ANALYSIS OF THE EFFECT OF TEMPERATURE AND AMOUNT OF SUNLIGHT ON SOLAR CELLS

BY

AUWAL ADAMU CST/NDSLT 2015/129

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APPROVAL PAGE

This project work has been read and as meeting the standard required for the award of ADAMAWA STATE POLYTECHNIC YOLA (SPY) in the department of science And laboratory technology (SLT) in the college of science and technology (CST).

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DEDICATION

We dedicate this project work to almighty Allah and our beloved parents, siblings and friends

ACKNOLEDGEMENT

We wish to thank Almighty ALLAH for giving me strength and wisdom to carried out this project work,

Our special thanks and appreciation goes to our supervisor MR. AUWAL AHMED TAHIR who gave us his valuable time to attend us and guide us throughout the project may Allah reward him with Aljanatulfirdaus Ameen.

We also thank our lecturers form the department of science and laboratory technology for their effort to lecture us throughout the academic program

Our special and immeasurable thanks goes to my lovely parents AlhajiAdamu Muhammed and Hajiya Fatima Abubakar and director Pinos and sweet mum Pariana for their contribution both morally and financially during our study in the college may Allah reward them amen

We also thank mallam Umar who guide us during the project work may allah reward him amen.

Our special thanks also goes to my lovely siblings and all the members of our family.

Finally we will not forget to thank our lovely fiends in the college for their good relation with us.

ABSTRACT

A solar cell or photovoltaic cell is a device which generates electricity directly from sun light. However, in some cases solar cells life-span is short and system failure that lead to produce low output voltage. Due to some factors that affect the solar cells, this project investigates the effect of temperature and the amount of sunlight on the performance of solar cells, the results obtained indicates that solar cells give optimum performance and gives the highest efficiency at lower temperatures and a bright sunlight especially during the summer periods, the study concludes that temperature and the amount of sunlight have significance effect on the performance of solar cells, hence it is recommended that these factors need to be taken into consideration when designing and planning solar projects.

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CHAPTER ONE

1.0 INTRODUCTION

1.1BACKGROUND

Solar cells, also called photovoltaic or pv cells, change sunlight directly to electricity when sunlight strikes the solar cell, electrons are knocked loose. They move towards the treated front surface. Electrons in balance created between the front and the back when the two surfaces are joined a current of electricity travels between the negative and the positive side (SOLAR SCHOOL.NET 2008).

Solar cells have seen remarkable improvement since the first issue of the journal solar energy materials in 1979. The photovoltaic (pv) field gas gives rise to a global industries capacity per year (Elsevier s.2008).

The problem with energy supply and use are related not only to global warming but also to such environmental concerns as in air pollution, deforestation and radioactive substance emissions. To prevent these effects, some potentialsolutionhas involved including energyconservation through improved energy efficiency a reduction in fossil fuel use and increase in environmentally friendly supplies. Among them, the power generation with the solar cells system has received great attention in research because it appears to be one of the possible solutions to the environment problem (R-J WAI. W-H WANG 2008).

Solar energy is energy that comes from the sun, the energy uses by solar cells that convert sunlight into direct current electricity. Solar cells are composing in various semiconducting materials. Semiconductors are materials which become electrically conductive when supplied with light or heat, but whichoperate as insulators at low temperature, (H.J QUISSER AND J.H WERNER 1995).

1.2 STATE MENT OF THE PROBLEM

Solar energy provides electricity using photovoltaic solar cells for example on government project most of the photovoltaic or solar cells are designed for street lightning or pumping but some of the solar cells have very short life span and encounter quite a lot of leading to poor system failure output , this problem is encountered due to what is called HOT-SPOT effect this can be caused by: partial shadowing mismatch cells, insufficient offering conditions, such as by understanding the amount of sunlight temperature the effect offering condition on the solar cells better output can be obtained. It is in the regard that this study is intended to be cause out with the following aims and objectives.

