(MPM-202)
Optoelectronics and Optical Communication System

UNIT-II (Optical Sources and Detectors)

Lecture-2

by

Prof. D. K. Dwivedi

Physics and Material Science Department

Madan Mohan Malaviya University of Technology, Gorakhpur

SYLLABUS

MPC-202 OPTOELECTRONICS AND OPTICAL COMMUNICATION SYSTEM Credits 4 (3-1-0)

UNIT I: Optical process in semiconductors

Optoelectronic properties of semiconductor: effect of temperature and pressure on bandgap, carrier scattering phenomena, conductance processes in semiconductor, bulk and surface recombination phenomena, optical properties of semiconductor, EHP formation and recombination, absorption in semiconductors, effect of electric field on absorption.

UNIT II: Optical sources and detectors

An overview of optical sources (Semiconductor Laser and LEDs), Optical Detectors: Type of photo detectors, characteristics of photo detectors, noise in photo detectors, photo transistors and photo conductors.

UNIT III: Optical fiber

Structure of optical wave guide, light propagation in optical fiber, ray and wave theory, modes of optical fiber, step and graded index fibers, transmission characteristics of optical fibers, signal degradation in optical fibers; attenuation, dispersion and pulse broadening in different types of optical fibres.

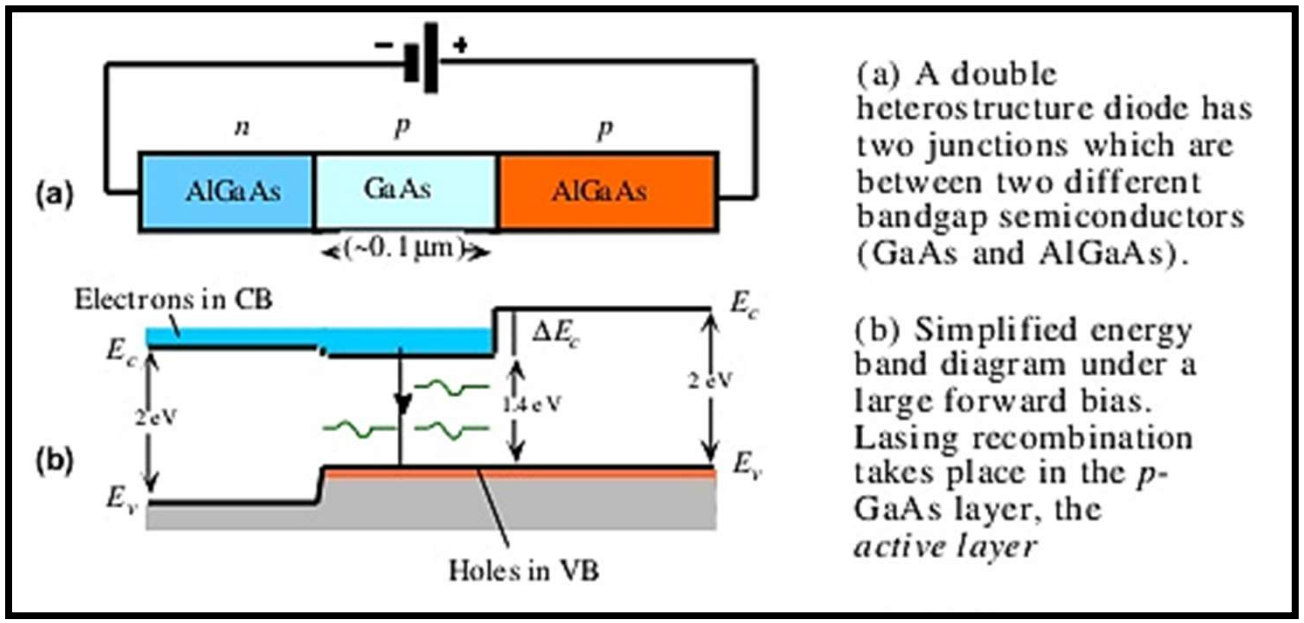
UNIT IV: Fiber components and optoelectronic modulation

Fiber components: Fibre alignments and joint loss, fiber splices, fiber connectors, optical fiber communication, components of an optical fiber communication system, modulation formats, digital and analog optical communication systems, analysis and performance of optical receivers, optoelectronic modulation.

