PHOTO CURRENT IN A P-N DIODE

Principle

- When a reverse biased p-n junction diode is exposed to light radiation, it produces electron hole pairs. It produces a reverse current.

Construction

1. It is made up of 'p' and 'n' type materials mounted on the insulated substrate which is sealed inside the metal case for safety.
2. A small glass window is fixed on the top to allow the sunlight to the diode.
3. The symbol of the photo diode is as shown in figure. 4.12.

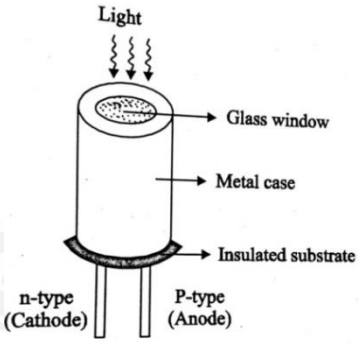

Fig. 4.11

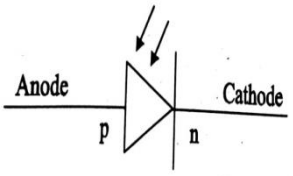

Fig. 4.12

Working

1. The photo diode is reverse biased as in fig. 4.13.
2. When no light is incident no charges are created.
3. Now a very little reverse current (I_R) flows through the circuit. This current is called ***Dark current***.
4. When we expose the diode to light, light photons incident on the p-n junction through glass window.
5. Each photon creates an electron-hole pair at the junction.
6. These charge carriers move towards the potential and producing a current known as photo current.
7. Photo current increases with the increase in intensity of light falling.
8. The current reaches a maximum and is called saturation current (I_S).
9. Total current, $I = I_R + I_S$

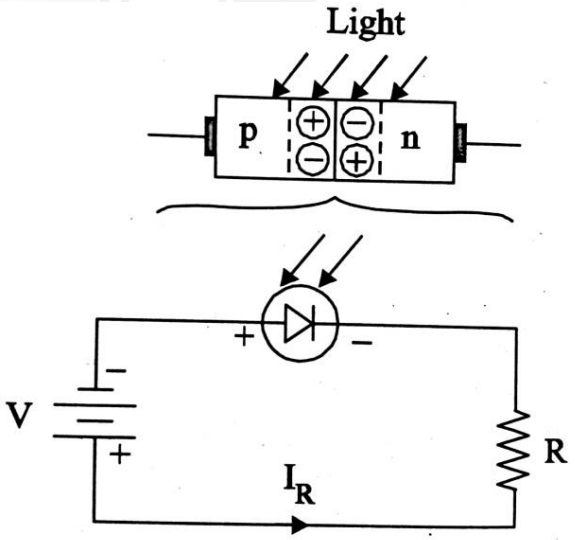

Fig. 4.13

Modes of operation

Photo diode operates in 3 modes. 1. Photo voltaic mode. 2. Photo conductive mode. 3. Avalanche diode mode.

Types: Based on modes of operation, there are different types of photo diodes.

1. PIN (*p* type – intrinsic – *n* type) photo diode.
2. APD (Avalanche pin photo diode)
3. Schottky photo diode.
4. Solar cell.

Advantages

1. They have long life period.
2. It is less in weight.
3. It is very compact (small in size).
4. Noise is less.
5. It can be rugged mechanically.

Disadvantages

1. Produced dark current is temperature dependent.
2. The thermal stability is very poor.

3. Amplification is required for better performance. 4.Efficiency is poor in rainy and winter seasons.

Applications

- Photo diodes are used in,

1. Charged couple devices (CCD), photo conductors and photo multiplier tubes.
2. Clocks, radio, camera, street light, etc.,
3. Lighting regulation and optical communication systems.
4. Electrical devices such as smoke detectors, CD players, TVs, remote controls, etc.,
5. Computed tomography (CT) in medicine.

SOLAR CELL

Principle

- It is a photo diode which converts sunlight into electric energy by photon absorptions.

