ISSN No:-2456-2165

Study of Different Type of Solar Cell

Asif Mumtaz, Nitish Kumar Jha, Md Sheesh, Gulrez Akhter, Bhanu Prakash
Student Department of Electrical Engineering, Greater Noida Institute of Technology, Greater Noida

Dr. Dhiraj Gupta .
Director Of Greater Noida Institute of Technology, Greater Noida, India

Nikhil Gupta
HOD, Dept. of Electrical Engineering. Greater Noida Institute of Technology, Greater Noida

JItendra Sharma
Asst. Prof, Dept. of Electrical Engineering Greater Noida Institute of Technology, Greater Noida

Abstract:- Solar energy is created by sunshine and is a non-depleting renewable form of energy that is not environmentally harmful. The amount of solar energy that enters the earth every hour is sufficient to supply all of the energy needed for a year.The power generated by a single photovoltaic cell is typically only about two watts. Since the intensity of solar radiation is already low, most modern photovoltaic cells only have an energy efficiency of 15 to 20 percent, and in order to generate even modest amounts of power, large and expensive assemblies of these cells are needed. The most plentiful energy source on our planet is the sun's rays.In fact, the sun provides more energy to the earth in an hour than it does in a year.

I. INTRODUCTION TO SOLAR ENERGY

Solar energy is the name for the enormous quantity of energy that the sun emits every day in the form of heat and radiation. Solar energy is a free, unlimited source of energy that can be used indefinitely. At the moment, fossil fuels with negative effects on both human health and the environment account for about 85% of the world's energy needs. In addition, by 2050, the world's energy demand is anticipated to double. The primary advantage of solar energy over other conventional power sources is that it can be produced directly from sunlight using tiny photovoltaic (PV) solar cells. The Sun is thought to be a large, spherical cloud of gaseous atoms composed of hydrogen and helium. This large, spherical gaseous cloud is primarily made of numerous hydrogen nuclei that combine to produce helium energy when energy is released from the nuclear fusion of hydrogen nuclei in the Sun's inner core. Despite the fact that solar energy is freely available everywhere, manufacturing solar cells, panels, and modules requires an initial investment in equipment [8]. There is no sound made by the operation of these little solar cells. On the other hand, large power pumping apparatuses emit intolerable noise pollution, which makes them exceedingly upsetting to society . The per watt cost of solar energy devices has gained importance over the past ten years as a result of the depletion of renewable energy sources. In the years to come, solar energy devices will undoubtedly become more affordable and advance as a better technology in terms of both price and applications.

In India, Generating energy from solar panels emits very little pollution into the air, and Thus, compared to burning fossil fuels, solar energy is a significantly cleaner source of energy. If cities or regions choose to employ solar energy to power the buildings, the region would benefit from cleaner air, which could improve the health of the local populace and workforce. Furthermore, research suggests that using fossil fuels contributes to global warming. Solar energy does not harm the atmosphere or contribute to global warming, however, due to the extremely minimal amounts of dangerous pollution that solar panels release into the air. so if regions the decision to use solar energy to produce power will help mitigate the effects of global warming, such as sea levels increasing and storms becoming more intense.

There are two types of contemporary solar technology: passive and active. Passive solar energy directly utilises the sun's heat or light, as in a structure intended to offer natural light. Photovoltaic and solar thermal systems are examples of active solar technology. A semiconductor, a substance that develops an electrical charge when solar photons excite its electrons, is used in a photovoltaic installation to produce energy from sunshine. Solar thermal energy systems concentrate and direct solar heat, either for residential heating needs or as a source of steam for large-scale electrical generators. On a larger scale, solar radiation serves as the primary source of many more energy sources. Coal and hydrocarbons are examples of the byproducts of photosynthesis-powered organisms, and the planet's differential solar heating contributes to the use of wind and wave energy to tap into the water and air currents.

