Solar Energy and Its Generations

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Abstract— Solar cell also called photovoltaic cell, a device which directly converts the sunlight (energy of light) into electricity (electrical energy). This photovoltaic effect produces both current and voltage for generating electrical power. Firstly this process requires a material which absorb the light raising the electrons to a higher state of energy secondly the movement of these higher electrons dissipates the energy into the external circuit and return to solar cell. By using the semiconductor material which makes form p-n junction make the photovoltaic conversion. We will study in this article the types of solar cell with its applications.

Keywords: Solar Energy, Photovoltaic Cell, Solar Cell, Power

I. INTRODUCTION

Because of technological advancements and population explosion world needs much energy and increment in climate change and greenhouse gases renewable energy source is greater than ever. The earth which receives an incredible energy supply from sun an average star in fusion reaction that has been giving energy among 4 billion years. Solar energy among all other renewable sources of energy is a free available for managing long term issues in the energy crises solar energy is an exhaustible and free source. The sun is a biggest spherical gaseous cloud star made up of hydrogen and helium. Sun composed of hydrogen nuclei combining and form helium energy from the fusion of hydrogen nuclei. The amount of sunlight is depending upon the season, clouds, time of the day and geographical location.

$${}_1^2H + {}_1^2H \rightarrow {}_2^3He + {}_0^1n + 3.27\text{Mev} \quad \ldots\ldots\ldots\ldots(1)$$

$${}_1^2H + {}_1^3H \rightarrow {}_2^4He + {}_0^1n + 17.59\ Mev \quad \ldots\ldots\ldots\ldots(2)$$

Photovoltaic cell requires three types of operation:-

1) Generating electron-hole pair by absorption of light.
2) The separation of charges of opposite types.
3) The separation of charges carries to an external circuit.

A. Generations and types of solar cell:

Three types of generations: First generation, second generation and third generation of solar cell

