Characterization and Life-Testing of Diode Lasers

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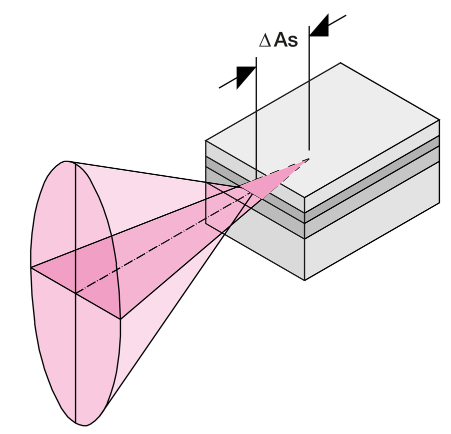
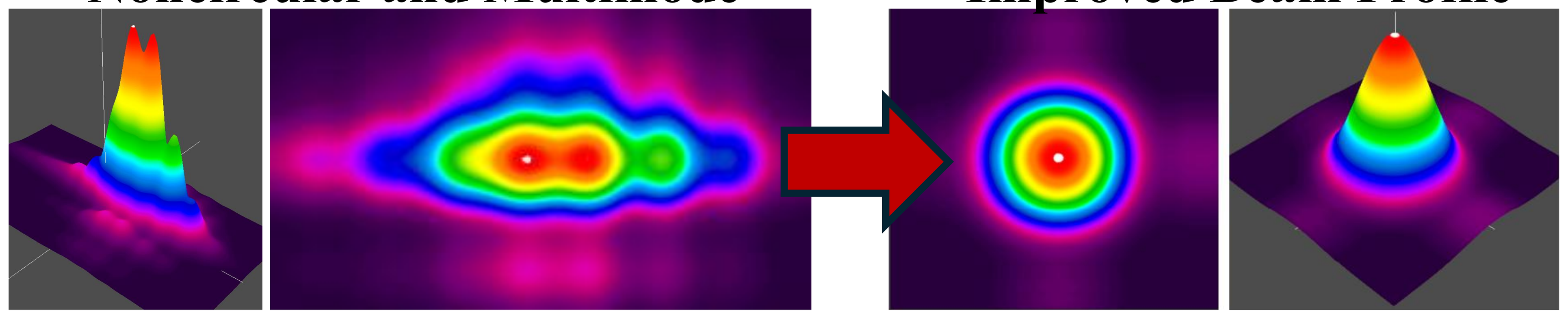
Introduction

- Diode lasers are compact sources of optical power.
- Traditional lasers typically have highly elliptical, astigmatic output beams, often with multiple spatial modes, which cannot be focused to a single point.
- A special process has been developed capable of creating lasers with single spatial mode circular beam profiles.
- This research aims to characterize and test these devices with a specific focus on heat dissipation and life testing.



A typical diode laser astigmatic beam profile showing different focal points in each axis [1].

