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WORKING IN PHOTOVOLTAIC CELLS

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ABSTRACT :

Recently has been development/improvement in photovoltaic efficiency and device manufacturing of cells. Especially doctor blade solar cells. Which show the higher open-circuit voltage (Voc), also short circuit current and power conservation energy. Now a day the ultra-high photovoltaic cells are used in space application. By using traditional photovoltaic cells we get only 17% to 24% efficiency, which is very low. But by using other technology as like nano technology, thin film technology we can improve this efficiency up to 25% to 30% or more than it. This is called ultra-high efficiency, used in aircrafts in Armey.

KEYWORDS: solar technology, working of solar cell, thin film technology, CNT-technology

1. INTRODUCTION:

The growing energy demand and the depletion of conventional energy sources along with global warming threats has motivated researchers to design the most efficient photovoltaic (PV) cells. A PV cell that used sunlight to generate clean electric power was first designed and fabricated by Bell Laboratories in 1955 [1]. Because of less efficiency and high cost. It was then predicted that silicon (Si) would soon be replaced by another material more suitable for solar cells because Si is not an ideal material for PV conversion The world-wild research and scientist was concentrating (or they have objective) on increasing the efficiency with reduce the cost and flexibility in photovoltaic devices, which can move anywhere. But still the end of the 20th century, all world researchers and scientist was applicable to improve the efficiency only up to 26.9%. Which was new world record in photovoltaic efficiency reported (2,Takamoto et al. 1997b). **B**ut they did not make such a photovoltaic device which could take every family i.e. cheap photovoltaic cells.

The major things to improve the efficiency of photovoltaic cells are:

A) Choosing the semiconductor material, with its appropriate band gap(1.5eV) i.e. its band gap can match the solar spectrum and optimizing their electrical, optical, structural properties, also it should have good thermal and electrical conductivity

B) And developing innovative device by engineers to store more power and it should very flexible which can easily able to move anywhere.

To achieve these goals, many researchers move towards the organic-polymer materials, nano-technology, thin film technology and other much more technology. Organic semiconductors have emerged as a class of materials that can be specifically designed to have a wide range of chemical, optical, and electronic properties, yet they can be processed via low-cost, solution-based techniques.

2. TRADITIONAL PHOTOVOLTAIC CELLS:

In 1955, Bell laboratory bring new technology by manufacturing first photovoltaic cell by using material silicon. Which had given only 4% to 11% efficiency [1]. But it had very costly. Although it was make new revolution in renewable energy. After they continually work on it and try to achieve its efficiency more than it but they didn't unable to reduce the cost. To reduce the cost and material they choose another material. The crystalline silicon solar cells by using thin film-technology; it reduced the thickness up to 50 µm silicon material consumption significantly and has potential to reach high efficiencies comparable to silicon wafer [3]. It is helpful for increasing the output voltage. However it was gave very little efficiency and very high cost but it was starting to go towards new revolution after that they use Nano-technology. It has build thickness up to 1 nm to 9 nm.

3. WORKING:

Photovoltaic (PV) cells are converts light energy into electrical energy which is made of

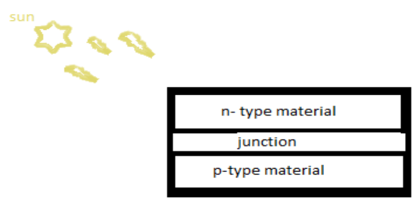

Figure 1: structure of semiconducting material

special materials called semiconductors materials. The semiconductors made up of two types of materials i.e. P-type which is positive and has holes majority and another material is N-type which is negative and has electrons majority. For that purpose generally use silicon materials, which has band gap 1 to 1.5 eV. Only on this band-gap electron liberates photons from it and we get proper electric fields. In fact, Over 95% of the solar cells produced worldwide are composed of the semiconductor material silicon (Si).

The interesting part starts when you put N-type silicon together with P-type silicon. Remember that every PV cell has at least one electric field. Before now, our silicon was all electrically neutral. Our extra electrons (electrons i.e. negative) were balanced out by the extra protons in the phosphorous. Our missing electrons (holes i.e. positive) were balanced out by the missing protons in the boron. When the holes and electrons mix at the junction between N-type and P-type silicon, however, that neutrality is disrupted as shown in figure 1. This electric field acts as a diode, allowing (and even pushing) electrons to flow from the P side to the N side, but not the other way around. It's like a hill electrons can easily go down the hill (to the N side), but can't climb it (to the P side). So we have got an electric field acting as a diode in which electrons can only move in one direction.