1.3 AIMS OF THE STUDY

The aim of this study is:-

- To analyze the effect of temperature and the amount of sunlight on solar cells.

1.4 OBJECTIVES OF THE STUDY

The objectives of the study are:-

- To study the effect of temperature on the output of solar cells.
- To study the effect of amount of sunlight on output of solar cells.

1.5 SIGNIFICANCE OF THE STUDY

The study is of great significance In the sense that it will proffer the solution toe those factors that affect efficiency of the solar cells, the study will also help In understanding the standard test condition(STC) of the cells position that suit the condition of solar cells for the absorption of light energy from the sun there by increasing output, durability and life span.

1.6 SCOPE OF THE STUDY

This study will only analyze on the effect of temperature and amount of sunlight on the output of solar cells only.

1.7 DEFINITION OF TERMS

- **SCIENCE** - denge (1980)" Science is simply acquitting of certain scientific knowledge as well as putting into practical the knowledge and the fact gathered".

Emovon (1979) viewed science as a broad body of knowledge which is acquired through observation and systematic experiment. According to oxford mini dictionary science is a branch of knowledge requring systematic study and method especially dealing with substance, life and nature laws.

- **PRACTICALS** – Is concerned with reality and action rather than theory and ideas , it is concerns critical examination of specific aspect in scientific felids such as physics, chemistry, biology etc.
- **SOLAR ENERGY** – Solar energy is the energy that comes from the sun.
- **SOLAR CELLS** – Solar cells are cells that absorb fadiant energy and convert it to electricity.
- **SEMI- CONDUCTORS** – These are materials which are neither good conductors nor insulators they have some free electrons by considerable.
- **INSULATORS** - Is a material with very very few electric space in the atomic structure
- **CURRENT** - is defined as the movement of electrons in a conductor in order to cause the movement of electrons
- **FREQUENCY** – Is the number of cycles per seconds of a sound, light or radio-wave
- **VOLTAGE** – Is the external force which tends to make electrons flow through a conductor

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 OVER VIEW OF SOLAR CELLS

Solar cells were first recognized by French Physicist Alexander Edmond Becquerel in 1839. it was also first build by Charles which coated the semiconductor silicon with an extremely of glad to form the junctions (1%efficient) (in 1883)(Russell o. patented the modern solar cells in 1946).

Modern age of solar power technology at tiles to bell laboratories experimenting with semi conductor, accidentally found that silicon doped with certain impurities was very sensitive to light in 19954. Solar cell can be homo junction devices, hereto junction or p-i-n and m-i-p junction. (HERFURTH, H.2011)

However, even after much research and development subsequent to discover, photovoltaic power, continued to be very efficient and solar cells will be used mainly for the purposes of measuring light. Most of the modern solar cells are made from either crystalline, silicon or thin-film semi conductors sunlight to electricity but, generally have higher manufacturing costs according to (HEINEMANN,S 2011).

Thin-film materials typically have lower efficiencies, but can be simpler and less costly to manufacture. A multi-junction or tandem cell are used in applications requiring very low weight and very high efficiencies, such are satellite and military applications, all types of photo voltaic systems are widely used today in a variety of applications (ELSENBERG,NAFTALI 2007).

2.2 GENERATION OF SOLAR CELLS

The study of cells is categorized into generation among which include

2.2.1FIRST GENERATION OF SOLAR CELLS.

Solar cells are typically made using crystalline silicon water. It consist of large area single layer p-n junction diode.

ADVANTAGES

- Broad spectral absorption range.
- High carrier mobility.

DISADVANTAGES

- Growing and saving of ingot in a highly energy intensive process
- Much of the energy on higher energy photon, at the blue and violet and of the spectrum, is wasted as heat.

2.2.2 SECOND GENERATION OF SOLAR CELLS

It is made up of cadmium telluride (CDTE) cells deposited on glass. and some are made up of amorphous silicon cells deposited on stainless steel ribbon.

ADVANTAGES

- Reduced mass
- Less support is needed when placing panel on root top
- Allow fitting panels on light or flexible materials,even textiles.