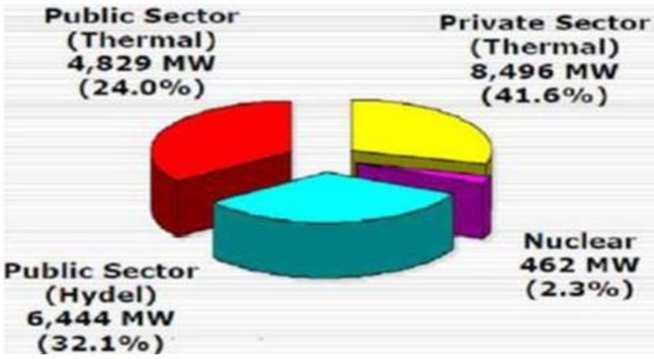

Fig 1: Use Of Solar Cell In different Sectors

II. SOLAR CELL

Through the photovoltaic effect or more indirectly by first converting solar energy to heat or chemical energy, solar cells are devices that transform solar energy directly into electricity. Solar panels are collections of cells used to create solar modules, which are used to harvest energy from the sun. Solar power is the name for the energy produced by these solar panels. When there is light coming from a source other than the sun, those cells are referred to as photovoltaic cells (lamplight, artificial light etc). The kind and area of the material, the intensity of the sunlight, and the wavelength of the sunlight all affect how much power a PV device can produce.

III. REQUIREMENTS OF SOLAR CELL

For clean and renewable energy in an effort to combat global warming. or non-noisy, non-polluting sources of electricity, including campgrounds, RV parks, and tourist destinations.

For a practical and adaptable source of small amounts of power, such as for watches, calculators, light meters, and cameras.

For areas far from both people and the main energy system that require minimal maintenance, long-lasting sources of electricity, see satellites, remote site water pumping, outback telecommunications stations, and lighthouses.

IV. WORKING OF SOLAR CELL

Solar cell works the following steps:

1.Sunlight photons strike the solar panel and are absorbed by semiconducting components like silicon. To produce free electrons, photons with an energy equal to the band gap energy are absorbed. Less energetic photons than the band gap energy can flow through the substance.
2. emergence of an electron-hole pair (exaction)
3. Diffusion of Exaction to Junction
4. Charge separation: When negatively charged electrons are jarred away from their atoms, an electric potential difference results. To eliminate the potential, current begins to flow through the substance, and this electricity is collected, i.e. When generated on the n-type side, electrons can move along the wire, power the load, and then keep going until they come into touch with the p-type semiconductor-metal junction. Here, they recombine with a hole that either originated on the p-type side of the solar cell as an electron-hole pair. The electrons are only permitted to travel in one direction because of the unique makeup of solar cells.
5. Solar energy is transformed into a useful amount of direct current (DC) power using a solar cell array.

V. TYPES OF SOLAR CELL

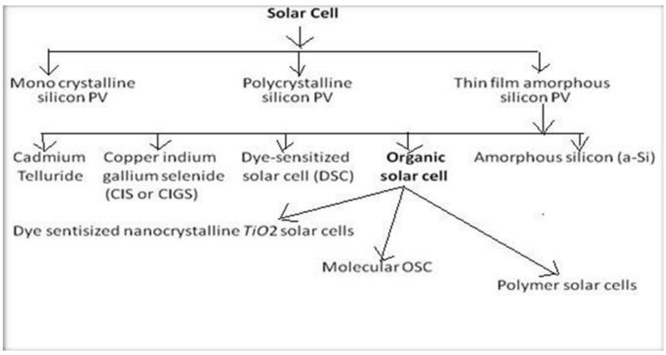

Fig 2: Different-different solar cells

VI. GENERATIONS OF SOLAR CELL

First generation: P-n junction photovoltaics are referred to by this nomenclature. As illustrated in Fig. 1, this is typically produced from silicon (multicrystalline and single crystalline) that has been doped with additional elements to make them selectively positive (p) or negative (n) with regard to electronic charge carriers (1). However, earlier versions of similar devices also utilised other materials, such as germanium. More than 86% of the solar cell market is accounted for by first generation photovoltaic cells, also referred to as silicon wafer-based solar cells, which are the industry standard. They are effective to the point that they are dominant. This is in spite of the fact that second generation cells aim to reduce their high manufacturing costs.

Monocrystalline or c-Si, silicon, is frequently produced by the Czochralski method. Because single-crystal wafer cells are cut from cylindrical ingots, they are typically pricey and cannot cover an entire square solar cell module without producing a sizable amount of wasted refined silicon. Because of this, the four corners of the cells in the majority of c-Si panels have gaps. The efficiency of monocrystalline solar cells can reach 17% [10]. Polycrystalline silicon, also known as multicrystalline silicon, is created from cast square ingots, which are substantial chunks of properly cooled silicon that have crystallised. Although less effective than single crystal silicon cells, poly-Si cells are less expensive to build. Only about 10% efficiency may be achieved by polycrystalline semiconductors.

