SNS COLLEGE OF ENGINEERING

Coimbatore-641 107

(An Autonomous Institution)

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Affiliated to Anna University, Chennai

DEPARTMENT OF PHYSICS

COURSE NAME :23PYT101 – ENGINEERING PHYSICS

I YEAR / I SEMESTER

UNIT 2 – LASER AND FIBER OPTICS

TOPIC 5 – SEMICONDUCTOR LASER AND IT'S APPLICATION

Introduction of Semi conductor laser

- **Semiconductor lasers** are solid-state lasers based on semiconductor gain media.
- A **semiconductor laser** (LD) is a device that causes **laser** oscillation by flowing an electric current to **semiconductor**.
- The mechanism of light emission is the same as a light-emitting diode (LED).
- When the two meet at the junction, an electron drops into a hole and light is emitted at the time.

Electroluminescence is the basic principle behind the operation of a semi conductor laser.

Semiconductor are classified in two types:

1. Direct band and 2. Indirect band

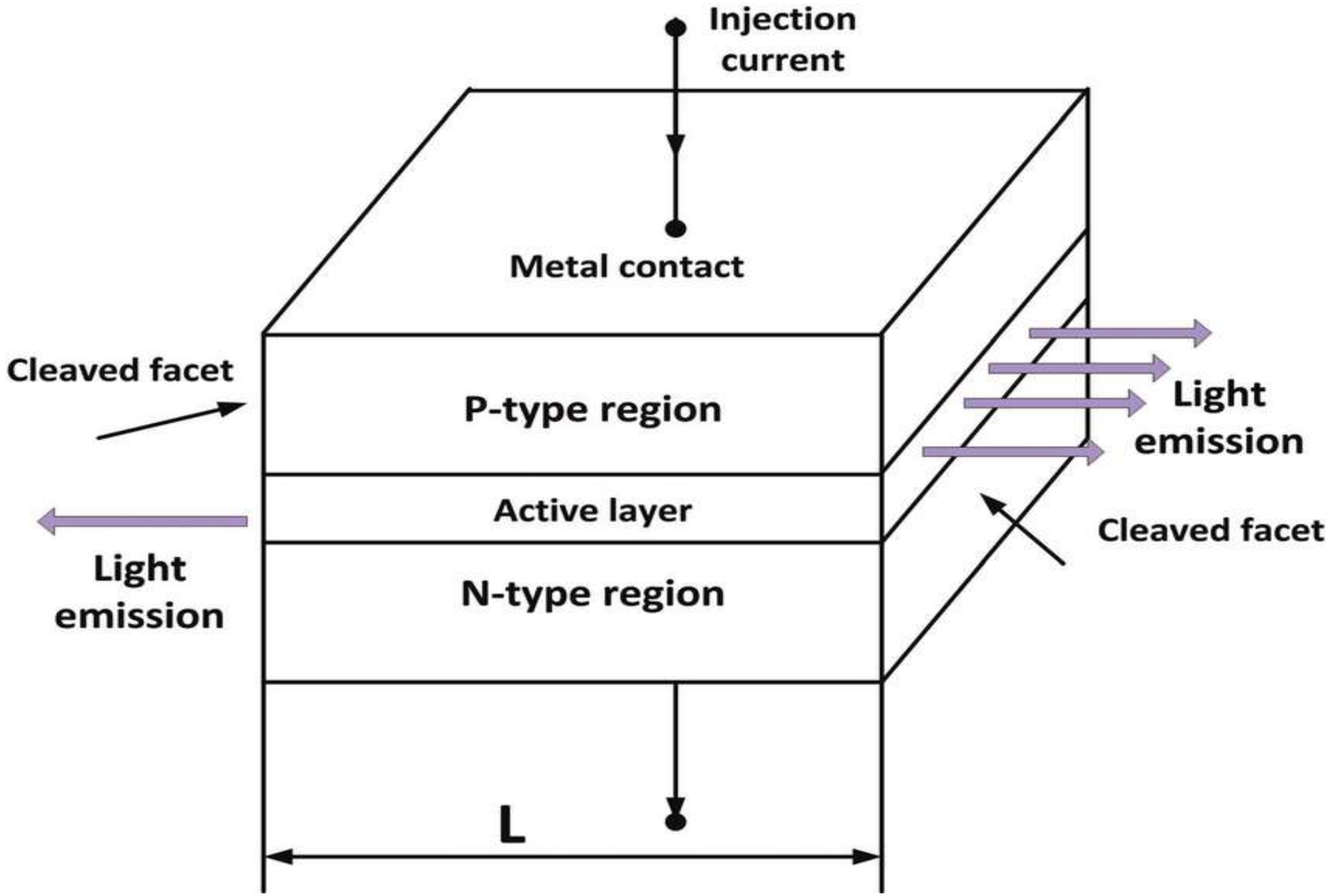
In direct band semiconductors the recombination's of an electron and a hole take place directly there by emitting photons. It’s used for laser action.

