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B—4—6 Visible GaAlAs Lasers with Buried Convex Waveguide Structure

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Visible-light-emitting GaAlAs lasers are becoming light sources in information processing systems such as audio- and video-disk players and laser printers. Here we report a new structure visible-light-emitting laser in the 0.7 µm wavelength range, called buried convex waveguide structure (BCS) laser. The BCS laser is the first BH type laser realized in the visible wavelength range.

It is difficult to grow the visible BH laser wafer due to the large Al contents in the GaAlAs layers and it is also difficult to realize the stable fundamental transverse mode operation because of the large difference in refractive index between the active region and the cladding and the burying layers. These difficulties are resolved in the BCS strucuture in which the active region is grown at the second growth stage and higher order modes are effectively suppressed in the truncated convex waveguide. The BCS lasers have realized the stable fundamental transverse mode operation for the wide waveguide width of 3-4 µm and showed very low threshold currents of 12-35 mA in the lasing wavelength range of 780 to 740 nm.

Figure 1 shows a schematic cross section of the BCS laser which has a truncated convex waveguide. The BCS laser was fabricated by two-step liquid-phase epitaxy including a selective etching.[1] Internal current confinement structure was formed at the first growth stage. After the first growth, 4.5-µm wide and 2.5-µm deep channels were formed along the $\langle 01\bar{1} \rangle$ orientation. A double-heterostructure was formed by growing an n-$Ga_{1-x}Al_xAs$ (Te-doped, x= 0.45-0.5), an n-$Ga_{1-y}Al_yAs$ active region (Te-doped, y=0.12-0.25), a p-$Ga_{1-x}Al_xAs$ (Mg-doped), and a p-GaAs cap layer at the second growth stage.

Figure 2 shows typical CW light output-current characteristic and lasing spectra. The single longitudinal mode operation was observed in the range of 1-15 mW/facet. The lowest threshold currents obtained were 12 mA at 780 nm and 35 mA at 740 nm. The stable fundamental transverse mode operation was obtained over 12 mW/facet under CW operation as shown in Fig.3. The fundamental transverse mode operation was confirmed over 100 mW/facet under pulsed operation and catastrophic degradation was observed at around 150 mW/facet at 750 nm under pulsed operation of 100 ns pulse width. The beam divergence (measured at halfpower points) along the junction plane was 16-20°. The aspect ratio of the far-field pattern was about 2.5. Figure 4 shows the dependence of the beam waist position along the junction plane on CW power levels. The beam waist position coincides with the laser facet to high power level.

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Reference

1) K. Hanamitsu, K. Shima, and M. Takusagawa, Topical Meeting on Integrated and Guided Wave Optics, Pacific Grove, California, (1982).

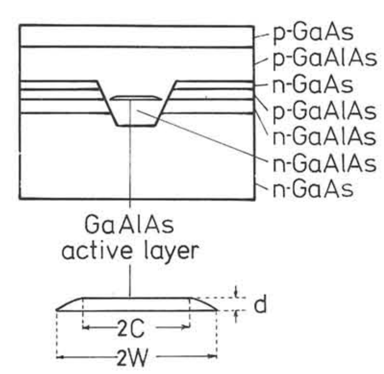

Fig. 1 Schematic cross section of the BCS laser.

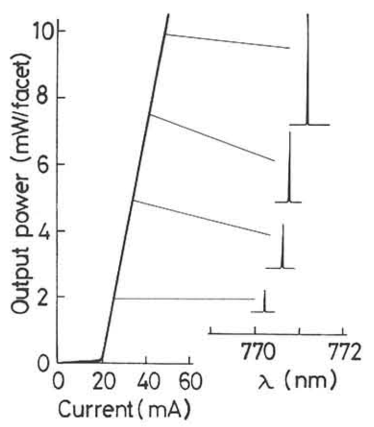

Fig. 2 Light output-current characteristic and lasing spectra of a 770 nm BCS laser.

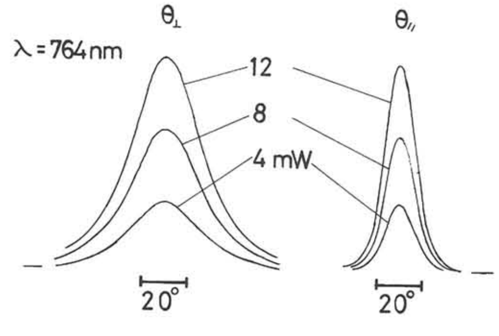

Fig. 3 Far-field patterns of a 760 nm BCS laser.

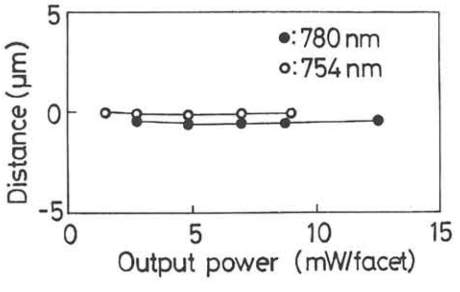

Fig. 4 Dependence of the beam waist position along the junction plane on output power. Distance zero indicates laser facet.