DISADVANTAGES

- Typically, the efficiency of thin –film solar cells is lower compared with silicon (water-based) solar cells.
- Amorphous silicon is not stable
- Increase toxicity

2.2.3 THIRD GENERATION OF SOLAR CELLS

It consists of non crystal solar cells, photo electro chemical cells and graetzel cells.

ADVANTAGES

- Low energy, high throughout processing technologies
- Gractezel even in low-light conditions.

DISADVAN TAGES

- Efficiency is lower compared to silicon (water based) solar cells
- Polymer solar cells, degraclation effect, efficiency is decreased over time due to· environmentaleffection.

2.2.4 FOURTH GENERATION OF SOLAR CELLS

It consist of a thin multi-spectrum layers which can be stacked to make spectrum solar cells

GENERATION	SOLAR CELLS
First generation	- single crystal silicon water (C-SI)
Second generation	- amorphous silicon (A-SI) - polycrystatalline silicon (POLY-SI) - cadmium tellunde (CDTE) - copper indium gallium diselerude (CIGS ALLOY)
Third generation	- Nan crystal solar cells - photo electro chemical (PEC) cells - gractzel cells - polymer solar cells - dye sensitized solar cells (DSSC)
Fourth generation	- hydride-inorganic crystal with polymer matrix

(KUENG, C. KRANZ 2003 AND AZULOY D BAL BERD B. 2005).

2.3 APPLICATION

In spite of the high initial cost, photovoltaic system are being used increasing to supply electricity for many application requiring small amount of power their cost-effectiveness increases with the location (where they are to be installed)from the main power grid lines (J.RANDAD ET.AL.2003).

Some application for which p v system have been developed are:

- Pumping water for irrigation and drinking.
- Electrification for remote village for providing street lightning and other community services.
- Telecommunication for the post and telegraph and railway communication network.

In addition, in developed countries solar cells are being used extensively in consumer products and application appliances be made from many semiconductors materials for example, Titanium Oxide (T_2O_2)(Y.SUITA AND S.S.TAADAKUMA 2006).

2.4 WORKING PRINCIPLE OF SOLAR CELLS

Solar cells convertlight a flow of photons to electric current, a flow of electrons when photons are absorbed by meter in the solar cells their energy excites electrons higher energy state where the electrons can move freely. (D SKALE 2008)

In the experiment to be observed, it will demonstrate how energy can be turned into different forms. First, Radiant energy which comes from the sun is turned into electrical energy by a small solar cell. The electrical energy from the solar cell is then used to make a small motor spin. In other words the electrical energy is converted into kinetic energy. Kinetic energy is the energy of motion. The motor has a small weight on it which is unbalanced weight moves or start rotating making the plastic wheel attached to it spinning(H.LUND AND O.SOLOMATOVA 2008).

Creation of pairs of positive and negative charges (called ELECTRON-HOLE-PAIRS) in solar cells by absorbed solar radiation separation of the positive and negative charges by potential gradient within the cells, the cells must be made of materials which can absorb energy (E) of a proton is related to the wave length (λ) by the equation :

$$E = hc/\lambda$$

Where E is the electron-volt (ev)and λ is in μm. The only materials suitable for absorbing the energy of the photons of sunlight are semi conductors like silicon; cadmium supplied gallium arsenide, titanium oxide.

