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A BRIEF STYDY ON THE PROGRESS ON PHOTOVOLTAIC CELL

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ABSTRACT:- photovoltaic cell, also known as a solar cell, is a device that produces voltage or electric current in a positive-negative junction and is referred to by one of those names. It operates under the effect of photons that are produced by sources of light. Within a piece of equipment known as a solar panel, these photovoltaic effects are carried out. Edmond Becquerel is credited with first conceptualising these phrases around the year 1839. Based on the semiconducting material that is employed in solar cells, these devices capture photons and convert them into energy. Based on their generation, solar cells are categorised as having distinct semiconducting materials. The conductivity of semiconducting materials is lower than that of metals but higher than that of insulators. They have a resistivity that ranges from 0.001 to 100 cm-1 and an energy band gap that ranges from 1 to 4 electron volts. They are categorised differently based on the kind of semiconducting material that is used in the photovoltaic cell.

KEYOWRDS:- Photocoltaic cell etc

SOLAR CELL GENERATIONS

Inorganic solar cells and hybrid solar cells are two more possible classifications for this. The inorganic solar cell utilises inorganic semiconducting elements such as silicon in addition to other materials that do not include silicon. In order to construct the hybrid solar cell, both inorganic and organic semiconducting materials are used as component parts of the device. Inorganic solar cells make up the first and second generations of solar cells. In the more recent decades, hybrid solar cells have been developed from third-generation solar cells.

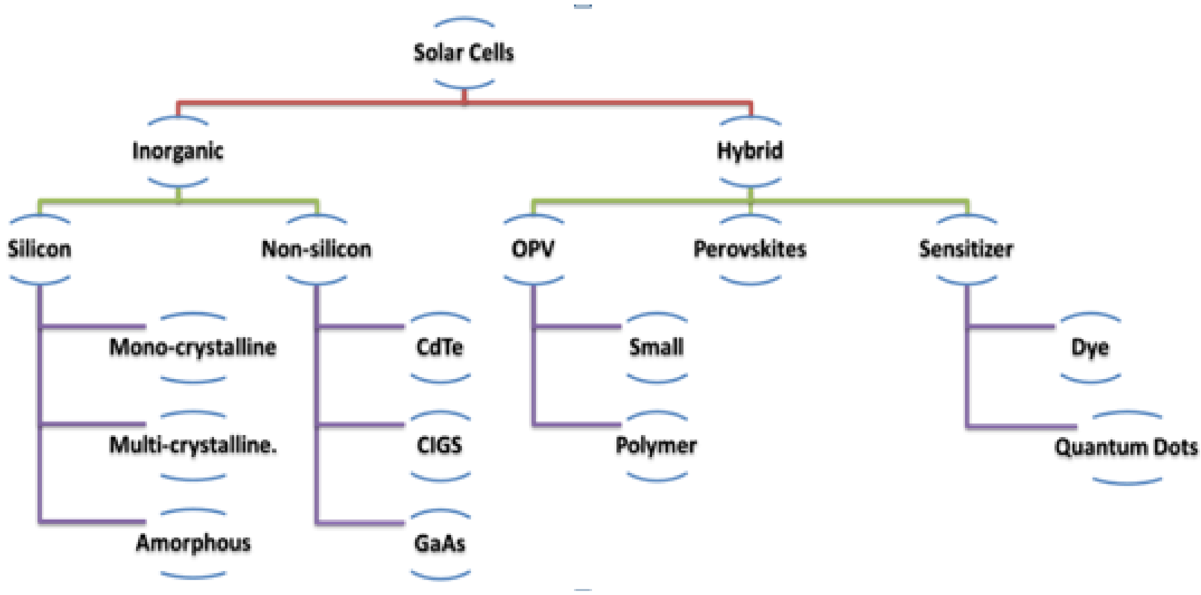

Figure 1.1 Classification of photovoltaic technology

First-generation solar cells

In the beginning, pioneers produce silicon-based solar cells that are of the first generation. These solar cells are marketed and accessible, but they are prohibitively costly and must be manufactured at higher temperatures. When referring to photovoltaic cells of the first generation, the terms mono-crystalline and poly-crystalline solar cells are often used. These mono-crystalline solar cells are able to generate electricity from the sun's rays thanks to their large surface area and single-crystal silicon composition, which was achieved by the process of diffusion using silicon wafers. Since the conditions had compacted in this structure, various interlocking silicon crystals had developed at a lower cost per unit area than monocrystalline boards, which makes it less expensive to make multi-crystalline solar cells from multi-silicon crystals than it is to make single-crystal silicon solar cells from silicon wafers. The band gap in the semiconductor amplifies the capacity of photovoltaic cells; if the energy of the photon is low, it translates into the flow of electrons, but if it is large, it turns into heat and surplus energy [3].

