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Using a Power / Wavehead for Emitter Level Screening of High Power Laser Diode Bars

APPLICATION NOTE

ILX Lightwave
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Using a Power / Wavehead for Emitter Level Screening of High Power Laser Diode Bars

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Emitter level screening has been shown to be an effective tool for testing high power laser diode bars and stacks[1,2,3]. Measurement of individual emitter output power, wavelength, and polarization purity allow the identification of defective individual emitters and anomalous stress on the laser diode bar that may lead to degradation in overall laser performance and reduced reliability.

Previous techniques have relied on a near field imaging spectrometer for the measurement of optical power and wavelength. While this technique provides rapid measurement, it is expensive and difficult to align. This application note describes a simple but effective measurement technique based on a scanned slit and measurement head capable of simultaneous measurement of optical power and wavelength.

Experimental Setup

The experimental setup is shown in Figure 1. The laser tested was a 40 watt CS packaged laser diode bar with 19 emitters, a threshold current of 7.5 amps, and nominal lasing wavelength of 806 nm. The individual emitter width and spacing of this laser were 150 μm and 500 μm respectively. The laser was mounted on a water cooled ILX Lightwave LDM-4415 mount. An LDX-3600 laser diode driver was used to provide transient free current to the laser and stable temperature control was provided using a LDT-5948 thermoelectric temperature controller.

Optical power and wavelength were measured using an ILX Lightwave OMM-6810B Optical Multimeter and OMH-6722B Power/Wavehead. This instrument utilizes an integrating sphere, colored glass filters, and silicon photodiodes to simultaneously measure optical power and wavelength[4] at power levels up to 1 watt. Using this technique wavelength measurement with an accuracy of ±1.0 nm and resolution of 0.1 nm are readily obtained. In order to sample individual emitters, a 20 mm focal length lens was used to image the output facet of the laser with 2.5x magnification onto a 100 μm slit located in front of the entrance port of the OMH-6722B measurement head. Using a slit provides good spatial resolution along the axis

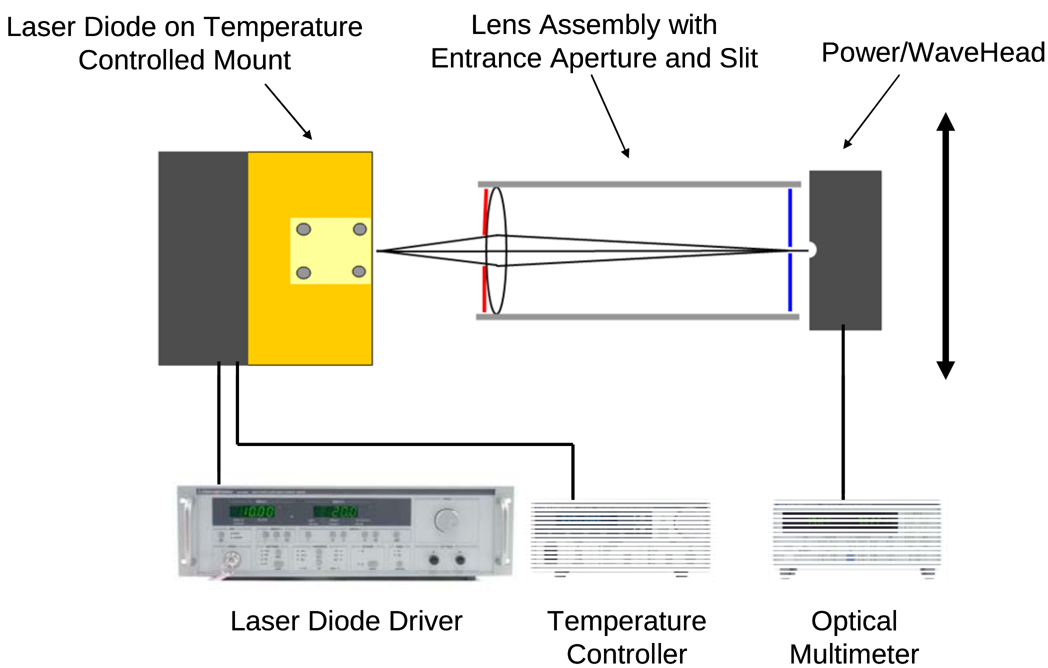

Figure 1. Experimental Setup

of the laser's exit aperture while allowing easy alignment by reducing sensitivity to position perpendicular to the laser bar.

A small reflective aperture was placed in front of the lens to limit the light entering the lens/measurement head assembly. This reflective aperture also prevented light absorption and heating of the black surfaces of the assembly. The lens/measurement head assembly was mounted on a precision translation stage with 0.01 mm resolution.

