UNIT IV

Optical properties of Materials

4.7.Light emitting diode

It is a p-n junction diode which emits light when it is forward biased.

4.7.1Principle

The injection of electrons into the p-region from n-region makes direct transition from the conduction band to valance band. Then, the electrons recombine with holes and emits photons of energy E_g,

The forbidden gap energy is given by

$$E_g = hv$$

Where h – Plank's constant

v- Frequency of the emitted radiation.

$$\text{But } v = c/\lambda$$

Where c – velocity of the light

λ - wave length of the light

$$\therefore E_g = (hc) / \lambda$$

Hence, the wave length of the emitted photon is given by the relation

$$\lambda = (hc) / E_g$$

The wave length of the light emitted purely depends on the band gap energy.

4.7.2Construction

Figure shows cross section view of a LED.

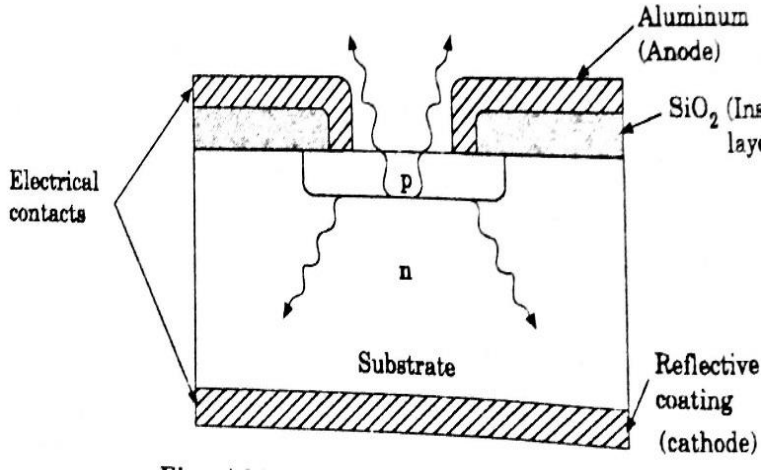

Fig 4.7.1 LED

A n-type layer is grown on a substrate and a p-type layer is deposited on it by diffusion. Since carrier recombination takes place in the p-layer , it is deposited on the top.

For maximum light emission, a metal film anode is deposited at the outer edges of the p-type layer. The bottom of the substrate is coated with a metal (gold) film. It reflects most of the light to the surface of the device and also provides cathode connection. Figure shows circuit and symbol of LED.

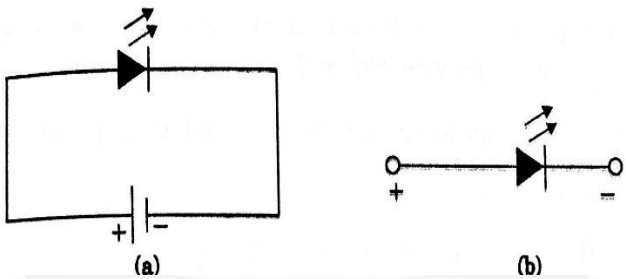

Fig 4.7.2 Symbol

4.7.3Working

When the p-n junction diode is forward biased, the barrier width is reduced, raising the potential energy on the n-side and lowering that of the p-side.

The free electrons and holes have sufficient energy to move into the junction region. If a free electron meets a hole, it recombines with each other resulting in the release of a light photon.

Thus, light radiation from LED is caused by the recombination of holes and electrons that are injected into the junction by a forward bias voltage (Fig.).

