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# GaAlAs/GaAs Quantum Well Gain-Coupled Distributed Feedback Lasers

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We have been studying new distributed feedback (DFB) semiconductor lasers with gain coupling[1]. Here, we report a new scheme which realizes a periodical gain perturbation in the quantum well active layer for the gain coupling, together with characteristics under cw condition featured by a very high single-mode-oscillation yield near 100%.

First, we fabricated a device with a graded-index (GRIN) separate carrier and optical confinement heterostructure (SCH) single quantum well (SQW) by two step low pressure organo-metallic vapor phase epitaxy (OMVPE). The SQW active layer was made to have a periodic change in thickness for the gain coupling. Figure 1 shows an example of cross-sectional scanning electron micrographs (SEM) of the GRIN-SCH-SQW with thickness modulation. We examined the region near the SQW active layer by using transmission electron microscopy (TEM). A TEM photograph is shown in Fig.2. This figure tells that the thickness of the SQW active layer changes from 4 nm to 14 nm, and that there is no damage or dislocation in the vicinity of the SQW active layer. A threshold current of 31 mA has been obtained under cw condition. Complete single-longitudinal-mode oscillation has been achieved in all the measured devices (over one hundred) in spite of their cleaved facets. We believe that this very high yield of single-longitudinal-mode oscillation is one of the evidences showing the dominance of gain coupling in the lasers.

We found that the gain saturation of the SQW was affecting the performance of the devices. Therefore, the multiple quantum well (MQW) configuration with three wells (8.8 nm) was substituted for the SQW active layer. A threshold current of 28 mA, which is lower than the above value, has been obtained. Spectra showing the properties of the gain coupling are presented in Fig.3. The stop-band-like structure is not observed under threshold in Fig. 3(a). The spectrum at 8.5 mW shown in Fig. 3(b) maintains symmetry with respect to the main mode. This means that the longitudinal spatial hole burning is not so severe as in the cases of index-coupled DFB lasers.

In summary, we have demonstrated cw operation of the gain-coupled DFB lasers with SQW and MQW active layers for the first time.

1) For example, Y. Luo, Y. Nakano, K. Tada, T. Inoue, H. Hosomatsu, and H. Iwaoka, Appl. Phys. Lett. **56**, 1620 (1990).

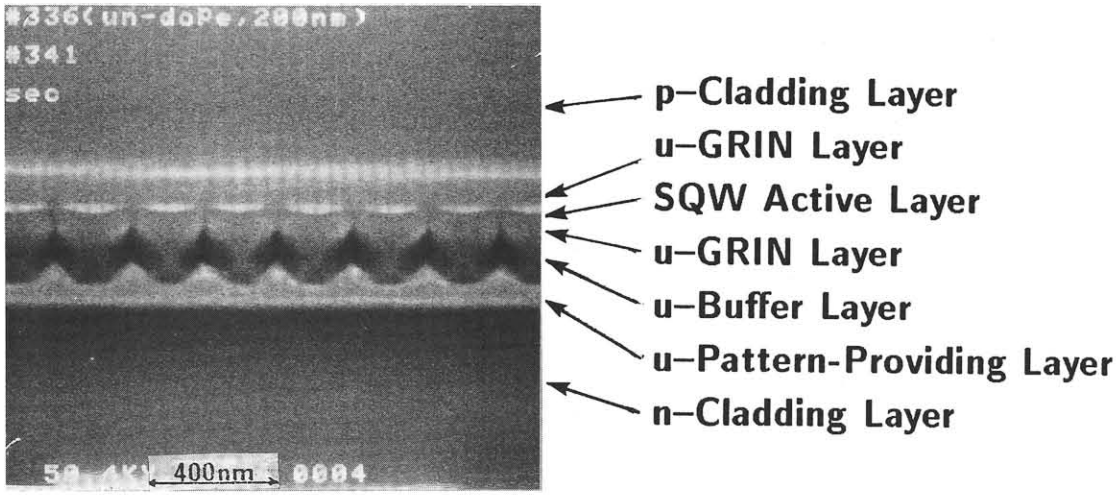


Fig.1 SEM photograph showing a longitudinal cross section of an SQW active layer with periodic thickness modulation for the gain coupling.

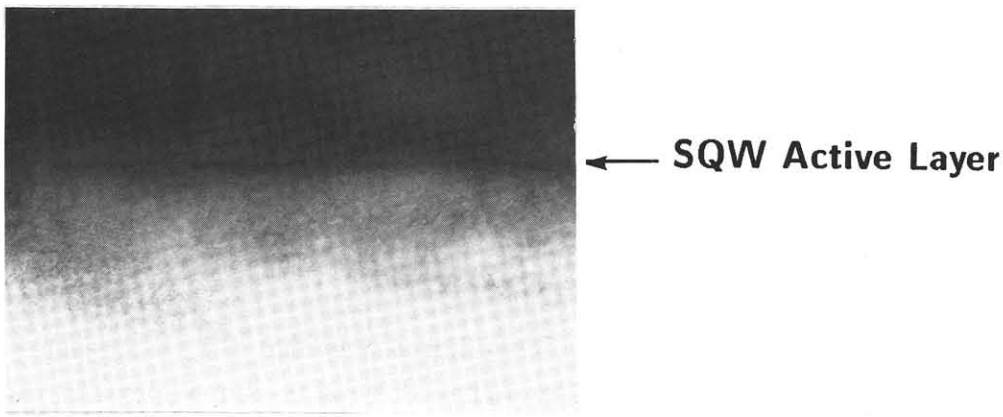


Fig.2 TEM photograph showing the vicinity of the SQW active layer.

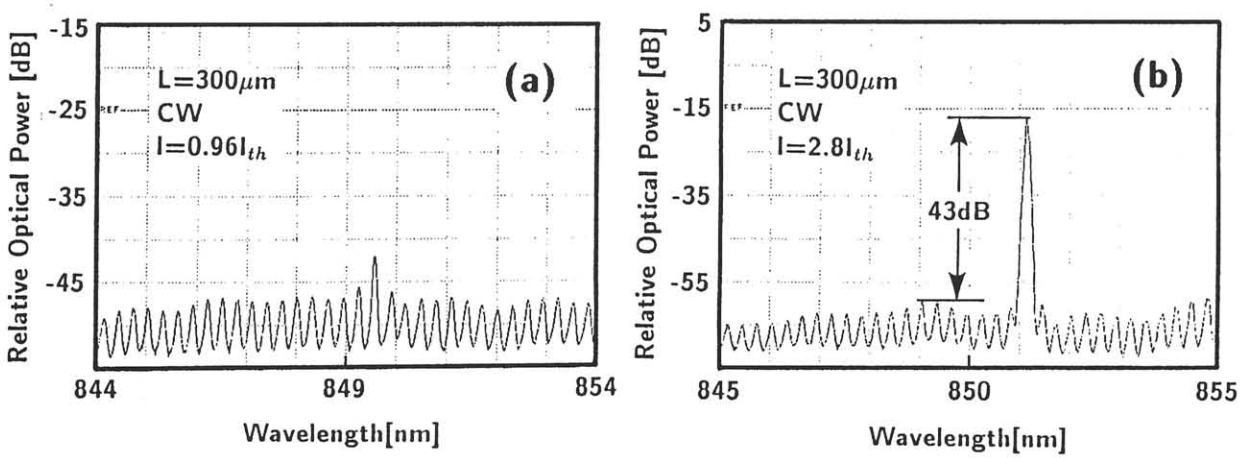


Fig.3 Spectra of an MQW device; (a) below threshold, and (b) at the output power of 8.5 mW.