# Method for Predicting Junction Temperature Distribution in a High-Power Laser Diode Bar

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LOMSS

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## Motivation/Objectives

- The junction temperature is one of the most important parameters in achieving optimal performance of a high-power LD bar, determining the center wavelength, spectrum distribution, wall-plug efficiency, and reliability.
- Experimental and analytical determination of the junction temperature distribution is critical for the development as well as the reliability assessment of a high power LD bar.
- Existing methods (thermal resistance, wavelength-shift, optical power output, and forward-voltage, and Micro-Raman spectroscopy) have limitations for the junction temperature distribution measurement of the high power LD bar.
- A hybrid experimental/numerical method is proposed to predict the junction temperature distribution of a high power LD bar and evaluate the performance of the commercial water-cooled microchannel.

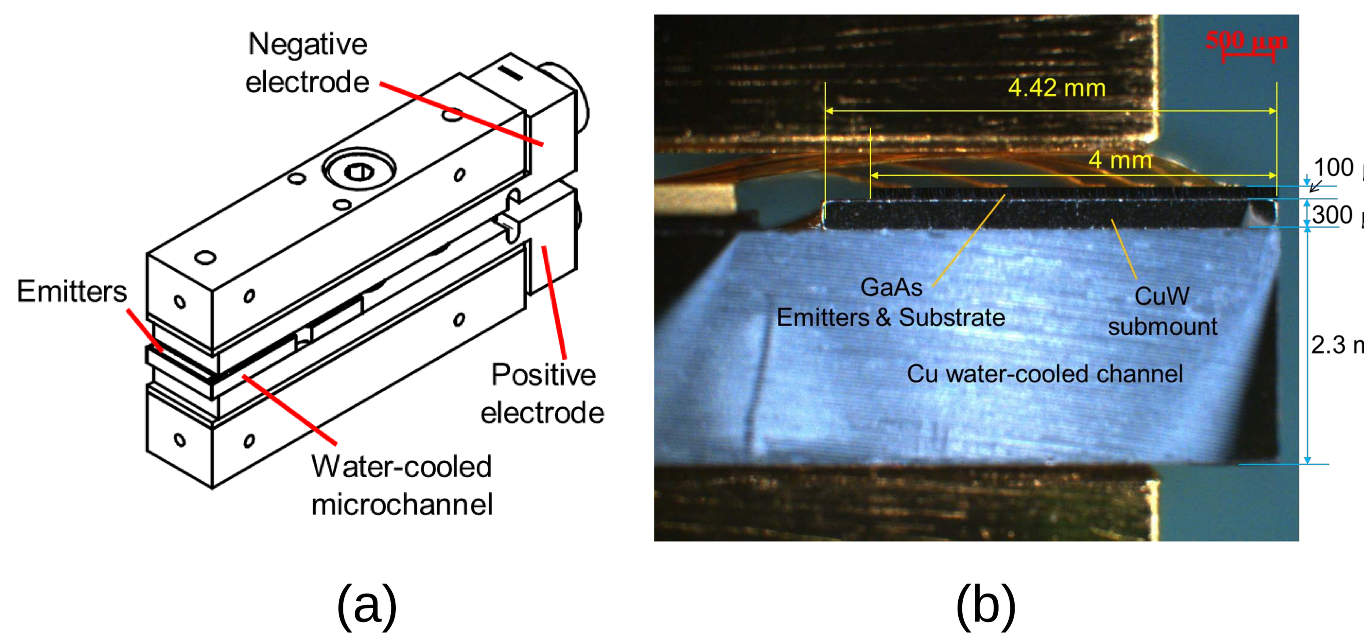


Figure 1. (a) LD bar with water-cooled microchannel and (b) side view of the LD bar

## Approach

- A commercial water-cooled LD bar was utilized to illustrate and validate the proposed method.
- A unique experimental setup is developed and implemented to measure the average junction temperatures of the LD bar emitters.
- After average junction temperature and heat dissipation measurements, the effective heat transfer coefficient of the cooling system is determined inversely.
- The characterized properties are used to predict the junction temperature distribution over the LD bar under high operating currents.

