B−4−7 Stable Two-Dimensional Oscillation in A Transverse-Distributed-Feedback Cavity Laser

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We proposed a two-dimensional laser, i.e., transverse-distributed-feedback cavity (TDFB/Cavity) laser[1] which has a pair of plane mirrors at both ends and a periodic grating and an active region between the mirrors as shown in Fig. 1. This TDFB/Cavity laser can be a stable and high power light source when it is adequately designed and fabricated. The most important point is to fabricate the grating at right angles to the mirrors.

In this paper, we report the establishment of the fabrication technique and demonstrate the highly stable two-dimensional oscillation in a TDFB/Cavity laser.

In the structure shown in Fig. 1, counter travelling modes, guided by the mirrors, are coupled to each other when the y-directional wavelengthes of the modes are nearly equal to twice the pitch of the grating. From this Bragg condition in the y direction, the field distribution in the y direction (the transverse mode) is stabilized and the emission angle of the two-dimensional mode is given as $\theta_{ex} = \sin^{-1}(\lambda/2\Lambda)$, where λ and Λ are the oscillation wavelength and the pitch of the grating, respectively.

In our experiment, we used hetero-epitaxial GaAlAs wafers, the configuration of which is shown in the previous paper[1]. The 2.5-μm pitch corrugation grating was fabricated by chemical etching after holographic exposure of photoresist films. The perpendicularity between the grating and cleaved facets was assured by a He-Ne laser beam reflected from the cleaved facet. The perpendicularity was examined using another cleaved facet of the sample as shown in Fig. 2 and the error is within 0.02°. The devices with the active areas of $500\times200\ \mu m^2$ were tested around 200 K under pulsed operation using 200-ns-wide pulses with 100 pps.

Figure 3 shows the far-field pattern along the junction plane of the laser with that of the conventional Fabry-Perot laser. The emission angles are in very good agreement with the theoretical value (θ_{ex}) of 9.7°. The beams contain several peaks, the FWHM of which is about 0.5° and the intervals of the peaks are about 0.9°. The beam profile did not change in the measured current range of 11.5 A to 12.5 A, which shows the stability of the two-dimensional mode. We measured light output vs. injection current characteristics as shown in Fig. 4. It is noted that the threshold current of the two-dimensional mode is lower than that of the one-dimensional mode (conventional Fabry-Perot mode). The emission spectra of the two-dimensional and one-dimensional modes are shown in Figs. 5(a) and (b), respectively. The spectrum of the two-dimensional mode was more stable than that of the one-dimensional mode for the change of injection current.

In conclusion, we showed that the threshold current of the two-dimensional mode can be lower than that of the of the one-dimensional mode and the output beams are highly stable for the change of the injection current.

The authers would like to express their thanks to Dr. J. Umeda, Central Res. Lab., Hitachi Co. Ltd for kindly supplying GaAlAs wafers.

Reference: 1)M. Yamanishi et al., Jpn. J. Appl. Phys. 19 (1980) L739.

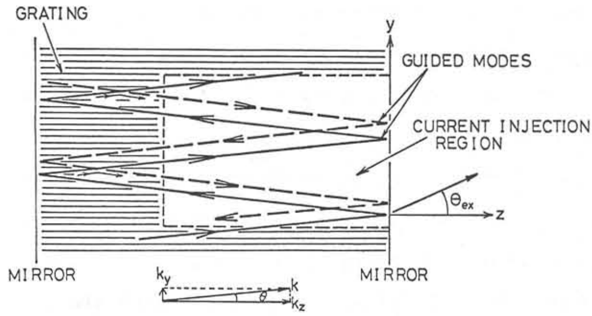


Fig. 1

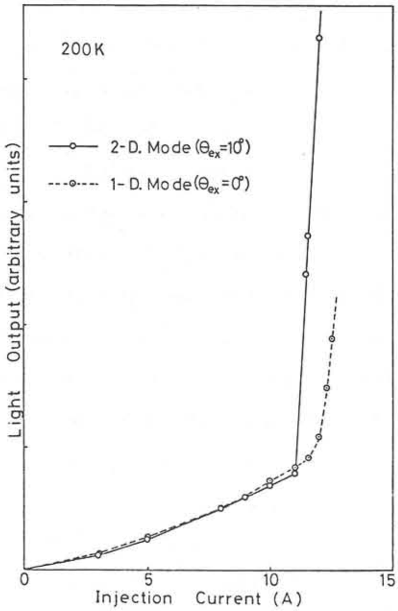


Fig. 4

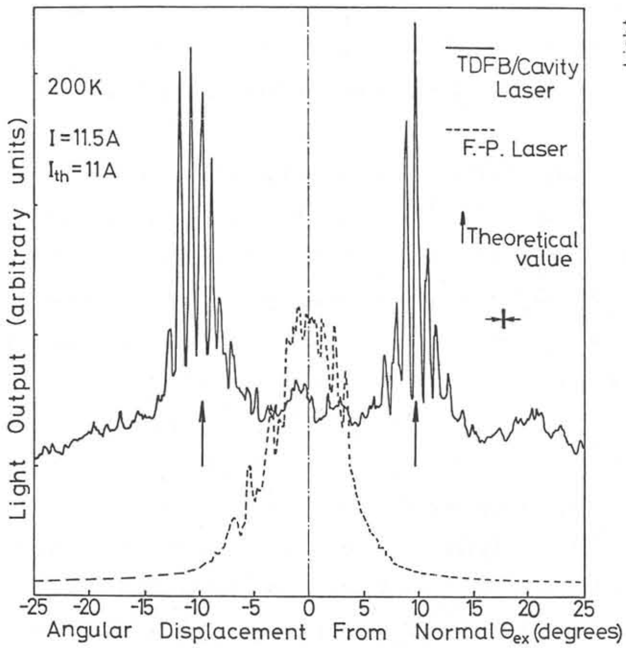


Fig. 3

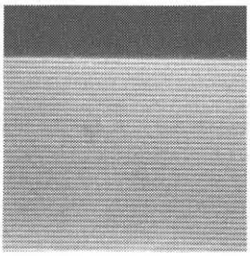
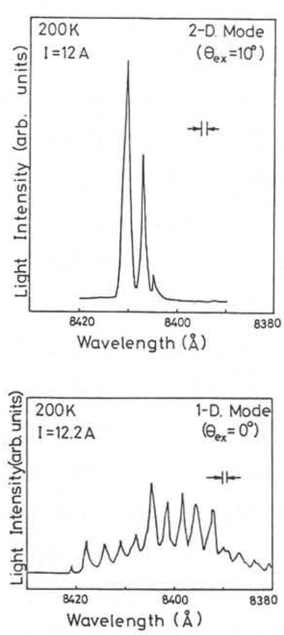


Fig. 2



(a)

(b)

Fig. 5