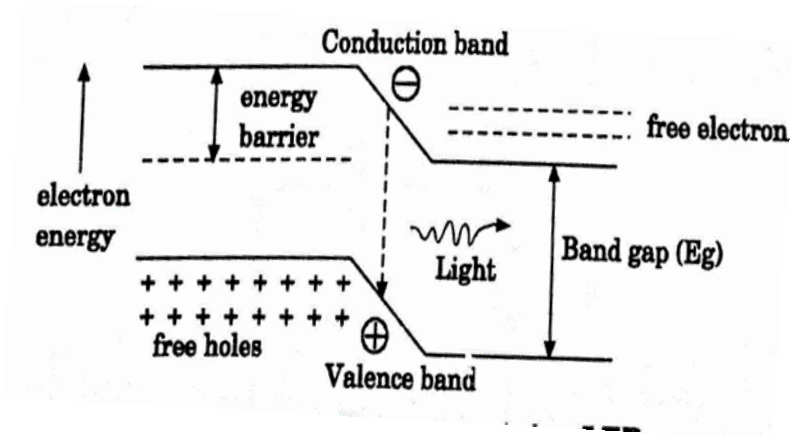

Fig 4.7.2.Energy band

4.7.4Advantages of LED Lights

- Long life. The components of an **LED** and the way that they generate light significantly extend the lifespan of these bulbs. ...
- Energy efficiency. ...
- High brightness and intensity. ...
- Exceptional color range. ...
- Low radiated heat. ...
- Reliability. ...

4.8.ORGANIC LIGHT EMITTING DIODE

4.8.1Construction

Organic light emitting diodes (OLEDs) are solid state devices made up of thin films or organic molecules that produce light with the application of electricity.

The organic light emitting diode (OLED) is also called light emitting polymer (LEP) or Organic Electro Luminescence (OEL) and it consists of a film of organic compounds.

Specially fabricated diode which is made up of organic materials which emits light when it is forward biased.

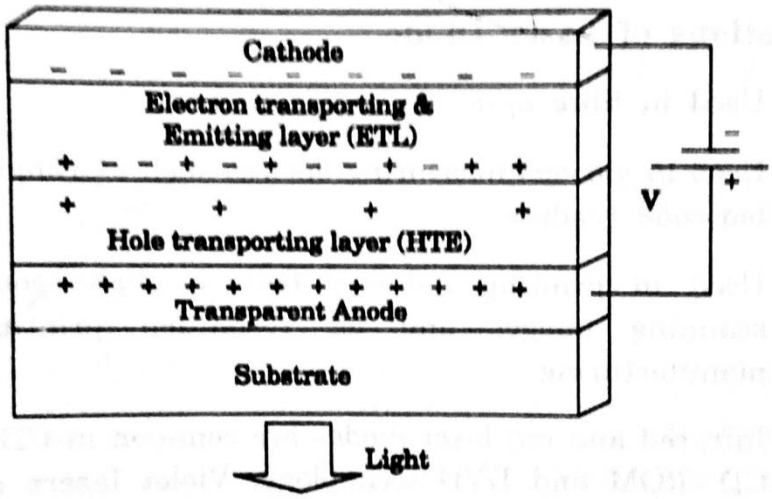

Fig 4.8.1.OLED

It consists of two layers. One is emissive layer and another one is conductive layer. Both are made of organic molecules. It has Metal cathode above emissive layer and anode below conductive layer

4.8.2.Working

An organic film is contacted by a metal electrodes on both sides. When a voltage is applied, positive charges (holes) are injected into the organic material (conducting layer) from one contact.

The negative charges (electrons) are injected from the other side into emissive layer.

When two different charge carriers meet, they recombine each other produce energy in the form of light photon

Types of OLEDs

(i) PLED

(ii) POLED

(iii) TOLED

(iv) SOLED

(v) IOLED

(i) PLED:Polymer Light Emitting Diodes (PLED) involve an electroluminescent conductive polymer that emits light when it is subjected to an electric current.

(ii) POLED

Patternable Organic Light Emitting Device (POLED) uses a light or heat activated electro active layer.

iii) TOLED

Transparent Organic Light Emitting Device (TOLED) uses a transparent contact to create displays.

iv) SOLED

Stacked OLED (SOLED) uses a novel pixel architecture that is based on stacking the red, green and blue sub pixels on top of one another.

(v) IOLED

Inverted OLED (IOLED) uses a bottom cathode that can be connected to the drain end of n-channel TFT.