Solar Cells

Third Generation Solar Cells

The Third-Generation solar photovoltaic cells have an ability to generate the electricity. It consists of three families with different principles are as follows:
polymer: fullerene, hybrid polymer, perovskites solar cells. It is a new emerging technology that has arisen after the first generation-wafer based and second generation-thin films shown in Fig. 6 and the summary of all types.

These types of solar cells are introduced to minimize the drawbacks of the first and second-generation solar cells. The major objectives of third generation solar cell are given below.
a) To reduce production cost
b) To increase the power conversion efficiency.

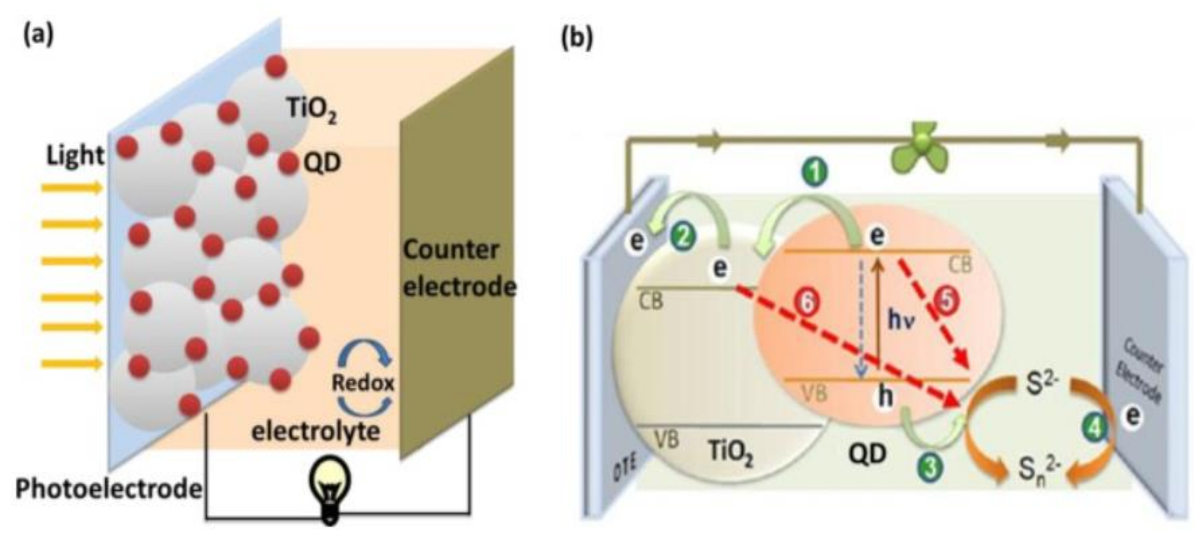
Most of the developed 3rd generation solar cell types are:
1) Nano crystal based solar cells.
2) Dye sensitized solar cells.
3) Concentrated solar cells.
4) Perovskite solar cells.
5) Quantum dot-based solar cells.
6) Organic solar cells (OSCs).

1. Nano Crystal Based Solar Cells

Nanocrystal based solar cells are generally also known as Quantum dots (QD) solar cells.

These solar cells are composed of a semiconductor, generally from transition metal groups which are in the size of nanocrystal range made of semiconducting materials.

QD is just a name of the crystal size ranging typically within a few nanometers in size, for example, materials like porous Si or porous TiO2, which are frequently used in QD.



(a) Schematic illustration of the structure of a quantum dot–sensitized solar cell (QDSC); and (b) schematic illustration of photoinduced charge transfer processes following a laser pulse excitation (7).

Fig. (24): A schematic explaining the structure of the quantum dot solar cells

This idea of the QD based solar cell with a theoretical formulation were employed for the design of a p-i-n solar cell over the self-organized in As/GaAs system.

Generally, the nanocrystals are mixed into a bath and coated onto the Si substrate.

These crystals rotate very fast and flow away due to the centrifugal force. In conventional compound semiconductor solar cells, generally a photon will excite an electron there by creating one electron-hole pair.
However, when a photon strikes a QD made of the similar semiconductor material, numerous electron-hole pairs can be formed, usually 2 or 3, also 7 has been observed in few cases.

