

Solar Cells

Third Generation Solar Cells

4. Perovskite solar cells

The German scientist Gustav Rose discovered the perovskite mineral in 1839, although significant exploration on these was carried out by the Russian mineralogist Lev Perovski, hence them being named perovskites.

Perovskite is a chemical compound of the calcium titanium oxide mineral, which is made up of calcium titanate (CaTiO_3) and is abundantly available in nature.

Perovskites have a crystal structure with a formula of: $\text{A}_{(n-1)} \text{B}_n \text{X}_{(3n+1)}$

(Where X = halogen, oxygen, nitrogen or carbon).

The bigger 'A' cation shares a cuboctahedral site with twelve X anions, and the smaller 'B' cation shares an octahedral location with six 'X' anions.

Its cubic unit cell is shown in figure (27):

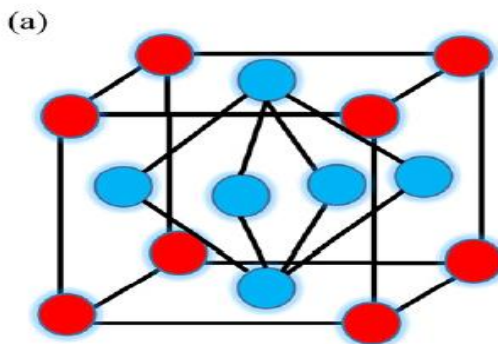


Fig. (28): A picture of cuboctahedral structure

Perovskites exhibit an exceptional ability to absorb light because they transport the electric charge when light falls on them, resulting in an increase in electron mobility.

Due to their:

- 1-long-range ambipolar charge transport,
- 2-high dielectric constant,
- 3-high absorption coefficient,
- 4-low exciton-binding energy,
- 5-ferroelectric characteristics, and other unique physical properties.

perovskite materials have sparked a lot of interest for their use in photovoltaic and optoelectronic devices?

Since the efficiency of solar cells based on perovskite materials has risen from an initial 3.8% to more than 25%, research interest in these materials has grown dramatic

5. Quantum dot-based solar cells

Quantum dots (QDs): are nanoscale semiconductor crystals that have proved to be fascinating materials in various areas of science, for example, in bio-imaging, light-emitting diode innovation, lasers, and solar cells.

They have electrical properties unique as well as: fluorescent properties, which include narrow emission spectra, high photochemical stability, continuous absorption and small dimensions (2–12 nm in diameter)

This unique set of characteristics has enabled them to be used in many applications, include:

light emitting diodes, photovoltaics, photoconductors, photodetectors, biosensors, etc.

Compared with molecular dyes, quantum dots are better in terms of their tunable photo response.

The most frequently used QDs or nanocrystals are:

cadmium selenide (CdSe), lead selenide (PbSe), cadmium sulphide (CdS), lead sulphide (PbS), cadmium telluride (CdTe), etc.

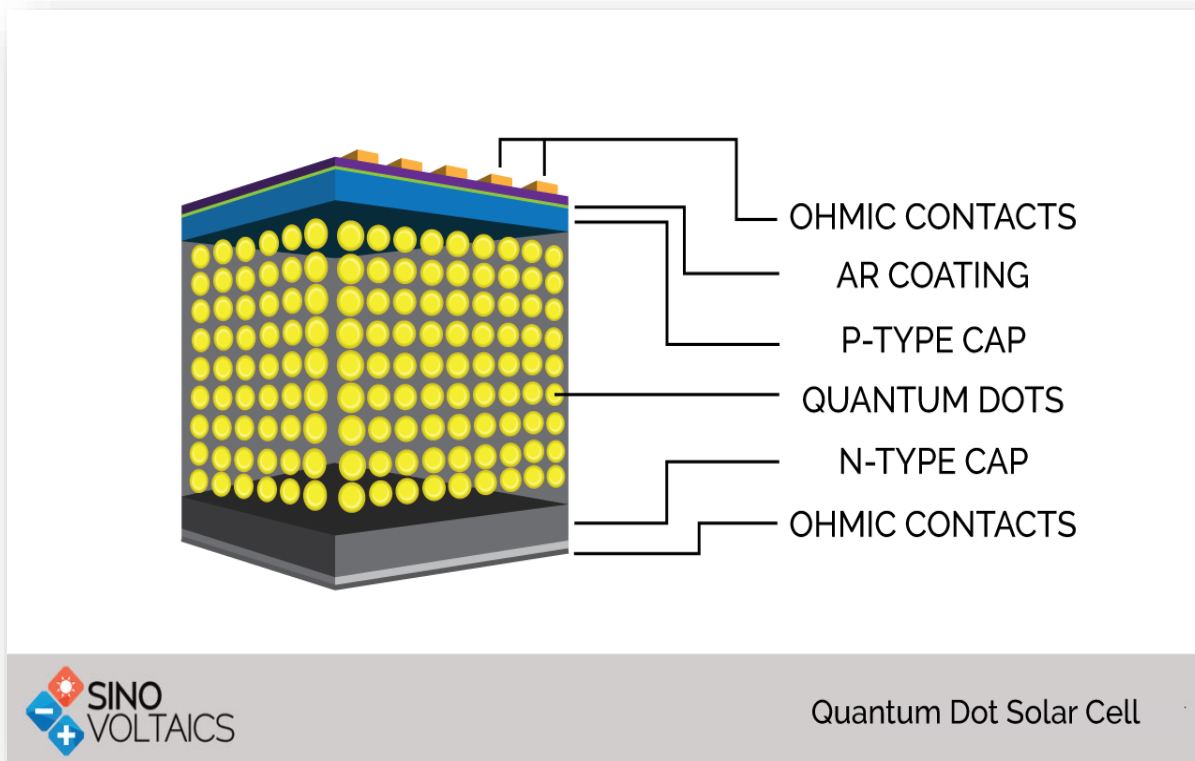


Fig. (29): A picture of quantum dot solar cells

Remember the joy of success
diminishes in your eyes
fatigue.