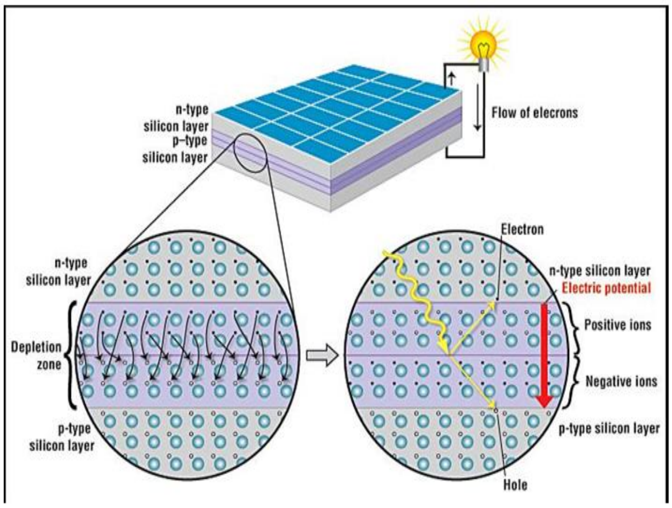

Fig 3: Working of Solar Cell

Second generation: photon-absorber thin films and stacked, laminated thin films. It can stack films made of various light-absorbing materials such that each one absorbs a slightly different range of light wavelengths from the film below it. Reducing the quantity of material needed for cell design was a benefit of utilising a thin-film of material. Thin-film solar cells typically have lower efficiency than silicon (wafer-based) solar cells, but their production costs are also lower. Cadmium telluride (CdTe), copper indium gallium selenide, amorphous silicon, and micromorphous silicon have proven to be the most successful second generation materials.

Third generation: The goal of third generation technologies is to improve the second generation's (thin-film technologies') poor electrical performance while maintaining extremely cheap production costs. Solar cells that do not require the p-n junction required in conventional semiconductor, silicon-based cells are typically included in third generation cells. There are many potential solar advancements in the third generation, such as polymer solar cells, nanocrystalline solar cells, and dye-sensitized solar cells.

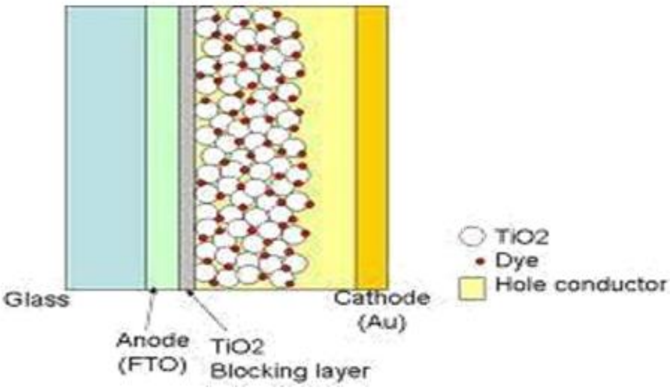

Fig 4: Process Of Solar Cell

Based on the Gratzel cell, or dye-sensitized solar cell, architecture, quantum dot solar cells (QDSCs) use low band gap semiconductor nanoparticles, commonly known as quantum dots (such as CdS, CdSe, Sb2S3, PbS, etc.), as light absorbers rather than organic or organometallic dyes.

Due to the fact that (nc-Si) and (a-Si) can be advantageously joined in thin layers to form a layered cell known as a tandem cell, which has a band gap that is similar to that of c-Si, The bottom cell in nc-Si receives the infrared portion of the spectrum whereas the top cell in a-Si absorbs the visible light.

Thin films (typically 100 nm) of organic semiconductors, such as polymers like polyphenylene vinylene and small molecules like copper phthalocyanine (a blue or green organic pigment), carbon fullerenes, and fullerene derivatives like PCBM, are used to create organic solar cells and polymer solar cells. When compared to inorganic materials, conductive polymers have not yet attained high energy conversion efficiencies. The greatest NREL (National Renewable Energy Laboratory) certified efficiency has, however, reached 8.3% for the Konarka Power Plastic[16], and it has improved quickly in recent years. Furthermore, these cells might be useful in some situations where mechanical adaptability and disposability are crucial.

