# Solar cells and their use

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**Abstract:** The sun's light is an unewable, renewable source of energy that is unaffected by environmental factors like noise and pollution. It is easily obtainable from the Earth's petroleum resources, natural gas, and other nonrenewable energy sources like coal. There were several stages of evolution in the composition of solar cells from one generation to the next. The silicon used in the early solar cells was largely produced as single crystals on silicon chips. Furthermore, advances in thin films the dye and organic solar cells improved the cell's efficiency. The inability to choose the best solar cell for a particular place is essentially what prevents advancement

**Keywords:** Solar cells technology, solar energy, Types of solar cells, Photovoltaic technology (PV);

## Introduction

The simplest solar cells on the market nowadays, referred to as "first generation" technology, are built on silicon wafers. The cost of the materials determines the price, which for this technology becomes unaffordable. The materials used are mostly silicon wafers, strengthened by a low-iron glass cover sheet and those used in other system components. As long as the PV sector continues to develop, this tendency is expected to continue [1]. The PV effect, which was initially identified by a researcher in the middle of the 1950s [2], is responsible for the conversion of solar rays into electricity in the solar collector, which is the key step in understanding the meaning of solar power. This system is essentially known as the emersion of an electrical voltage between two electrodes that are attached to a solid or liquid system by shining light onto this system [3]. In practice, photovoltaic devices include a pn-junction in a semiconductor. These photovoltaic devices are called solar cells (fig.1). The important thing about this semiconductor is what material it is made of to absorb light. The material of semiconductor can absorb the spectrum of the sun. The absorption properties of the material are directly connected to the light which is absorbed in a region more or less close to the surface. When light is absorbed, electron-hole pairs are created and extend the junction, which is separated by an electric field. Moreover, semiconductors should be near the surface [4]. Solar cells are currently used in practical applications in the shape of modules, which are made up of crystalline Si cells connected in series by a layer of thin-film material in series connected. The modules have two aims. Firstly, they protect the solar cells from environmental hazards. Secondly, they generate a higher voltage than a single cell, which can deliver less than one volt [2]. Thin-film solar cells are synthetic by the placing of thin layers of semiconductor materials onto a solid support material. Thus, sunlight gets into the intrinsic layer, which will produce free electronnegativity in the conductor. The P-n types of layers produce field of electrons across the intrinsic layer. The electrical field carries the free electrons into the thin n-sort while positive charges go to the thin p-sort. Utilizing thin films instead of silicon wafers decreases the a particular amount of semiconductor material required for each cell. Solar cells can be manufactured by slight layers of silicon in the shape of amorphous, whereas the atoms of silicon are much less ordered than in the crystalline forms [4]. Other silicons used in thin-film PV cells include gallium arsenide, copper indium diesel [6], cadmium telluride [7], as well as titanium dioxide.

 


**Fig. 1: Schematic of a typical PV module. [5].**

Solar cells are semiconductors that convert sunlight into direct current electricity (DC). Humans have a long history of utilizing solar energy for heat, but producing electricity is much more recent. It is closely linked to modern solid-state physics. A solar cell performs the photovoltaic influence; "photo" – light; "voltaic" – electricity (fig.2). In the PV effect, photons hit the surface of a semiconductor material such as silicon and release electrons from the material's atoms. Adding chemical compounds to the material's composition is very helpful for releasing electrons. This generates an electrical current. Over the photovoltaic influence, a typical 4-inch silicon solar cell can produce about a watt of DC electricity. Groups of photovoltaic cells can be electrically ordered into arrays and modules, which could be utilized to fresh batteries, motors, and supply energy of any number of electrical appliances. Thin-film (PV) materials promise to decrease material requirements and manufacturing costs for photovoltaic modules and systems. Photovoltaic systems have unrivalled advantages over common power-generating technologies. PV systems could be designed for different sets of applications and operational needs and can be utilized for distributed power generation. It include no moving parts, are modular, easy to expand and even able to be carried in some cases. The features of photovoltaic systems are energy independence and environmental protection, which are both important. Firstly, sunlight is accessible and friendly to the environment, with no noise and pollution. Generally, if a photovoltaic system is designed well, it requires maintenance, which extends its long service life. Nowadays, the primary factor in constructing a PV system is the cost of photovoltaic modules and equipment compared to other energy sources [8].

