# 1D and 2D 1.5 m InGaAsP-InP diode laser arrays: experiment and modeling

**G. Belenky, A. Gourevitch, D. Donetsky, D. Westerfeld**

*State University of New York at Stony Brook, Stony Brook, NY 11794 USA*
garik@ece.sunysb.edu

**B. Laikhtman**

*Hebrew University, Jerusalem, 91904, Israel*

**C. W. Trussell**

*US Army NV&ES Directorate, 10215 Burbeck Rd, Ft Belvoir, VA 22060-5806 USA*

**H. An, Z. Shellenbarger, R. Martinelli**

*Sarnoff Corporation, 201 Washington Rd., Princeton, NJ 08543 USA*

**Abstract:** 25W continuous wave (CW) power at 1.47-µm was obtained from a 20-element 1 mm x 1 cm diode laser array at 16 C. 110-W of quasi-CW (5 ms 20 Hz) power was achieved from a four-bar two-dimensional array.


**OCIS codes:** (140.2020) Diode lasers, (140.5960) Semiconductor lasers.

Recent years have seen an increased interest in the development of high-energy Q-switched solid-state sources operating in an eye-safe wavelength range. Erbium doped crystalline hosts offer great potential as efficient pulsed eye-safe laser sources with applications in range finding, target ID, and 3D LIDAR. Resonant pumping of the $^4I_{13/2}$ level eliminates the need for sensitizer ions, and the crystalline matrix provides excellent thermal, spectral, and mechanical properties for high energy, high repetition rate applications. Direct resonant pumping of Erbium lasers can be performed in absorption bands near 1.47 and 1.54 µm [1].

This abstract reports on the parameters of 1.47 - 1.49 µm one-dimensional (1D) and two-dimensional (2D) InP based diode laser arrays designed for high-duty-cycle operation.

The InGaAsP/InP heterostructures were grown by metal organic chemical vapor deposition. The active region consisted of three 6-nm-thick compressively strained QW's incorporated into a two-step graded index waveguide with a total thickness of 710 nm. The laser bars were HR/AR coated with the reflection coefficients of 95 % and 3 %, respectively. The threshold current density of 480 A/cm$^2$ and the differential efficiency of 60 % were measured for single lasers with contact area of 100 µm x 1 mm. The device characteristic temperatures were found to be $T_0$ = 54 K and $T_1$ = 160 K within the temperature range 20 to 60 C. Zn-doping of 1.5-µm-thick p-cladding provided optical loss as low as 2 - 3 cm$^{-1}$ [2, 3].

We studied theoretically and experimentally the temperature distribution in a laser bar. The current spreading and temperature distribution were analyzed using complex analysis methods. We used bars with twenty

100-μm-wide emitters. Center-to-center emitter separation was 500 μm and the fill factor was 20 %. The bars were mounted in grooves in microchannel heatsinks providing heat removal from both sides of the bar.

The current dependences of the CW and quasi-CW (qCW) output power and the wall-plug efficiency for a 1D diode array at a coolant temperature of 16 C are shown in Figure 1. The slope efficiency of 0.5 W/A remained constant in qCW mode up to the measured output power of 27 W. Power roll-off in CW mode was observed when the drive current exceeded 40 A. The wall-plug efficiency peaked at 37 % at 40 A injection current and was better than 34 % up to the maximum drive current of 60 A.

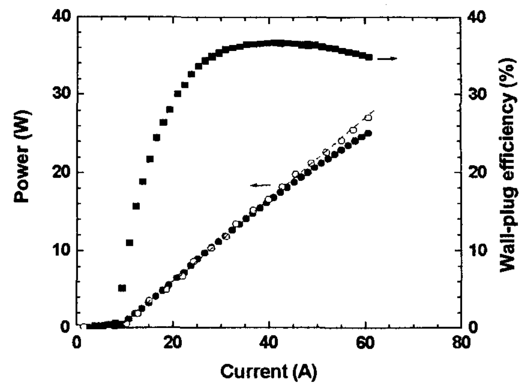


Fig. 1. Output power (circles) and wall-plug efficiency (squares) of a 1.47 μm 1D array operated in qCW (5 ms 20 Hz, open circles) and CW (closed circles) modes at coolant temperature of 16 C.

We measured the spectral position of the emission peak of individual devices to determine the overheating of the laser active region. The corresponding overheating temperature was 18 C for CW mode and 13 C at QCW mode at 60 A drive current. The estimated device thermal resistance in CW mode of the 1D array was 0.37 K/W.

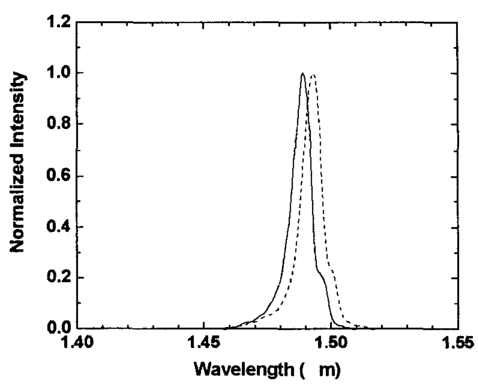


Fig. 2. The integrated emission spectra of 2D array at 18 C (solid line) and 25 C (dashed line) measured in qCW.

A four-bar 2D array with a bar-to-bar pitch of 3.2 mm was fabricated. The integrated emission spectra for the array measured at 30 A in qCW mode at 18 C and 25 C are shown in Figure 2. The temperature change allows tuning the position of the array emission peak while keeping the full-width at half-maximum of 8 - 9 nm. A light power of 110 W was achieved at a current of 60 A.

## References


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