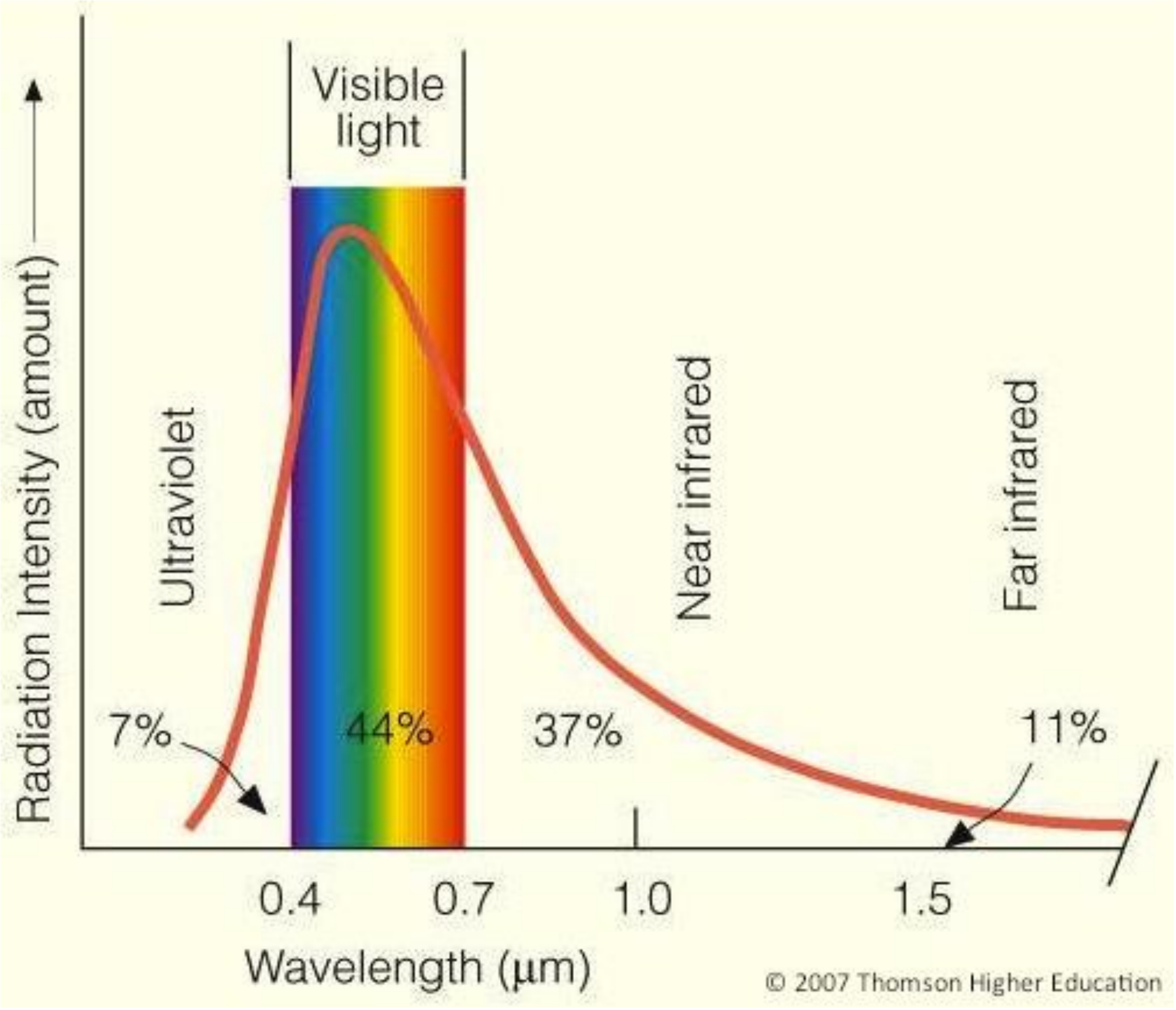
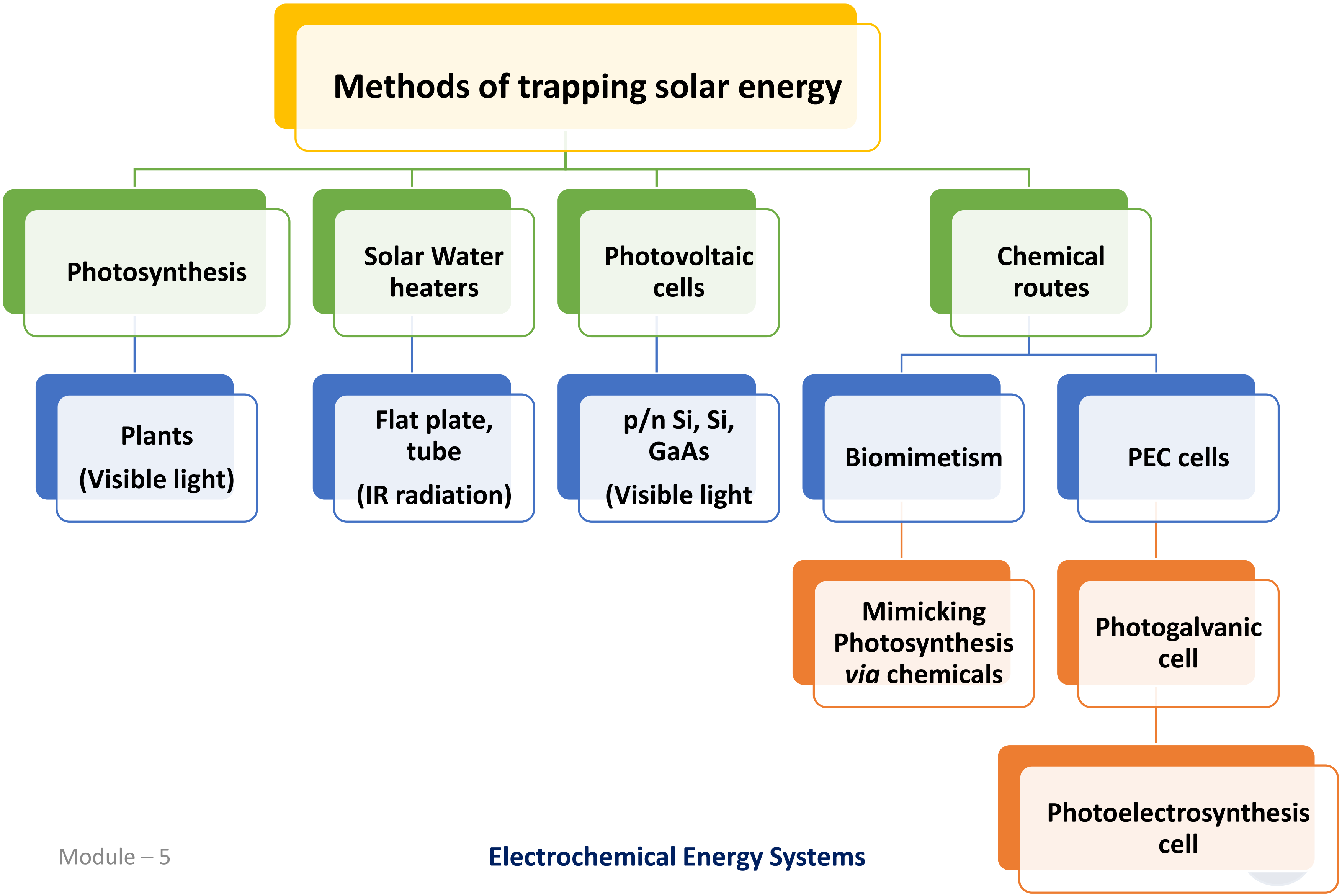
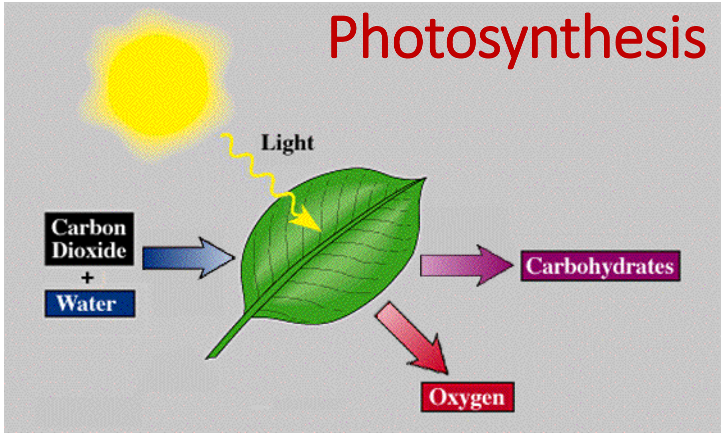
Spectral Properties of Sunlight