1. Homo junction laser 2. Hetero junction laser

Homo junction semi conductor laser

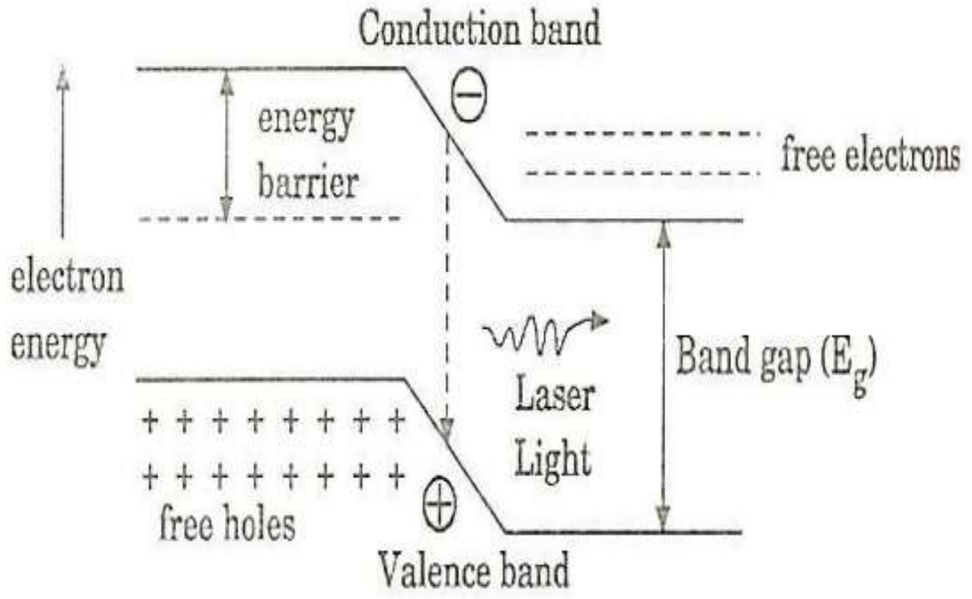
Construction:

- The active medium is a p-n junction made from GaAs.
- The p-region and n-region in the diode are obtained by doping germanium (Ge) and tellurium (Te) respectively in GaAs.
- The thickness of the p-n junction layer is made very thin, typically of the order of few microns and the end faces of the crystal are made partially reflecting to form an optical resonator.
- Electric current is applied to the crystal through metal electrodes fixed on its upper and lower surface.


Injection current
Metal contact
Cleaved facet
P-type region
Light emission
Active layer
Cleaved facet
Light emission
N-type region
L

Energy level diagram

- The population inversion is achieved by injecting e^- s across the junction from the n-region to the p-region by the mean of a forward biasing voltage applied across it.
- The recombination of e^- s and holes in the region result in the emission of photons.
- The process is spontaneous and the laser radiation is random and incoherent.



- But these photons triggers the stimulated emission of photons to get generated by increasing the rate of recombination of e^- s and holes.
- The current density is increased the emission becomes more and more coherent and the radiation intensity increase.
- The wavelength of the emitted light radiation depends upon the concentration of donor and acceptor atoms in GaAs and also on the energy gap of the particular semiconductor.

