DEVELOPMENT AND APPLICATION OF 3rd GENERATION SOLAR ELEMENTS

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Abstract: This paper is designed to achieve low-cost and high power conversion efficiency for the production of third-generation solar panels. These solar cells have the ability to exceed the Shockley-Queisser limit. This review focuses on various third-generation solar cells, such as dye-sensitized solar cells, perovskite-based cells, organic photovoltaics, quantum dot solar cells, and tandem solar cells, a collection of different materials that exploit the maximum solar spectrum. achieve high power conversion efficiency. Along with these solar cells, other third-generation technologies are discussed, including up-conversion, down-conversion, hot carrier, and multi-excitation. The article includes an overview of previous work in this area, as well as an introduction to the technologies, including their working principles and components. Advances in various components and improvements in performance parameters such as fill factor, open circuit voltage, conversion efficiency and short circuit current density are discussed. There is also talk about the widespread distribution of these technologies in sales.

Keywords: third generation; single crystal; polycrystal; perovskite; sensitive to dye; tandem solar cells; organic photovoltaics

A solar cell is a power source based on semiconductor photocells that directly converts solar radiation energy into electrical energy. The operation of solar cells is based on the internal photoeffect phenomenon. The first solar cell was developed in 1953-1954 by US scientists G. Pearson, K. Fuller and D. Chapin [1-5]. The capacity of the solar cell depends on the semiconductor material, the structural features of the solar cell and the number of cells in the cell. Silicon in the manufacture of solar cells, materials based on gallium Oa, arsenic Az, cadmium Syo, sulfur 5, antimony 8, and tellurium Te are used. A solar cell is usually made of a solar cell in the form of a flat panel with a shiny coating on top. The number of solar cells in the battery is up to several thousand, the level of the panel is tens of thousands, the current is hundreds of A, the voltage is tens of V, and the generator power is up to several tens of kW [6-8].

The solar cell is mainly used to supply space and earth satellites with electricity. On Earth, the solar battery is used as a power source in portable automatic radio stations and radio receivers. The Institute of Physics and Technology of the Academy of Sciences of Uzbekistan deals with the issues of using solar energy in Uzbekistan.

Solar cells (SC), often called photovoltaic (PV) cells, use the PV effect to convert light energy into electricity and are one of the most important environmentally friendly energy sources, along with hydropower and wind/wave energy. Over the past two decades, PV technologies have been steadily evolving to improve the power conversion efficiency (PCE) of solar cells. SCs can be divided into different categories according to the period of development, as well as the materials they use. These categories include:

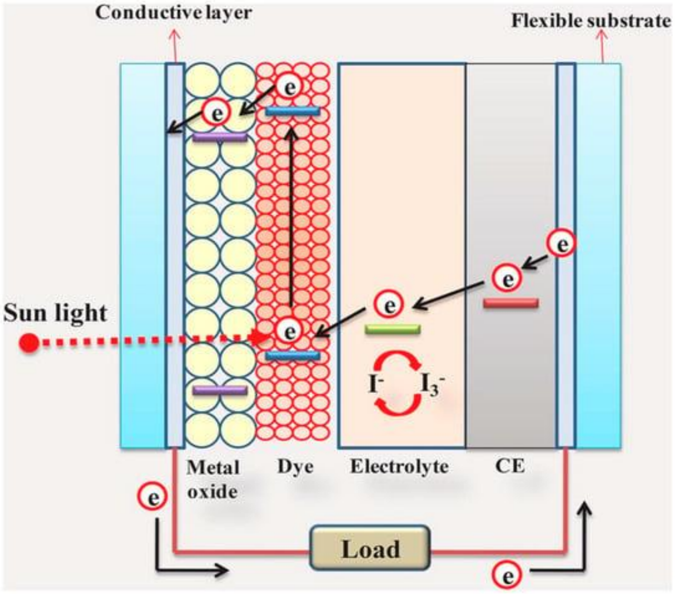
(1) First generation of silicon (Si) type and most efficient, but efficiency decreases as temperature increases.

(2) Thin film second generation is cheaper than type Si and is already commercially available

(3) Third generation, which are PV technologies processed with solutions based on semiconductors.