Solar energy conversion devices

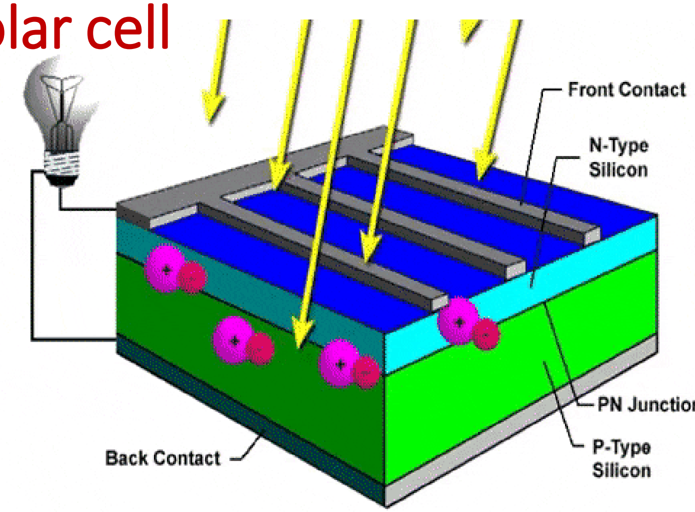


Solar Energy Conversion

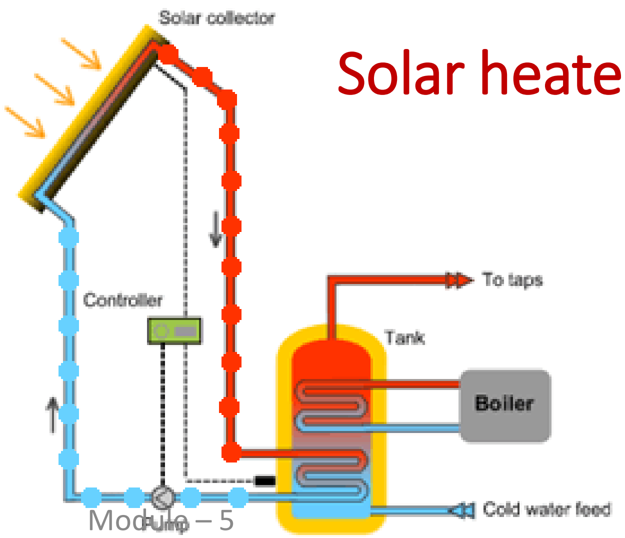


Photosynthesis

Solar cell



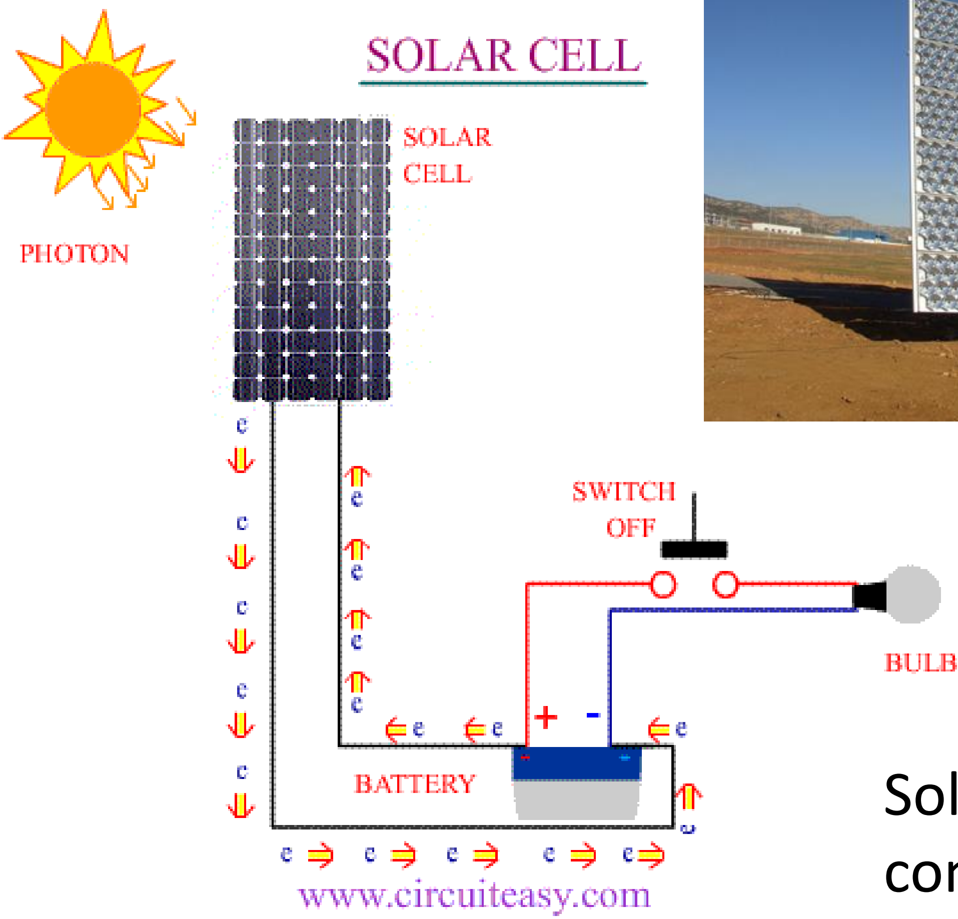
Solar Energy Conversion



Solar heater

Solar Furnace

Solar cell



Solar cell is a device that directly converts the **energy of light** into **electrical energy**