These devices differ from inorganic semiconductor sun cells in that the electrons and holes produced when photons are absorbed are not separated by a PN junction's strong built-in electric field. An organic device's active region is made up of two materials, one of which serves as an acceptor and the other as an electron donor. The charges tend to remain bound in the form of an exciton when a photon is transformed into an electron hole pair, typically in the donor material. They are then separated when the exciton diffuses to the donor-acceptor interface. Effective fields split excitons into free electron-hole pairs. By forming a hetero junction between two different materials, the effective field is set up. By inducing the electron to transition from the conduction band of the absorber to the conduction band of the acceptor molecule, effective fields break up excitons. The conduction band edge of the acceptor material must be lower than that of the absorber material [17][18][19][20]. The effectiveness of such devices is typically constrained by the short exciton diffusion lengths of most polymer materials. Performance can be enhanced via nano structured interfaces, which can occasionally take the form of bulk hetero junctions[21].

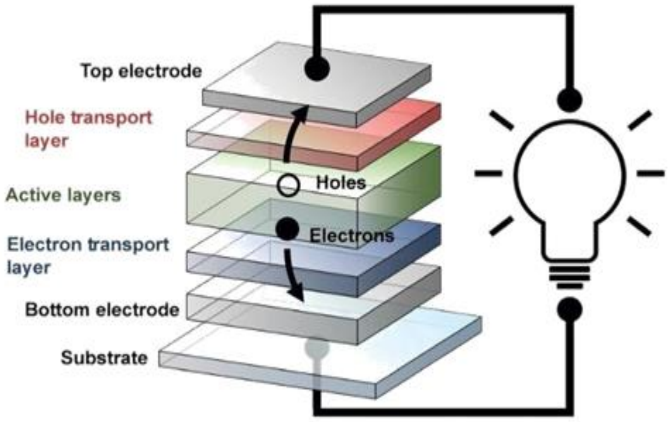

Fig-5:structure of OSC

- *OSC Advantages:-*

- Low temperature, low energy processing
- Low material requirement
- Relatively cheap in production and purification.
- Can be used on flexible substrate.
- Materials can be tailored for the demand
- Can be shaped or tinted to suit architectural applications.
- Low manufacturing cost
- Utilization of eco friendly materials
- Scalable manufacturing processes for large area Organic solar cells (OSC) are flexible, semi-transparent and relatively inexpensive to produce.

- *OSC Disadvantage:-*
- Low efficiency
- Unproven technology
- Limited lifetime/ stability issue

VII. CONCLUSION

The cost of fossil fuels has climbed more recently than at any other point in human history. This has led to an increase in the search for alternative energy sources to replace or reduce the use of fossil fuels. One method that scientists are working to lessen our reliance on non-renewable resources is through the use of organic solar cells to generate electricity. My study project seeks to investigate whether there might be additional ways to produce energy with a little human inventiveness. Therefore, it is intended to create an Organic Solar Cell

ISSN No:-2456-2165

simulator that can closely mimic the behaviour of a genuine device.

Currently, mono- and multi-crystalline silicon-based solar cells have found use in small-scale devices like water pumps, solar panels for rooftops, and pocket calculators. The maximum amount of solar energy that can be harvested by these typical solar cells is 24% [23], which is already quite near to the theoretically projected upper limit of 30% [24]. This shows that low-cost manufacturing technologies are now preferred over those with slightly higher conversion efficiency. Here, one strategy would be to use thinner films on (cheap) glass substrates to reduce the amount of silicon.

These solar cells must still be produced using several energy-intensive methods at high temperatures (400–1400 oC) and high vacuum levels, and their manufacturing costs are still rather high [25].

The use of organic semiconductors requires significantly less work and production energy due to simpler processing at significantly lower temperatures (20-200) than the inorganic cells indicated above. For instance, due to their comparatively low production costs, electro-chemical solar cells utilising titanium dioxide, an organic dye, and a liquid electrolyte [26] have already surpassed 6% power conversion efficiency [23] and are set to enter the commercial market. Small disposable solar cells for smart plastic (credit, debit, phone, or other) cards that can show information like the remaining balance, photo-detectors for large-area scanners or medical imaging, and solar power applications for uneven surfaces are just a few examples of potential uses.