## Hybrid Experimental and Numerical Method

- **Test setup**
- Two current sources and N-MOSFET were used to switch the operating current to the probe current.
- The current sources, DAQs, and an optical power sensor are integrated into a LabVIEW program.

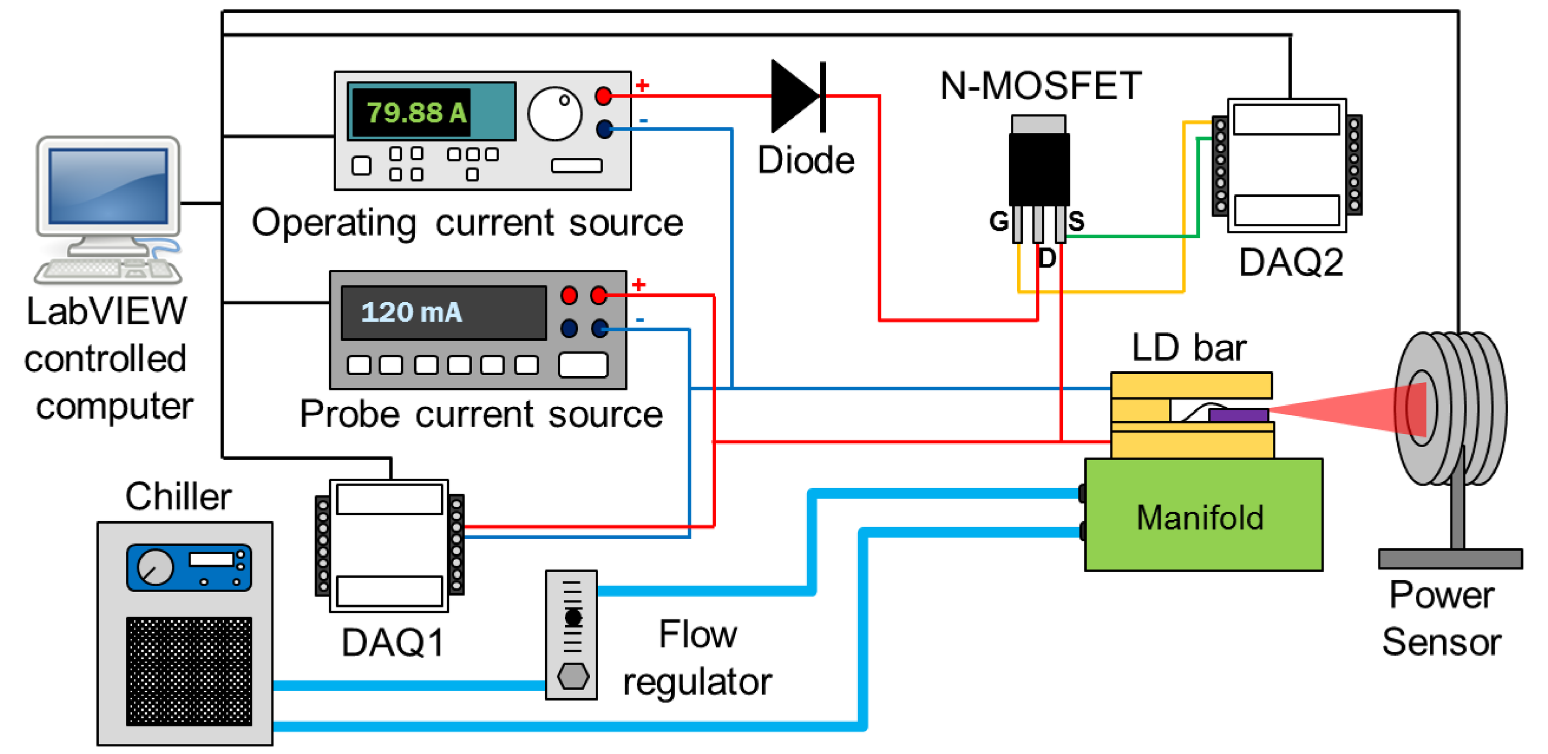


Figure 2. Schematic illustration of junction temperature measurement setup

- **Experimental results**
- The averaged junction temperature at the operating current can be measured using the forward voltage method.