Second-generation solar cells

Many people consider thin-film innovation to be a "second-generation" solar cell system. Substrate materials for solar cells are semiconductors, and they are often fabricated as thin sheets (in mm thickness). Nowadays' materials may be broken down into two groups: silicon-based and non-silicon-based. Semiconductors that are not derived from silicon are employed in solar cell production. These novel materials. These solar cells, like many others, rely on a bendable substrate made of a cheap polymer or similar material. The substrates have a few layers of doped granular silicon cells, and these cells react to various wavelengths of light. Crystalline silicon solar cells provide more product variety, greater durability, and lower costs than their pure silicon counterparts. The efficiency rates of the Cadets and the CIGS have both been increased to 20%.

Third-generation solar cells

Nano-crystalline solar cells constitute the foundation for these photovoltaic cells, which also include organic and inorganic semiconducting materials. This photovoltaic gadget is not made of silicon but rather consists of a combination of unique materials. They are more cost effective while also improving the orientation of cells towards the light. They are assembled by an increasing number of individual components, but they rely on the formal positive-negative junction to separate photogenerated charge carriers and to overcome the benefits of earlier generations of solar cells [4]. This is because they have been assembled by an increasing number of individual components. They include Perovskite solar cells, nanocrystal-based solar cells, polymer-based solar cells, organic photovoltaic cells, dye-sensitized solar cells, and others. These solar cells were designed to convert light into energy in a lucrative manner by using inexpensive materials and easy production techniques, as well as to be stable, environmentally friendly, and so on.

Quantum Dots (QD) solar cells are another name for nano crystal-based solar cells. These cells are made up of a series arrangement of nanocrystal semi-conductors that belong to transition metals substrates. Because of the centrifugal force gained by the semi-conductor, the particle sizes of the organised nano-crystals vary between nanometers, which enhances rapid rotation.

Polymer solar cells that are powered by polymer substrates to construct extremely flexible and conductive substrates are referred to as PSCs (Polymer solar cells). These cells have their own continuous layer of a functionalized thin coating on top of the polymer matrix that they are contained inside. Despite the fact that researchers have fabricated flexible solar cells, they have only achieved an efficiency of over 3.0% [5].

A hybrid usage of renewable serves as the backbone of both organic solar cells and plastic solar cells. The latest breakthroughs in inorganic compounds materials have been included. These nanostructures materials, which include capacitive biodegradable materials and polyatomic, have a charge carrier capacity utilization and a high capacity for absorbing light over a wide range of wavelengths suggesting that they may be used to generate electricity when exposed to sunlight through the photovoltaic effect. These characteristics suggest that these materials might be used in solar cells. Using polymer-based materials may boost the efficiency of power transfer in organic solar panels. Optical characteristics of complex chemicals, such as Maximum absorbance and molecular coefficient, have very high numerical values. Because of this, only a select few materials can soak up the enormous amount of light. As opposed to their inorganic component integrated counterparts, organic solar panels are restricted in their efficiency, stability, and resilience [6]. Organic solar cells are a promising solution for these and other problems.

Solar cell that makes use of molecules made of perovskite and uses them on newly produced thin films. Using the configuration of ABX3, in which A and B each represent a distinct cation and X stands for a halogen group, it is possible to achieve optimal functionalization of the material. The crystal structure was enhanced and had a higher PCE after being treated with a variety of various cations. On account of problems with stability and durability, effective fabrication had been rendered impossible, and the material's deterioration had led to a decrease in PCE.

DYE-SENSITIZED SOLAR CELLS

Due to its low price, easy assembly, little environmental impact, and high efficiency, photosensitizer solar cells (DSSCs) are a major technological advance. The DSSC was developed by M.Gratzel and O'Regan in 1991, and its trouble-free production allowed it to achieve a value and skyrocketing efficiency of 11%. [6] The cell is constructed out of diamond as the contra electrode, tio2 salt as even the liquid, and nano TiO2 plated with noble metals dye on Tio2 thin plate as electrochemical reaction. In addition to its many other advantages, the DSSC is also very convenient because of its mobility, low weight, cheap cost, simplicity of production, and sparse population of application (such as solar thermal collectors). It takes the place of the p-n semiconductor in the PV circuit.