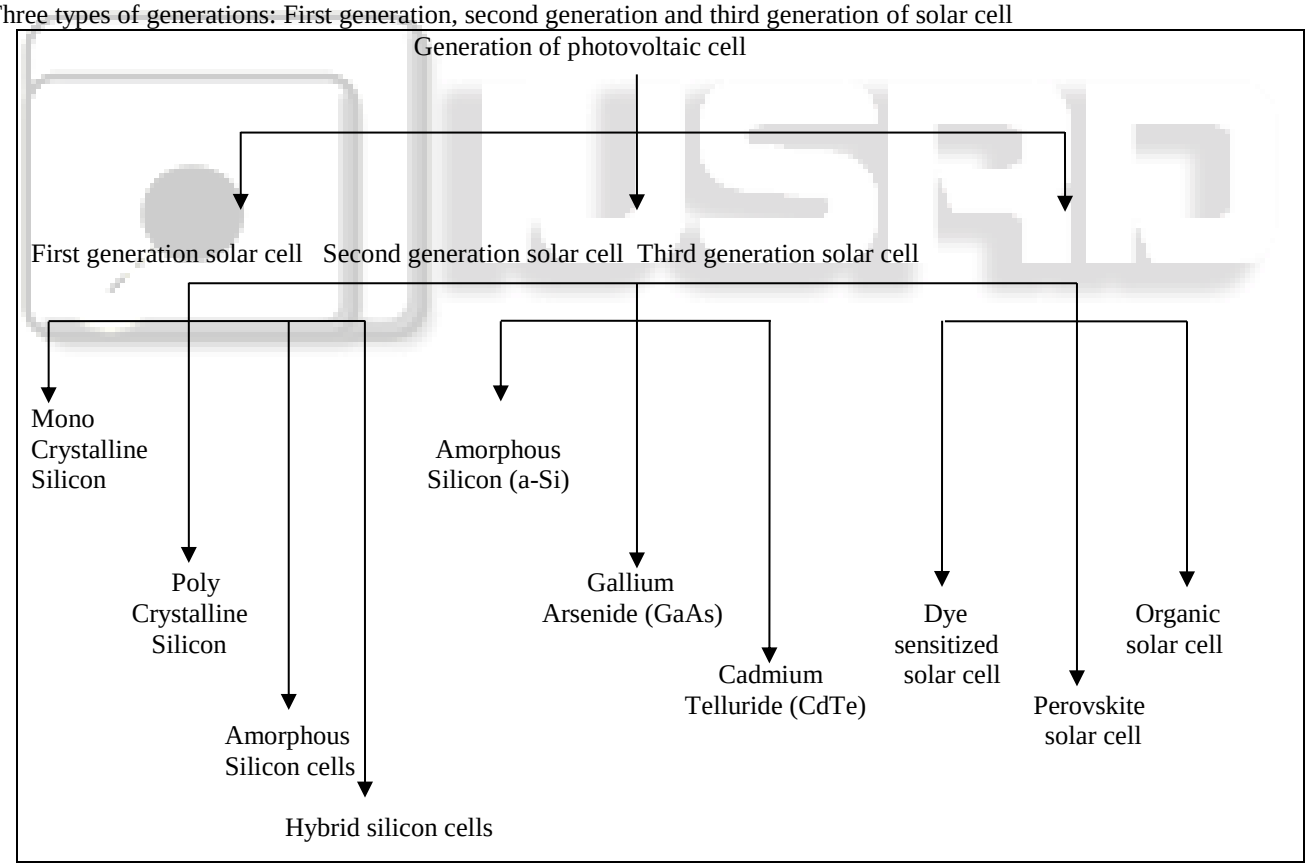

Fig. 1:

1) First generation photovoltaic cell

First generation photovoltaic cell based on silicon cells developed by Bell Laboratories in 1954 having 6% efficiency. Silicon is the most abundant material on earth a semiconductor material with energy gap 1.1ev.

2) Monocrystalline silicon

Monocrystalline solar cell if the whole wafer having only the one silicon crystal called monocrystalline solar cell made up of thin wafer of silicon with comparing polycrystalline and amorphous silicon cell which having higher efficiency is 26%.

3) Polycrystalline silicon:
If the whole wafer having crystal grains called multi crystal or polycrystalline silicon produced from metallurgical grade silicon by purification process this process is called Siemens process. Polycrystalline silicon has much less purity than single crystalline silicon and recorded the highest efficiency is 21%.

4) Amorphous silicon cell:
Amorphous silicon cells are the non-crystalline silicon used for making solar cell made by vapor depositing thin layers of silicon material lacks the ordering of the silicon in the form of crystal due to this have no semiconductor property.

5) Hybrid silicon cells:
Sanyo introduce hybrid silicon solar cell perform well in terms of indirect light and much less likely to loss efficiency as the temperature increases.

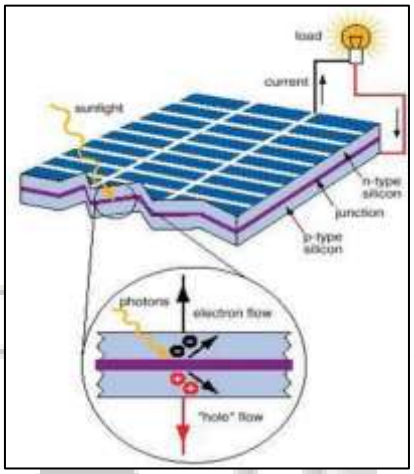

Fig. 2: Structure of silicon solar cell adapted from [12].

6) Second generation photovoltaic cell:
Thin film solar cell is called second generation solar cell compared to crystalline silicon cells they are made from layers of semiconductors materials only a few micrometer thickness. As mentioned above three types of 2nd generation solar cell together they accounted for around 16.8% of the panel sold in 2009. As they have been able to reach 20% of efficiency level in the laboratory. One of the biggest advantages by using thin layer of silicon that panel can be made flexible. Few fundamental difference between first generation solar cell and 2nd generation solar cells is the semiconductor which used in the cell has a direct band gap as it opposed to the indirect band gap of silicon, but these cells till depend on a p-n junction design.