تذكر فرحة النجاح
يصغر في عينك
التعب .

6. Organic solar cells (OSCs)

OSCs featuring organic polymer molecules are an innovative replacement for traditional inorganic photovoltaic technologies that offer the potential for large-area applications and flexible energy generation. These organic molecules aim to enhance the charge transport and light absorption in solar cells.

OSCs have gained importance based on the fact that they may become an alternative to their inorganic counterparts in conventional solar cells owing to their:

- 1- cost-effective.
- 2- environmentally friendly.
- 3- lightweight.
- 4- abundant nature.

Low temperature manufacturing, colour tuning, flexibility and deposition on various substrates are additional characteristics offered by OSCs.

Their performance can be improved further with a clear understanding of the nanostructure morphology, device structure and material optimization.

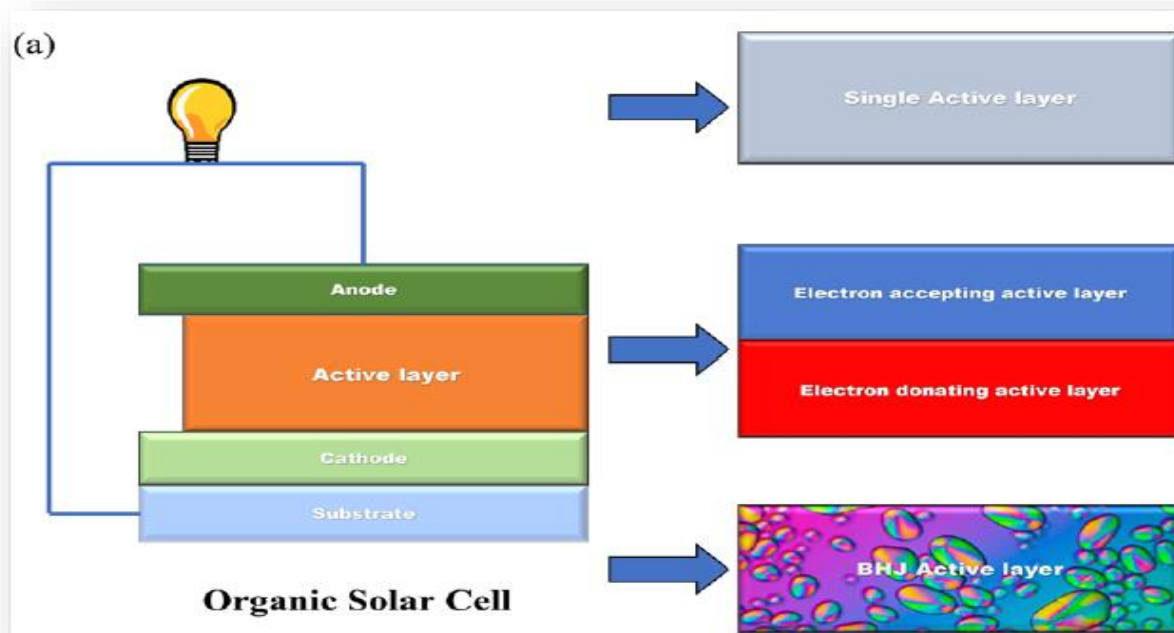


Fig. (30): A schematic explaining the structure of organic solar cells

Future of Solar cell Technology:

The future of solar energy looks bright, with continued growth and innovation expected in the industry. Here are some of the key trends and developments that are likely to shape the future of solar energy:

Increasing adoption: The use of solar energy is expected to continue to grow rapidly, with many countries setting ambitious targets for the deployment of solar power. As the price of solar technology continues to fall and the environmental benefits of solar energy become more widely recognized, it is likely that more and more individuals and businesses will turn to solar as a source of electricity.

Innovations in technology: The solar industry is constantly innovating, with new technologies being developed all the time. Some of the most promising developments in solar technology include the use of nanomaterials to increase the efficiency of solar cells, the development of transparent solar panels that can be integrated into windows and other building materials, and the use of artificial intelligence to optimize the performance of solar systems.

Growing role in the transportation sector: Solar energy is also expected to play an increasingly important role in the transportation sector, with the development of solar-powered vehicles and the use of solar panels for electric power vehicles.

Increased storage capacity: One of the main challenges of solar energy is the fact that it is an intermittent source of electricity, with production varying depending on the time of day and weather conditions. However, the development of new technologies, such as solar thermal storage and advanced batteries, is helping to overcome this challenge by allowing excess solar energy to be stored and used when needed.