LETTER

First Room Temperature CW Operation of GaInAsP/InP Surface Emitting Laser

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SUMMARY We have achieved the room temperature cw lasing operation of GaInAsP/InP surface emitting lasers for the first time. By employing a buried heterostructure with 1.3 μm range active region and a MgO/Si heat sink mirror, cw operation was obtained up to 14°C with the threshold current of 22 mA.
key words: *surface emitting laser, semiconductor laser, buried heterostructure, GaInAsP/InP, optical fiber communication*

GaInAsP/InP vertical cavity surface emitting laser diodes (SELDs) are attracting much interest for new era optical fiber communication systems and optical interconnects. So far, room temperature pulsed operations of GaInAsP/InP SELDs have been realized [1]-[4], and a high temperature operation and a quasi-cw operation were also reported for photo-pumped devices [5], [6]. However, the cw operating temperature for current injection devices was limited to −126°C [7]. Very recently, we have reported cw operation at −31°C by introducing a buried heterostructure named circular planar buried heterostructure (CPBH) and a thermally conductive MgO/Si multilayer heat sink mirror [8]. Those features allow for strong carrier confinement and efficient heat sinking. In this study, we further reduced the threshold level by increasing the mirror reflectivity and accelerated the heat sinking by bonding devices on a diamond heat sink.

The device structure, as illustrated in Fig. 1, and the fabrication process of the device were very similar to those described previously [8], [9]. The circular active region (1.3 μm of wavelength, 0.7 μm in thickness, 12 μm in diameter) was buried by current blocking layers and cladding layer through a single step PBH regrowth process. The series resistance was typically as low as 10 Ω owing to the smooth current flow in the thick contact layer with the aperture of 14 μm in diameter [9]. In this experiment, we enhanced the mirror reflectivity by adding a pair of dielectric multilayers to the previously reported ones, i.e. 8.5 pairs of MgO/Si for p-side and 6 pairs of SiO_2/Si for n-side. Both of multilayers deposited on test InP wafers exhibited reflectivity of 99.4%, the accuracy limit of measurement. The devices were bonded p-side down on a Au-coated diamond heat sink with a Ga solder.

The minimum threshold current for measured devices at 77 K under cw condition was 0.42 mA. Figure 2 shows the cw lasing characteristic of one device, which operated up to 14°C. The threshold current at this temperature was as low as 22 mA. Because of extremely high reflectivity of both heat sink mirror and output mirror, the output power level is estimated to be several μW. However, we can see a single mode spectrum above threshold with the spectral width of 0.2 nm, the resolution limit of the optical spectrum analyzer used. From the observation of the near field pattern, we found a circular spot profile. The far field divergence full angle was 4.2 degrees at half maximum.

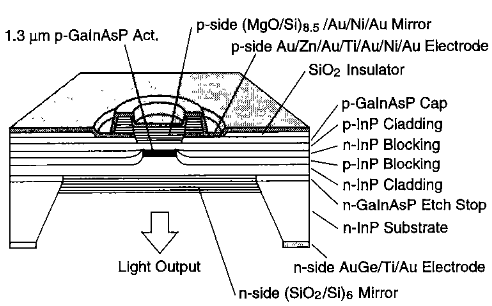

Fig. 1 Structure of GaInAsP/InP surface emitting laser.

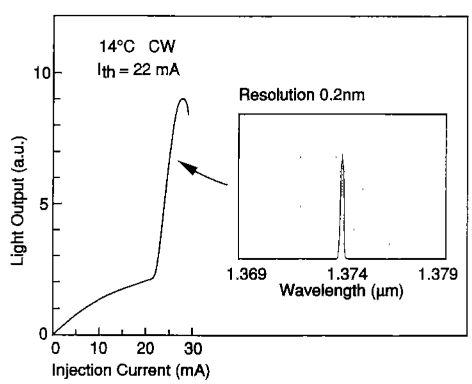

Fig. 2 Room temperature cw lasing characteristic.

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We have successfully achieved room temperature cw lasing in 1.3 μm GaInAsP/InP surface emitting lasers. High temperature operation and output power are the next targets, which will be obtained by the reduction of internal cavity loss and the optimization of mirror reflectivities.

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