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B-4-2 (Invited) GaAs ACOUSTIC DISTRIBUTED FEEDBACK LASERS

M.YAMANISHI*, T.KAWAMURA*, K.TSUBOUCHI** AND N.MIKOSHIBA**

* Department of Electrical Engineering, University of Osaka Prefecture, Osaka,
** Research Institute of Electrical Communication, Tohoku University, Sendai.

The possibility of providing distributed feedback by acoustic waves has been pointed out by Kogelnik and Shank.[1] Ever since, the posibility has been attracting the attention of many solid state device researchers. However, none of the various proposed acoustic distributed feedback (ADFB) lasers have yet been realized, thus far. We proposed an ADFB laser[2] where a set of distributed Bragg reflectors (DBR's) and surface acoustic wave (SAW) form a two-dimensional feedback loop. After we attempted the excitation of a GHz-SAW by a grating converter on GaAs[3] and the demonstration of the oscillation[4] of our two-dimensional DBR laser by using a corrugation grating instead of SAW's, we have recently realized the ADFB laser,[5] proposed by us. In this paper, we review experiments of the ADFB lasers in addition to the theoretical scheme of the lasers.

Figure 1 shows the configuration of the laser. From Bragg conditions for the DBR and SAW, the oscillation wavelength λ_2 and the external emission angle θ_{ex} of the two-dimensional DFB mode are obtained theoretically as follows:[2]

$$\lambda_2=\frac{(2\Lambda_z/N_z)n_{eff}}{[1+(\Lambda_z/N_z)^2/\Lambda_a^2]^{1/2}}=\frac{\lambda_1}{[1+(\Lambda_z/N_z)^2/\Lambda_a^2]^{1/2}} \qquad (1)$$

and

$$\theta_{ex}=\sin^{-1}(\lambda_2/2\Lambda_a) \qquad (2)$$

where Λ_z and Λ_a are the period of the DBR's and the acoustic wavelength, respectively. n_{eff} and N_z denote the effective refractive index and an integer, representing the order of the Fourier component of the DBR's. High frequency SAW's (typical frequency~1.2GHz) were excited on the GaAs by mode conversion from bulk waves. The samples were pumped optically at 80 K by an N_2 laser.

Spectra of the output of the lasers are shown in Figs.2 and 3. Oscillations of the ADFB modes were observed when microwave power above a certain threshold was applied to a ZnO transducer on the back side of the GaAs.

At the present stage, although the lasers are optically pumped ones, it would be practically easy to construct current injection lasers with the ADFB's. In the presentation, the possibility of realizing injection lasers[6] will be theoretically considered. Also, we shall briefly discuss their application to wavelength tuneable and beam scanning lasers, and to very high speed repetitive Q-switching lasers.[7]

References

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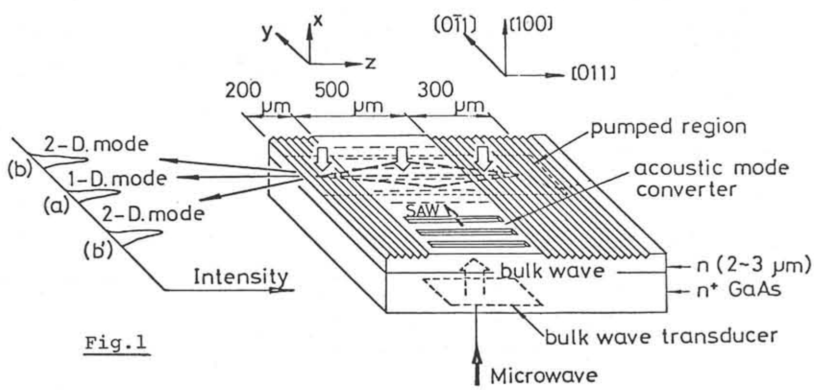

Fig.1

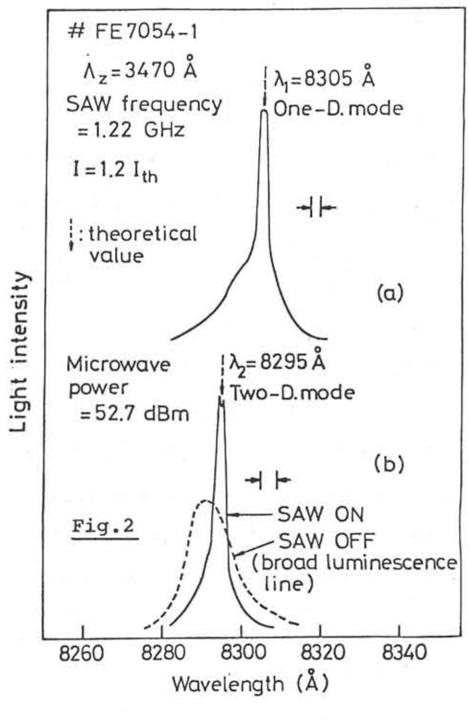

Fig.2

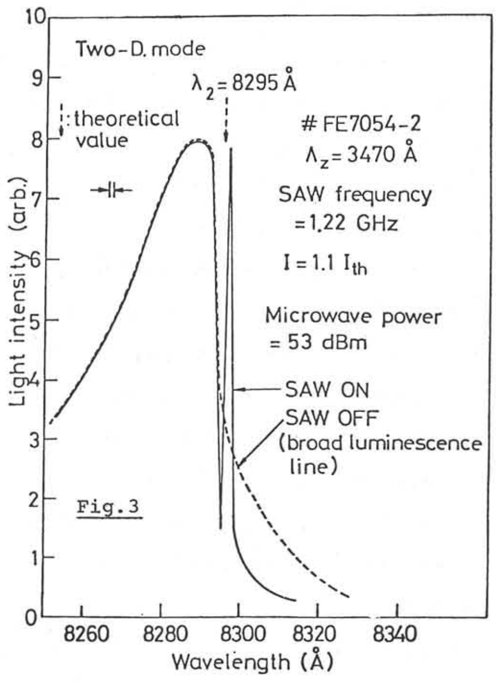

Fig.3