What are the methods for fabricating diode lasers



Overview

How to Manufacture a Laser Diode. Manufacturing a laser diode combines advanced semiconductor processing and precision optics.

Key Takeaways

Diode lasers are fabricated through a multi-step process involving epitaxial growth, photolithography, etching, metallization, facet formation, and packaging to create efficient semiconductor light sources. 1.

Substrate and Epitaxial Growth

The fabrication begins with a high-quality semiconductor substrate, typically n-type GaAs for visible and near-infrared lasers or InP for longer wavelengths. On this substrate, epitaxial layers are grown using techniques like MOCVD (Metal-Organic Chemical Vapor Deposition) or MBE (Molecular Beam Epitaxy). These layers include the n-cladding, active layer (quantum well or multiple quantum wells), and p-cladding, forming the optical gain medium of the laser diode.

2.

Photolithography and Mesa Formation

Photolithography is used to define the mesa or ridge structures that confine current and optical modes. A photoresist is applied, exposed to a patterned mask, and developed to create the desired geometry. Etching techniques, such as wet chemical etching or chemically assisted ion beam etching (CAIBE), remove material selectively to form the ridge or mesa, which guides the laser mode and improves efficiency.

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3.

Dielectric Deposition and Metallization

After mesa formation, a dielectric layer is deposited to provide insulation and protect the sidewalls. Metallization follows, forming p-type and n-type contacts for electrical injection. These contacts are typically made of metals like Ti/Pt/Au for p-contacts and AuGe/Ni/Au for n-contacts, ensuring low-resistance electrical conduction.

4.

Facet Formation

The laser cavity facets are critical for optical feedback. Traditionally, facets were created by mechanical cleaving, but modern processes often use etched-facet technology (EFT) with photolithography and CAIBE to precisely define the mirrors. This allows on-wafer testing and higher yield, avoiding fragile cleaved bars.

5.

Singulation and Packaging

After wafer-level processing, individual laser diodes are singulated using scribing and breaking along lithographically defined lines. The chips are then bonded to heat sinks and packaged to ensure thermal stability and mechanical protection. Packaging may include fiber coupling for single-mode lasers or TO-can modules for general applications.

6.

Advanced Structures

Modern diode lasers often use ridge waveguide, buried heterostructure, or GRINSCH (graded-index separate confinement heterostructure) designs to improve efficiency, reduce threshold current, and control beam quality. Quantum well structures in the active region enhance optical gain and allow precise wavelength control.

Summary

The diode laser fabrication process integrates semiconductor epitaxy, microfabrication, and precision packaging to produce reliable, high-performance lasers. Key steps include epitaxial growth, photolithography, etching, metallization, facet formation, and thermal management, with modern techniques enabling wafer-level testing and integration with photonic circuits.

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Article Content

The Complete Guide to Diode Lasers

How to Manufacture a Laser Diode. Manufacturing a laser diode combines advanced semiconductor processing and precision optics. The main stages are: Using TCAD software,

Laser Diode Tutorial

The information contained within this tutorial will give all the general information necessary to create an excellent laser diode system. For specific questions about laser diodes, mounts, and drivers please

Laser-Fabricated Micro/Nanostructures: Mechanisms, Fabrication

Following this, we systematically review various micro/nanostructures fabricated by laser techniques, such as laser ablation, laser-induced periodic surface structures (LIPSS), and two

Laser diode fabrication | PPTX

It then outlines the key steps in the fabrication process, which includes epitaxial growth on a GaAs wafer, photolithography to pattern mesas, mask etching, dielectric deposition, metallization for

LASER DIODE MODULE MANUFACTURING

In this article we consider two important aspects of laser diode module assembly: efficient light coupling to an optical fiber and bonding the parts of a laser diode module.

GaAs nano-ridge laser diodes fully fabricated in a 300-mm CMOS

This work demonstrates monolithic III–V laser diode integration on 300-mm Si wafers entirely carried out in a CMOS manufacturing pilot line, without the need for any III–V substrates or ...

Semiconductor laser diode and its fabrication process

The present invention relates to a semiconductor laser diode and a fabrication process for that semiconductor laser diode, and relates in particular to technology effective in production technology

LASER-DIODE FABRICATION: Alignment and etching

Engineers at BinOptics and ASML and have collaboratively addressed these issues by adapting semiconductor manufacturing processes of stepper

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GaAs nano-ridge laser diodes fully fabricated in a 300-mm CMOS pilot ...

Here we report the electrically driven gallium arsenide (GaAs)-based laser diodes fully fabricated on 300-mm Si wafers in a CMOS pilot manufacturing line based on a new integration

LASER diode fabrication @ SSPL,DRDO | PPT

This document discusses the fabrication process of laser diodes. It begins with an overview of laser diodes and their basic working principle of stimulated emission.

Nitride semiconductor laser device and fabricating method thereof ...

Abstract: A method for fabricating a nitride semiconductor laser device including a step to expose surfaces of an n-type nitride semiconductor layer (102) and a p-type nitride semiconductor layer

Laser Engraving Settings for Wood (Beginner''s Cheat

Starter power, speed, and DPI settings for 11 popular wood species on diode and CO2 lasers. Plus how to run your own test grid for perfect results.

Planar optical waveguide array module and method of fabricating the ...

In the configuration, such optical parts as optical elements 101 and 103 (for example, a laser diode and a photodiode) and a filter 102 can be integrated on a platform substrate 100. Therefore, the number of

Diode lasers: From laboratory to industry

In this paper the diode laser based technologies and measurement techniques ranging from laboratory research to automated field and industry have been reviewed. The application

Laser diode

The laser diode chip removed and placed on the eye of a needle for scale A laser diode with the case cut away. The laser diode chip is the small black chip at the front; a photodiode at the back is used to

Laser Diode Technology 101: What is it & How it Works

Laser Diode Technology 101: What is it & How it Works Learn about laser diode technology, including history, construction, & applications - everything you need to know about them from the basics to

How semiconductor laser diodes work

A simple overview of how semiconductor diodes work like a cross between ordinary (gas) lasers and LEDs.

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This document summarizes the fabrication process of semiconductor laser diodes at the Solid State Physics Laboratory (DRDO). It first introduces lasers and semiconductor lasers. It then outlines the

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