B-2-1 (Invited) LPE and Characteristics of GaInAsP/InP 1.5 μm Region Laser Diodes

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Introduction

There have been intensive interests in a 1.5~1.6 μm wavelength region light source for the optical communication system, because of the minimum loss near 1.55 μm and small dispersion in high quality silica fibers. These wavelength region can be covered with GaInAsP/InP DH lasers. However, in LPE, there had been a serious problem of melt-back of the quaternary active layer by the In-P melt which was used for the growth of an InP confining layer. This problem was solved by three methods. They are low temperature LPE(580~600 °C)[1], growth of an anti-meltback layer[2] and growth of InP confining layer under large amount of supersaturation(10~12 °C) at conventional LPE temperature(630~650 °C)[3]. It has been known that GaInAsP/InP 1.5 μm region lasers fabricated by these methods shows comparable characteristics as that of 1.1~1.3 μm region lasers. This paper describes the low temperature LPE and characteristics of 1.5 μm region lasers[4].

Low temperature LPE

Low temperature LPE has several following advantages other than to prevent the dissolution of the active layer.

1 Thermal decomposition of InP substrate is considerably reduced.
2 Diffusion of Zn from the Zn-doped InP is expected to be small.
3 The low growth rate makes it easier to grow the thin active layer.
4 Epitaxial layer surface is flat compared with that of the crystal grown at conventional temperature.

But, there is one problem in the low temperature LPE. The amount of P in the melt for the growth of GaInAsP becomes very small, and it is difficult to weigh source InP with high accuracy. To overcome this difficulty, a modified source-seed method is applied by using a specially designed carbon boat.

Structure and characteristics

Two types of the laser diodes, planar stripe structure and buried-heterostructure, were fabricated.

[Planar stripe lasers] : Threshold current (I_{th}) value was independent of the oscillation wavelength (active layer composition) in the wavelength region of 1.53~1.60 μm. Other results of investigation are as follows.

1 I_{th} shows minimum at stripe width of 13 μm (170 mA, CW, 27 °C).

2 T_0 is in the range of 65～70 K.

3 CW operation is possible up to 53 °C.

4 "Kink free" I-L characteristics is obtained up to 7～8 mW for the lasers of 6μm stripe width.

5 Half-width value of longitudinal mode envelope is about 30 Å at 800 Mbit/s in lasers with a 6 μm stripe width.

[Buried-heterostructure lasers]: It is well known that I_{th} value of the GaInAsP/InP lasers have high temperature sensitivity. Since the highest diode stem temperature is supposed to be 50 °C in the fiber communication systems, the development of a low I_{th} laser is now of an urgent necessity.
To realize a low I_{th} laser in the 1.5 μm region, buried-heterostructure, which had been successfuly applied to 1.3 μm region lasers,[5,6] was investigated.
The lasing characteristics of a laser with 2.5 μm active layer width and 200 μm cavity length were evaluated at room temperature under CW operation.
The minimum threshold current was 25 mA at 26 °C.
Stable fundamental transverse mode operation was confirmed by the observation of far field pattern. The differential quantum effeciency was typically 25 % per facet. The emitting wavelength was 1.55 μm, and single longitudinal mode operation were obtained. T_0 value was found to be 55～60 K in the range of 0～50 °C, and the temperature limit for CW operation was 65 °C.
Accelerated life test (40 °C, 5mW/facet, APC) of this buried-heterostructure lasers is now in progress.

References

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