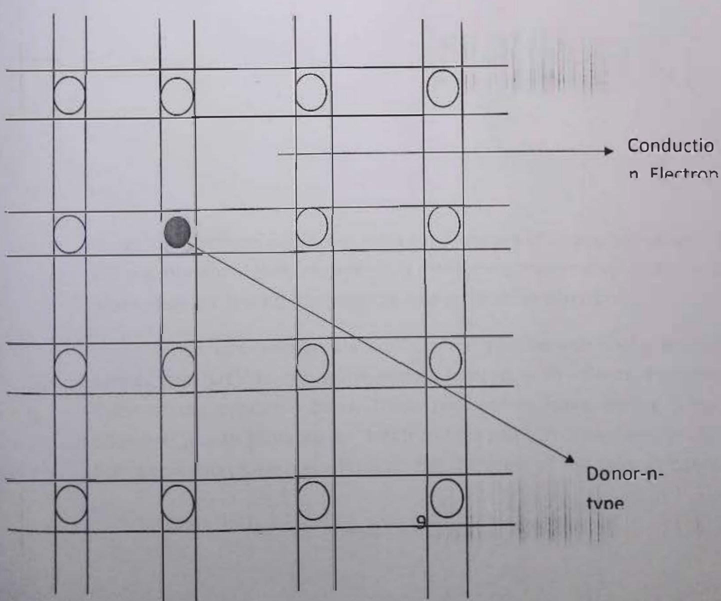
2.5 HOW TO WORK ON BASIC ATOMIC CONCEPT

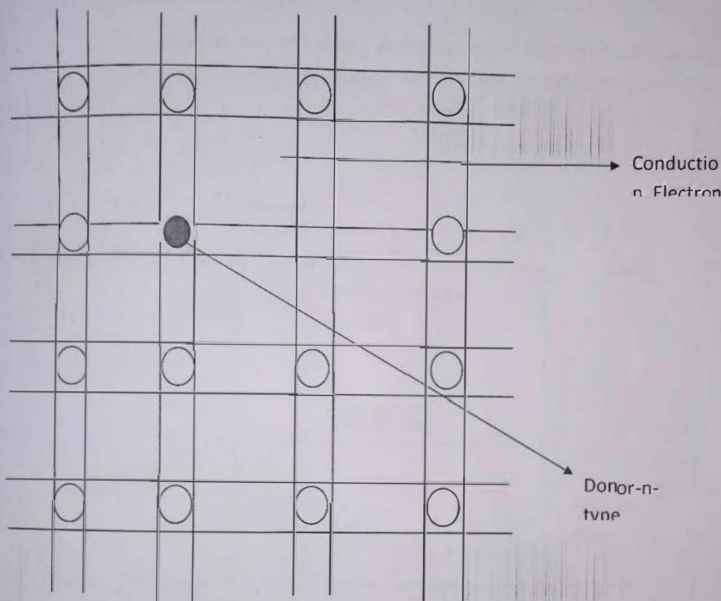
To understand how the solar cellswork, it is necessary to go back to some basic atomic concept. In the simplest mode of the atom, electrons orbit at central nucleus, compose of protons and neutral. Each electrons caries one negative charge. Every atom has the number of electrons at there are protons, so on the whole it is electrically neutral. The electrons so on the discrete kinetic energy levels, which increase with the orbiting of orbital radius, when atoms bond together to form a solid, the electrical conductors but in insulators and semi conductors there is an "energy gap", sometimes called the "forbidden gap" in which no electron orbit can exists, between the layer or "valance" band and the "outer or conduction" band. Valance electrons help to bind together the atom in a solid by orbiting two adjacent nuclei, while conduction electron, being less closely bound to the nuclei, are free to move in response to an applied voltage for electric field. The fewer conduction electrons there are, the higher the electrical resistivity ofthe material.

In semi conductors, the material from which solar cells are made, energy gab EQ. is fairly small .because of this, electrons in the valance band can easily be made jump to the conjunction band by the injection of energy, Either in the form of heat(thermal excitation) or light(photo excitation). This explains why the resistivity of semi conduction decreases as the temperature is raised or the material illuminated. The excitation of valence electrons to the conduction band is best accomplished when the semi conductors is in the crystalline state. i.e. when the atom are arranged in a precise geometrical formation " lattice".

At room temperature and low illumination, pure or so-called "intrinsic" semi conductors have a high resistively. But the resistivity can be greatly reduced by "doping, i.e" introducing a very small amount of impurity, of the order of one in a million ato ms.