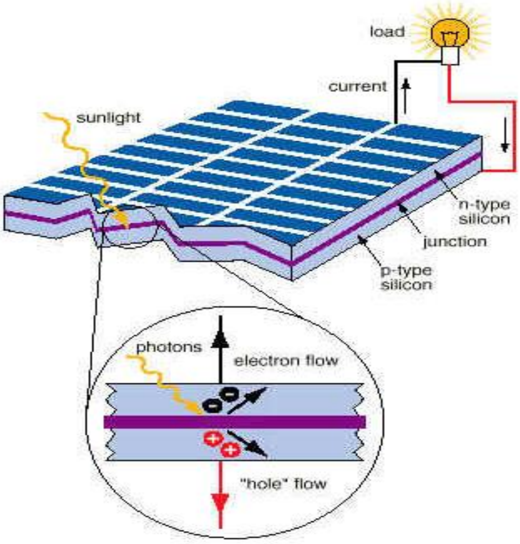


**Fig. 2: Schematic of a typical solar cell [9].**

**Energy from solar cells**

Power is provided by the Sun. Radiation carried by electromagnetic waves leaves space. Light and radio waves are just two examples of electromagnetic radiation. In water, electromagnetic radiation manifests as waves. People typically conceive of electricity as something that flows, similar to how water waves are composed of upper and lower waves. That is accurate. The particles that make up electricity are known as electrons. Electric current is the name for the stream. Two different types of current exist. the one-way current (DC). Additionally, the direction of the current (AC) varies often [10].

### The arrangement of solar cells

Little grains of monocrystalline Si or thin films are created by fabricating the mono- c-Si. Mono c-Si are pieces from a big mono crystal which has been expanded at about 1400 °C, which is a costly process. The Si should be pure and possess a good crystal structure so that it can absorb sunlight [11]. Silicon crystal cells are directly connected to the solar system's efficiency, so they predominate. Tthe photovoltaic market mono- crystals are more efficient for the reason they are not expensive. To keep costs low, cells are nowadays made from multi-crystalline materials rather than single-crystalline. In accordance with the module's lifetime and their better outputting activity, it could be that crystalline Technological Si cells become known. Noncrystalline Si PV are not only less expensive but also lower effective than other kinds of PV cells. These PV cells, which are produced from amorphous thin films, are utilized to power a variety of consumer products. Noncrystalline Si solar modules are becoming more useful as the solar industry evolves [12]. Cadmium tellurium and copper indium are both thin metals.-Film modules with acceptable diversion effectiveness are now possible to get on the market.( Fig. 3). High-activity solar cells created from GaAs and InP are utilized in specific applications such as powering satellites or in systems which work under high-intensity sunlight.

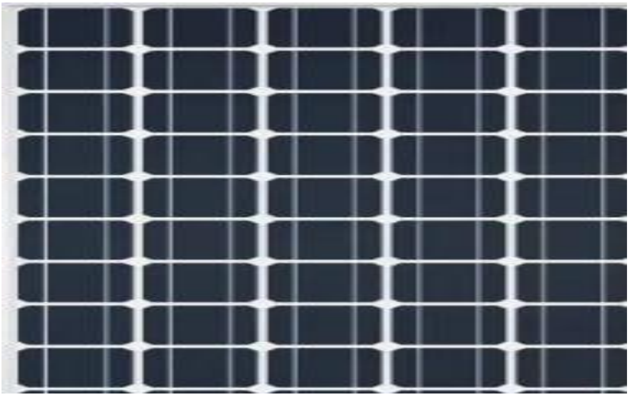

**Fig. 3: illustrates amorphous-silicon solar panel (13).**

(Fig. 4) displays an atypical view of the **assembly** of a silicon ***photovoltaic.*** The current fabricated in the semiconductor is extracted by coming closer to the front and back of the cell. As can be seen at the top, the structure (finger) should permit light to move through that supplies current to the bus bar. When a photovoltaic cell absorbs sunlight, it should reduce the reflection of light to increase its efficiency. This is named the anti-reflection coating (arc), which is covered by a light layer of insulation material.