Types of solar energy conversion cells

(1) Photovoltaic Cells

- Photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect

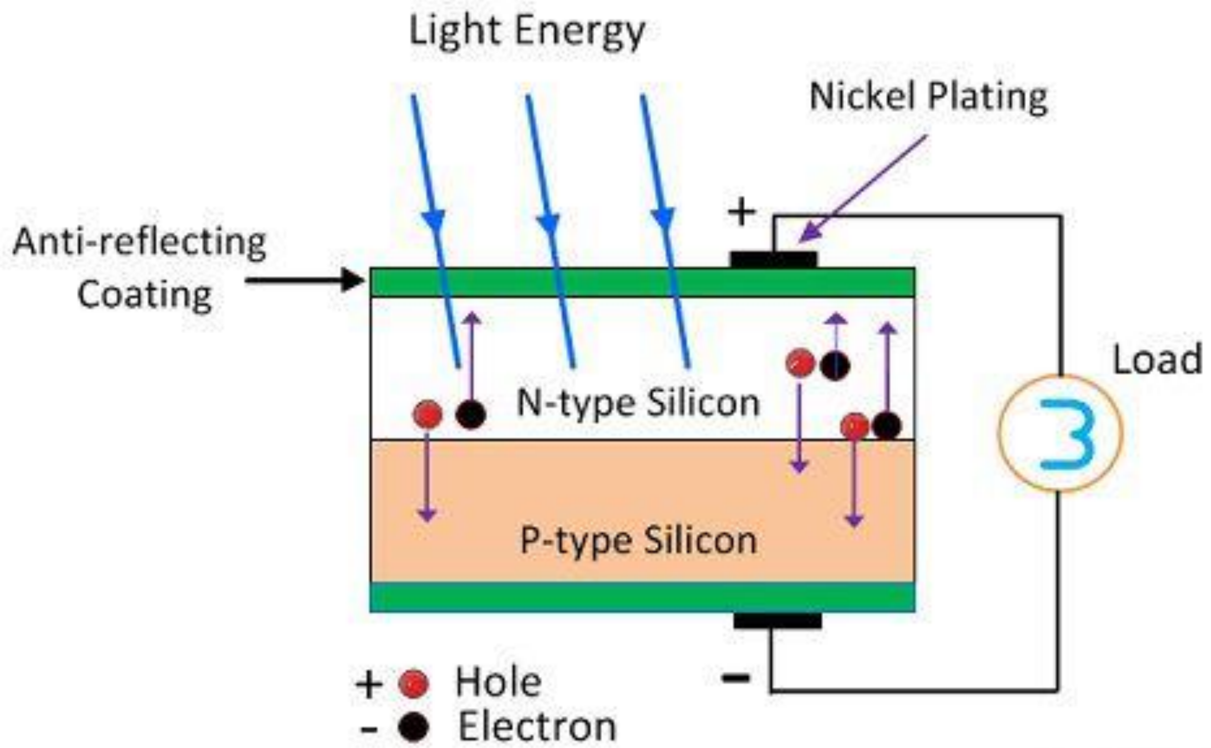
(2) Photoelectrochemical cells

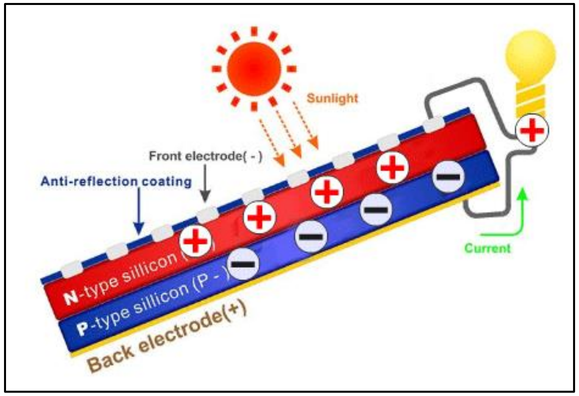
- Photoelectrochemical cell is a photocurrent-generated device composed of an electrolyte, a photoactive semiconductor electrode

(3) Dye-sensitized solar cells

- Dye-sensitized solar cells (DSC) is a photoelectrochemical solar cell, consisting of a dye-sensitized semiconducting working electrode (WE), a redox electrolyte and a counter electrode (CE)

