

CL43_Q1: Name the type of semiconducting material used in the fabrication of diode lasers and why such a material is chosen.

Ans:

Direct band gap semiconducting material such as GaAs, AlGaAs, InP etc are used in diode lasers. The basic principle involved in diode lasers is recombination of electron and holes in the depletion region resulting in the emission of a photon and this is possible only with direct band gap semiconducting material.

CL43_Q2. With suitable examples distinguish between direct and indirect band gap semiconductor

Ans:

Direct band gap semiconductor:

- i. In a direct band gap semiconductor the top of the valence band and the bottom of the conduction band occurs at the same value of momentum.
- ii. In a direct band-gap semiconductor, a direct recombination takes place with the release of the energy equal to the energy difference between the recombining particles.
- iii. Example: Gallium Arsenide (GaAs), InP, AlGaAs etc

Indirect band gap semiconductor:

- i. In a Indirect band gap semiconductor the maximum energy of the valence band occurs at a different value of momentum to the minimum in the conduction band energy;.
- ii. In an "indirect" gap, a photon cannot be emitted because the electron must pass through an intermediate state and transfer momentum to the crystal lattice.
- iii. Example: Silicon and Germanium

CL43_Q3. If the band gap of direct band gap semiconductor is 0.2 eV, estimate the wavelength of laser emitted from it. To which region of electromagnetic spectrum does it belong?

Ans:Solution: $E_g = 0.2 \text{ eV}$, $\lambda = ?$

$$E_g = h\nu = \frac{hc}{\lambda}$$

$$\lambda = h\nu = \frac{hc}{E_g}$$

$$\lambda = h\nu = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{3.2 \times 10^{-20}}$$

$$\lambda = 6.211 \times 10^{-6} \text{ m}$$

The emitted light belongs to the longer wavelength side of the visible part of the electromagnetic spectrum.