7) Amorphous silicon:
Compare with conventional wafer based crystal silicon hydrogenated amorphous silicon uses organized structure, yields 1.7ev higher band gap compare to 1.1ev for crystal silicon allows stronger absorption in the visible region of the spectrum. But amorphous silicon has its limited in adoption due to low efficiencies as recorded 14.0%.

8) Gallium Arsenide (GaAs):
Gallium Arsenide is used for single crystalline thin film and for multi junction. Solar cell based on multijunction solar cells efficiency recorded 42.3% GaAs is mostly used for high efficiency applications.

9) Cadmium Telluride (CdTe):
Cadmium Telluride has achieved 22.1% similar efficiencies to Cadmium Indium Gallium Silicon (CIGS) band gap close to an ideal at 1.43%. Cadmium Telluride has advantages good absorption and low energy losses. In Cd Te, Cd is a toxic material and Telluride is particularly rare.

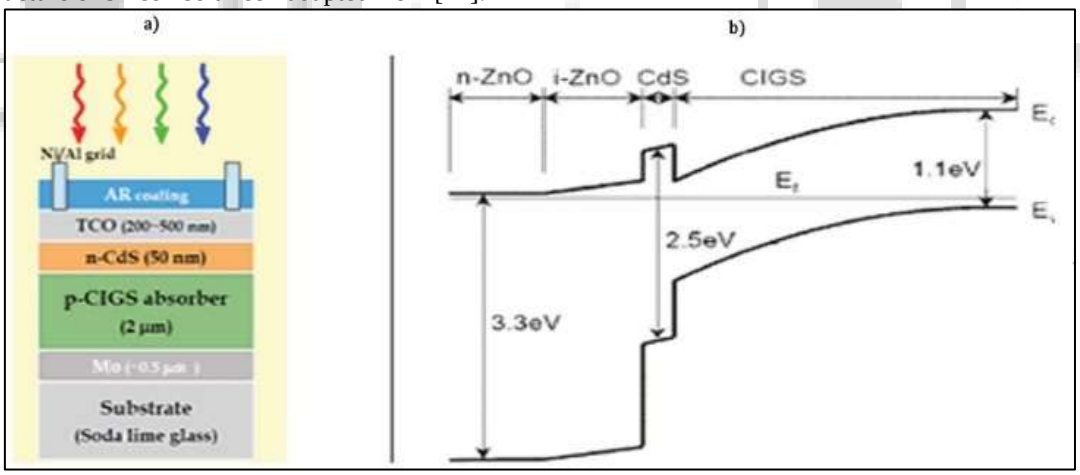

Fig. 3: (a) Basic structure of a CIGS solar cell (b) CIGS solar cell band diagram.

10) Third generation photovoltaic technologies:
High cost of 1st generation PV technologies and toxicity and limited availability of the materials for 2nd generation solar cells a new 3rd generation of solar cells emerged. 3rd generation solar cell very differ from 1st and 2nd generation of solar cell. 3rd generation of solar cells are being made from variety of new material besides silicon, silicon wires nanomaterial, organic dyes conductive plastics and solar inks using conventional printing press technologies. By using this material solar energy less expensive more efficient and without ant toxicity used by more and more people.

11) Dye sensitized solar cell:
Dye sensitized solar cell is used for their high efficiency, simple technology and cost. The conversion of visible light into electricity can be achieved through spectral sensitization of wide band gap semiconductor such as SnO_2, ZnO and TiO_2. Sensitization is the process with the help of dyes which required to improve their ability to absorb the radiations and inject the electrons into the conduction band.