(1) Photovoltaic Cells





- **System converts light energy to electricity**
- **Applications in Aerospace & Satellite etc.**

Photovoltaic Cells

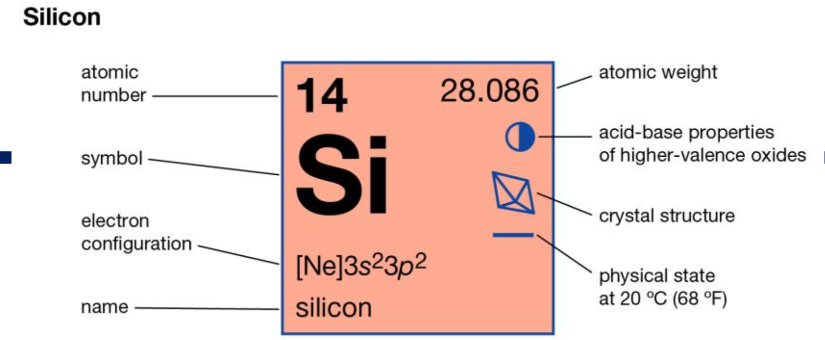
- A photovoltaic solar cell is a device that converts the energy of sunlight directly into electricity by the photovoltaic effect.

- The photovoltaic effect involves creation of a voltage (or a corresponding electric current) in a material upon exposure to electro-magnetic radiation.

- Though the photovoltaic effect is directly related to the photoelectric effect, the two processes are different.

- In the photoelectric effect electrons are ejected from a material's surface upon exposure to radiation of sufficient energy.

Why Silicon?

