Extended Abstracts of the 16th (1984 International) Conference on Solid State Devices and Materials, Kobe, 1984, pp. 157-160

C-3-4

A Comparison of C^3 and Novel Passive Cavity Single Frequency Lasers Operating at 1.55 Micron

R Plastow, A C Carter and P J Williams

Plessey Research (Caswell) Ltd
Allen Clark Research Centre
Caswell Towcester Northants

We report the operation of two types of 1.55 micron wavelength single longitudinal mode laser, one using a novel self-aligned external cavity, the other a C^3 device using multiple infil buried heterostructure technology. The novel device shows adjacent mode rejection of better than 200:1 over a temperature range of 16°C, the C^3 laser shows better than 1000:1 mode rejection over a 3°C temperature range.

INTRODUCTION AND BACKGROUND

Single longitudinal mode lasers operating at a wavelength of 1.5 micron are an important component for long haul telecommunication systems. Many types of single mode laser have been described, including those with internal wavelength selection (DFB, DBR), those with a passive external cavity(1,2,3) and those with an active external cavity (C^3) (4,5). The DFB/DBR devices operate over a broad current and temperature range but are complicated to fabricate, whereas the C^3 laser is simple to produce but requires additional control circuitry. We describe in this paper a simple to fabricate novel self-aligned structure which operates in a single mode over a temperature range of 16°C with an adjacent mode rejection of 200:1, and compare its performance with C^3 lasers showing superior mode rejection over a more limited temperature and current range.

STRUCTURE AND FABRICATION

Both devices are based on the multiple infil buried heterostructure laser(6), grown by LPE and with a wavelength of 1.55 micron. The C^3 laser consists of two such lasers cleaved and subsequently held in close alignment. They are optically coupled but electrically separate, and both cavities are separately electrically driven.

The structure of the novel device is shown in Figure 1. It consists of a 1.55 micron wavelength multiple infill buried heterostructure laser with an external passive cavity comprising a cleaved semiconductor chip with a reflective metallic coating on one facet. The chip is transparent to 1.55 micron emission and is conveniently fabricated from InP single crystal material. The external cavity is thus purely passive, unlike the C^3 laser where the cavity is run under conditions of gain. We have found the gap between the cavities to be non-critical in our device, and this can be attributed to the lack of gain in the rear cavity.

Two major advantages arise from using semiconductor material rather than an air gap for the external cavity; the refractive index of the cavity and laser have a similar temperature variation, thus the loss modulation with wavelength due to the external cavity remains constant with temperature and also the passive cavity mirror is automatically aligned by butting the two chips together whilst solder bonding. This results in a compact and stable assembly.

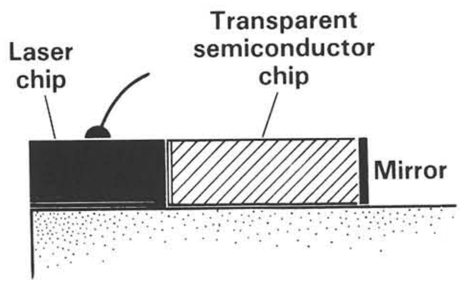


Fig. 1 Structure of Novel Passive Cavity Device

SINGLE MODE PERFORMANCE

Figure 2 shows the regions of single mode performance for a C^3 laser, plotted as a function of current to the two sections of the device. In the regions marked "rapid scan" one of the sections is well below threshold and a small change of current to this section causes a large change in refractive index and a rapid scan between, in this case, twelve separate longitudinal modes. More equal distribution of current gives regions of stable single mode operation over a broader current range, although both instability (shaded region) and bistability are possible for certain current ranges. The temperature range over which any one particular longitudinal mode is stable is 2 to 3°C in this device.

Figure 3 shows the spectrum of a C^3 laser operating at 1.55 micron. Adjacent mode rejection is 1000:1. Figure 4 shows the spectrum of a self-aligned device operating at 1.55 micron. Mode separation is 12 Å, and adjacent mode rejection is better than 200:1. This rejection ratio is maintained over a temperature range of 16°C (10°C - 26°C) over which the mode moves smoothly at a rate of 0.9 Å/°C, continuously tuning over nearly 16 Å. Bias current was 60 mA and threshold of this particular device was 29 mA at 20°C. Single mode operation was also observed for a bias current range of 40 mA at 20°C.