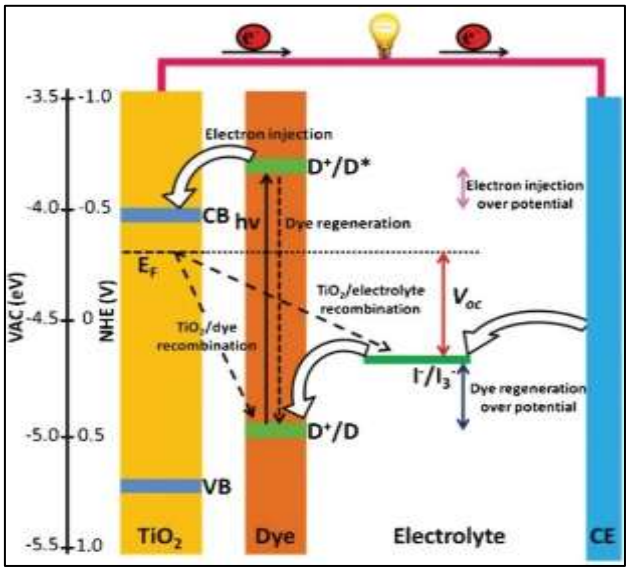

Fig. 4: Energy-level diagram of a DSSC. VAC = vacuum energy level, CB=conduction band, VB=valenceband

12) Perovskite solar cell:

Organic, inorganic hybrid Perovskites have gained considerable research attention due to advantages such as high electron and hole mobility long carrier diffusion length band gap and low exciton binding energy. XYA_3 is the structure of organic inorganic hybrid halide based perovskite where X is an organic cation $CH_3NH_3^+$ or $CH_3NH_2^+$, Y is a divalent cation (Pb_2^+ or Sn_2^+) and where A is a monovalent halide anion (I^- , $Br^-$and Cl^-). With efficiencies in excess of 28% predicted in the near future because the performance of perovskite solar cell has been improved rapidly.

13) Organic solar cell:

Organic solar cell absorbing layer based on certain organic semiconductor and the structure consists of photoactive organic layers comprised of p-type and n-type semiconductor .Due to low cost manufacturing processing that is used for strong advantages of organic photovoltaic other advantages is their low weight and environmentally friendly degradability offers new opportunities for this solar cell.

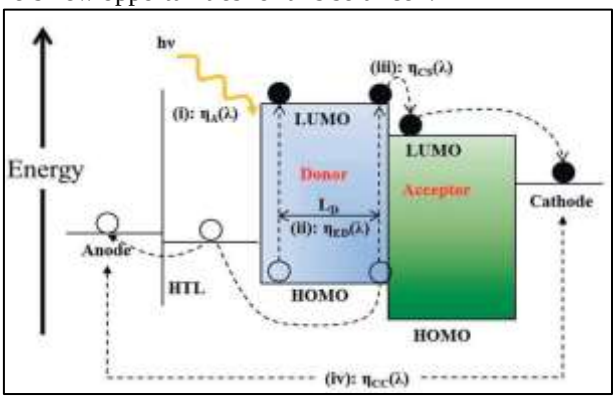

Fig. 5: Mechanism of an organic solar cell

This is all about to make easy to understand about solar cell.

II. CONCLUSION:

Solar power nowadays one of the biggest and most demanding free sources of electricity. The generations of solar cell developed as per requirements increases the efficiency .Solar energy is free from pollution, renewable source, no greenhouse gas emitted and fast growing technology. The cost of any solar system will come down when its production increases.

REFERENCES

[1] Nabhani N and Emami M (2013) Nanotechnologies and its applications in solar cells.
[2] Aldous Scott. "How solar cells work" How stuff work 22 may 2005.
[3] Sethi V.K. Panday M. and Shukla P. Use of nanotechnology in solar PV cell. International Jouranal of chemical Engineering and Applications.
[4] Wall A (2014) advantages and disadvantages of solar energy process industry forum, 7 August 2013. Web 2 February 2014.
[5] Kiran Ranabhat An Introduction to solar cell energy.
[6] Renewable Energy Network for 21st Century (REN21) RENEWABLE 2016 Global status Report.
[7] Green M. A. (2001) Solar energy the state of the Art London: James & James.