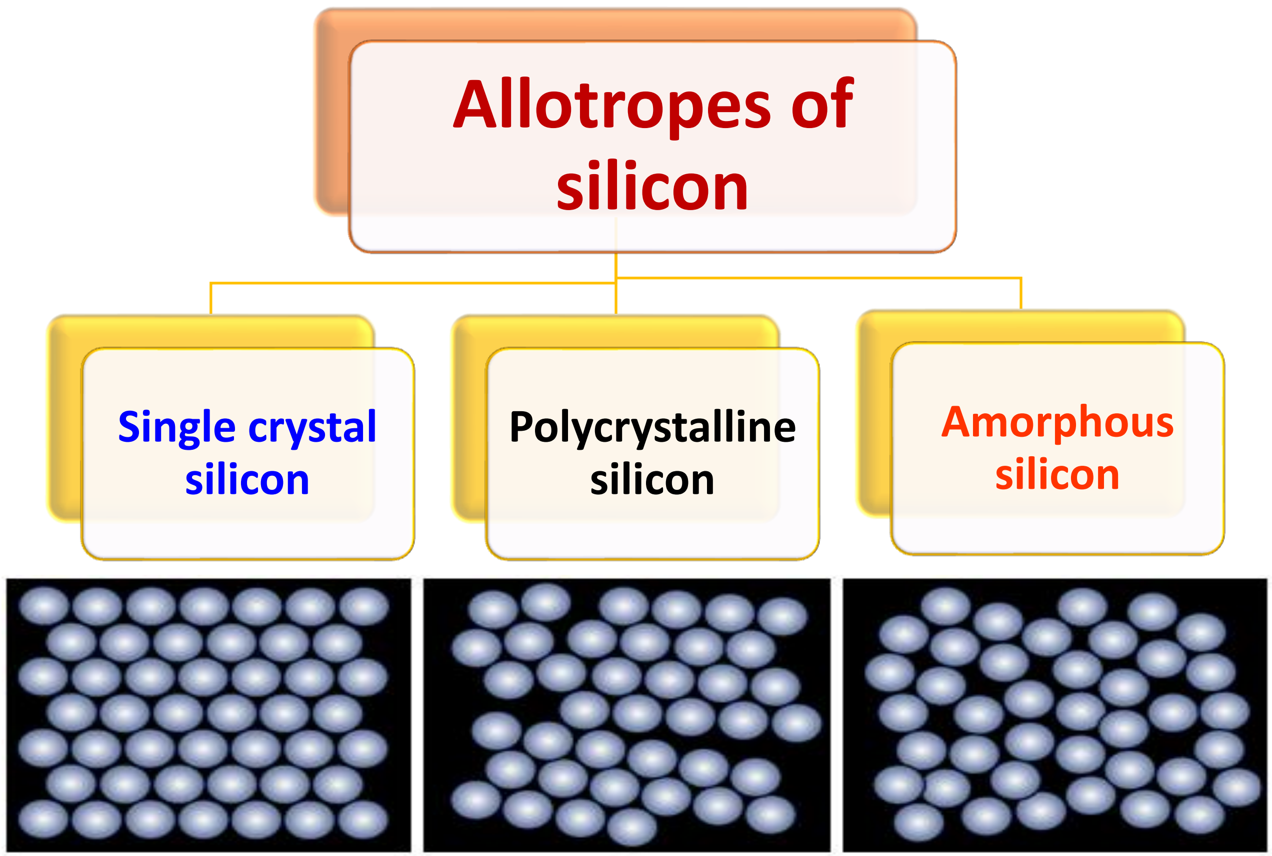


- Silicon is a very common element abundant in nature. It is the main element in sand and quartz.
- Silicon is considered as the most suitable material for solar energy conversion because of

  1) Most abundance (~28% by mass) after oxygen
  2) Optimum band gap of 1.23 eV at 300 K
  3) Cost effectiveness
  4) Interestingly, silicon has a greater density in a liquid state than a solid state.

Structure of Silicon

The crystal structure, or atomic arrangement, of any material has a great deal to do with its electrical properties.



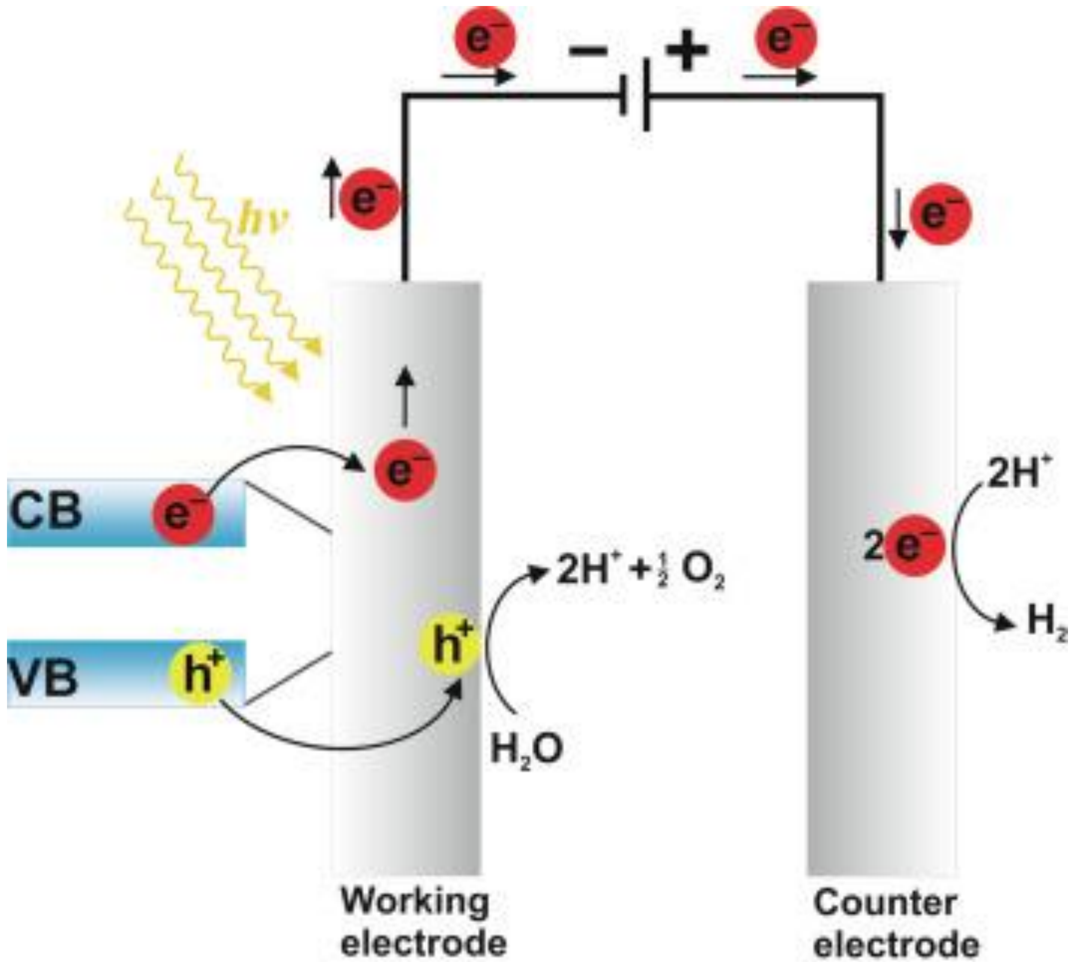
Types of silicon

- **Single crystal silicon -** In its crystalline form, a material is characterized by an ordered array of component atoms. This array is repetitive with displacement through the material sample.