Unlike conventional photovoltaic systems, in which a single semiconductor is used for both load carrier conveyance and transmittance, this design separates these two functions. An attaching group attached to the diode at the modified electrode region allows the dye to absorb visible light. This makes it possible for the color to take in light. By injecting electrons from the photo-provoked photocatalyst in to semiconductor's valance band, electric charge is separated just at boundary. This was completed at the shallowest possible level. Nano TiO2 and dyes with a broad absorption waveband are used to collect a focused beam. The low DSSC efficacy in certain areas may largely be attributed to the fact that only a few variety of dyes can cover such a broad spectrum. What makes photovoltaic devices work is the segregation of charges at the boundary between two electrically insulating materials.

To catch you up, silicon-based, solid-state doped cells have formed the backbone of this business, leading to a proliferation of both knowledge and resources. A photosynthetic device is a kind of electrical generator that converts light into electrical current. Photovoltaics (crystalline) of the I-generation have the potential to achieve a conversion efficiency for power (PCE) of up to 25%. However, their broad usage has been restricted due to the high cost of production, prompting the hunt for a replacement that is both ecologically benign and economical solar device. FIrst solar cells have efficiency rates of up to 28% thanks to the use of films made of cadmium telluride, indium gallium selenide, gallium arsenide, and other related materials. Devices of this kind boost the effectiveness of the photovoltaic skill system and outperformed the more common Si cells in every way. Nonetheless, there are still issues, like as high production costs, with the I-generation cells. After almost twenty years of research and development, the third generation of solar cells, also known as the hybrid film type, was made accessible. Dye-sensitized solar cells with PCEs of up to 13%, organic solar cells with PCEs of up to 11%, perovskite solar cells with PCEs of up to 19.3%, quantum dots solar cells with PCEs of up to 10%, etc., have all been developed in the last few decades.

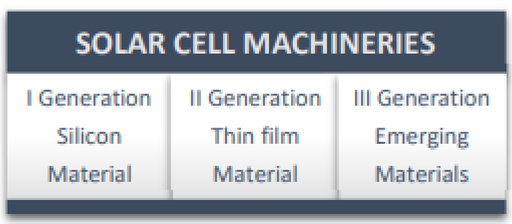

Figure 1.2. Generations of solar cell

The dominance of photovoltaics held by inorganic solid-state cells is susceptible to being challenged in our day-to-day lives and is susceptible to being supplanted by third-generation technologies such as nanopowders and polymers that are highly conductive electrolytes.