Noncircular and Multimode | **Improved Beam Profile**

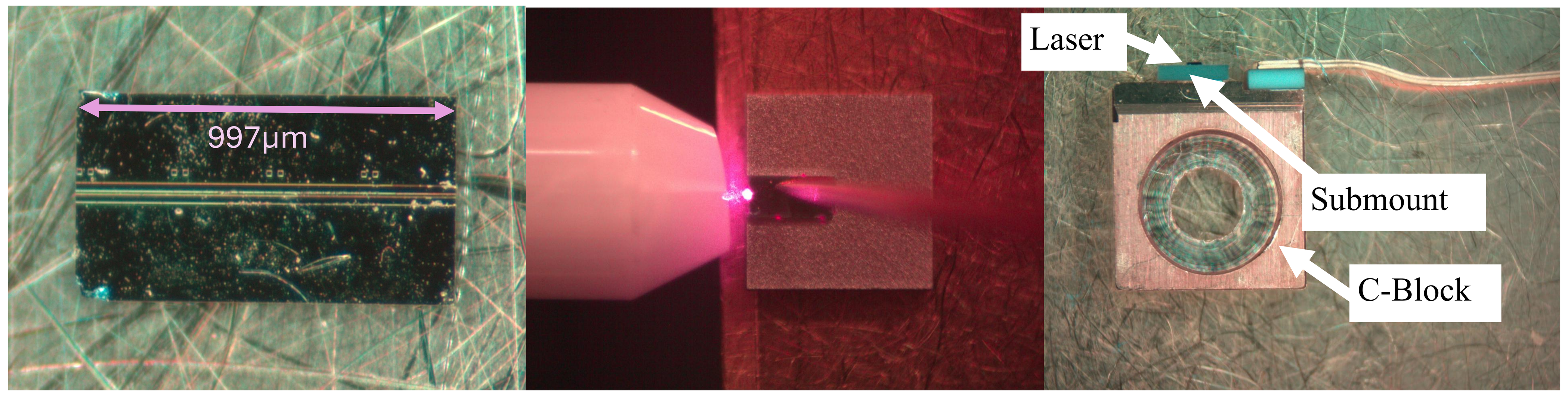


Noncircular and multimodal ridge waveguide diode laser at 10mW output power and lasing wavelength of 808nm.

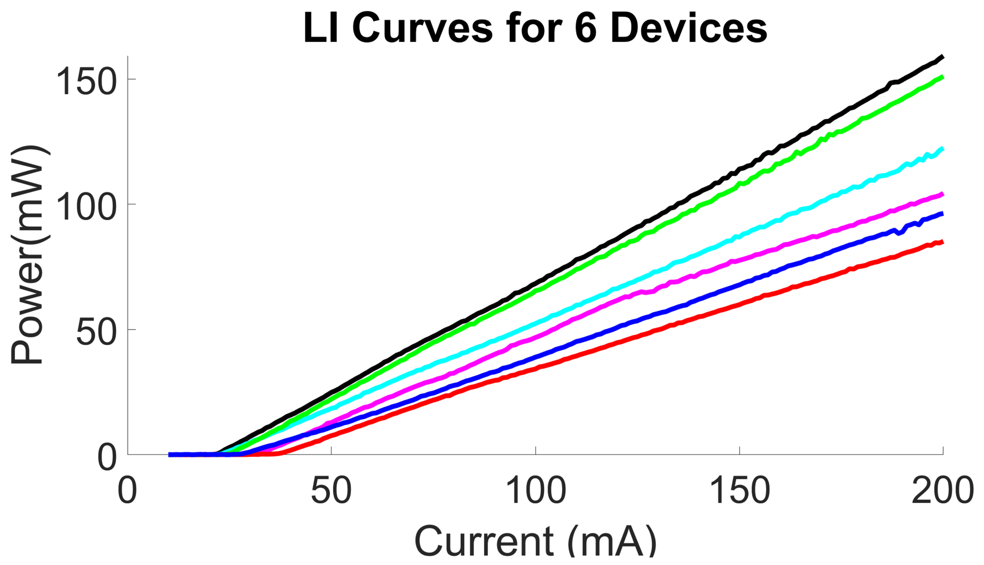
Our circular and symmetrical device at 5mW output power and lasing wavelength of 868.5 [2].

Laser Characterization and Heat Sinking

- Lasers need to be heat-sunk to effectively dissipate heat under constant or continuous wave (CW) operation.
- In this study, lasers are bonded to aluminum nitride submounts, which are soldered atop copper tungsten C-block heatsinks.
- Lasers are characterized by measuring LIV (Light power vs. Current vs. Voltage) curves during pulsed operation at various stages in the process, enabling the effects of packaging and extended operation on laser power to be assessed.
- LIV curves are analyzed to extract three key parameters: threshold current, slope efficiency, and series resistance, all measures of a laser's quality and power efficiency.
- Burn-in and reliability testing is performed to study the lifespan of the packaged lasers.