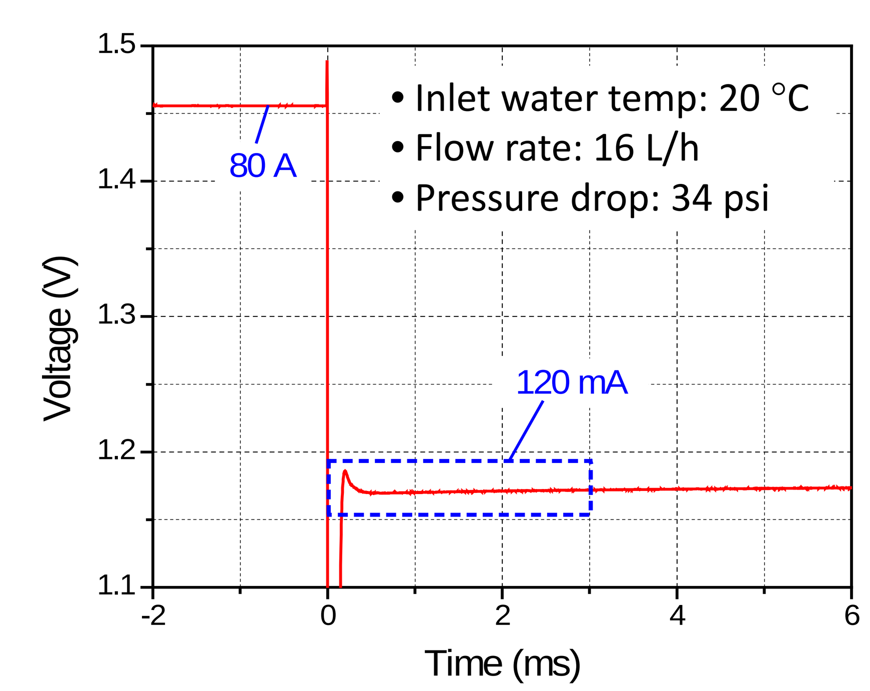


Figure 3. Transient voltage behavior of the LD bar obtained after switching the operating current from 80 A to 120 mA

