The laser diode beam is no longer round

Overview

Examples of laser sources which emit elliptical beams (Fig. 1) are laser diodes and tapered amplifiers. In both cases, the beam shape is due to the flat structures of their active semiconductor layers.

Key Takeaways

Laser diode beams are typically elliptical and astigmatic due to the rectangular geometry of the active layer and the ridge waveguide structure.

Beam Shape and Geometry

Laser diodes emit light from a very thin PN-junction, often only about 1 micron thick, which is the active region where light is generated. The diode's ridge waveguide confines the light, but because the waveguide is much wider in one direction than the other, the emitted beam is asymmetric, resulting in an elliptical cross-section rather than a circular one. The fast axis (narrow dimension) diverges more rapidly than the slow axis (wide dimension), producing a beam with different divergence angles in vertical and horizontal directions.

Divergence and Astigmatism

The beam divergence is also unequal along the two axes. Typical divergence ratios range from 2: 1 to 4: 1, with the fast axis diverging more strongly. This astigmatism is inherent to the diode's structure and is a key reason why the beam is not round.

Multi-mode diodes or diode bars can further complicate the beam profile, creating hot spots and uneven intensity distributions.

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Optical Solutions

To achieve a more circular beam, several optical techniques are used: Cylindrical lenses: Reduce divergence along the fast axis while leaving the slow axis unaffected, partially circularizing the beam. Aspherical lenses: Can help collimate the beam more uniformly. Fiber coupling: For single-mode diodes, coupling into an optical fiber acts as a spatial filter, producing a nearly perfect TEM00 circular beam.

For multi-mode diodes, the fiber homogenizes the beam, reducing hot and dark spots. Microlens arrays: Often used for multi-emitter diodes to shape and homogenize the output.

Summary

The non-round emission of laser diodes is intrinsic to their design, caused by the rectangular active region and ridge waveguide, leading to elliptical, astigmatic, and highly divergent beams. While this is acceptable for some applications, optical elements like cylindrical lenses, aspherical lenses, or fiber coupling are commonly used to circularize and improve beam quality for precision applications.

Article Content

Anamorphic Shaping of Laser Beams

Examples of laser sources which emit elliptical beams (Fig. 1) are laser diodes and tapered amplifiers. In both cases, the beam shape is due to the flat structures of their active semiconductor layers.

Beam not circular? : r/lasercutting

Something fishy is going on inside the laser cavity... the possible causes are many, but it''s usually temperature or internal alignment related in these lasers, or it can also happen due to debris in the

46 Laser Diode Beam Converter

This lesson will show how to design the optics to convert a beam from a laser diode into a circular collimated beam. We start with the specs for a typical laser diode, which has a different divergence in

Laser calibration. Beam not round. : r/ChineseLaserCutters

I just got an Omtech 80w and am calibrating the beam alignment. As I''m doing this I notice that the beam isn''t producing round holes in my tape but rather two half moon shapes.

Laser Beam Shaping Overview

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Because laser diodes diverge in an asymmetrical pattern, a spherical optic cannot be used to produce a circular collimated beam from a diode. The lens acts on both axes at the same time, which maintains

Techniques for Beam Circularization

The document discusses three methods for circularizing elliptical laser diode beams: 1) A cylindrical lens pair expands the narrow dimension of the beam to create a more circular profile.

Chapter 2 Laser Diode Beam Basics

aser diodes are most widely used. Their beams are ellip-tical, asti matic, and have large divergence. These characteristics make lase diode beams difficult to handle. In this chapter we discuss in detail

Fundamentals of Lasers

Beam divergence is defined by the full angle. In laser diodes, beam divergence is specified with two values because of the presence of astigmatism (see Diodes vs. HeNe). In this case the orientation of

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

Although laser light is often thought of as a straight, parallel beam, the light emitted from a laser diode actually diverges to some extent as it diffracts. The light beam at some distance from

Longer Ray5 5W Laser Settings — 2026

The Longer Ray5 is a 5W diode laser engraver and works with LightBurn,LaserGRBL. This page lists 47 community-tested settings covering speed, power, passes, air assist, and DPI across a range of

Power Over Fiber – optical delivery of power, photonic power, optical ...

Power Efficiency of Power over Fiber The following sources of power losses need to be considered: Efficient laser diodes typically have efficiencies around 50% to 60% including fiber coupling.

Propelling the PCSEL into the deep-UV

Figure 5. Angleresolved photoluminescence setup used for deep-UV PCSEL characterisation, with illustrations of the 266 nm pump beam and the PCSEL emission. By going

xTool F2 Review: The Fastest Portable Dual Laser Built

The xTool F2 is the portable laser engraver most small-business owners have been waiting for. xTool took everything that made the F1 a crowd

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5 Best Laser Cutters & Engravers in July 2026

Diode lasers contain a small compound semiconductor material within them, and work by applying electricity to that compound to produce the

Laser Machine Ortur Laser Master 3 Diode Laser

Diode Laser Ortur Laser Master 3 is a high-precision laser machine that allows engraving on wood, metal, and acrylic in colors. Shop 10w, 20w or 40w laser

International Online Shopping Store for Premium

Shop for electronics, apparel, mobile phones, beauty products & more online from the overseas market at low prices in Philippines. Experience the best online

Collimated beam

In the lower picture, the light has been collimated. A collimated beam of light or other electromagnetic radiation has parallel rays, and therefore will spread minimally as it propagates. A laser beam is an

5 Best Fiber Laser Engravers and Cutters for Precision Work

Discover the best fiber laser engravers and cutters for fast, high-precision work on metal, plastics, coated materials, and more.

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