There are t wo kinds of dopant. These whi ch have more valen ce electrons that the se mi conductors itself are called "Donors"and those whi ch have fewer are ter med "ACCEPT ORS". In a sili con crystal, ea ch ato m has four valence ele ctrons, whi ch are shared with a neigh boring atom to form a sta ble tetrahedral structure. Phosphorus, which has five valence atoms, Is a donor and cost extra electrons to appear in theconduction band. Silicon so doped is called-"N-TYPE" on the other hand, boron,with a valence of three is an acceptor leaving so called "HOLES" in the lattice, which acts like positive charges and render the silicon "P-TYPE". The drawing below are two _dimensional representations of n-and p-type silicon crystals, in which the atomic cluclei in the lattice are indicated by circles and the bounding valence electrons are shown as lines between the





Holes like electrons will move under the influence of an applied voltage, but as the mechanism of their movement is valence electrons substitution from atom to atom, they are less mobile than the free conduction electrons.

When lights falls on the front surface, photon with energy in excess of the energy gap (I.lEV in crystalline silicon) interact with valence electrons and lift them to the condition band. These movements leave behind holes so each photon is said to generate an "electron-hole pair". In crystalline silicon, electron-hole generation take place through the thickness of the cells, in concentrations

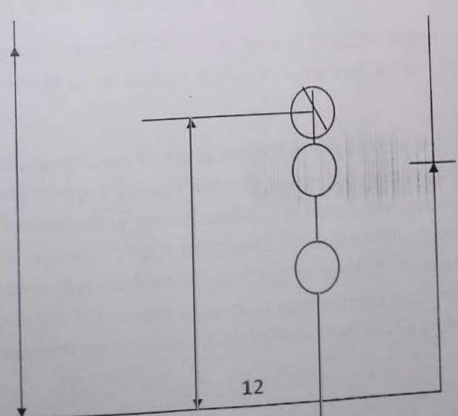
It is a plot of the energy levels in the crystal (ordinates) as a function of distance from the front surface (abscissa). Fred Ereble c. (1991) perganon press plc.

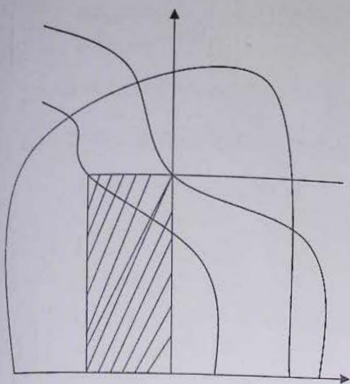
2.6 HOT SPOT EFFECT

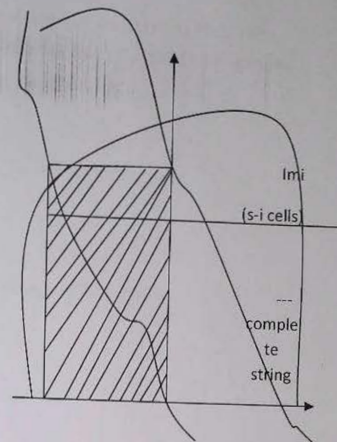
In the early days of photovoltaic'smodules someti mes failed through what is kno wn as "HO T SPO T EFFECT" th is phenomenon can be provoked by partial shadowing or soiling, cracked or mismatched cells or inter connect failures. in extreme cases ,it can lead to solder melting and to encapsulate.

To understand the hot-spot effects, consider a series connected str ing of a matched cells as in fig (a) (for simplicity, only three cells are shown). If one of the ells **Y** is shadowed, soiled or damaged so as to reduce the current it can generate to a value below that of the others, it will be forced into reverse blast.

This because all the cells must carry the sa me current and the shadowed or damaged cells can only do this under negative voltage.