A simple application program was written to control the instruments and collect measurement data.

Results

Figure 2 shows the results of a near field scan performed at 25°C, 40A drive current, and with a 0.01 mm step size. The optical output of each emitter is clearly resolved. The output of the emitter #5 is very low indicating a defective emitter. Wavelength "bow" is also clearly visible in the profile with the wavelength varying from about 804.8 nm at the right side of the array to a maximum of 806.7 nm in the center. Wavelength bow is due to the packaging induced stress caused by the mismatch in the coefficients of thermal expansion between the laser bar material and the CS package substrate. In addition to the overall bow in the wavelength profile, it can be seen that emitter #11 is blue shifted by approximately 0.4 nm, indicating potential facet damage[3].

It is possible to calibrate the wavelength shift in terms of temperature by performing a second scan at a different temperature. Wavelength measurements resulting from scans at 25°C and 30°C are shown together in Figure 3. Based on these results, the average wavelength shift with temperature is 0.71 nm for a 5°C shift in temperature, or 0.14 nm/°C. Using this value and the calculated range in wavelength of 1.85 nm at 25°C, it is straightforward to calculate that the temperature of the array varies 13.0°C from the center to the right side.

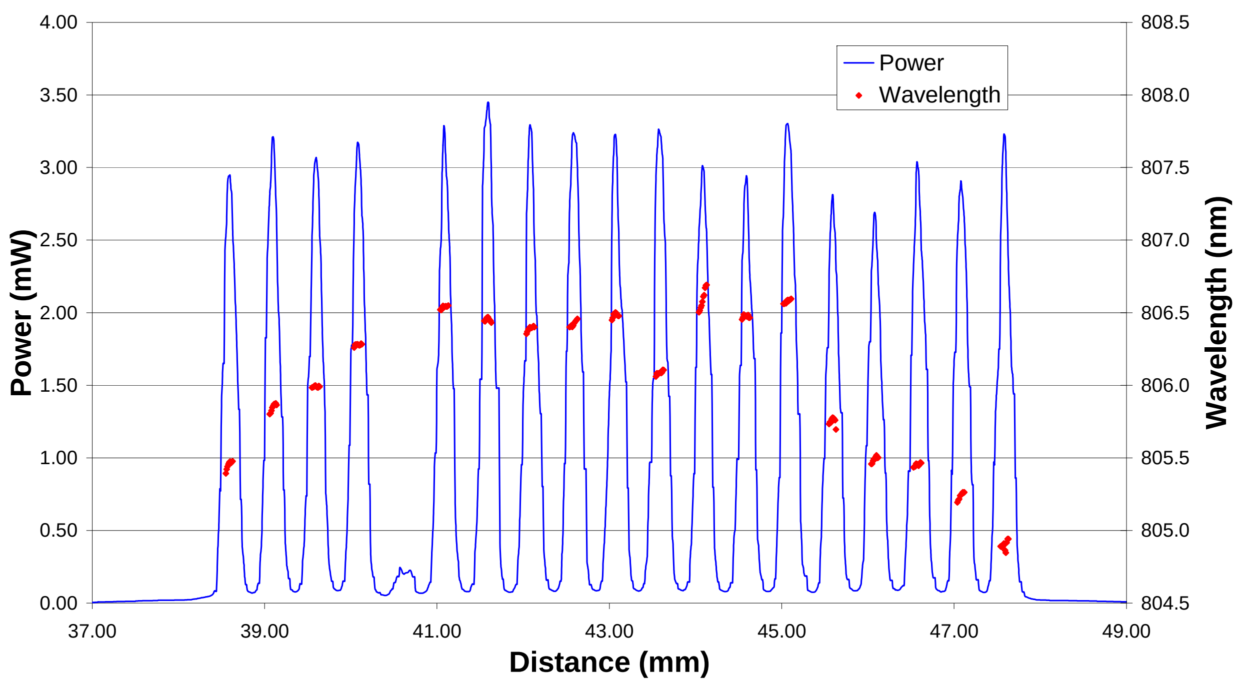

Figure 2. Near Field Scan at 25°C

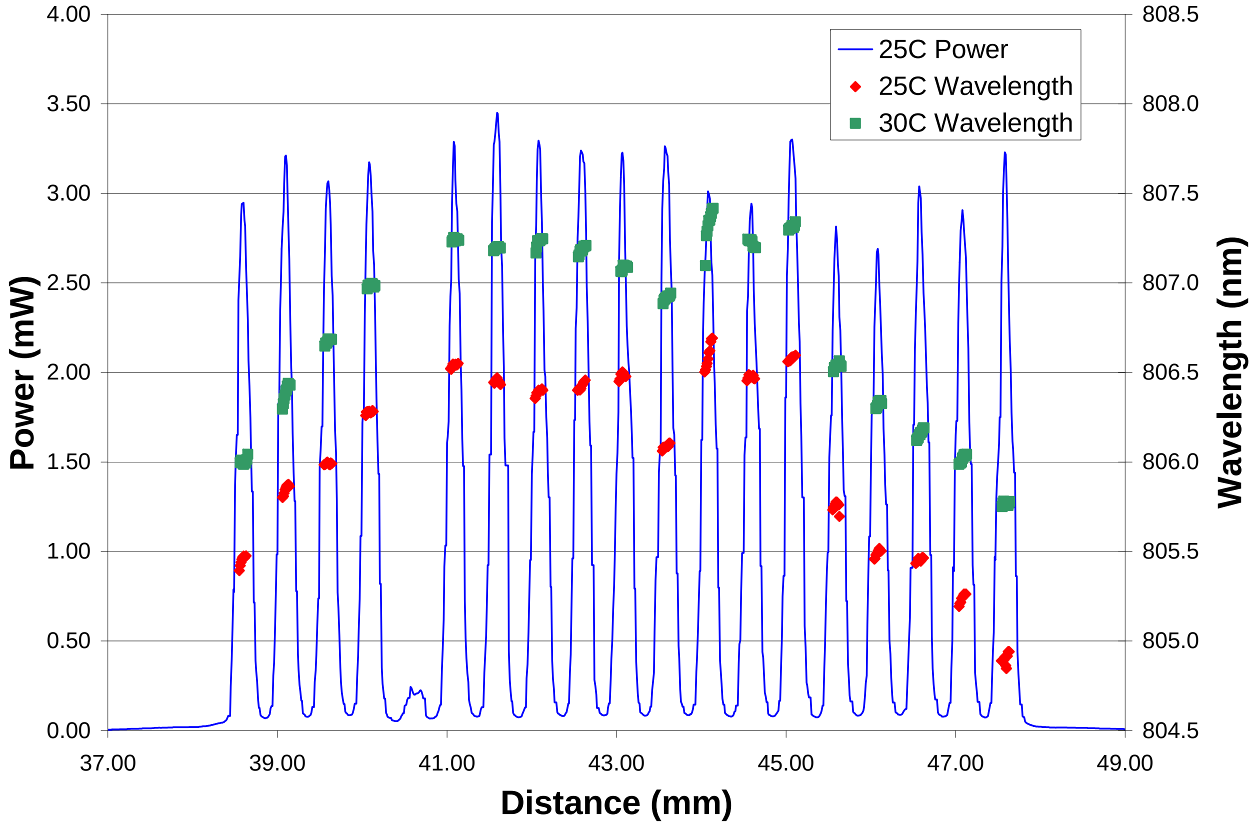

Figure 3. Wavelength Variation with Base Temperature

Summary

A simple technique has been described for measuring emitter-level optical power and wavelength in high power laser diode bars. The technique relies on the use of a scanned slit in conjunction with an ILX Lightwave OMM-6810B Optical Multimeter with OMH-6722B Power/Wavehead. This measurement technique can be used to identify defective emitters and anomalous stress that may lead to reduced reliability in laser diode bar assemblies.

References

1. Ryan Feeler, Edward F. Stephens, and J. Stanley Whiteley, “Minimization of Laser Diode Array Degradation via Emitter-Level Screening of Laser Diode Subassemblies,” 19th Solid State and Diode Laser Technology Review, June 13-15, 2006, Albuquerque, NM.

2. Mark A. Stephen, Aleksey Vasilyev, Elisavet Troupaki, Graham R. Allan, Nasir B. Kashem, “Characterization of High-Power Quasi-CW Laser Diode Arrays,” *Lidar Remote Sensing for Environmental Monitoring VI, Proceedings of the SPIE, V. 5887 (2005),* Upendra N. Singh, editor.

3. David B. Jones, “Minimization of Diode Array Degradation,” presented at InterOpto 2006, July 2006.

4. “Laser Wavelength Measurement Using a Colored Glass Filter,” ILX Lightwave Corporation Technical Note #TN6810B-7.

The following publications are available for download at www.ilxlightwave.com.