SYSTEM RELATED MEASUREMENTS

Errir rate measurements have been performed on the single mode of both types of device through a monochromator to simulate a dispersive fibre link. The absence of mode partition effects at a modulation rate of 565 Mb/s was confirmed. Dynamic spectral linewidth of the novel device was typically 2 Å for 95% modulation depth, with a peak current 30 mA above threshold. Such a linewidth should not impose a significant limitation on the transmission capacity with these devices.

CONCLUSION

We have demonstrated both a C and a novel external passive cavity laser operating at 1.55 micron. Both structures are suitable sources for long haul telecommunication systems.

REFERENCES

1. K R Preston et al, Elec Lett, 1981, 17, pp.931-933
2. Chinlon Lin et al, Elec Lett, 1983, 19, pp.561-562
3. K Y Liou, Elec Lett, 1983, 19, pp.750-771
4. W T Tsang et al, APL, 42, (8), Alp 1983, pp.650-652
5. R Plastow et al, OFC 1983, New Orleans
6. R Plastow et al, Elec Lett, 1982, 18, pp.262-263.

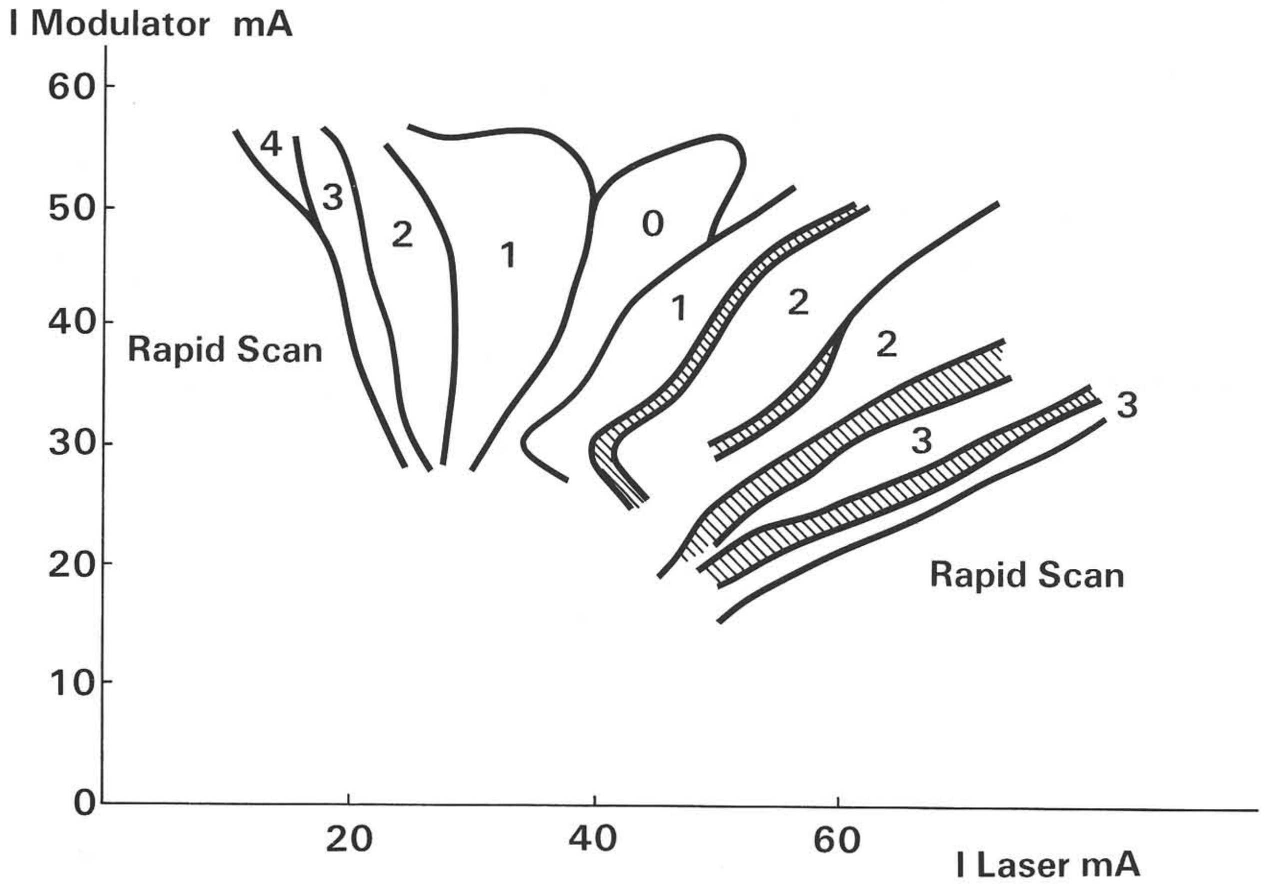


Fig. 2 Regions of Single Mode Operation of C^3 Laser

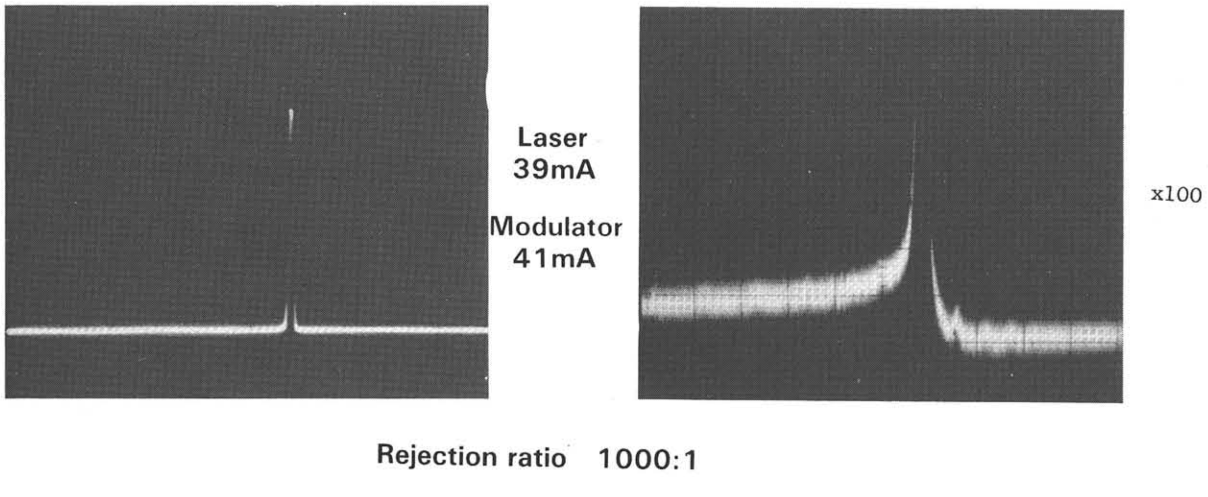
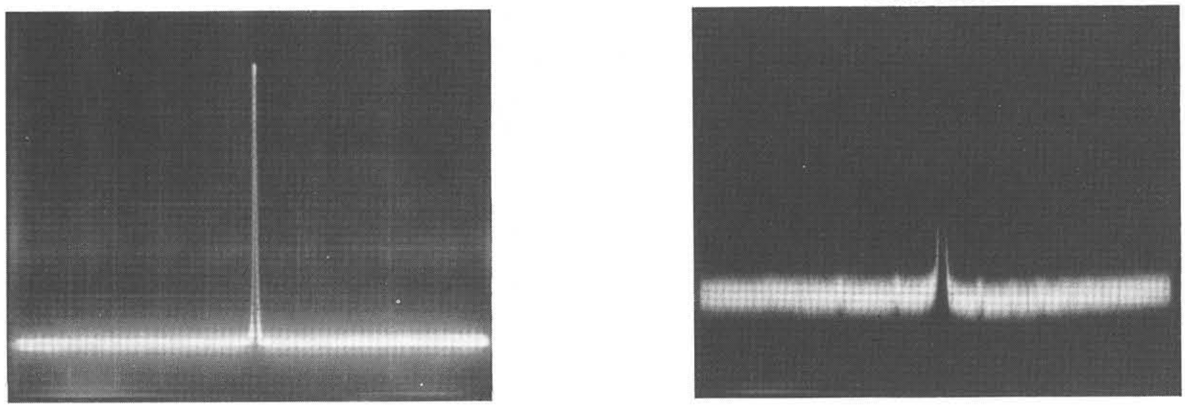


Fig. 3 Spectrum of C^3 Laser

Bias 52mA



x25

12A/mode

Fig. 4 Spectrum of Novel Passive Cavity Laser