In this condition, power is dissipated in cell **Y** and the amount isequal to theproduct of the string current and the reverse voltage developed across **Y** for any irradiance level, maximum power will be dissipated in the short-circuit condition, when the reverse voltage across **Y** is equal to the voltage across the other(s-I) cells in the string. This condition is illustrated for two –types of cells in fig (b) and(c). the power dissipated in the cell **Y** is shown in the heated rectangle constructed at the intersection of the verse **I-B**

Characteristics of the(s-I) cells in the case of the cells with a high shunt resistance fig (6), the condition of maximum dissipation occurs when cell **Y** is fully shadowed.

Note in both cases how **I-V** characteristics of the complete string are distorted, such distortions provide important clues in fault detection. In cases where the cell string extends along several modules in series, the reverse voltage developed across **Y** can amount to hundred of volts. To prevent this happening and there by limit the power that can be dissipated in damaged of shadowed cells, it is now common practice to connect a bye-pass diode across each module or, in some cases, across sections of the module, as indicated by the broken line in fig (a).

these are integrated in the module the terminal box but sometimes they are integrated in the module during fabrication. FRED TREABLE C. (1991) per ganon press plc.

2.7 FACTORS AFFECTING SOLAR CELLS

2.7.1 EFFECT OF CURRENT –VOLTAGE

- Influence of temperature
- Influence of electrolyte conductivity
- Influence of sub state conductivity cell width and cell contacts
- Influence of counter electrode
- Influence of iodine concentration
- Influence of mass transport conditions
- Nature of electrical contact
- Lighting condition.

CHAPTER THREE

3.0MATERIALS AND METHODS

3.1MATERIALS

The following materials will be used for the study.

- Solar cells (10 w)
- 2 pieces of enameled coated wire (1.5m)
- Electric motor
- Solder (rosin core)
- 6 inch (15- centimeter)diameter card board circle
- Scissors
- Glue
- Plastic wheel with axle hole in center
- Black marketing pen (tempo marker)
- Stop watch
- One (1)sheet of black construction paper
- Several sheet of colored transparency film in a variety of colors
- Paper and pencil or pen.

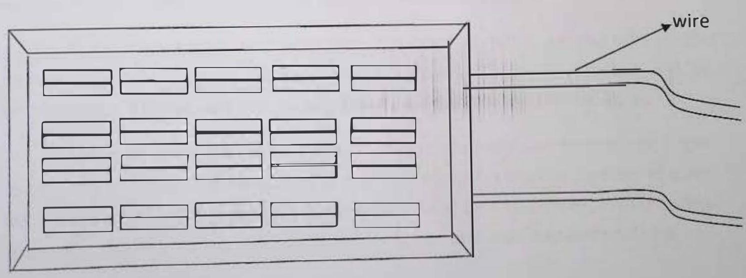


Figure 3.1: solar cells.

3.2 METHOD

3.2.1 SETTING UP THE EXPERIMENT

- First, the ends of 2 pieces of enameled coated wire will be stripped, which exposed about 1 inch (2.5 centimeters) of metals, using knife.
- Molten soldering gun will be dropped on to each of the leads on the solar cells. And the stripped wires will be quickly placed on the molten solder, tiny drop of solder will be added on top of the wires, making sure the wire is completely surrounded by the solder.
- To ensure both wires are securely attached. The wires will be pull gently, after have been left for about 10 minutes, when it was completely cooled.
- Same procedure will be applied to electric motor
- 6- inch (15 centimeter) diameter of cardboard circles will be glued to plastic wheel and then pushed gently on to shaft of the electric motor.
- The edge of the card board on wheel will be marked with ink. The dot will be used as a frame of reference to measure the speed when the wheel is spinning.

3.2.2 DOING THE EXPERIMENT

The solar cells will be connected with electric motor and the wheel and will be placed in bright sunlight to observe the spinning motion.

Using stop watch and watching the marked point on the wheel, the number of spins will be counted in 15 seconds. Then the number will be multiplied by 4 to convert it in minutes and the results will be recorded.

Different portion of the solar cells will be shaded black transparent paper to observe the spinning motion of the wheel. In each case the number of spins will be counted for 15 seconds and then multiplied by 4 to convert it to minutes. The same procedures will be carried out for green and blue transparent films.