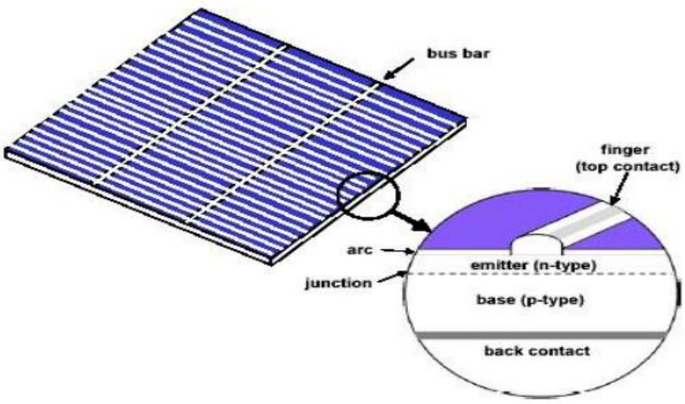


**Fig. 4: Reveals the structure of typical crystalline silicon PVcell (14).**

The depletion region is expanded to absorb the majority of the photon. Other losses to the current created by the cell emerge from light reversal from the upper surface, shadow of the cell by the upper contacts, and deficient light absorbent. Due to silicon's limited light absorption capabilities as an indirect-gap semiconductor, the last attribute may be significant for crystal Si cells. Utilizing multi-layer antireflective, exterior structures that generate tiny pyramids and making the back contact optically reflective are among steps used to mitigate these losses.[16]. When integrated with a textured given this geometry's top surface, light trapping, which serves as an excellent remedy for silicon's poor absorptive. Some cells' top-contact shading can be reduced by creating these contacts in small laser grooves, or the contacts can all be moved to the cell's back. Ohmic losses in the transmission of the current generated by the solar cell, which are typically grouped as a series resistance and reduce the fill factor of the cell, are another loss in commercial cells. If their success is on par with that of light-emitting diode (LED) technology, there is much to look forward to.. Noncrystalline silicon is one of several thin-film engineering techniques. The use of these solar cells as a film on less expensive substrates like glass or plastic is possible. Additional thin-film technologies include thin silicon with multi-crystal, copper indium telluride/cadmium sulphide, cadmium telluride/cadmium sulphide, and gallium arsenide cells. There are many benefits to thin-film cells, including easier deposition and assembly, the ability to deposit on cheap substrates or building materials, the ease of mass production, and the high fittings for many applications [17]. For solar cells to be useful, they must be able to receive enough sunlight. They are reasonably priced, come in a variety of designs, and are environmentally friendly. They would blend in if placed on a wall or roof (Fig.5). Thin-layer panels could be used to create synthetic roofing tiles [18]. Usually, solar cells and a few wires are not enough to power a building. operating water pumps for agricultural and domestic uses Direct current electricity, which solar panels produce, is suitable for electronic devices. However, alternating current is usually used for household appliances and lighting. To change the voltage, a tool called an inverter is required. From alternative to direct current. Hospitals are enormous buildings with large parking lots, thus they have a lot of roof space. These give excellent chances for hospitals to install solar panels and cut expenditures. The environment and solar energy will gain a lot if the opportunity is taken into account. Hospitals all around the world may obtain energy through the use of solar energy, which is ecologically benign. In addition to lowering hospital utility expenses, solar power may also be used to power hospitals worldwide the globe. The healthcare sector, including local and international hospitals [19]. Hospitals have contributed significantly to the development of renewable energy consumption. The environment, hospital utility expenses, and the expansion of solar energy in the future will all benefit from this. We also need to start considering how renewable energy may help the healthcare industry.


**Fig. 5: Solar panels on hospital roofs.**

**The principle behind solar cells**

We need to keep in mind the type of the material and the sunshine to realize the work of a photovoltaic cell. Solar cells consisting of two kinds of material; one is p-type Si and the other is n-type silicon. The wavelengths of specific light can convert the atoms in the Si to ions, and the internal field generated by the depletion region separates the empty holes from the free electrons within the photovoltaic device (fig.6).

 

