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A Study on Infrared Plastic Solar Cells Using Nano Technology

K. Himabindu[#1],C N Sujatha[*2]
[#1]*UG Student, Department of ECE, Sreenidhi Institute of Science and Technology, Ghatkesar, Hyderabad*
[*2]*Professor, Department of ECE, Sreenidhi Institute of Science and Technology, Ghatkesar, Hyderabad*
[1]sonyhimabindu@gmail.com
[2]cnsujatha@sreenidhi.edu.in

Abstract*—Sun is a never ending source of energy. Extinguishing of fossil fuels and greenhouse effect had lead to the use of everlasting source of energy. One such source of energy is solar energy generated by using solar cells. Solar energy is an abundant source that is renewable and eco friendly. It was used in various fields like household purposes, industrial purposes etc. But this solar energy is not being used widely because of their inefficiency on cloudy days and they are not cost effective. Application of nanotechnology in solar energy field lead to arise of infrared plastic solar cells. These are made by using polymers and have the capability of converting even sun's infrared rays and able to work on cloudy days. With this invention there was a solution for the drawbacks of solar energy utilization. This report deals with the working, efficiency and implementation of nanotechnology in solar cells in making of effective infrared plastic solar cells.

I. INTRODUCTION

Nanotechnology was first proposed by Richard Feynman. Nano is the Greek word for dwarf (short). Nano means "one billion" or 10^{-9} meters.Nanotechnology is the process of design, production, characterisation anddevices, application of structures, and systems by controlling the size and shape at the nanometer (i.e.in order of 10^{-9})scale. When reduced to 100nm the materials show drastic changes with respect to physical, chemical, optical, magnetic, mechanical and electrical properties. All this leads to applications in bioscience, medical, environmental science, electronics, and so on[1].

Nanotechnology has a large variety of disciplines including physical science, chemistry, molecular biology, mechanical engineering, computer science, and material sciences. This vast application also includes the field of renewable energy i.e. solar energy. The existing solar panels made of silicon material failed to meet the requirements. Use of nanotechnology in solar energy field created an opportunity to overcome drawbacks and increase in efficiency.The figure 1 tells us how various fields of sciences are involved in the nano technology.

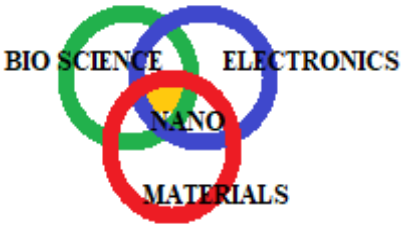

Fig. 1 Involvement of various sciences in Nano technology

II.CONVENTIONAL SOLAR CELLS

A solar cell is a photovoltaic device that converts solar energy into electrical energy based on the photovoltaic effect principle. 95% of all solar cells produced worldwide are made of

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semiconducting matter silicon (Si). The element that is second most in Earth Crust. Silicon has the advantage of being available in large quantities.

A. Solar cell structure:

The solar cell (crystalline silicon) has two parts. They are the n-type semiconductor layer (emitter) and the p-type semiconductor layer (base). Sandwiching of these two layers gives leads to the formation of PN junction. Anti-reflection coating was done on the surface to reduce loss of incident light rays energy due to reflection. Proper metallic contacts are made to n-type and p-type side of the semiconductor for goodelectrical conductivity.

B.Solar Panel:

The solar panel means to connect the solar module in large number to get the most efficient energy. The solar module consists of solar cells connected to each other. Solar cells connected to each other are placed between two glass panels in order to protect them from bad weather. As the absorption area of the module is higher, more power can be generated.