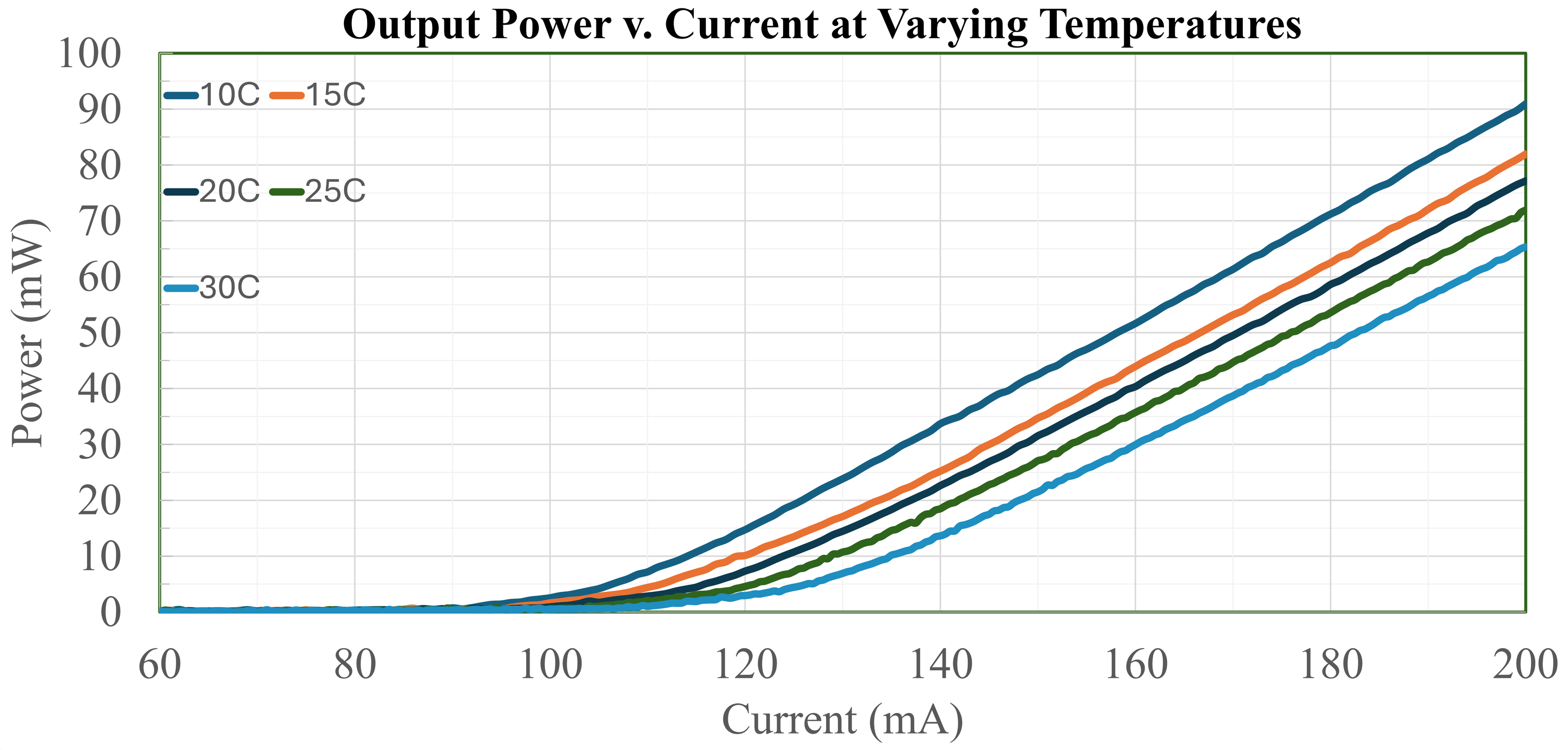
Images of a diode laser at each stage of packaging. From left to right: An unmounted diode laser, a diode laser mounted to a submount being operated at 180mA and directed into an optical fiber, and a c-block heatsink with the submount and laser mounted to it.



