Fiber and Integrated Optics, Volume 9, pp. 219–223

0146-8030/90 $3.00 + .00

High-Power Diffraction-Limited Phase-Locked GaAs/GaAlAs Semiconductor Laser Array

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Abstract *High-power diffraction-limited phase-locked gallium-arsenide (GaAs)/gallium-aluminum-arsenide (GaAlAs) semiconductor laser arrays have been fabricated using the LPE technique, the standard photolithographic technique, wet etching, and proton bombardment. The tailored gain-guided arrays are made by varying the width of the channels of the lasers while keeping the spacing between them constant. The array consists of six lasers. Its optical output power per facet is 300 mW at 2.7 I_{th} with single-mode continuous wave (CW) operation and single lobe far-field pattern with full width at half maximum (FWHM) of 1.9°.*

Introduction

There are many applications of semiconductor laser arrays such as optical pumping of solid-state lasers, infrared illumination, laser soldering, eye surgery, optical transmission, and optical ranging. Some of the applications need high power only, while other applications require single-mode and single-lobe patterns.

Phase-locked arrays are multichannel waveguide devices. In general, they support many lateral modes (supermodes) that result in broad far-field patterns and broad spectral linewidths. A method of discriminating among the supermodes to enforce a single supermode operation is pursued.

The coupled-mode analysis [1] and experimental results show that arrays with identical channel widths and center spacings give similar intensity patterns of fundamental and highest order supermodes. This makes it difficult to discriminate among them. In addition, the far-field pattern of the highest order supermode is two-lobed. On the contrary, arrays with nonuniform channel width and center-to-center spacing have the advantage of discriminating among supermodes. Asymmetrically chirped arrays often operate on the fundamental supermode and show the single-lobe far-field pattern [2].

Received: April 2, 1990; accepted: June 25, 1990

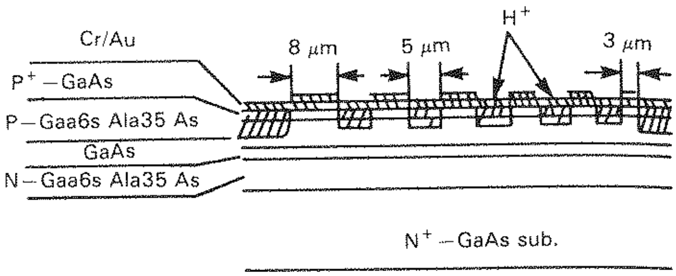


Figure 1. Cross-section of a GaAs/GaAlAs wafer.

In this paper, results with asymmetrical chirped arrays are reported.

Devices and Features

GaAs/GaAlAs wafers of devices are grown by the LPE technique. The cross section of the wafer is shown in Fig. 1.

The channels and the gaps between lasers can be observed by photolithographic technique, wet chemical etching, and proton bombardment. The widths of the channels of the six lasers are: 3 μm, 4 μm, 5 μm, . . . , and 8 μm; the confined gaps between lasers are kept constant at 5 μm. Therefore, center-to-center spacings -/- vary from 6 μm to 10 μm. That means the coupling strength between lasers varies, as do the radiating areas. The cavity length of six lasers is 250 μm. The current–voltage characteristics are shown in Fig. 2.

The forward voltage is 1.3 volts, the reverse voltage is 4.5 volts, and the differential resistance is 1.5 Ω. The optical power versus injection current is shown in Fig. 3. The optical power is 300 mW/fact when injection current equals 2.7 I_{th}. The differential quantum efficiency is 35 percent. The near-field pattern and far-field pattern are shown in Figs. 4 and 5, respectively. In the *p–n* junction plan, the far-field