C.Working:

When the sunlight falls on the solar panel, it is observed by the solar cell. The absorbed light increases the energy in the electrons in the material which makes to break the covalent bonds and produce free electron. This produced electron is free to move in the semiconductor material and go to higher energy levels. But, negatively charged particles(electrons) remain at high energies for only a small interval of time before returning to their original low energy level position. Therefore, PN junction collects the carriers before they lose their energy from the light rays. When light energy falls on electrons P-type material energies and further electrons move into n-type region. Thus they stay high powered instead of going back to original low power position. Collection is the process of moving light-producing carriers from the P-type area to the N-type. The collection of electrons can be used by device to generate current or can be converted to voltage form without collecting. The carriers that leave the solar cell in the current leave their energy connected to it, and then back into the solar cell. The same process is repeated in the solar cell once again. The current that is produced by the solar cell is Direct Current, and that can be converted to 240 volt AC current using an inverter for various devices [2]. The figure 2 explains about the working of conventional solar panels.

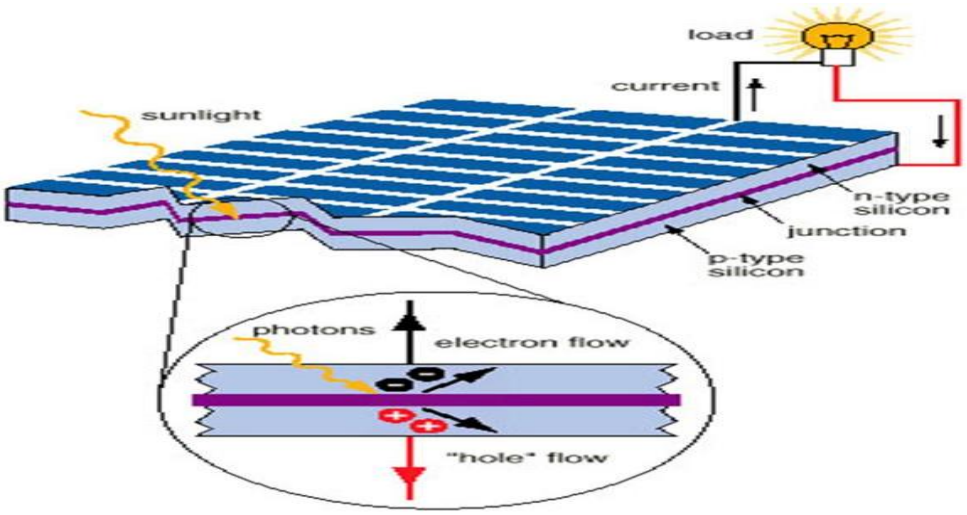

Fig. 2 Working of Solar Panels

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III. PLASTIC SOLAR CELLS

Plastic is the material made by using polymers- large molecules formed by repeated combination of smaller molecules in the form of chains. Generally plastic is a non conductive material. But with the discovery of Alan Heeger, Alan MacDiarmid, and Hideki Shirakawa at the end of 1970's proved that conducting polymers do exists. For this discovery Alan Heeger received the Noble Prize. From then research has been going on the conductive polymers in various fields including the renewable energy field [3]. This led to invention of infrared plastic solar cells. Use of nanotechnology in plastic solar cells which contains first generation solar cells help them to utilise even sun's infrared rays which are invisible. Plastic solar cells are made by combining nano particles called Quantum dots with polymer to make them convertthe energy in the infrared rays [4].As they are made by using plastic, they are thin and can be rolled into sheets as shown in the figure 3.

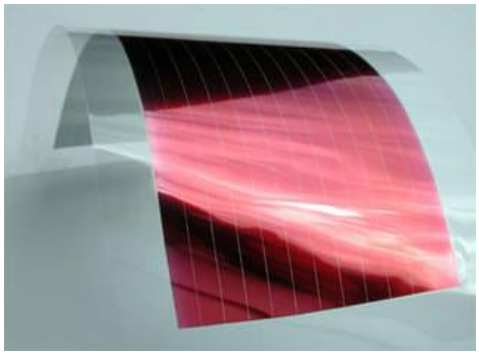

Fig. 3 Plastic solar cells in the form of Sheets

When the dimensions of a potential well or box concerned with the particle or reduced to the order of De-broglie wavelength of electron (within few ten's of nanometres) then energy levels of electron change. This is called Quantum confinement.[4]. As the size of the material decreases the band gap in atoms increases as in the figure 4.