An example LI curve for 6 different devices. These graphs are used to compare devices with varying lengths and widths, and before and after packaging.

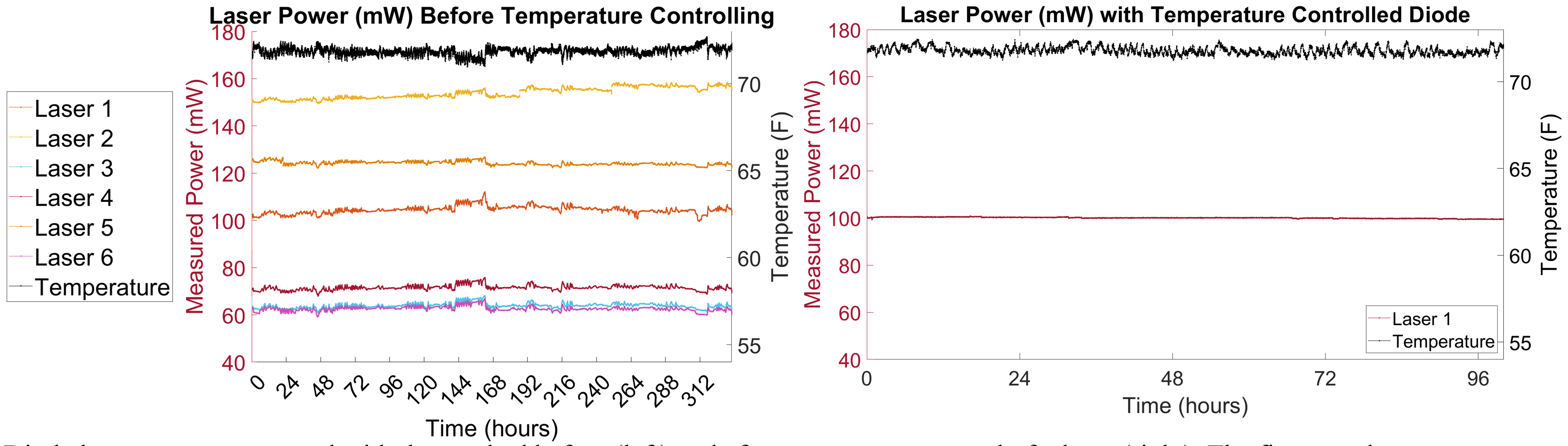
Temperature Sensitivity

- Packaged laser LIV curves were measured at different temperatures to understand how laboratory temperature fluctuations impact laser output power.
- Analysis of the data below, taken from a commercial diode, yields a T0 value, or a measure of the laser diode temperature sensitivity, of 120ºC [3]. However, our devices should have higher T0 values, indicating lower temperature sensitivity.
- Wavelength shift vs. temperature data provides a thermal impedance of 33º C/W for our packaged devices, which is comparable to similarly packaged devices observed in literature [4].



Diode Laser Test Bed

- A 10-channel long-term reliability test bed is being developed to monitor and log the output power of up to 10 diode lasers for hundreds to potentially several thousands of hours.
- The test bed measures the output power with a transimpedance amplifier, which uses a photodiode to convert the output power of the laser into a measurable voltage.
- These results are used to assess the lifespan and power degradation of diode lasers compared to commercially available devices over multiple weeks of operation.
- Improvements were made to the test bed by using a temperature-controlled diode laser stage to limit power fluctuations due to external temperature drift.
- Further work may involve adding temperature-controlled stages to all 10 channels, moving the entire test bed to a temperature-controlled oven, and increasing the duration of testing.



Diode laser powers measured with the test bed before (left) and after temperature control of a laser (right). The first test shows fluctuations inversely proportional to temperature, which are eliminated when temperature control is applied, as seen in the second test.

Acknowledgments and References

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