Extended Abstracts of the 19th Conference on Solid State Devices and Materials, Tokyo, 1987, pp. 521-522

B-10-2 (LN)

Tunable Wavelength Conversion Using a Multi-Electrode DFB LD with a Saturable Absorber

H. Kawaguchi, K. Oe, H. Yasaka, K. Magari, M. Fukuda, and Y. Itaya

Electrical Communications Laboratories
Nippon Telegraph and Telephone Corporation
3-1, Morinosato, Wakamiya Atsugi-shi, Kanagawa

Wavelength conversion devices for photonic switching and optical computing has been expected for the long time. Tunable wavelength conversion is successfully demonstrated here for the first time using a multi-electrode DFB LD with a saturable absorber. The laser emits coherent light that can be tuned over more than 2.2 Å by changing its current distribution, when laser light is injected into a saturable absorbing region. This device operated for both TE and TM polarized input. Therefore, the system will be simple to construct because polarization matching is not necessary.

The p-type electrode of the 1.55 μm InGaAsP/InP buried heterostructure DFB LD is divided into three sections as shown in Fig. 1. Each section is 100 μm long. The resistance between electrodes is about 100 Ω, which is sufficiently large compared with the resistance between the p- and n-type electrodes. Thus the divided regions can be excited independently through the electrodes.

The driving current was not injected into the electrode located on the side ($I_1 = 0$ in Fig. 1). The non-injected region acts as a saturable absorber and the absorption coefficient decreases with increasing input optical power[1]. Therefore, the current vs. light output curve shows bistability. When the bias current ($I_b=I_2+I_3$) is set to just below the turn-off threshold as shown in Fig. 2(a), the laser can be switched from OFF to ON by the injection of optical power into the saturable absorber because the turn-on threshold is decreased (Fig. 2(b)).

The lasing wavelength of the multi-electrode DFB LD can be tuned by changing the driving current I_2 and I_3 in Fig. 1[2]. Figure 3 shows the lasing wavelength vs. the current ratio $I_3/(I_2+I_3)$ for both the TE and TM polarized light input. The lasing wavelength was swept over 2.8 Å for the TE input (1.55295 μm, ∼110 μW) and 2.2 Å for the TM input (1.5528 μm, ∼330 μW) without any mode hopping, when the ratio $I_3/(I_2+I_3)$ changed from 0.1 to 0.42. The laser operated with a single longitudinal TE mode for both cases, and the output power was about 1 mW. The coupling losses were estimated to be around 10dB for input and 5dB for output.

Switching time was measured to be 50 MHz by using the input pulse train generated by direct current modulation. This switching time will be improved by using a larger optical input and by decreasing the amount of hysteresis. This device can also be used for a regenerative optical amplifier with a pulse-shaping function.

References

1) H. Kawaguchi, Appl. Phys. Lett., 41 (1982) 702.
2) Y. Yoshikuni and G. Motosugi, IEEE J. Lightwave Tech., LT-5 (1987) 516.

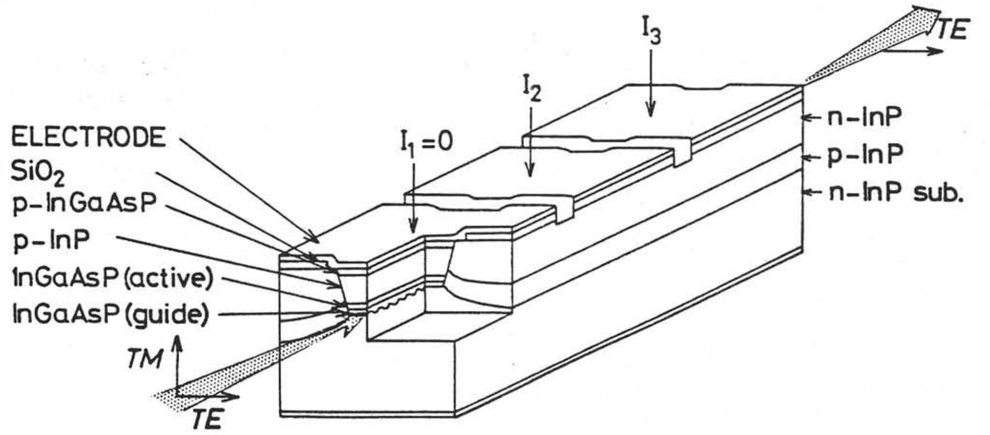
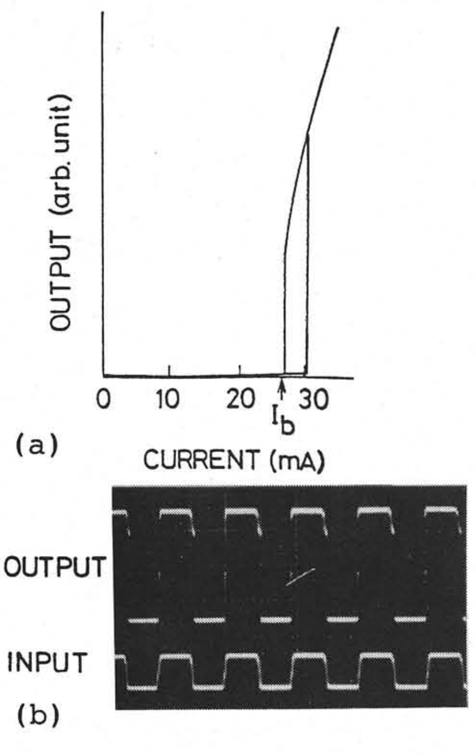


Fig. 1 Structure of a multi-electrode DFB LD with a saturable absorber



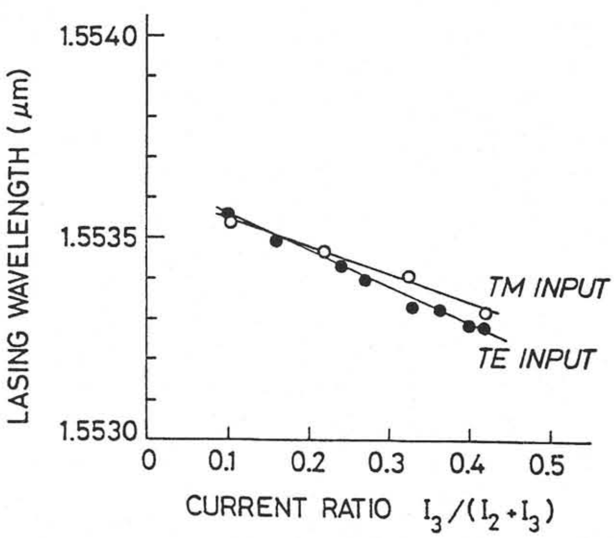


Fig. 3 Lasing wavelength dependency on current ratio $I_3/(I_2+I_3)$ with optical input

Fig. 2 (a) Current vs. light output curve
(b) Optical input and output waveforms