- **Polycrystalline silicon -** Where a polycrystalline material is concerned, the object is composed of a number of sub-sections, each of which is crystalline in form. These subsections, however, are independently oriented so that at their interfaces the atomic order and regularity undergo sharp discontinuities.

- **Amorphous silicon (non-crystalline for higher light absorption) -** The final category, the amorphous material, displays no atomic regularity of arrangement on any macroscopic scale.

(2) Photoelectrochemical cells



Types of Photoelectrochemical cells

Photo-electrochemical cells are classified into two types according to their application

1. Liquid Junction Solar Cell (LJSC) –
   - This cell is used to convert solar energy into electrical energy

2. Photo-electrosynthesis (PES) cells –
   - In this class of cells, solar energy is converted into chemical energy in the form of fuels.

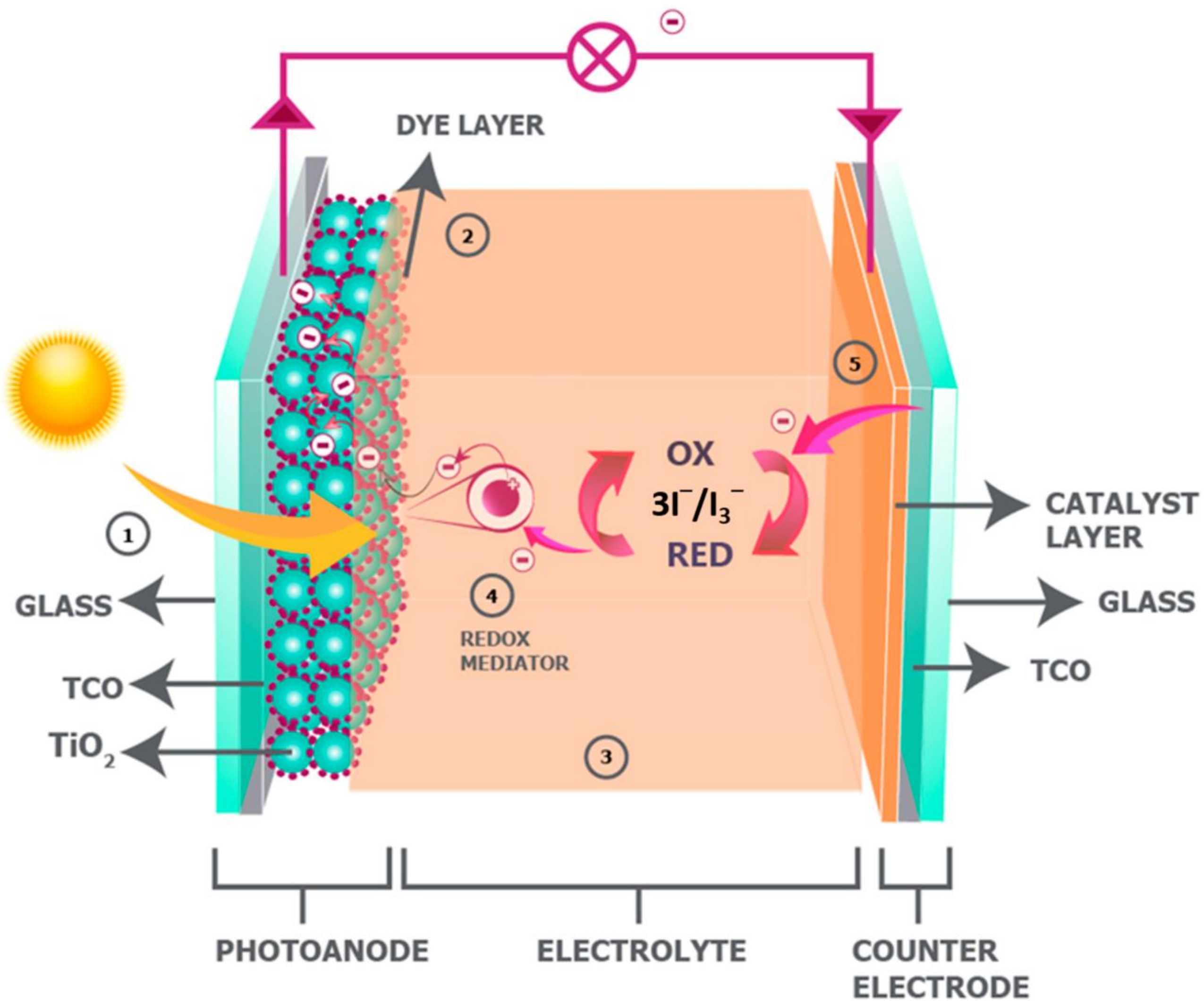
The requirements for the electrode materials are:

1) Band gap (E_g) should be optimum

2) The doping level should be optimum, so that there will be a good spatial separation of the photo-generated carriers and hence, high quantum efficiency.