White Papers

- A Standard for Measuring Transient Suppression of Laser Diode Drivers
- Degree of Polarization vs. Poincaré Sphere Coverage
- Improving Splice Loss Measurement Repeatability
- Laser Diode Burn-In and Reliability Testing
- Power Supplies: Performance Factors Characterize High Power Laser Diode Drivers
- Reliability Counts for Laser Diodes
- Reducing the Cost of Test in Laser Diode Manufacturing

Technical Notes

- Attenuation Accuracy in the 7900 Fiber Optic Test System
- Automatic Wavelength Compensation of Photodiode Power
- Measurements Using the OMM-6810B Optical Multimeter
- Bandwidth of OMM-6810B Optical Multimeter Analog Output
- Broadband Noise Measurements for Laser Diode Current Sources
- Clamping Limit of a LDX-3525 Precision Current Source
- Control Capability of the LDC-3916371 Fine Temperature Resolution Module
- Current Draw of the LDC-3926 16-Channel High Power Laser Diode Controller
- Determining the Polarization Dependent Response of the FPM-8210 Power Meter
- Four-Wire TEC Voltage Measurement with the LDT-5900 Series Temperature Controllers
- Guide to Selecting a Bias-T Laser Diode Mount
- High Power Linearity of the OMM-6810B and OMH-6780/6790/6795B Detector Heads
- Large-Signal Frequency Response of the 3916338 Current Source Module
- Laser Wavelength Measuring Using a Colored Glass Filter
- Long-Term Output Drift of a LDX-3620 Ultra Low-Noise Laser Diode Current Source
- Long-Term Output Stability of a LDX-3525 Precision Current Source
- Long-Term Stability of an MPS-8033/55 ASE Source
- LRS-9424 Heat Sink Temperature Stability When Chamber Door Opens
- Measurement of 4-Wire Voltage Sense on an LDC-3916 Laser Diode Controller
- Measuring the Power and Wavelength of Pulsed Sources Using the OMM-6810B Optical Multimeter
- Measuring the Sensitivity of the OMH-6709B Optical Measurement Head
- Measuring the Wavelength of Noisy Sources Using the OMM-6810B Optical Multimeter
- Output Current Accuracy of a LDX-3525 Precision Current Source
- Pin Assignment for CC-305 and CC-505 Cables
- Power and Wavelength Stability of the 79800 DFB Source Module
- Power and Wavelength Stability of the MPS-8000 Series Fiber Optic Sources
- Repeatability of Wavelength and Power Measurements Using the OMM-6810B Optical Multimeter
- Stability of the OMM-6810B Optical Multimeter and OMH-6727B InGaAs Power/Wavehead
- Switching Transient of the 79800D Optical Source Shutter
- Temperature Controlled Mini-DIL Mount
- Temperature Stability Using the LDT-5948
- Thermal Performance of an LDM-4616 Laser Diode Mount
- Triboelectric Effects in High Precision Temperature Measurements
- Tuning the LDP-3840 for Optimum Pulse Response
- Typical Long-Term Temperature Stability of a LDT-5412 Low-Cost TEC
- Typical Long-Term Temperature Stability of a LDT-5525 TEC
- Typical Output Drift of a LDX-3412 Loc-Cost Precision Current Source
- Typical Output Noise of a LDX-3412 Precision Current Source
- Typical Output Stability of the LDC-3724B
- Typical Output Stability of a LDX-3100 Board-Level Current Source
- Typical Pulse Overshoot of the LDP-3840/03 Precision Pulse Current Source
- Typical Temperature Stability of a LDT-5412 Low-Cost Temperature Controller
- Using Three-Wire RTDs with the LDT-5900 Series Temperature Controllers
- Voltage Drop Across High Current Laser Interconnect Cable
- Voltage Drop Across High Current TEC Interconnect Cable
- Voltage Limit Protection of an LDC-3916 Laser Diode Controller
- Wavelength Accuracy of the 79800 DFB Source Module

Application Notes

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- App Note 3: Protecting Your Laser Diode
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- App Note 10: Optimize Testing for Threshold Calculation Repeatability
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- App Note 21: High Performance Temperature Control in Laser Diode Test Applications
- App Note 22: Modulating Laser Diodes
- App Note 23: Laser Diode Reliability and Burn-In Testing
- App Note 25: Novel Power Meter Design Minimizes Fiber Power Measurement Inaccuracies
- App Note 26: ReliaTest L/I Threshold Calculations
- App Note 27: Intensity Noise Performance of Semiconductor Lasers
- App Note 28: Characterization of High Power Laser Diode Bars
- App Note 29: Accelerated Aging Test of 1310 nm Laser Diodes
- App Note 30: Measuring High Power Laser Diode Junction Temperature and Package Thermal Impedance

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 Rev01.092308