3.2 Light Emitting Diodes (LEDs)

- LEDs are preferred for optical systems where bit rates are upto 1 to 200 Mb/sec.
- The radiation from LED is in wide angle and incoherent.

Principle of Operation

- For using LED as optical source in optical fiber communication system; it has following characteristics :
    1. High radiance output or brightness.
    2. Fast emission response time.
    3. High quantum efficiency.

Radiance

- Radiance is a measure of radiated optical power.
- High radiance will ensure better optical power coupling into a fiber.

Emission Response Time

- Emission response time is defined as the delay between application of current pulse and optical emission due to this.
- Fast emission response time will ensure high bit rate of system.

Quantum Efficiency

- The quantum efficiency is defined as the fraction of electron-hole pairs that recombine radiatively.
- High quantum efficiency is preferred.

LED Structures

- For providing high radiance and high quantum efficiency, LED uses carrier confinement and optical confinement

Carrier confinement

- Carrier confinement results in high quantum efficiency.
- Carrier confinement provides a high level of radiative recombination in active region of device

Optical confinement

- Optical confinement prevents the absorption of the emitted radiation by the material surrounding the p-n junction.

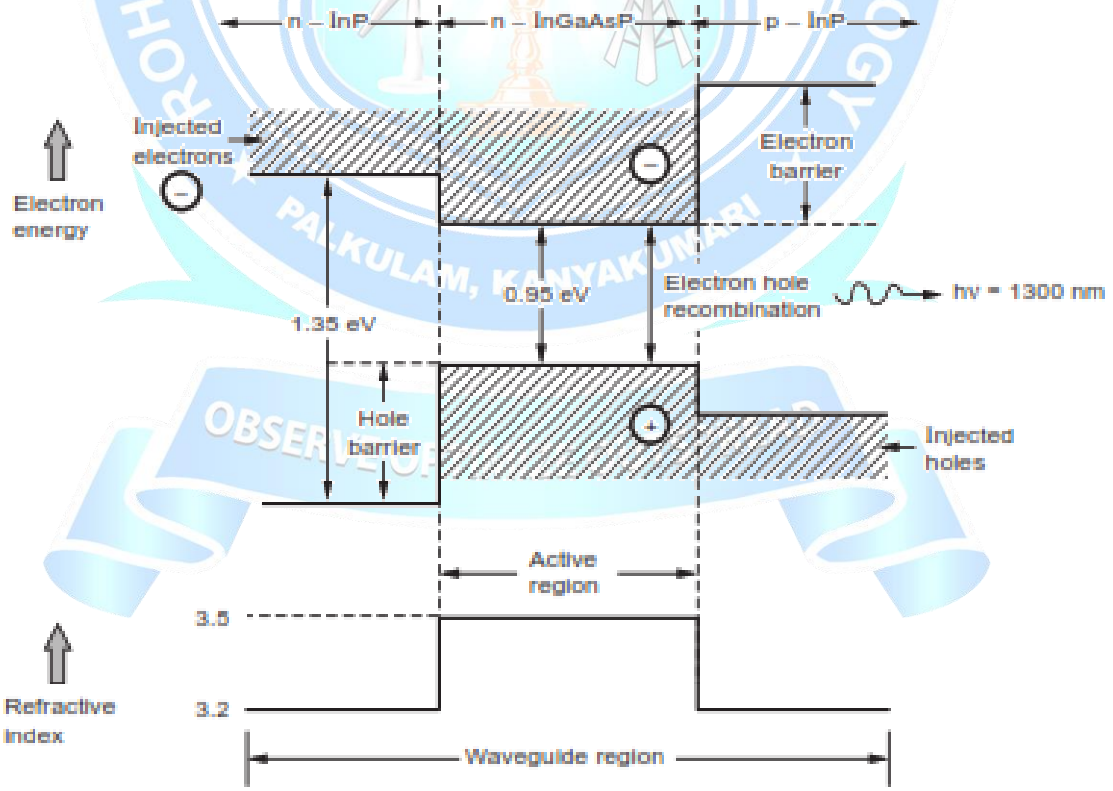
Heterojunctions

- A heterojunction is an interface between two adjoining single crystal semiconductors with different energy bandgaps.

- Heterojunctions are of two types, Isotype (n-n or p-p) or Antisotype (p-n)
- Heterojunctions are used for carrier and optical confinement.

Double Heterojunctions

- In order to achieve efficient confinement of emitted radiation double heterojunctions are used in LED structures. A heterojunction is a junction formed by dissimilar semiconductors.
- Double Heterojunction (DH) is formed by two different semiconductors on each side of active region. Figure shows Double Heterojunction (DH) light emitter.
- The crosshatched regions represent the energy levels of free charge. Recombination occurs only in active InGaAsP layer. The two materials have different bandgap energies and different refractive indices.
- The changes in bandgap energies create potential barrier for both holes and electrons. The free charges can recombine only in narrow, well defined active layer side.
- A Double Heterojunction (DH) structure will confine both holes and electrons to a narrow active layer. Under forward bias, there will be a large number of carriers injected into active region where they are efficiently confined



- Carrier recombination occurs in small active region so leading to an efficient device.

- Another advantage of DH structure is that the active region has a higher refractive index than the materials on either side, hence light emission occurs in an optical waveguide, which serves to narrow the output beam.

Advantages of DH

1. Reduced active region.
2. Large numbers of carriers are inejcted.
3. Carriers can efficiently confined.
4. Narrow output beam.