Construction

1. It consists of heavily doped 'p' and 'n' type materials grown over the substrate as in figure.
2. Thickness of *'p'* and *'n'* regions is made small.
3. The *'p'* and *'n'* materials are connected to the load resistance 'R_L' through ohmic contacts.
4. Above *'p'* and *'n'* materials, a glass window is fixed to allow the sun light photons.
5. The symbol of solar cell is as shown in fig. 4.15.

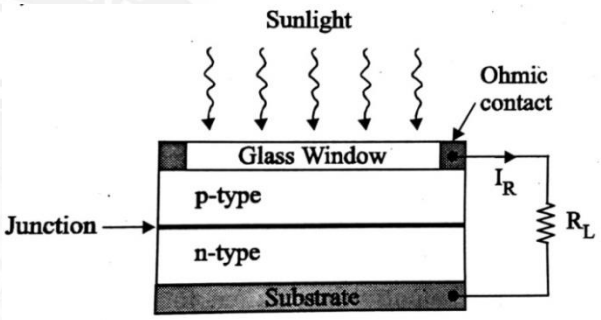

Fig. 4.14

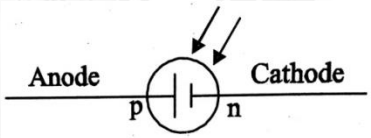

Fig. 4.15

Working

1. The solar cell is exposed to light without load resistance (R_L) and the photons are allowed to fall on *'p'* and *'n'* materials.
2. These photons collide with valence electrons and detached from the atoms, thus electron hole pairs are produced as shown in figure. 4.16.
3. These electrons and holes diffuse and reach the depletion region as shown in figure. 4.17.
4. Now, electrons from *'p'* type move towards *'n'* type and holes from *'n'*typemove towards *'p'* type as shown in figure 4.18.
5. If the diode is open circuited, the electrons and holes accumulate on either side of the junction, which gives open circuit voltage V_0 as shown in figure. 4.19.
6. Now if a load resistance 'R_L' is connected across the diode, then a reverse current 'I_R' flows through the circuit as shown in figure. 4.14.
7. Magnitude of current is proportional to the intensity of light falling on it.

Advantages

1. The energy used by solar cell is a renewable energy source (sun light).
2. These cells are eco-friendly and save electricity charges.
3. It is a pollution free device with higher efficiency.
4. Life time and durability is longer.

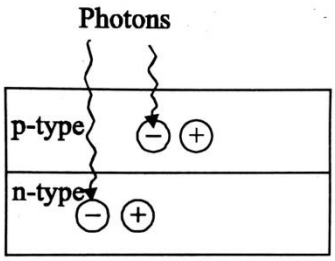

Fig. 4.16

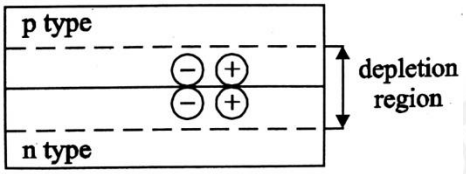

Fig. 4.17

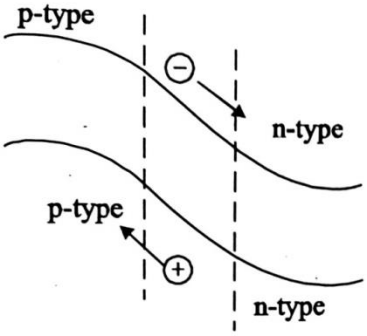

Fig. 4.18

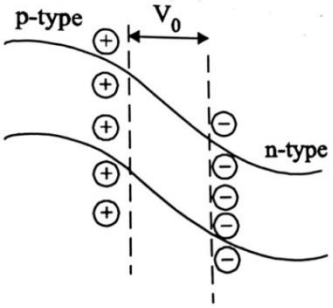

Fig. 4.19

Disadvantages

1. Installation cost is high.
2. It will not work in winter and rainy seasons.
3. The solar panels occupy more space.
4. Produced electrical energy should be converted from DC to AC, it is difficult.

Applications

1. It is used in production of electricity for daily needs.
2. Produced electricity can be used for commercial purposes also.
3. They are used in artificial satellites and in space probes.
4. Solar panels are used in calculators, watches, street lights, toys etc.,