

Article Overview

Laser diode lifespan is evaluated through burn-in, accelerated aging, and continuous monitoring of performance parameters to predict long-term reliability.

Overview of Lifespan Testing

Laser diodes are highly reliable devices, often capable of tens of thousands of operational hours, but their longevity depends on careful testing and operating conditions . Lifespan testing serves two main purposes: identifying defective devices early and predicting long-term performance under normal operating conditions.

Burn-In Testing

Burn-in is a process applied to all manufactured laser diodes to remove devices prone to early failure, often called "infant mortality" . During burn-in, diodes are operated at elevated temperatures or currents for several hours while monitoring key parameters such as threshold current, optical output power, and forward voltage. This process stabilizes performance and reduces parameter drift during later use .

Accelerated Life Testing

Life testing involves accelerated aging of a sample group under controlled conditions, typically using high temperature, elevated injection current, or increased optical power . Temperature acceleration is most common, as described by the Arrhenius model, which predicts that small increases in junction temperature can exponentially reduce lifetime. For example, a 10°C increase in operating temperature can roughly halve the expected lifetime of a laser diode . Activation energies for GaAs diodes typically range from 0.3 eV to 0.7 eV, influencing the rate of degradation .

Measurement Techniques

During testing, laser diodes are characterized using LIV curves (Light output, current, voltage) and monitored via internal photodiodes if available . Key parameters include:

- o Threshold current: the current at which lasing begins
 - o Slope efficiency: rate of increase in output power with current
 - o Series resistance: affects voltage drop and heating
- Long-term test beds can monitor multiple diodes simultaneously for hundreds to thousands of hours, often with temperature-controlled stages to minimize environmental effects .

Factors Affecting Lifespan

Laser Diode Lifespan Test

Several factors influence laser diode longevity:

- o Operating current: Lower currents below the rated maximum can exponentially increase lifetime
- o Temperature: Proper heat sinking and active cooling (e.g., TECs) are critical
- o Packaging and soldering: Soft solders like InSn reduce thermal stress and improve reliability
- o Optical and environmental conditions: Facet degradation and contamination can shorten lifespan

Predictive Modeling

Using data from accelerated life tests, statistical models can predict operational lifetime under intended conditions. The Arrhenius equation and empirical formulas allow engineers to estimate how changes in temperature or current affect expected lifetime . This enables design optimization for reliability in industrial, telecommunications, or scientific applications.

Summary

Laser diode lifespan testing combines burn-in, accelerated aging, and continuous monitoring to ensure high reliability. By controlling temperature, current, and environmental factors, and by analyzing LIV curves, manufacturers can predict long-term performance and reduce early failures, ensuring that diodes meet their intended operational lifetimes .

Life Test Rack for Application Simulation To simulate the conditions of different applications, LASER COMPONENTS

This application note describes how multi temperature testing can be used to calculate laser diode lifetime statistics and activation

Before we can fully understand how these different properties effect diode lifetime it is critical to take a deep dive into

In this review-style guide, we'll answer the question many engineers and buyers ask--how long do diode lasers

Qualification results of diode lasers for space applications are presented. Quantum well lasers (AlGaAs / GaAsP at

This report intends to summarize some of the degradation modes and capabilities of typical LEDs and laser diodes

Laser Diode Lifespan Test

Life test studies are used to collect laser diode lifetime data under carefully controlled operating conditions. These data are then used

LASER DIODE LIFE TEST What Is A Laser Diode Life Test? Life-tests consist of the highly accelerated ageing, under controlled

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

As required for long term lifetest, the system provides a class-100 clean environment and a controlled temperature for laser diodes

Laser diode reliability test system The "Swarm" series are short-pulsed-compatible laser diode reliability evaluation systems ideal for

Life-test and qualification test system for laser diode reliability evaluation in CW or pulsed regime down to 1 nanosecond. Up to 112

Laser diode life testing is used for part qualification during product development as well as for lot testing throughout the production

These results are used to assess the lifespan and power degradation of diode lasers compared to commercially available devices

Calculating laser diode reliability Abstract: Provides guidelines for calculating laser diode reliability from accelerated life test data.

Laser diode life testing is used for part validation during product development and batch testing throughout the entire production life

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