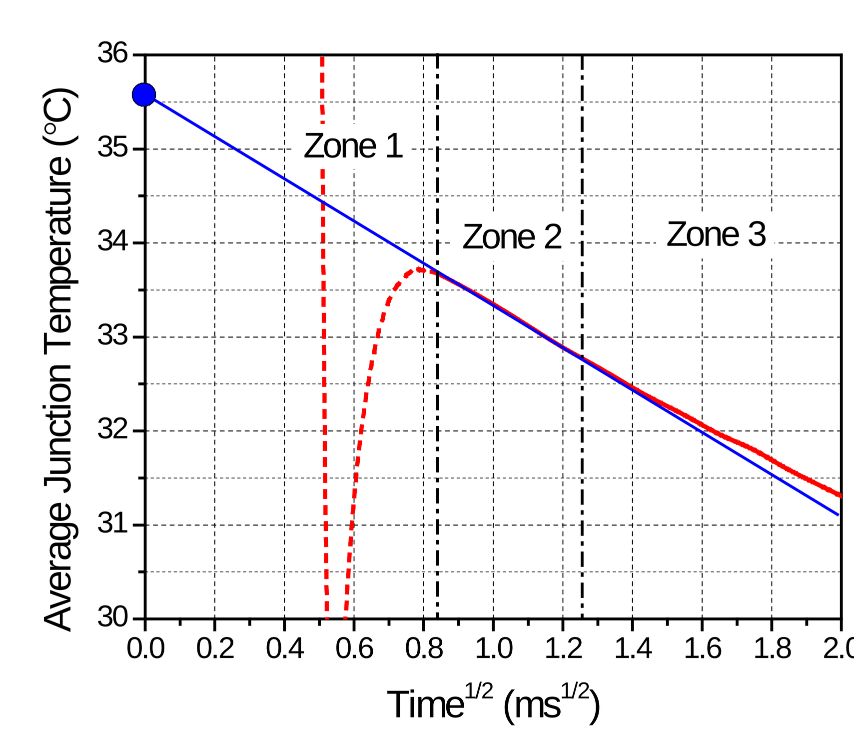


Figure 4. The average junction temperature in the square root time scale. The linear extrapolation provides the estimated average junction temperature at the operating current

- **Numerical prediction**
- The effective heat transfer coefficient of the cooling system was determined inversely using numerical simulation.
- The characterized properties were used to predict the junction temperature distributions of the LD bar.

