From the foregoing we can conclude that:

1. A change in temperature invariably affects thepower output ofsilicon solar cell.
2. As the temperature increases the voltage increases and current andpower decrease.
3. There is direct proportionality between the power output performance of the cell and the cell temperature.
4. The series resistance R_S is large and the shunt resistance(R_{Sh}) is small.

6.0 References

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