

Article Overview

A heterojunction laser diode is a semiconductor laser that uses layers of different materials to confine both electrons and light, enabling efficient lasing at room temperature.

Principle

A heterojunction laser diode is based on a PN junction formed from two different semiconductor materials with distinct bandgap energies and refractive indices . When forward biased, electrons from the n-type region and holes from the p-type region recombine in the active layer, releasing photons. The heterojunction enhances carrier confinement and optical confinement, which increases the efficiency of stimulated emission and allows lasing at lower threshold currents .

Construction

The typical structure consists of five layers:

- o Active layer: A narrow bandgap material such as GaAs, where light generation occurs.
- o Cladding layers: Wider bandgap materials like AlGaAs on either side of the active layer, which confine carriers and light.
- o Substrate and contact layers: Provide mechanical support and electrical connections . The polished and parallel end faces of the active region act as an optical resonator, reflecting photons back and forth to stimulate coherent light emission .

Working Mechanism

- o Forward biasing injects electrons and holes into the active region.
- o Population inversion is achieved as the carrier density in the conduction and valence bands increases.
- o Spontaneous emission occurs initially, followed by stimulated emission, where photons trigger further recombination in phase, producing coherent light.
- o Optical confinement due to the refractive index difference between the active and cladding layers guides the light along the junction . Double-heterojunction designs further improve confinement, allowing continuous-wave operation at room temperature and reducing the threshold current significantly .

Advantages

- o Lower threshold current due to better carrier and optical confinement.
- o Room temperature operation, unlike early homojunction lasers.
- o High efficiency and stable output suitable for optical communication systems.
- o Wavelength control through material selection and quantum well engineering .

Applications

Heterojunction laser diodes are widely used in:

- o Fiber optic communications
 - o CD/DVD/Blu-ray players
 - o Laser pointers and barcode scanners
 - o Optical sensors and medical devices
- The heterojunction concept is fundamental to modern semiconductor lasers, forming the basis of the double-heterostructure and quantum well lasers that dominate the industry today .

In this chapter, the realisation of semiconductor lasers which operate continuously at room temperature with reasonably

Abstract The basic optical, electrical, and mechanical characteristics and the working principles of laser diodes are summarized.

Preview text heterostructure laser diode is a type of semiconductor laser where the active region is sandwiched between two layers

Lecture 21 - Laser Diodes - 2 - Outline In-plane laser diodes, cont. (continuing from Lect. 20) Cavity design (in-plane geometries)

A single heterojunction between two materials improves the confinement of light and electrons enough for

By convention, when the distributed reflectors are within the active laser cavity the laser is called a DFB laser and when they are

How diode lasers make light In a laser diode, we take things a stage further to make the emerging light more pure and

The photons can go wherever they like in lateral directions; and this will simply not be good enough for laser diodes. Essentially, we

9.4.2 Homostructure Lasers The first semiconductor lasers consisted of two layers made from the same compound, generally gallium

In this chapter, both the basic and the advanced heterojunction laser structures are discussed. The relationships

Heterojunction laser diode

between geometric

When a PN junction diode is forward biased, the electrons from the n region and holes from

Laser light can also be produced in semiconductors. The most compact of all lasers is semiconductor diode laser. It is also called

Schematic illustration of the the structure of a double heterojunction stripe contact laser diode 1999 S.O. Kasap, Optoelectronics

Semiconductor diode lasers used in CD and DVD players and fiber optic transceivers are manufactured using alternating layers of

Multiple layers have to be built-up in the laser structure to develop more efficient lasers operating at room

The Large Optical Cavity (AlGa) As-GaAs heterojunction laser diode was recently described with the unique feature that the p-type

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