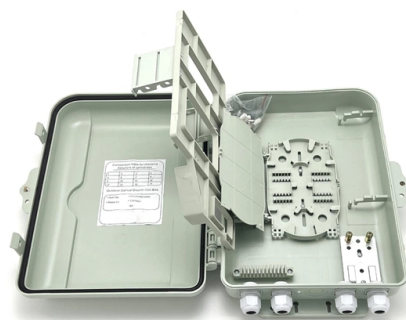


Light emission of laser diodes



Overview

Adjusting the depth and width of quantum wells to select the wavelength of emission is one form of band-gap engineering.

Key Takeaways

A laser diode emits coherent, monochromatic, and highly focused light through stimulated emission at a semiconductor p-n junction. Working Principle

A laser diode is a semiconductor device similar to a light-emitting diode (LED), but it produces coherent light using a process called stimulated emission of radiation (LASER: Light Amplification by Stimulated Emission of Radiation). When an electric current passes through the p-n junction, electrons from the n-type region recombine with holes in the p-type region. This recombination releases energy in the form of photons, which are identical in frequency, phase, and direction, resulting in a highly focused and intense beam.

Optical Cavity and Light Amplification

The laser diode contains an optical cavity formed by reflective layers at the ends of the semiconductor structure. One end is fully reflective, and the other is partially reflective, allowing light to exit as a laser beam. Photons emitted in the cavity stimulate further photon emission from excited electrons, amplifying the light and producing a coherent, narrow-band output. Some laser diodes use heterostructures or quantum wells to confine electrons and photons in a thin active region, improving efficiency and optical gain.

Characteristics of Emitted Light

- Coherent: All photons have the same phase and frequency, enabling precise focusing.
- Monochromatic: Light is of a single wavelength, which is determined by the semiconductor material and junction design.
- Directional: The beam is narrow and well-collimated, suitable for optical communication and precision applications.
- Efficient: Laser diodes convert electrical energy into light with high efficiency, often exceeding 50% under ideal conditions .

Applications

Due to their compact size, efficiency, and precise light emission, laser diodes are widely used in fiber-optic communications, barcode scanners, laser printers, medical instruments, LIDAR systems, and optical storage devices . In summary, the emission of light by a laser diode is a result of stimulated emission in a semiconductor p-n junction, enhanced by an optical cavity, producing a coherent, monochromatic, and highly directional laser beam suitable for a wide range of technological applications.

Article Content

Laser Diode

A laser diode emits monochromatic light, meaning it produces light of a single wavelength or color. This wavelength

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Adjusting the depth and width of quantum wells to select the wavelength of emission is one form of band-gap engineering. The

Laser Diode Characteristics, Precautions for Use and Drive Circuit ...

Laser diodes (LD) are semiconductor devices that convert electrical energy into high-power optical energy. These

Laser Diodes – semiconductor, gain, index guiding, high power

This comprehensive introduction explains laser diodes — electrically pumped semiconductor lasers where optical gain is obtained in

Laser Diode Fundamentals: Bandgap Energy and Wavelength

After you have a working knowledge of three basic principles and how they determine the laser's emission wavelength, we can then

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