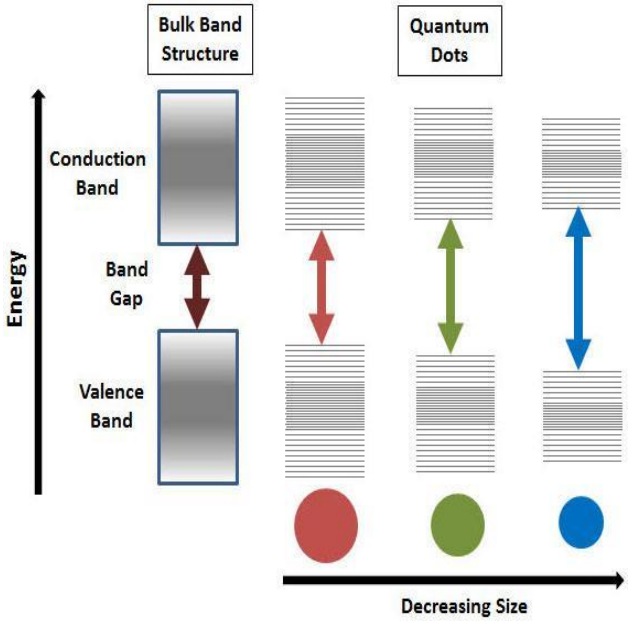

Fig. 4 Quantum Confinement

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A. Construction and Working:

The working of plastic solar cells is similar to traditional solar cells, but nano technology is used in solar cell manufacturing. The plastic solar cell is originally made by compressing hybrid, organic polymer into small nanorods dispersed in plastic. The nanorods are made in a beaker which contains cadmium selenide, targeting rods with a diameter of 0.7nm to detect as much sunlight as possible. Nanorods are a type of nanoscale objects that have a diameter of 1–10nm. The display is useful and interesting because it is small in size and light in weight. The nanorods would be of length approximately 60nm. P3HT (poly- (3-hexylthiophene)), nanorods with plastic semiconductors are mixed all together. The transparent electrode is siat with the mixture. Thickness of 200nm, means 1000 times the size of human hair. Aluminum coated plastic that acts as a back electrode completes the solar cycle.

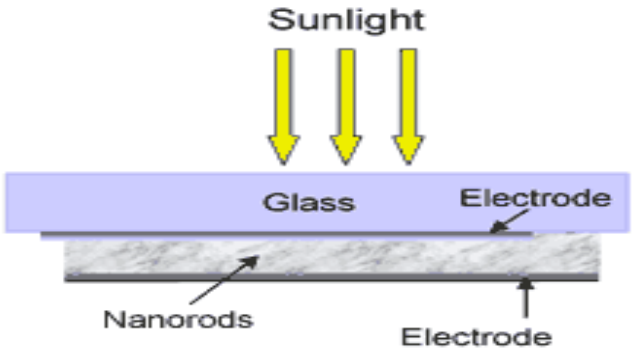

Fig. 5 Structure of Plastic solar cells

When a plastic solar cell absorbs light of specific wavelength, the nanorods act as wires and generate an electron and electrovacancy(called hole) in the crystal which just move like an electron. The generated electron travels until the end of rod and is collected by the aluminium electrode. The hole which is a positive charge is transferred to the plastic semiconductor, which is known as hole career and transferred to the electron, generating current [5]. The space occupied by the plastic solar cells is very less that we can held the panel with 8 solar cells in our hands as in the figure 6.

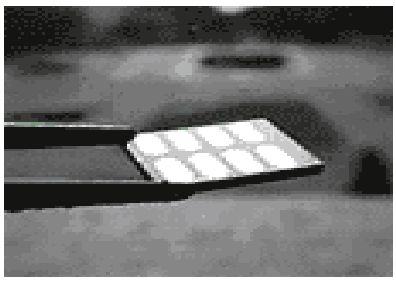

Fig. 6 Solar panel containing 8 plastic solar cells

There are many advantages of plastic solar cells. They are

1. Plastic solarcells areup to 30% more efficient and practical than conventional solar cells.
2. They are where impact rather than bulky conventional solar panels is.
3. Flexible and can be sprayed on to any device t just like a paint.
4. Reproduction is also very simple that they can be easily produced in a beaker [6].