2. Dye Sensitized Solar Cells (DSSCs)

DSSCs are thin-film solar cells that consist primarily of a layer s porous in nature. The layer is of Titanium dioxide (TiO_2) nanoparticles, and it is covered with molecular dye (a charge transfer dye) whose photosensitivity stimulates the absorption of solar energy.

DSSCs based solar cells generally employ dye molecules between the different electrodes.

The DSSC device consists of four components:

1- semiconductor electrode (n-typeTiO_2 and p-type NiO),
2- a dye sensitizer,
3- redox mediator,
4- a counter electrode (carbon or Pt).

Advantages of DSSCs:

1- highly flexible,
2- transparent
3- low cost.
4- easily produced.
5- have low toxicity.
6- an effective performance.
7- have the ability to work under low-light condition,

They can work in diffuse light (less intense light like at dawn, dusk or in cloudy weather also) and fluorescent light, meaning that they can be used indoors as well.

The novelty in the DSSC solar cells arise due to the photosensitization of nano grained TiO_2 coatings coupled with the visible optically active dyes, thus increasing the efficiencies greater than 10%.

Disadvantages of DSSCs:

1- Degradation of dye molecules and hence stability issues. This is due to poor optical absorption of sensitizers which results in poor conversion efficiency.
2- The dye molecules generally degrade after exposure to ultraviolet and infrared radiations leading to a decrease in the lifetime and stability of the cells.
3- Moreover, coating with a barrier layer may also increase the manufacturing more expensive and lower the efficiency.

