Solar Cells

Solar cell is an electronic device which directly converts sunlight into electricity and considered the basic unit of solar energy generation system where electrical energy is extracted directly from light energy without any intermediate process.

Theory of solar cells

Light shining on the solar cell produces both a current and a voltage to generate electric power.

The working of a solar cell solely depends upon its photovoltaic, hence a solar cell also known as **photovoltaic cell**.

This process requires **firstly**, a material in which the absorption of light raises an electron to a higher energy state, and **secondly**, the movement of this higher energy electron from the solar cell into an external circuit. The electron then dissipates its energy in the external circuit and returns to the solar cell.

A variety of materials and processes can potentially satisfy the requirements for photovoltaic energy conversion, but in practice nearly all photovoltaic energy conversion uses semiconductor materials in the form of a p-n junction.

A solar cell is basically a semiconductor p-n junction device. It is formed by joining p-type (**high concentration of hole or deficiency of electron**) and n-type (**high concentration of electron**) semiconductor material. at the junction excess electrons from n-type try to diffuse to p-side and vice-versa.

The p–n junction is commonly used for solar cell. The important role of p–n junction is the charge separation of light-induced electrons and holes.
A (p–n junction) is used for charge carrier separation in most cases

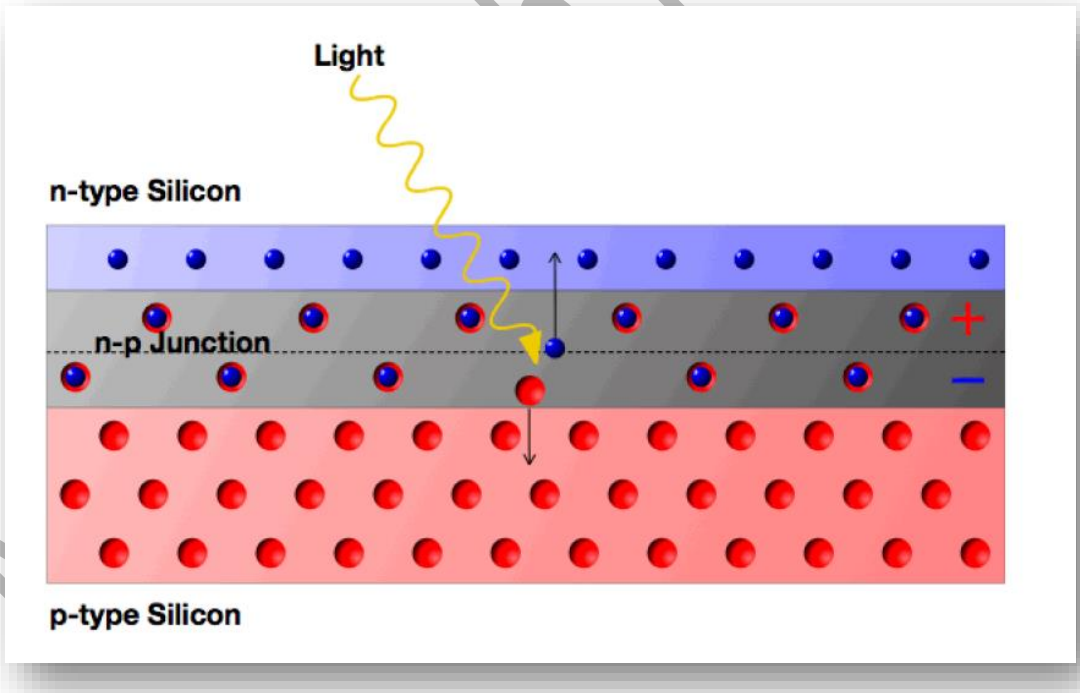

Fig. (16): A schematic explaining the p–n junction

What is the basic working principle of a solar cell?

A solar or photovoltaic cell has negative front contact and positive back contact.

A semiconductor p-n junction is in the middle of these two contacts like a battery. If these two sides are connected by an external circuit, current will start flowing from positive to negative terminal of the solar cell.

