Dislocation-Free Strained InGaAlAs MQW Growth over InGaAsP/InP Grating

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We present MOVPE growth of strained InGaAlAs-MQW/InP over InGaAsP/InP grating. We have successfully grown dislocation-free MQW located very close to the grating.

InGaAlAs lasers are superior to InGaAsP lasers in terms of temperature characteristics and modulation speed. For 10-Gbit/s data transmission over 10km up to 85℃, 1.3-μm InGaAlAs-MQW DFB lasers are necessary. There are some reports on InGaAsP-MQW over grating [1], but few reports on InGaAlAs-MQW. Adding to the compatibility of preserving grating shape and introducing no dislocation, in this case, there is still a problem of discrepancy of fit growth temperature among InP (600℃) and InGaAlAs (~ 700℃[2]).

We have used low-pressure metalorganic vapor phase epitaxy for overgrowth. The substrate has a chemically through-etched InGaAsP (λ_{PL} = 1.2 μm) grating capped with InP. The periodicity of the grating is 203nm. Figure 1 shows the structure of the overgrown layers. We have not used arsenic pressure in heating up and initiated the overgrowth with InP at the growth temperature T and the growth rate R. First, influences of R were investigated at $T = 550$℃. When $R = 2.2$ μm/h, standard condition for bulk InP growth, the surface of the overgrown layer became rough, while at R of ≤ 0.7 μm/h flat surfaces were obtained. Then we changed T in a range from 490℃ to 600℃ at $R = 0.7$ μm/h. The lower the T, the better the gratings were preserved, but dislocation occurred at $T \leq 550$ ℃ (Figure 2). We have obtained the best result under the condition of $R = 0.7$ μm/h and $T = 570$℃. Combining this growth condition with a right procedure of heating to the InGaAlAs growth temperature, we have been able to stack the MQW only 70nm above the grating with no dislocation (Figure 3). A sharp PL spectrum have been observed (Figure 4).

After we had optimized growth condition, we fabricated DFB lasers. A typical *L-I* curve and lasing spectrum are shown in fig. 5 and fig. 6, indicating good crystal quality of the laser.

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[1] T. Koui et al., J. of Crystal Growth, vol. 195, pp. 503－509, 1998

[2] T. Tsuchiya et al., Conference Proceedings of IPRM 2000, pp. 266－269, 2000

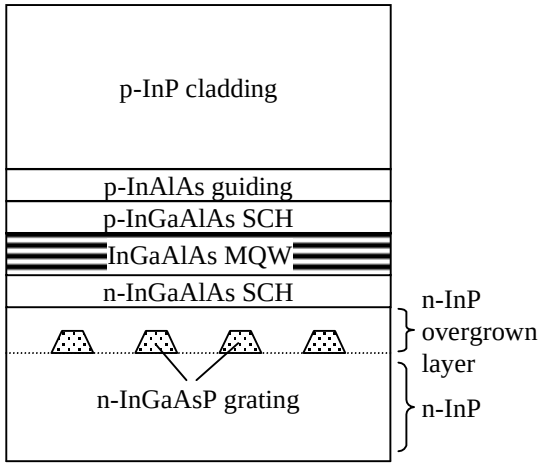

Fig. 1 Structure of the overgrown layers

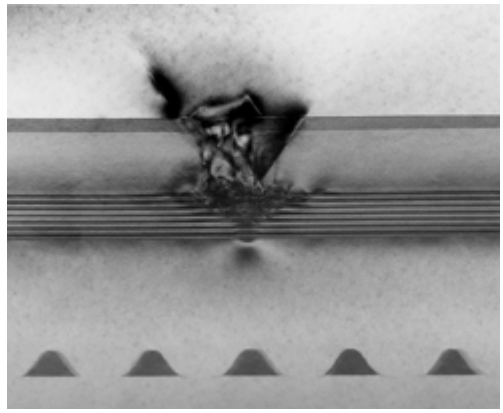

Fig. 2 Dislocation nucleating under growth condition of T=490℃ (TEM image)

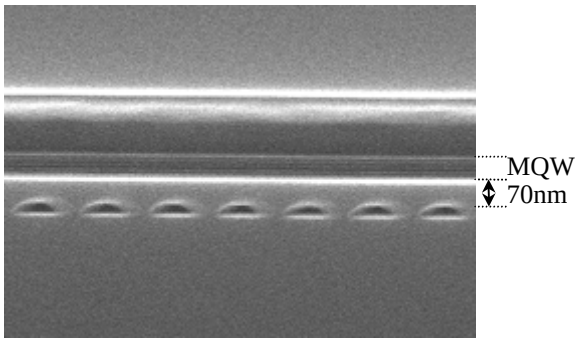

Fig. 3 Cross sectional SEM image of the overgrown layers under the best condition (T = 570℃, R = 0.5 μm/h)

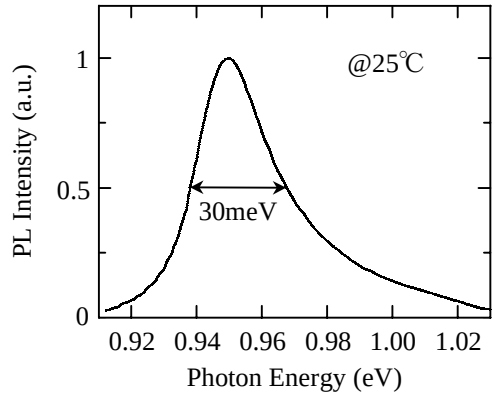

Fig. 4 PL spectrum of the overgrown MQW

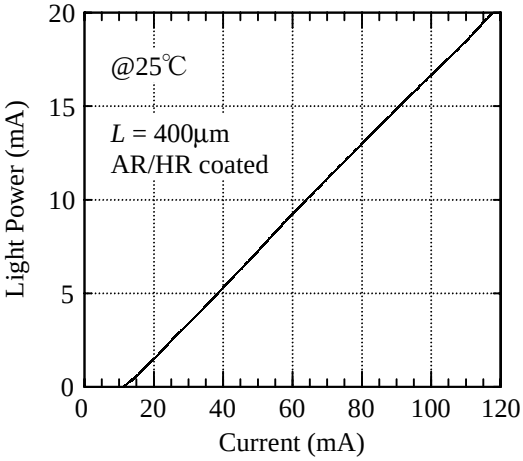

Fig. 5 Light versus current characteristics of the InGaAlAs-MQW DFB laser

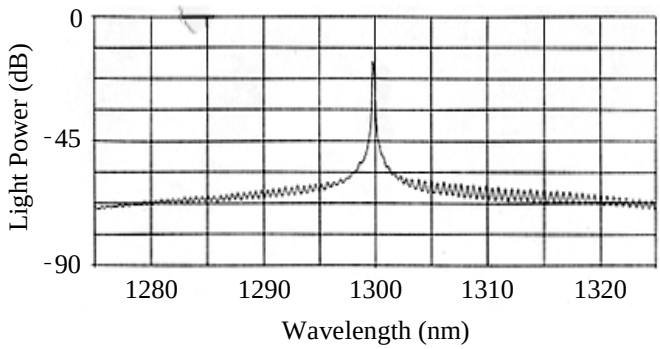

Fig. 6 Lasing spectrum of the DFB laser