Construction of Ga-As Laser

- The Gallium Arsenide laser is designed in such a way that **a piece of N-type gallium aluminium arsenide material is taken and a natural gallium arsenide material is pasted, the third layer of p-type gallium aluminium arsenide material is pasted over that.**

- The two ends of length wise are fully polished in order to amplify the light by cross reflection. Here one end is partially polished from where we get the laser beam.



(a) A double heterostructure diode has two junctions which are between two different bandgap semiconductors (GaAs and AlGaAs).

(b) Simplified energy band diagram under a large forward bias. Lasing recombination takes place in the *p*-GaAs layer, the *active layer*

Working of Ga-As Laser

- When **the forward biased is applied to the metallic layer** through contact points. The electric field is produced. This **electric field causes the electrons to move from lower band of energy towards high band of energy level.**

- Population inversion take place at the higher band of energy level and when the electrons fall back at the lower energy band, it emits light through the polished end of the laser.

- **Cross reflection** of the light take place which multiplies strength of laser beam. At the end **strong beam of laser comes out** through the partially polished end.

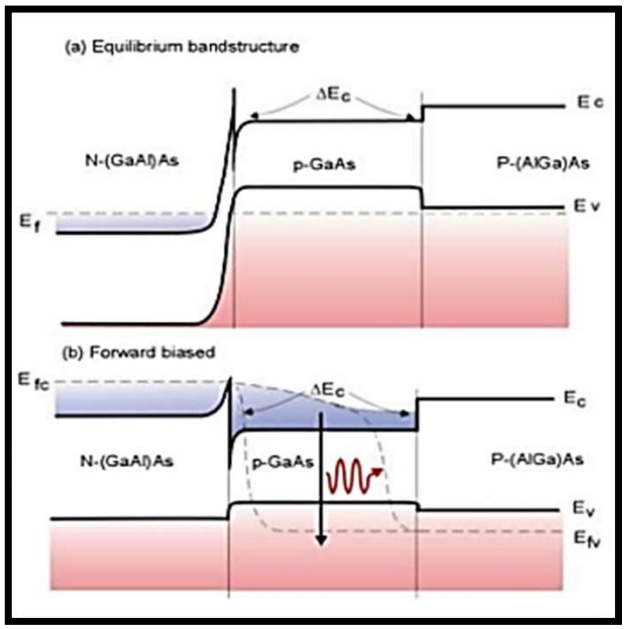
Population Inversion

- When p-n junction diode is forward biased, then there will be injection of electrons into the conduction band along n-side and production of more holes in valance band along p-side of the junction. Thus, there will be **more number of electrons in conduction band comparable to valance band, so population inversion is achieved.**

- Therefore, **when the electrons and holes are injected into the junction region from opposite sides with forward biasing,** then population inversion is achieved between levels near the bottom of the conduction band and empty levels near the top of the valance band.

Working of Ga-As Laser

- When electron recombines with hole the energy in form of photons is released only in some semiconductors like GaAs otherwise in Si and Ge indirect band gap semiconductors the energy is released in the form of heat. Thus, **Si and Ge can not be used for the production of laser.**



- The spontaneously emitted photon during recombination in the junction region of GaAs will **trigger laser action** near the junction diode. The photons emitted have a wavelength from 8200 Angstrom to 9000 Angstrom in the infrared region.

Advantages of Semiconductor

- ✓ It is very small in dimension.
- ✓ The arrangement is simple and compact
- ✓ It exhibits high efficiency

Disadvantages of Semiconductor Laser

- ✓ The output is usually in the form of wide beam.
- ✓ The purity & mono chromaticity are poorer than other type of laser.

Applications

- ✓ Semiconductor diode lasers are used in CD and DVD players.
- ✓ Fiber optic transreceivers are manufactured using alternating layers of various III-V and II-VI compound semiconductors to form lasing hetero structures.
- ✓ Used in laser printers and laser diodes.


THANK YOU