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Any system cannot be 100% efficient. So apart from advantages there are disadvantages like:

1. The main drawback with plastic solar cell is cost effectiveness. But chemists are working over it.
2. As they are very thin wear and tear occurs when constantly exposed to atmosphere. So we need constant maintenance [6].

IV. APPLICATIONS

1. Plastic solar cells can be used in making of a solar power panel poster which helps in providing electricity to the remote areas.
2. They can be sprayed on to any other materials like a paint and used in portable devices.
3. Any device coated with plastic solar cells can be used in mobile phones or other wireless devices.
4. Plastic solar cells can be sprayed on the top of a hydrogen powered car which continuously helps in recharging the battery by converting solar energy into electrical energy as shown in the figure 7.

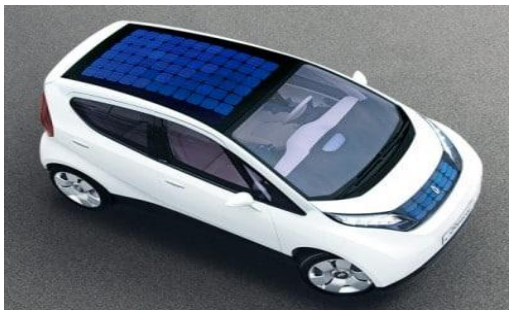

Fig.7 Plastic Solar cells Painted on a car

5. Used in ocean navigation i.e. in light house[7].
6. In the field of publicity plastic solar cells can be used in making the hoardings used for advertising than using other energy sources as in the figure 8.

Fig. 8 Plastic Solar Cells for Advertisement Purpose

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V. CONCLUSION

The usage of energy is growing with increasing population and this cannot be satisfied by the existing energy resources. . It is said that we use one by ten thousand times of the solar energy only that reaches on the earth. Due to some disadvantages of Conventional solar cells their is being limited. But plastic solar cell helps in converting sun's infrared radiation and can produce electricity even on cloudy dayshave lead to overcome few disadvantages of conventional solar cells. At present though they are cost effective we can reduce the drawback in future. If we are able use to 0.1 % of the earth surface with solar forms then we can replace all kindof energies with solar energy,thus providing electricity even to the remote areas.

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REFERENCES

[1]Charles P Poole and Frank J Ovens, “Introduction to NanoTechnology”, 2003

[2] Ryan C. Chiechi, Remco W.A. Havenith and Jan C.Hummelen “Modern plastic solar cells: materials, mechanisms and modeling”,Materials Today,Volume 16, Issues 7–8,pp. 281-289, July–August, 2013.

[3]Alex C. Mayer, Shawn R. Scully and Michael D. McGehee, “Polymer-based solar Cells”,Materials Today,volume 10,No 11,pp. 28-33, November 2007

[4] Oleg D. Neikov and Nikolay A. Yefimov, “Handbook of Non-Ferrous Metal Powders (Second Edition)-Nano Powders”, 2019

[5] Shraddha R.Jogdhankaand ChannappaBhyri,“A review on infrared plastic solar cells”, Krishisanskriti, Impending Power Demand and Innovative Energy Paths - ISBN: 978-93-83083-84-8,pp. 333-340,2012,

[6]Prabhat Gupta andVaishali Srivastava “Comparison between Solar cell and Infrared Plastic Solar Cell” IJIRCCE journal, Vol. 6, Issue 3, pp. 2476-2480, March 2018.

[7] Jay patel andPrernaGoswami “Infrared Organic Photovoltaic: A review”,Research Journal Engineering and Tech.,Vol:8,Issue 2,pp. 159-164,2017