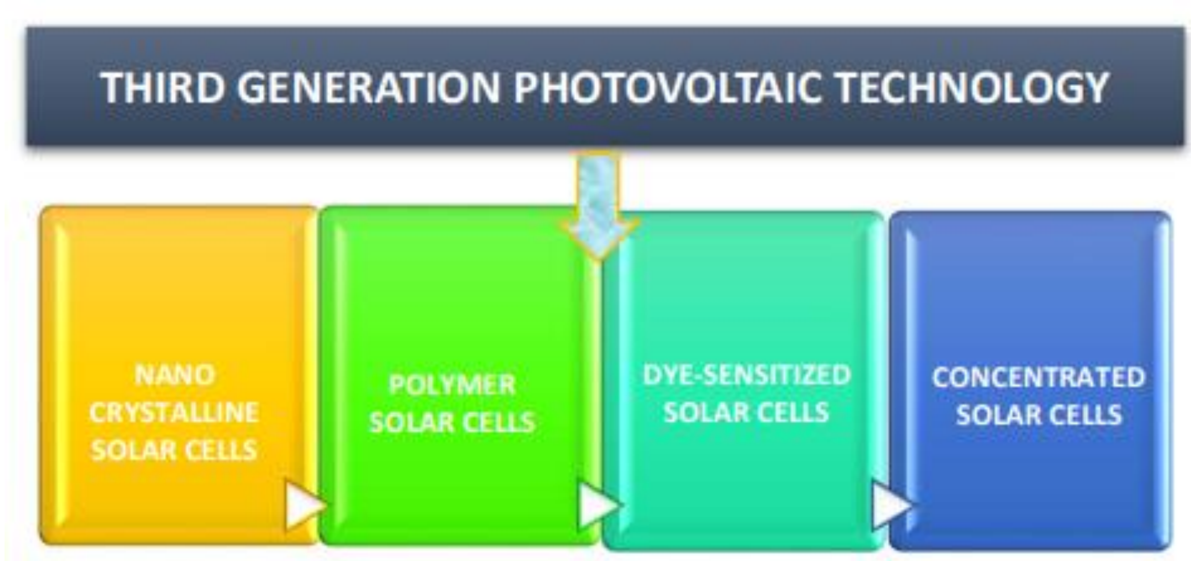

Figure 1.3.Types of third generation photovoltaic technology

Researchers are now focusing their efforts on all aspects of DSSC, including photo cathode variation, photoanode variation, dye synthesis, electrolyte modification, additive and dopant preparation, and co-adsorbent synthesis. Numerous electrolytes have been investigated and tested in order to make steady progress towards improved power conversion efficiencies for DSSCs. These efforts are being made day by day.

The following is the procedure that takes place inside a DSSC in order to transform the energy from light into current:

At some point, the photon will be absorbed by dye that has been deposited onto the surface of the semiconductor.