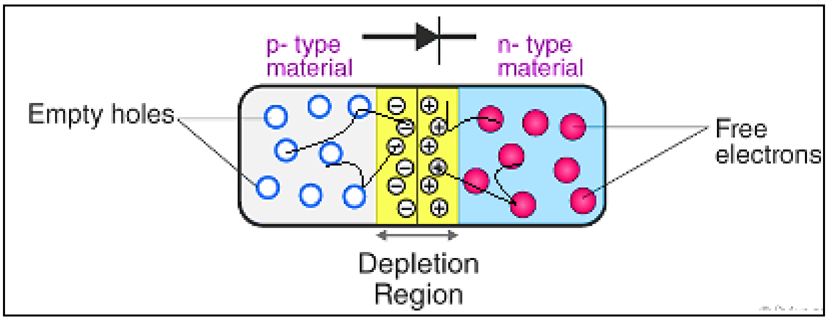


**Fig. 6: Exhibits depletion zone separates holes from electrons**

Both the holes and the electrons backed into the positive and negative sides, respectively. The internal potential energy barrier prevents most negative and positive charges from rejoining even if they are drawn to one another; instead, they must travel through an external circuit outside the material.. Since a circuit may be built from cells that have light, free electrons must flow through the load in order to reconnect with the positive holes. The kind and area of the material, the sunlight's wavelength, and its intensity all affect how much electricity a photovoltaic system generates. More than 25% of the sun energy cannot be converted into electricity by single-crystal silicon solar cells [20], because the electromagnetic radiation found in the infrared area lacks the energy to distinguish between the substance's positive and negative charges. Because isolating the material's charges requires more energy. Due to higher internal energy losses than single crystal silicon, polycrystalline Si solar cells now have an efficiency of less than 20% whereas amorphous Si solar cells have an efficiency of roughly 10%. A typical single-crystal silicon PV cell generates 100 watts of power at 0.5 volts DC and 3 A (1000 W/m2) under full sunlight (1000) [21]. The power yield of the cell is directly correlated with the brightness of the sun. For example, it suggests that if the sun's brightness were to be half, the power would do the same. The fact that solar cells' voltage is independent of their size and maintains stability as light strength changes is another important characteristic of photovoltaic cells. Nevertheless, the size and intensity of the light directly affect the current in a device. One should either hold the photovoltaic cells gadget directly exposed to the sun or gather the sunlight using mirrors or lenses to increase the energy yield. Even if the current output is relatively steady at higher temperatures, the voltage is dropping, which causes a reduction in power as the cell's temperature raises. [22].

**Sorts of solar cells**

**Based on the kinds of crystals they contain, there are three different types of solar cells:**

**1. Amorphous Silicon Solar Cell (A-Si):** It is the non-crystalline form of silicon utilized for photoelectric cells and thin-film transistors. Its thickness is less than 1, so output costs are lower due to the low material costs. Their efficiency is lower than that of the other cells. It utilizes triple layers of amorphous silicon so that each layer has different band gap energy. The variation of band gaps allows each layer to respond to various parts of the Sun's energy spectrum to enhance conversion efficiency. [23]

**2. Monocrystalline** solar cells: in these cells, silicon is doped with boron to yield a p-kind semiconductor. Monocrystalline rods get out of silicon and then stretch out into thin wafers. The upper layer of wafers is doped with phosphorous to produce an n-type semiconductor**. It eventually develops** a P-n junction [24].

3. **Polycrystalline silicon cells:** Solar cells made of polycrystalline silicon are made by pouring silicon liquid into blocks that are then spread out onto plates. Crystal formations of various sizes are created as the material solidifies. The cooling condition has a major impact on crystallite size. Larger sizes of crystallites are lost if the molten silicon is cooled slowly enough. These polycrystalline silicon solar cells have a cheap cost and high efficiency [24].

**Application of Solar Cells**

Solar energy usage in residences is rising. Devices in houses may easily run on solar-generated electricity. Additionally, solar energy is utilized to power solar heaters that provide hot water to residences. Energy is gathered and stored on batteries by solar cells installed on the top of the house for usage during the day at home for various reasons. The amount of energy used at home is reduced in this way. We may see solar panels on the rooftops of various structures [25]. These panels are used to generate power for various workplaces or structures. The solar panels convert solar energy from the sun into electricity, enabling workplaces to utilize it on their own. However, solar energy is often used for ventilation in many locations. It facilitates operating bath ventilators. Buildings with floor ventilators and ceiling ventilators.Ventilators are used in households to remove heat from the kitchen and in buildings to regulate moisture [26]. Additionally, solar energy not only aids in the development of the home's ventilation system but also aids in the circulation of water throughout any structure. The power pump and the solar energy supply unit can be connected. However, for it to work, DC power is required. Circulate all over your house. On the other side, solar lights use sun energy and are referred to as daylighting. The inherent energy of the sun is captured by this light throughout the day and released at night. To illuminate the night, they convert this energy into electricity. Utilizing this technique is reducing the demand on nearby power plants. Remote structures are also making extensive use of solar energy. Solar panels and batteries may be transported by remote schools, community centers, and clinics to create and consume power wherever they are [26].

## Conclusion

The production of solar energy has become one of the most renewable sources of power. When compared to other energy sources like fuels and petroleum resources, it offers several advantages. It can help with addressing the increased request for energy and is optimistic, substitutive, and acceptable. Even though solar energy conversion techniques are straightforward, technology based on nano-crystal QDs in semiconductor-based solar cells has the potential to convert more than 60% of the sun spectrum into electricity. However, it is quite worrying that they are retreating over time. This industry has a variety of difficulties, such as lowering manufacturing costs, raising public awareness, and improving infrastructure. The daytime energy needs are met by solar electricity, according to studies on solar cells.

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