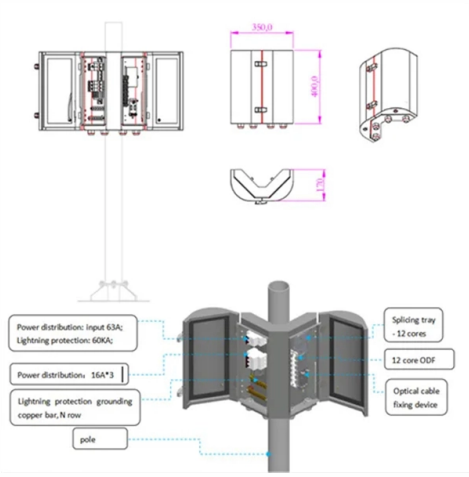
Reasons for High-Temperature Deformation of Laser Diodes



Article Overview

High-power laser diodes typically experience catastrophic optical damage and structural deformation at local temperatures ranging from 120°C to 200°C, depending on material and device design.

Thermal Limits and Deformation Mechanisms

High-power laser diodes under continuous wave (CW) operation generate extremely high internal power densities, with over 25% of the electrical power converted into heat rather than light, leading to localized hot spots in the active region of the device . These hot spots can induce thermal stresses that exceed the yield strength of the semiconductor layers, causing plastic deformation and ultimately catastrophic optical damage (COD), . COD is characterized by the formation of defects such as dark line defects (DLDs) and facet degradation, which can destroy the laser's active region .

Critical Temperature Range

Experimental studies have shown that the onset of COD and high-temperature deformation occurs when local temperatures reach approximately 120°C to 200°C . It is important to note that these temperatures are measured over larger experimental probes, while the actual local temperatures in the active layers can be significantly higher due to nanoscale heat accumulation . The precise deformation temperature depends on factors such as the laser diode material (e.g., GaAs/AlGaAs or GaN-based), layer composition, and thermal conductivity of the active region ....

Article Content

Jan 10, 2026

Thermal and mechanical issues of high power laser diode

J. Souto, J.L. Pura and J. Jimenez: About the physical meaning of the critical temperature for catastrophic optical damage in high

May 24, 2026

A temperature effect study on the laser diode module spectral ...

Abstract The paper presents the study results of the semiconductor laser active medium temperature effect, that

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Catastrophic Optical Damage in Semiconductor Lasers: Physics and

Catastrophic optical damage (COD) is one of these mecha-nisms. It occurs particularly in high-power operation of diode M. Hempel,

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Laser diode optical output dependence on junction temperature for high ...

Abstract Laser diode optical output is studied and modeled. Four major diode parameters (threshold current, slope

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Thermal and mechanical issues of high-power laser diode degradation

As a result, dislocations and threads of dislocations grow across the active layers and lead to rapidly growing temperatures in the

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A thermomechanical model for the mechanism of rapid degradation of AlGaAs based high power laser bars (808 nm) is presented.

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The study of temperature-dependent degradation of optical output on

The degradation mechanism of 808nm GaAs-based high-power laser diode bars (LDBs) with 6 single laser diodes was investigated

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The Impact of Temperature on the Performance of Semiconductor Laser Diode

Adjusting temperature synthesis plays a major role in laser applications. Laser work at relatively high temperatures has a major

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Chapter 14 DEGRADATION AND RELIABILITY

at high power densities; and (iii) degradation of current-confining junctions. It is important to mention at the outset that although

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Catastrophic optical damage of high power InGaAs/AlGaAs laser diodes ...

The defects generated by the catastrophic optical degradation (COD) of high power laser diodes have been examined

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Thermal Stress in High Power Semiconductor Lasers

Thermal stress is one of the most critical problems in packaging of high-power diode lasers. In this chapter, effects of

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Why Laser Diodes Shift Wavelength with Temperature

To understand why temperature moves the wavelength of a laser diode, you need to look at two things: the

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Temperature effect on laser diodes and its influence on the aging processes of the laser diode. The method of burn-in is described as

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High-Temperature Deformation of Laser Diodes

High power laser diodes under continuous wave (cw) operation are devices with extremely elevated internal power densities within

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Strain and temperature distribution in broad-area high-power laser ...

High-power laser diodes, with a wavelength of 808 nm and an optical output power >1 W per facet, are important as

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Catastrophic Optical Damage in Semiconductor Lasers:

Catastrophic optical damage (COD) is an optical output-limiting destructive mechanism in

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Defect signatures in degraded high power laser diodes

Degradation of high power laser diodes is related to defect formation in the active parts of the laser. Extended defects

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Thermal and mechanical issues of high power laser diode

Introduction High power laser diodes under continuous wave (cw) operation are devices with extremely elevated internal power

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Thermal and mechanical issues of high-power laser diode degradation

We present herein an overview of the cathodoluminescence analysis of catastrophically degraded high power laser

May 08, 2026

Processes of the Reliability and Degradation Mechanism of High

High-power semiconductor lasers have attracted widespread attention because of their small size, easy modulation,

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About the influence of temperature operation and packaging stress on ...

Abstract Catastrophic optical damage (COD) is a degradation mode of laser diodes. COD is associated with a

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Identification of Degradation Mechanisms Based on Thermal ...

Abstract and Figures A method of identifying laser degradation mechanism is established based on thermal

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Thermal and mechanical issues of high-power laser diode degradation

The optical-strength properties of 3S PHOTONICS GaAs-based semiconductor laser structures are presented.After

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Thermal Regime of High-power Laser Diodes

Thermal fields in high-power laser diodes were calculated in 3 D thermal model at CW operation for some heatsink

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One of the reasons is the added bonding mechanical stress to the laser diode, other reason is the effect of package materials on an

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The Impact of Temperature on the Performance of Semiconductor Laser Diode

Abstract and Figures The features of a semiconductor laser diode (LD) are extremely dependent on the temperature of

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Thermomechanical issues of high power laser diode ...

Abstract and Figures Catastrophic optical degradation (COD) of high power laser diodes is a crucial factor limiting

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Transient temperature effects on the optical power wavelength shift of ...

Abstract The effect of junction temperature change on the wavelength shift and optical power output of high-power

Oct 24, 2025

Thermal and mechanical issues of high power laser diode

A very high percentage of that power is effectively converted into light, but over 25% is transformed into heat. Therefore, heat

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Effects of temperature on laser diode ignition

Among these issues, the effects of temperature on laser diode ignition should be paid much attention mostly because

Aug 04, 2025

About the influence of temperature operation and packaging stress on ...

COD is associated with a localized overheating of the active region of the laser. The COD power threshold decreases

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Laser diode degradation: mechanisms and defects

Thermal strain, laser radiation self- absorption, local collapse of the thermal conductivity, and thermal lensing are the mechanisms

Mar 04, 2026

Transient temperature effects on the optical power wavelength shift of ...

Future research will build off this and focus on the temperature dependent aspects of individual components (laser

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Laser Diode Thermal Management: Why Heat Control Matters for ...

Discover how laser diode thermal management influences output stability, degradation, and long-term reliability. Learn

Mar 28, 2026

Thermal and mechanical issues of high-power laser diode degradation

About the physical meaning of the critical temperature for catastrophic optical damage in high power quantum well laser diodes.

Jun 24, 2026

Thermomechanical Issues of High Power Laser Diode Catastrophic

This work also inspected the effect that the inhomogeneous temperature distributions would play in determining the lateral mode

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