3) Should have large values of absorption co-efficient (α). This is usually found for direct band gap SC's.

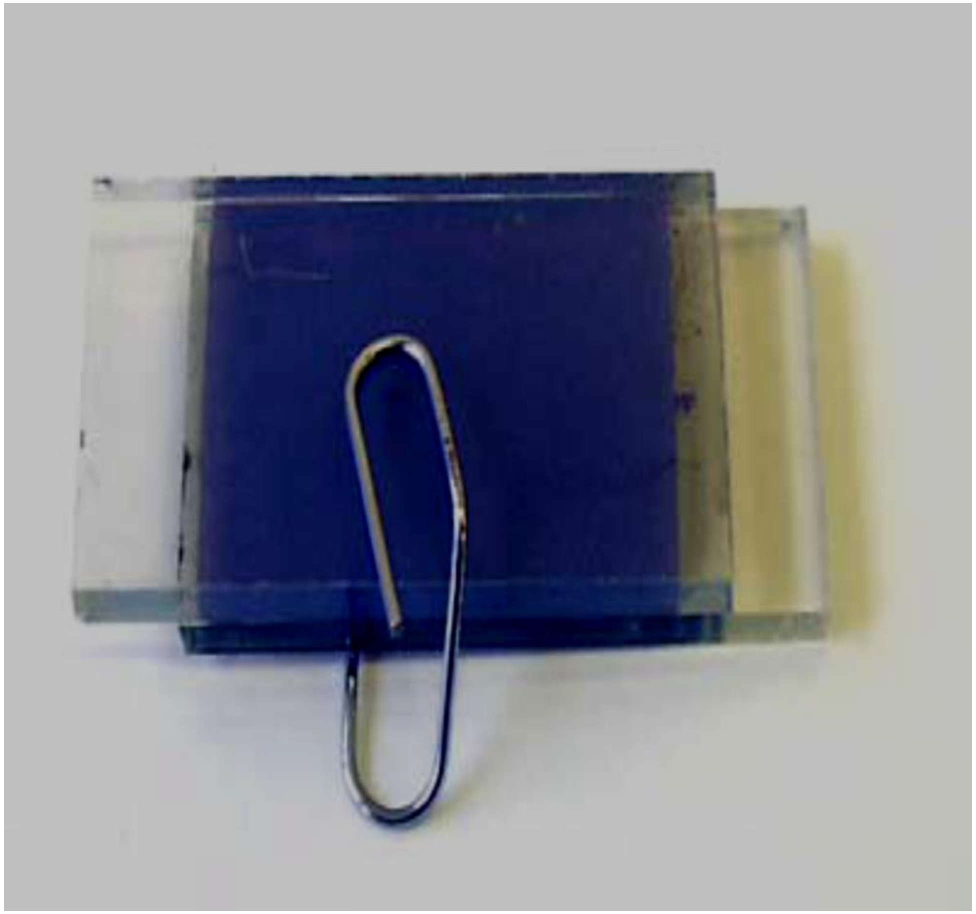
(3) Dye-sensitized solar cells - Grätzel cell



Dye-sensitized solar cells - Grätzel cell

1. Sunlight energy (photon of light) passes through the titanium dioxide layer and strikes electrons within the adsorbed dye molecules. Electrons gain this energy and become excited because they have the extra energy.
2. The excited electrons escape the dye molecules and become free electrons. These free electrons move through the titanium dioxide and accumulate at the -ve plate (dyed TiO_2 plate).
3. The free electrons then start to flow through the external circuit to produce an electric current. This electric current powers the light bulb.
4. To complete the circuit, the dye is regenerated. The dye regains its lost electrons from the iodide electrolyte. Iodide (I^-) ions are oxidized (loss of 2 electrons) to tri-iodide (I_3^-). The free electrons on the graphite plate then reduce the tri-iodide molecules back to their iodide state. The dye molecules are then ready for the next *excitation/oxid/red* cycle.

Dye-sensitized solar cells - Grätzel cell



Upper Plate :

Dye coated TiO_2 Plate (-Ve)

Lower Plate :

Graphite coated conductor (+Ve)

By Hermetic sealing

Prepared Grätzel cell

Applications of solar cell

Solar cells are used in a wide variety of applications

- Toys, watches, calculators
- Electric fences
- Remote lighting systems
- Water pumping
- Water treatment
- Emergency power
- Portable power supplies
- Satillites