For silicon, the band gap at room temperature is Eng. = 1.1 eV and the diffusion potential is UD = 0.5 to 0.7 V. Construction of a Si solar cell is depicted in Figure (17)

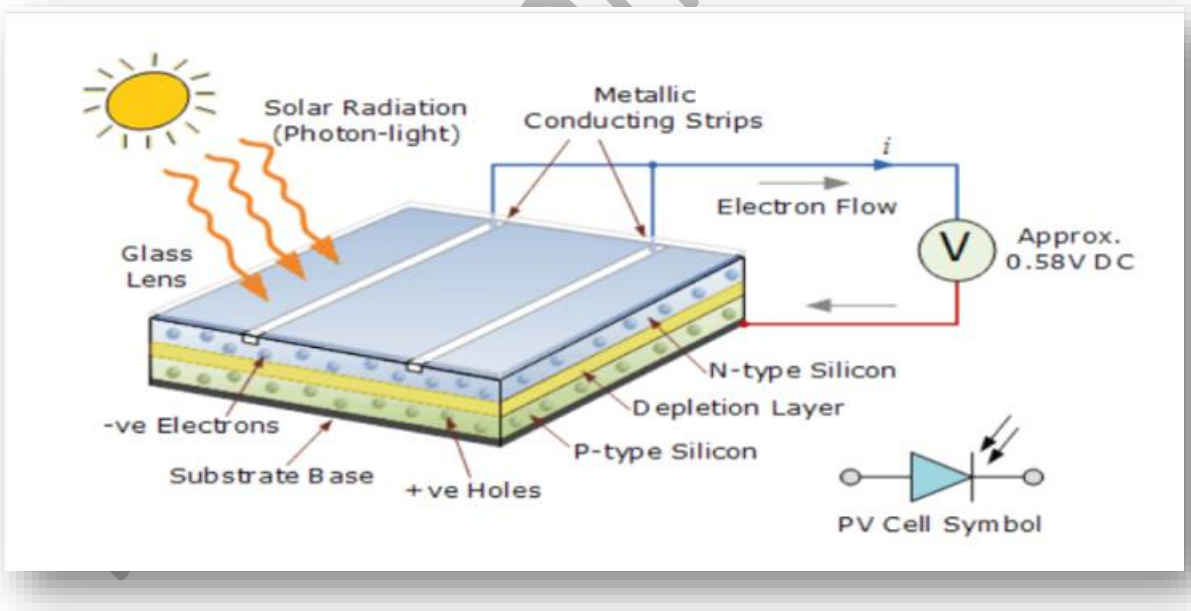

Fig. (17): A schematic explaining the Construction of a Si solar cell

Historical Developments of solar cells

1839: Photovoltaic effect was first recognized by French physicist Alexandre-Edmond Becquerel.

1883: First solar cell was built by Charles Fritts, who coated the semiconductor selenium with an extremely thin layer of gold to form the junctions (1% efficient).

1946: Russell Ohl patented the modern solar cell.

1954: Modern age of solar power technology arrives – Bell Laboratories, experimenting with semiconductors, accidentally found that silicon doped with certain impurities was very sensitive to light.

solar cells are currently developed in laboratories around the world are several methods.

Since the sunlight is not always available, all these businesses of PV solar cells may not work at night and a lot of electricity unused will go. Therefore, energy storage is an important factor in solar cell market.

Recently, in 2014, Harvard University researchers developed a new type of battery based on organic molecules called Quinone. It is found in plants and is economical in a sense that it can store sunlight energy for a couple of days.

This device not only can store energy but can also reduce the costs of renewable energy by 25%, relying on a new aqueous, rechargeable lithium-oxygen battery used in sunlight.

Solar cells are currently the most promising candidate for providing the next generation of secure, sustainable and affordable energy source. Besides the obvious advantages solar cells bring on the table, such as energy independence and pollutant reduction.

The solar cell or photovoltaic cell fulfills two fundamental functions:

1- Photogeneration of charge carriers (electrons and holes) in a light-absorbing material
2- Separation of the charge carriers to a conductive contact to transmit electricity.

Types of Solar Cells

1- Homojunction Device

- Single material altered so that one side is p-type, and the other side is n-type.

- p-n junction is located so that the maximum amount of light is absorbed near it.

2- Heterojunction Device

- Junction is formed by contacting two different semiconductors.

- Top layer - high bandgap selected for its transparency to light.

- Bottom layer – low bandgap that readily absorbs light.

3- p-i-n and n-i-p Devices

- A three-layer sandwich is created,

- Contains a middle intrinsic layer between n-type layer and p-type layer.

- Light generates free electrons and holes in the intrinsics.

Advantage solar cells

- It is clean and non-polluting
- It is a renewable energy
- Solar cells do not produce noise and they are totally silent.
- They require very little maintenance
- They are long lasting sources of energy which can be used almost anywhere
- They have long life time
- There are no fuel costs or fuel supply problems.

Fig. (18): A picture of the Solar cells

Disadvantages solar cells

- Solar power can’t be obtained in night time
- Solar cells (or) solar panels are very expensive
- Energy has not been stored in batteries
- Air pollution and weather can affect the production of electricity
- They need large area of land to produce power supply more efficient.