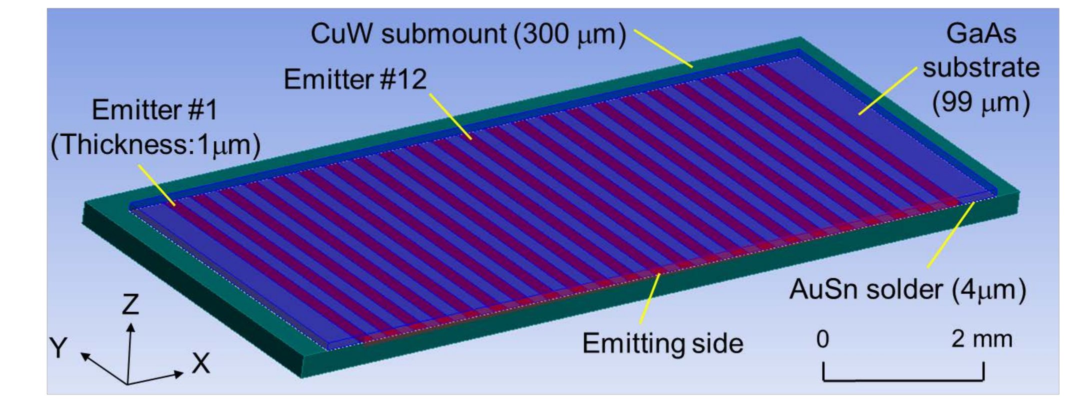


Figure 5. 3D model

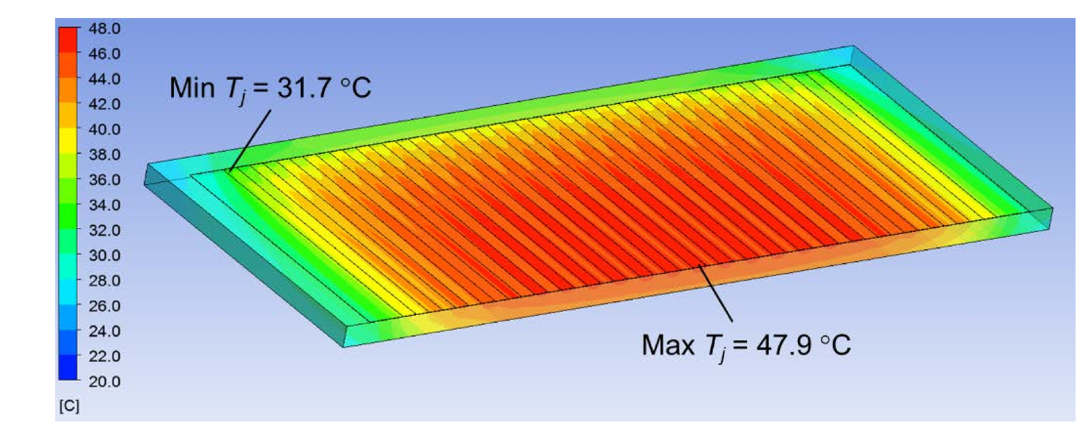


Figure 6. Temperature distribution of the LD bar at 160 A

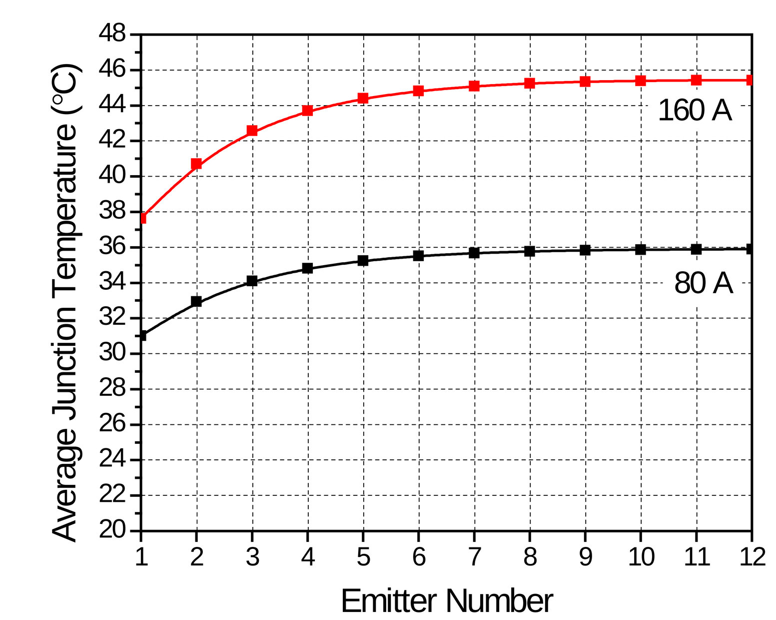


Figure 7. Average junction temperature of each emitter in the left half (symmetry)

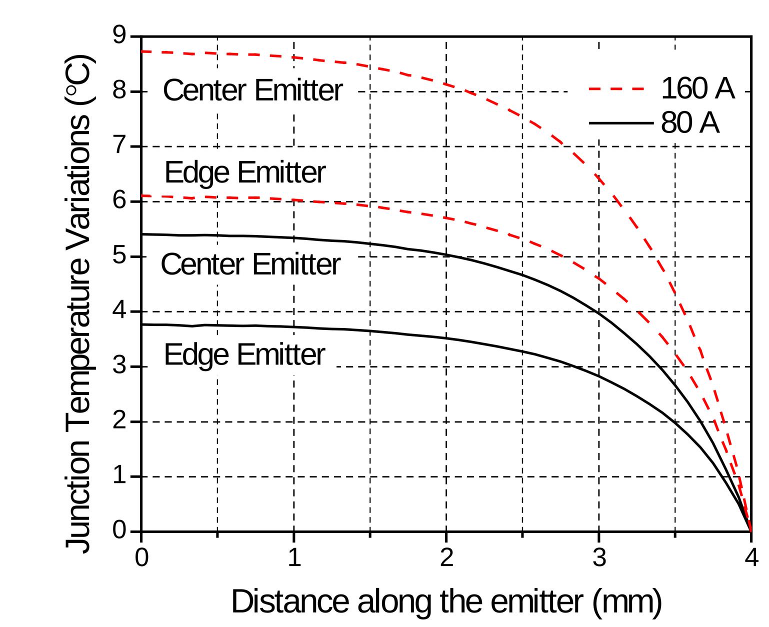


Figure 8. Junction temperature variations along the emitter

## Impact

- A hybrid experimental and numerical method was proposed and implemented for predicting the junction temperature distribution of a high-power LD bar.
- The proposed method can be used to determine the proper operation condition of the LD bar as well as to evaluate designs during packaging platform development.

## Related publication

- D.-S. Kim, C. Holloway, B. Han, and A. Bar-Cohen, "Method for predicting junction temperature distribution in a high-power laser diode bar," APPLIED OPTICS, vol. 55, pp. 7487-7496, 2016/09/20 2016.