When sunlight spreads on positive material. Each photon with enough energy will normally free exactly one electron, and result in a free hole as well. If this happens close enough to the electric field, or if free electron and free hole happen to wander into its range of influence, the field will send the electron to the N side (negative side) and the hole to the P side (positive side). This causes further disruption of electrical neutrality, and if we provide an external current path, electrons will flow through the path to their original side (the P side) to unite with holes that the electric field sent there, doing work for us along the way. The electron flow provides the current, and the cell's electric field causes a voltage. With both current and voltage, we have power, which is the product of the two. Because of the flow of electrons and holes, the two semiconductors behave like a battery, creating an electric field at the surface where they meet and this surface we call the p/n junction. The electrical field causes the electrons to move from the semiconductor toward the negative surface, making them available for the electrical circuit. At the same time, the holes move in the opposite direction, toward the positive surface, where they await incoming electrons. Through metal contacts, an electric charge can be tapped. If the outer circuit is closed, then direct current flows.

4. THIN-FILM SOLAR CELLS

Thin-film silicon offers an exciting opportunity for the development of efficient low-cost solar cells. Thin film CIGS technology is very promising for achieving high efficiency at economic price. An ink based non-vacuum process is used to fabricate CIGS solar cells both on rigid and flexible substrates. As reported, an aqueous precursor metal-oxide suspension manufactures from nano-particles of Cu, Ia, and Ga oxides is coated onto a Mo foil or a non-conducting substrate, improving cell efficiency to 8.9 % on polyimide, 13.0 % on Mo foil, and 13.6 % by using on glass substrate [4,5]. The most exciting recent development in this area is the achievement of 9.8% efficiency in a 3.5-µm poly-silicon thin film in the so-called STAR cell structure [6]. This size is very less than grain size (10µm). Thin film technologies reduce the required mass of light absorbing material, resulting in reduced processing costs but also reduced energy conversion efficiency. Because these thin films are nearly mass-less, they can be stacked to form multiple layer film cells which yield an average of 30% efficiency while standard semiconductor efficiency is limited to 14% [10]. This was new achievement in renewable energy research.

5. NANO-TECHNOLOGY:

Since the early 1990’s, considerable attention has turned to lightweight, flexible organic thin-film photovoltaic based on soluble conducting polymers [7]. This new class of devices relies upon the interaction between a nano-material and a conjugated polymer [8]. In addition to enhancing photovoltaic conversion efficiency, the incorporation of nano-materials can potentially improve photochemical, mechanical, and environmental stability. The researchers found that the very narrow structure of the nano-tube forced the electrons to pass one by one, generating further electrons with the spare energy from the higher energy photons, in a nearly ideal energy conversion process that could be the key to higher efficiency solar panels [9]. To obtain the SWNT (single wall nano tube) we use CVD(chemical vapor deposition) method due to of graphene film is very

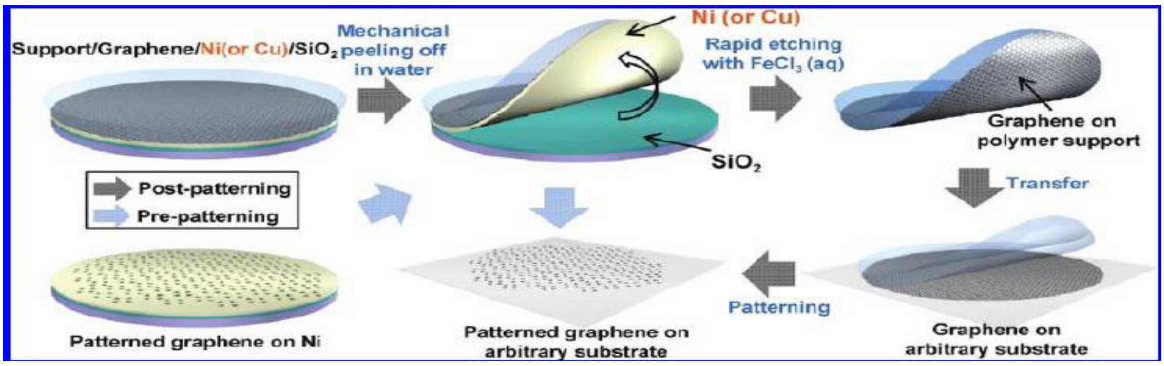

Figure 2 : The process how CVD graphene transfer to arbitrary substrate.

thinner we can easily generate in electron hole pairs shown in fig. 2[11]

6. CONCLUSION:

Enormous progress has been made in photovoltaic cells. Now a most of the scientist using nano-materials due its varies verity in its beautiful properties. An ultra-high solar cell fabricated by using varies materials. Various thin-film technologies such as amorphous silicon, CIGS, and CdTe materials and devices continue to show significant advances in their conversion efficiency. Recently all the scientist try to manufacturing low cost photovoltaic devices which can easily handle and flexible. Today this is necessity to develop their electric power station but our all power sources come to ends after five year but only one and one power sources till the end of the earth i.e. sun. It does have end before the end of earth.

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