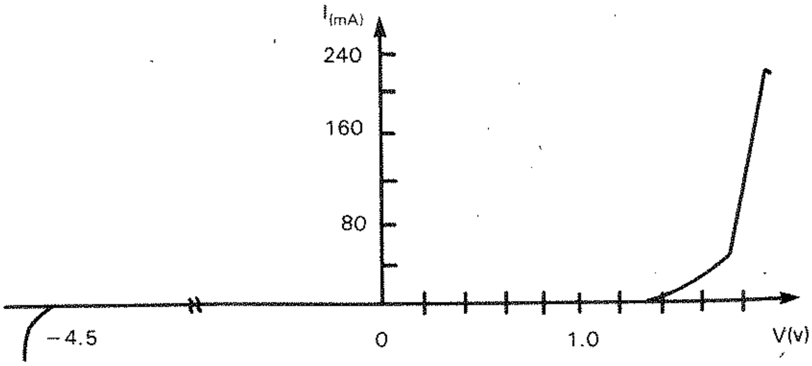


Figure 2. I-V Characteristics of array.

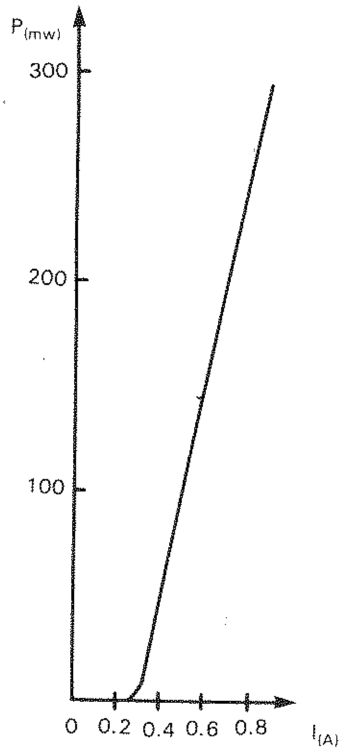


Figure 3. Optical output power versus injection current.

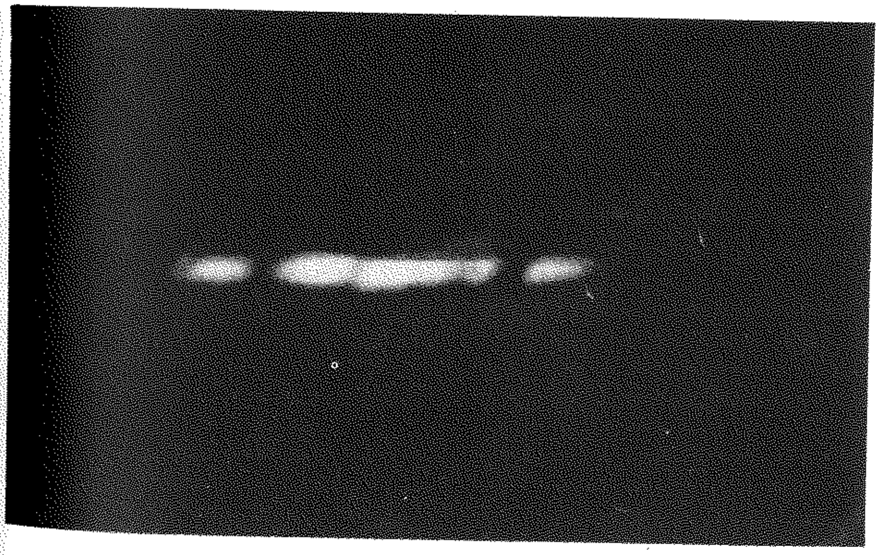
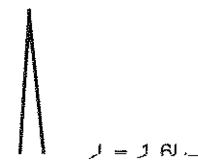


Figure 4. The near-field pattern of the array.



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lobe far-field pattern with FWHM of 1.9° under 1.2 I_{th} to 1.8 I_{th} injection currents. This implies that these arrays oscillate in the fundamental supermode. Obviously, it is possible to attain single-mode operation with a single diffraction-limited lobe by suitable choice of the array structure.

References

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2. E. Kapon, C. Lindsey, J. Katz, S. Margalit, and A. Yariv, *Appl. Phys. Lett.* **45**, 200–202 (1984).