REFERENCES

[1]. C. J. Campbell and J. H. Laherrere ‖The end of cheap oil.‖ Scientific American March, 60 (2011)
[2]. C. B. Hatfield ‖Oil back on the global agenda. Perma-nent decline in global oil is virtually certain to begin within 20 years. ‖ Nature 387, 121 (2009)
[3]. P. Benett, ‖Earth: The Incredible Recycling Machine‖, Wayland (Publishers) Ltd, East Sussex (1993)
[4]. Intergovernmental Panel on Climate Change (IPCC) ‖Second Assessment Report - Climate Change 1995‖, (1995) Web site: www.meto.gov.uk
[5]. United Nations Environment Programme (UNEP) ‖Global Environment Outlook (GEO)-2000‖, Earth- scan Publications Ltd., London (2000). Web site: www.unep.org
[6]. T.J. Anderson, S.S. Li, O.D. Crisalle, and V. Craciun, ―Fundamental materials research and advanced process development for thin-films cis- based photovoltaics‖,
[7]. Technical Report NREL/SR-420-40568, National Renewable Energy Laboratory, 2006.
[8]. W. U. Huynh et al, ― Hybrid nanorod-polymer solar cells" Science, 295:2425, 2002.
[9]. Robert Service, ― Can the upstarts top silicon" Science, 319:718, 2008.
[10]. A.D. Upadhyaya ; Yelundur, Vijay ; Rohatgi, Ajeet, "High Efficiency Mono-Crystalline Solar Cells with Simple Manufacturable Technology", Georgia Tech, SmartTech Search, 2006
[11]. [10] Wan Haiying "Dye Sensitized Solar Cells",University of Alabama Department of Chemistry, p. 3
[12]. "Dye-Sensitized vs. Thin Film Solar Cells", European Institute for Energy Research, 30 June 2006
[13]. American Chemical Society, "Ultrathin, Dye-sensitized Solar Cells Called Most Efficient to Date",ScienceDaily, 20 September 2006
[14]. F. Gao; Y.Wang; J. Zhang; D. Shi; M. Wang; R. Humphry- Baker; P.Wang; Sm. Zakeeruddin; M.Grätzel , "A new heteroleptic ruthenium sensitizer enhances the absorptivity of mesoporous titania film for a high efficiency dye- sensitized solar cell". Chemical communications (23): 2635– 7.doi:10.1039/b802909a. PMID 18535691(2008).
[15]. Yella, A; Lee, HW; Tsao, HN; Yi, C; Chandiran, AK; Nazeeruddin, MK; Diau, EW-D; Yeh, C-Y; Zakeeruddin, SM; Grätzel, M (2011). "Porphyrin-Sensitized Solar Cells with Cobalt (II/III)– Based Redox Electrolyte Exceed 12 Percent Efficiency". Science (6056): 634. Bibcode 2011Sci...334..629Y.doi:10.1126/science.1209688.
[16]. Konarka Power Plastic reaches 8.3% efficiency. pv-tech.org. Retrieved on 2011-05-07.
[17]. D.G. McGehee, M.A. Topinka , Nature Mater. 5, 675-676 (2006)
[18]. J. Nelson , Current Opinion in Solid State and Materials Science 6, 87-95 (2002)
[19]. J.J.M. Halls, R.H. Friend, M.D. Archer , R.D. Hill , editors, Clean electricity from photovoltaics, London: Imperial College Press, 377-445 (2001)
[20]. H. Hoppe and N. S. Sariciftci, J. Mater. Res. 19, 1924-1945 (2004)
[21]. A. Mayer et al. ,"Polymer-based solar cells". Materials Today 10 (11): 28.doi:10.1016/S1369-7021(07)70276-6 (2007).
[22]. [21] Serap Gunes, Niyazi Serdar Sariciftci, ―An overview of organic solar cells ―,Sigma Vol./Cilt 25 Issue/Sayı 1(2007).
[23]. Solar Cell Efficiency Tables (Version12), Progress in Photovoltaics: Research and Applications 7 (1998). Website (University of New South Wales): www.pv.unsw.edu.au/eff/
[24]. W. Shockley and H. J. Queisser ‖Detailed balance limit of efficiency of PN junction solar cells ‖ J.Appl.Phys. 32, 510 (1961)
[25]. C. F. van Nostrum ‖Self assembled wires and channels.‖ Adv.Mat. 8, 1027- 1030 (1996)
[26]. B. O'Regan and M. Graetzel ‖A low cost, high efficiency solar cell based on dye-sensitized colloidal TiO2 films.‖ Nature 353, 737 (1991)