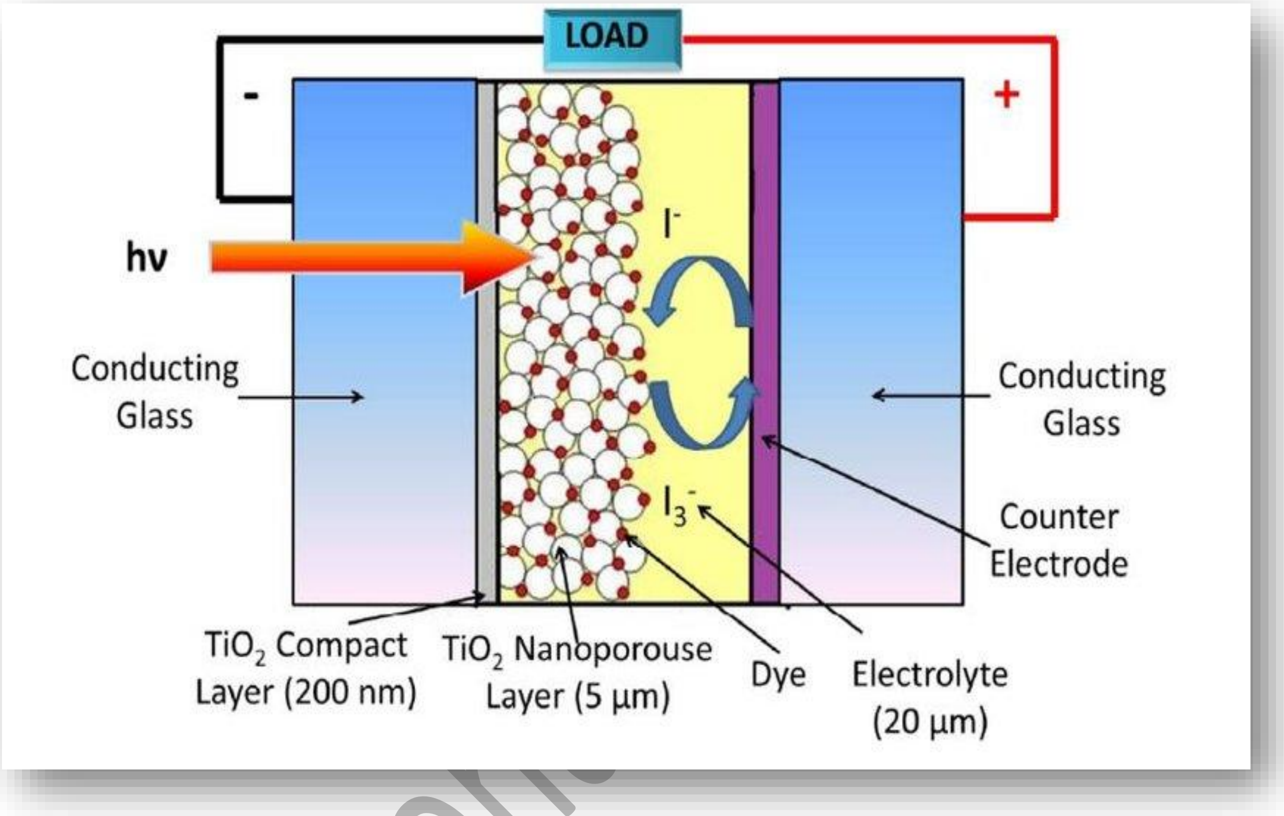


Fig. (25): A schematic explaining the structure of dye Sensitized Solar Cells

3. Concentrated Solar Cells

Concentrating photovoltaic (CPV) has been established since the 1970s.
It is the newest technology in the solar cell research and development. The main principle of concentrated cells is to collect a large amount of solar energy onto a tiny region over the PV solar cell, as shown in the figure below .

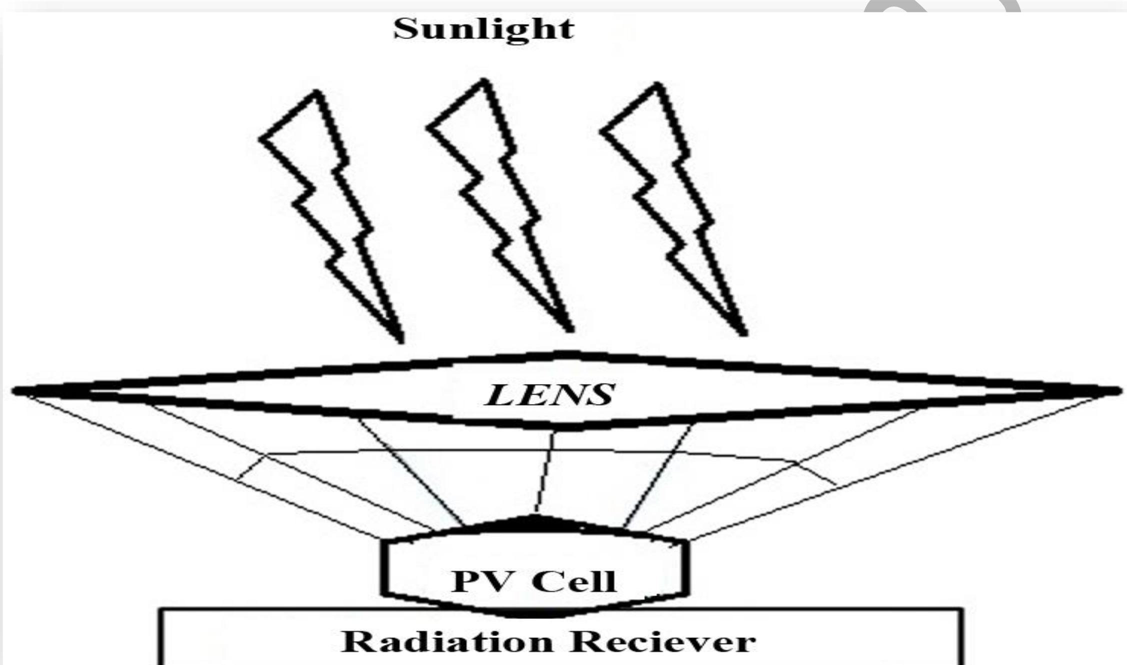


Fig. (26): A schematic of concentrated solar cell

The principle of this technology is based on optics, by using large mirrors and lens arrangement to focus sunlight rays onto a small region on the solar cell.

The converging of the sunlight radiations thus produces a large amount of heat energy.

This heat energy is further driven by a heat engine controlled by a power generator with integrated.

CPVs have shown their promising nature in solar world.

It can be classified into low, medium, and high concentrated solar cells depending on the power of the lens systems. Concentrating photovoltaic technology have the following merits, such as solar cell efficiencies >40%, absence of any moving parts, no thermal mass, speedy response time and can be scalable to a range of sizes.

Fig. (27): A picture of concentrated solar cell