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

4.1 HOW THE AMOUNT OF LIGHT AFFECT A SOLAR CELL

The efficiency of the solar cells used in a photovoltaic system, in combinational with latitude and climate, determines the energy output of the system. For example a solar panel with 20% efficiency and an area of $1m^2$ will produce 200w at standard test condition (STC).but efficiency on a clear day and decreases on cloudy day.

Solar cells efficiency is the ratio of the electrical output of a solar cell to the incident energy in the form of sunlight. The energy conversion efficiency of solar cell is the percentage of the solar energy to which the cell is exposed that is converted by dividing a cell's power output (in watts) at its maximum power point (pm) by the input light (E, in W/m^2) and the surface area of the solar cell (Ac in M^2).

4.2 ENERGY REQUIRED FOR SOLAR CELLs

To understand the efficiency of spectral line to solar cell, the energy required for solar cells was considered. The photons below a certain energy cut-off which called band gab energy (1.12 ev in silicon corresponding to a Temperature of 1.1Mm) are net absorbed by material.

The photons that are absorbed only need to have 1.12ev of energy to dislodge electrons. At shorter sun light and higher energies silicon electrons will get energized and current will flow.

4.3 THE EFFECTS OF TEMPERATURE

THE one sample of the commercially solar cells is used for experimental measurement. The solar cells was fabricated mono –crystalline structure with using phosphorus diffusion into a p-type silicon wafer.

Voltage-current [I-v] characteristics and outputs parameters of solar cell were measured. To obtain of solar cell I-v characteristics, sample was illuminated under sun radiation with light intensity equal $1000w/m^2$ the measurement were performed at 35^0C ,40^0C ,45^0C,44^0C,and45^0C temperature with highly accurate measuring equipment. Voltage-current characteristics of sample have been showed in graph.

Increases in temperature reduce the band gap of a solar cell. Where by affecting the solar cell out parameters, the parameters most affected by temperature is Vol. The open circuit voltage decreases with temperature due to the temperature dependence of the reverse saturation current.

$$I_{\bullet} = qA\ \blacksquare ni2$$

LND

Where D is the diffusivity OF the minority carrier

Given L is the diffusion length of the minority carrier,

ND is the doping

G is the electronic charge.

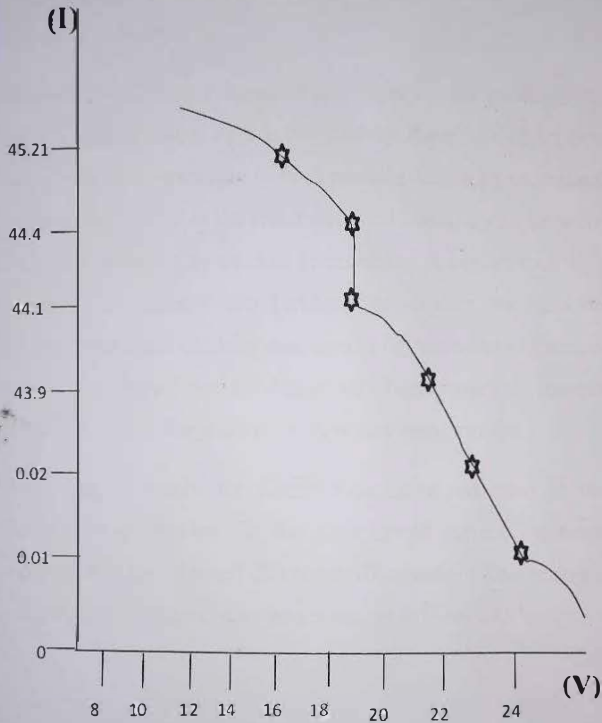
In the above equation, the most significant effect is due to the intrinsic carrier concentration [ni] lower band gaps giving a higher intrinsic carrier concentration so higher temperature results, the higher in from the output and fundamental parameter of solar cells like maximum output power [pm] fill factor [ff], short circuit current [1sc], and open circuit voltage [Volt] can be exracted.shows the output parameters of solar cell sample at different temperature.