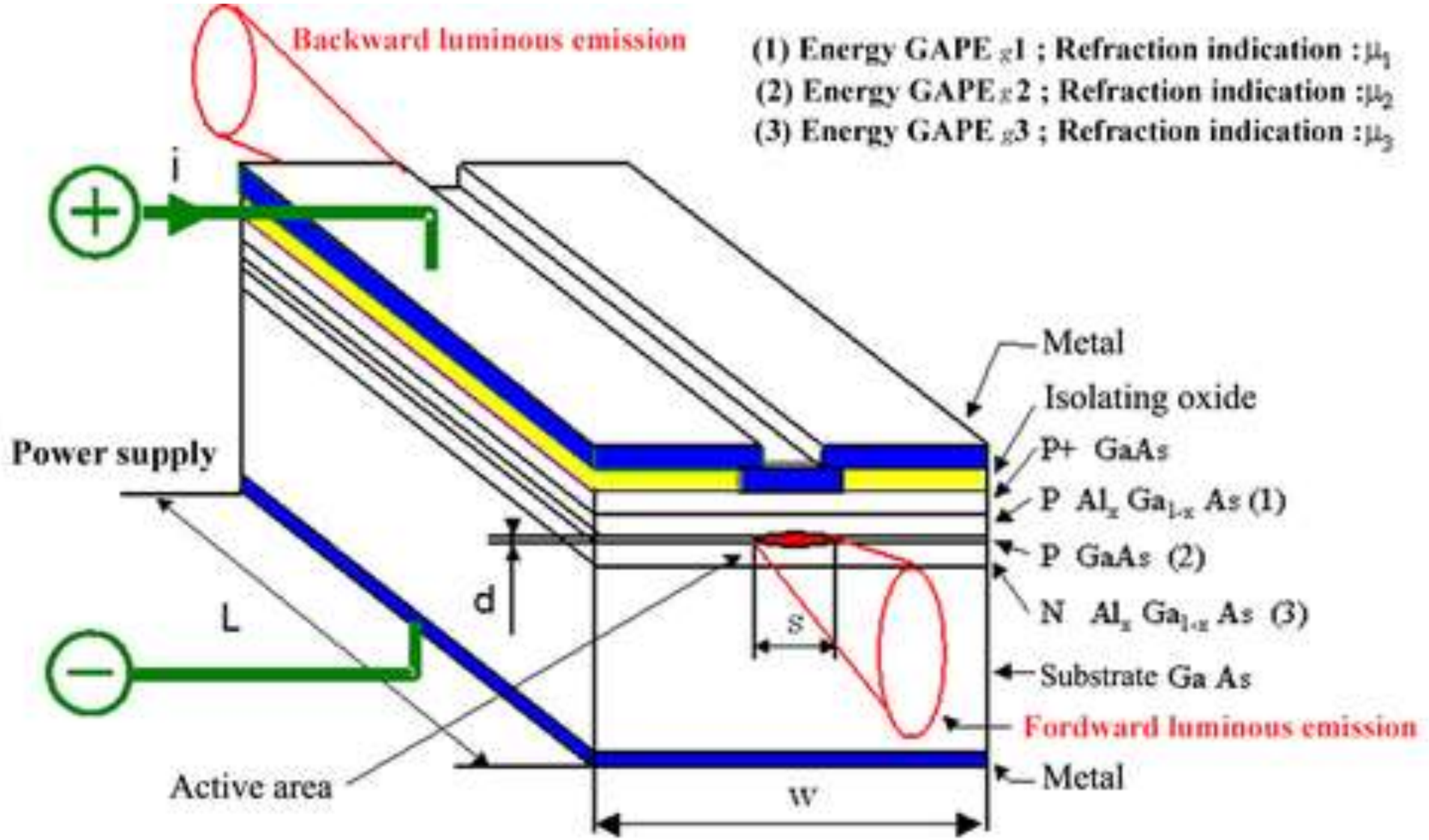
Assignment

1.What is the principle of semiconductor laser?

2. Distinguish between homojunction and heterojunction?

3. Why gallium arsenide is used for semiconductor laser?

Homo junction semi conductor laser



- Hetero junction laser have high efficiency even at room temperature.
- It is composed of various doping combinations of GaAs and AlGaAs.
- The p-layer of GaAs has an active region that is only 0.1-0.2 μm thick.
- AlGaAs layer on both side serve as potential barriers and provide confinement for charge carriers to flow with in the active region.
- The excitation and recombination radiation can occur only with in the active region.
- Due to multilayer in the laser structure carriers are confined to a narrow region, the population is built up at lower current level.

- The operating current level is less than 50mA and the output power is 10mW.
- The light emitting at wavelength in the active region 1.1 to 1.6 μm is desirable.

Characteristics:

1. Type: It is a solid state semiconductor laser.
2. Active centre: p-n junction diode made from a single crystal of GaAS.
3. Pumping method: Direct conversion method.
4. Power output: 10mW.
5. Nature of the output: Continuous (or) pulsed
6. Wavelength: 8300 to 8500 A^0

Advantages of semiconductor laser

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.

APPLICATION OF LASER

References

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