One of the most important technological advances in the world of solar cells is the DSSC. It acts as a cell that mimics the method used by plant cells to produce energy [9-13]. Photoelectrochemical cell is a photoelectrochemical cell, created by the combined effect of photon energy and chemical reactions. DSSC has the potential to be a future energy source because it is slightly more transparent and cheaper than conventional solar photovoltaics. However, some issues still need to be addressed before it can be claimed as a viable commercial product. These issues and the significant advances in DSSC technology in recent years are highlighted in this section. We provide a clear understanding of the latest DSSC updates related to various components. According to different DSSC components, we can divide this section into sub-sections and get a brief feedback of improvements suggested by different researchers. Innovative research on the use of nano-sized TiO2 (titanium dioxide) porous film electrodes in DSSCs was originally published by O'Regan and Gratzel. DSSC quickly became an active area of research because it was found to have very high photon-to-electricity conversion efficiency. Since then, a large amount of work has been reported [14-18].

Photoanode, sensitizer, electrolyte and counter electrode are important elements of DSSC. The photoanode is designed using semiconductor nanostructures. A variety of nanostructures, including nanorods, nanotubes, nanowires, nanocones, and nanorods, have been created in transparent conductive glass. Successfully developed an 11.4% efficient DSSC by designing and synthesizing donor–acceptor type co-adsorbents, which were found to be effective in competitive light absorption by I-/I3-, prevented dye aggregation, and reduced charge recombination. , the carboxy-anchored organic dye of LEG4 was shown to work well as a co-sensitizer with the silyl-anchored dye of ADEKA-1 in DSSCs. The authors were able to produce a 14.3% efficient cell with an optimized cobalt (III/II) complex redox electrolyte solution and GNP counter electrode. This indicates that silyl-anchor dyes are a suitable option for use as photosensitizers in DSSCs, which is mainly due to the good adsorption properties of ADEKA-1 to the TiO2 electrode. The figure below shows the schematic of the DSSC [19-25].



DSSC scheme. Reproduced with permission from Devadiga et al., Renewable and Sustainable Energy Reviews, Elsevier, 2022.

The photoanode consists of semiconductor nanoparticles embedded in transparent conductive glass and is dye-sensitive. Many semiconductor oxides such as ZnO, SnO2, WO3 and TiO2 are used as photo-anode materials. Among these semiconductor oxides, TiO2 has been more widely used due to its availability, low cost, compatibility, and non-toxicity. The morphology of the semiconductor plays an important role in the DSSC because it acts as a substrate to absorb the dye and receive electrons from the dye. The dye, after photo-excitation, introduces an electron into the conduction band of the semiconductor, where it is again passed through the counter electrode and causes a circuit. TiO2 nanoparticles are frequently used due to their excellent dispersion and crystallinity. Anatase, brookite, and rutile are the three most stable polymorphs of TiO2; The complex synthesis process of brookite makes it the least common of the mentioned polymorphs of TiO2. Anatase and rutile have the same solar energy conversion performance to some extent; however, anatase is preferred over rutile due to its higher charge transport, larger specific surface area, and higher electron Fermi level [26-28].

We know that among renewable energy sources, solar energy provides more energy. As an example of small self-consumption facilities, Spain is gradually growing. More and more houses have chosen to install photovoltaic panels because they save money on electricity bills and we can take environmental responsibility that is time-consuming. However, many people don't know how solar panels work.

How Photovoltaic Solar Panels Work

As the name suggests, it uses solar energy to generate electricity. Among the advantages of solar energy that we have, it does not pollute the environment, but it is unlimited, but there are some disadvantages, such as its continuity.

Photovoltaic generation is a property that must have certain materials that generate electricity under the influence of sunlight. This happens when the energy in sunlight ejects electrons, creating a flow of electricity. We should know that solar radiation is a stream of photons. The performance of a solar panel depends mainly on how strong the light it receives is. To understand how solar panels work, we need to know how the power of a solar module is calculated.

It is important to understand that the amount of solar radiation falling on the solar panel varies depending on the day and time of year. The generated current must be calculated using significant fluctuations, and this makes the calculation difficult.

There are different ways to compare silicon-based panels, and they can basically be divided into a few categories: amorphous, polycrystalline, and monocrystalline. We will analyze what are the unique features of each of the solar panels:

-Amorphous panels: they are used less often, because they do not have a defined structure and in the first months of work they lose a lot of efficiency.

- Polycrystalline panels: they are distinguished by the fact that they are composed of crystals of different orientations and have a blue color. The manufacturing process has the advantage of being cheaper, but the disadvantage is an inefficient product.

- Monocrystalline panels: they are considered the highest quality products. Here, the cells form a panel and are made of high-purity silicon crystal solidified at a uniform temperature. Thanks to this construction, it has high performance and efficiency, allowing free movement of electrons. Despite the fact that the production process is more expensive, it gives the modules great efficiency.

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