Table output parameter of solar sample in different temperature

s/n	Time interval (MM)	Temperature	Voltage(VOLT)	Current(A)
1	0	35^0c	24.10	0.01
2	15	40^0c	21.30	0.02
3	30	45^0c	20.10	43.9
4	45	44^0c	19.S5	44.1
5	60	44^0c	19.85	44.4
6	75	45^0c	18.80	45.39

4.4 A GRAPH OF CURRENT AGAINST VOLTAGE

The higher the current, the lower the voltage and the higher the voltage, the lower the current



4.5 Effects of light intensity

In the output parameter of solar cell sample in different temperature the voltage v-I characteristics of previ•us sample at light} 100,150,350 MA/cm^2 have been shown. As can be seen, V-I characteristics of solar cell very under different levels of illumination.

Shadow is define as a region where light cannot reach. A dark image projected onto a surface where light is blocked by the shade of an object, the experiment was conducted repeatedly in both partial shadow [penumbra] and total darkness shadow [umbra].from the result obtained above it can be seen that light intensity in partial darkness or shadow [penumbra] is higher than light intensity in total darkness or shadow the [umbra].The higher the darkness the lower the temperature ,light intensity and current but the voltage increases in dark shadowy [umbra]. Also the lower the darkness the higher the light intensity, temperature and current but the voltage decrease in penumbra darkness.

According to results for silicon solar cells reduction in the open.-circuit (voltage is about 14mv/•c. the short circuit current increases slightly with temperature, for solar cell this about 100cma/aem^2) decreases with increasing temperature. The maximum power output is menus 45°c.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION.

5.0 INTRODUCTION

This chapter was discuss on the analysis on the effect of solar cell. Solar cells, also called photovoltaic cells, change sunlight directly to electricity when sunlight strikes the solar cell. Electrons are knocked loose. The efficiency of the solar cells used in a photovoltaic system in combination with latitude and climate determines the energy output of the system.

5.1 SUMMARY

The project was summarized on how sunlight is having the effect on solar and the amount of temperature base on the result obtained the sample of the commercially solar cells is used for experimental measurement. The solar cell was fabricated mono-crystalline structure with using phosphorous diffusion into a p-type water voltage current (i-v)

Characteristic and output parameter of solar cell were measure. To obtain solar cell current voltage was illuminate under sun radiation. The measurement were performed at $35^{0\,c}$ 40^{0c} 44^{0c} and 45^{oc} and the I-V curve were included.

5.2 CONCLUSION

In conclusion this study examined the effect and the mount of light and temperature on a solar cell, which observed that changing of solar cell. Efficiency affected the voltage (output) of the solar cell. These changing of cell temperature, partial shadow or cracked and the use of voltage which is an obstacle to solar cell for absorbing efficient radiant energy.The result is significantly demonstrated that higher efficiencies can be obtained when the cell surface is positioned normal to the sun direction without any obstacle (covered). Also observed that solar cell are often fabricated with a reflective back, surface (also act as the electrode)so that protons passing through the entire water still have a change to be absorbed on the rebound trip which showed that little temperature light suffers more reflection loss at the front surface than large temperature which affect the solar cells.

5.3 RECOMMENDATION

After the study of the effect of temperature and amount of light on solar cell carried out experimentally. It was found that partial shadow is a major problem to the efficiency of light to solar cells.

There are some Ways to avoid these effects: Avoiding partial shadow by position of solar panel array where there will be no regular shading.

Solar system owners should be vigilant in making sure that there no nearby trees which might grow tall enough to eventually cause shading issues.

Engineers need to develop new technology on solar system that can manage less efficiency energy.

Manufacturers of solar cells were suggested for using (super black solar cells) under development technologies that may offer high efficiencies even in inclement weather.

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