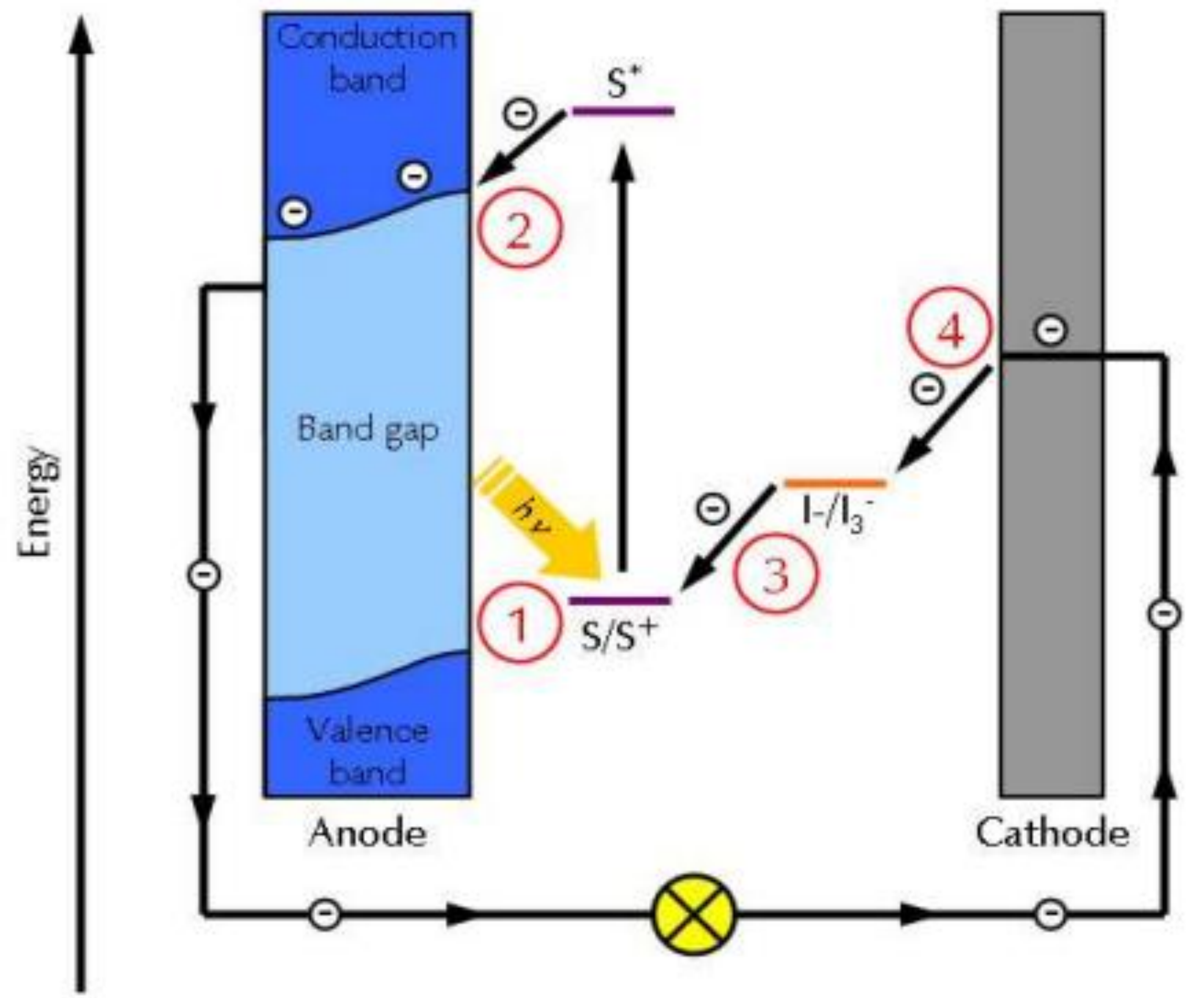

Figure 1.4 Mechanism of dye-sensitized solar cell

Electrons that are inserted into the conduction band of TiO2 are elated between the nanoparticles of TiO2 with the assistance of diffusion in the direction of the TCO back contact. After then, the electrons arrive, at long last, to the counter electrode Pt in the course of the flow of the circuit. 2I- ions are oxidised to I2, where it goes to the oxidised state, i.e., I3-, by interacting with I-. The oxidised form of photosensitizer (S+) enables the electrons starting with I- in the redox shuttle route towards a rebirth of the ground state (S).

S+ + e- = S (1.2)

The oxidised type I3- in the redox, when it comes into contact with the counter part, causes it to scatter, and then it is further reduced to I- ions.

$I3^- + 2e^- = 3I$ (1.3)

The efficiency of a dye-sensitized solar cell is determined by a number of factors, including the HOMO and LUMO energy levels, the Fermi level of the semiconductor, the photosensitizer absorption range, and the electrolyte's redox potential (I-/I3-).

REFEREBECES:-

1. Abdou E.M., Hafez H.S., Bakir E., Abdel – Mottaleb M.S.A. (2013), 'Photostability of low-cost dye sensitized solar cells based on natural and synthetic dyes', Spectrochim. Acta A, Vol. 115, pp. 202 – 207.

2. Bay, L., & West, K. J. S. E. M. (2005), 'An equivalent circuit approach to the modelling of the dynamics of dye sensitized solar cells', Solar Energy Materials and Solar Cells, 87(1-4), 613-628.

3. Calogero G., Jun – Ho Yum., Sinopoli A., Marco G.D., Graetzel M. (2012), 'Anthocyanins and betalains as light harvesting pigments for dye sensitized solar cells', Sol. Energy, Vol. 86, pp. 1563 – 1575.

4. Eli, D., Ahmad, M., Maxwell, I., Ezra, D., Francis, A., & Sarki, S. (2016), ' Dye-sensitized solar cells using natural dyes extracted from roselle (Hibiscus sabdariffa) flowers and pawpaw (Carica papaya) leaves as sensitizers', Journal of Energy and Natural Resources, 5(1), 11.

5. Haider, A. J., Jameel, Z. N., and Al-Hussaini, I. H. (2019), 'Review on: titanium dioxide applications', Energy Procedia, 157, 17-29.

6. Haider, A. J., Jameel, Z. N., and Al-Hussaini, I. H. (2019), 'Review on: titanium dioxide applications', Energy Procedia, 157, 17-29.

7. Kalyanasundaram K and Graetzel M. (2019), 'Applications of functionalized transition metal complexes in photonic and optoelectronic devices', Coord. Chem. Rev., Vol. 77, pp. 347 – 414.

8. Kurtoglu M.E., Longenbach T., Gogotsi Y. (2011), 'Preventing Sodium Poisoning of Photocatalytic TiO2 Films on Glass by Metal Doping', Int. J. Appl. Glass Sci., Vol. 2, pp. 108 – 116.

9. Li Y., White T.J., Lim S.H. (2004), 'Low temperature synthesis and micro structural control of titania nanoparticles', J. Solid State Chem., Vol. 177, pp. 1372 – 1381.

10. Muruga jothi K., Jeyakodi Moses J. (2008), 'A Study on the characteristic improvement of property of Terminalia chebula on Cotton Fabric', Orient. J. Chem. 24 903 – 910.

11. Prince, M.B. and Wolf, M. (2022), 'New developments in silicon photovoltaic devices', Journal of the British Institution of Radio Engineers', vol.18, no.10, pp.583,594.

12. Prince, M.B. and Wolf, M. (2022), 'New developments in silicon photovoltaic devices', Journal of the British Institution of Radio Engineers', vol.18, no.10, pp.583,594.