



**HAL**  
open science

# 1.5 $\mu$ m PHASE SHIFTED DISTRIBUTED FEEDBACK LASER

M. Gilleron, J. Charil, D. Lesterlin, P. Correc, J. Bouley

► **To cite this version:**

M. Gilleron, J. Charil, D. Lesterlin, P. Correc, J. Bouley. 1.5 $\mu$ m PHASE SHIFTED DISTRIBUTED FEEDBACK LASER. Journal de Physique Colloques, 1988, 49 (C4), pp.C4-337-C4-339. 10.1051/jphyscol:1988471 . jpa-00227969

**HAL Id: jpa-00227969**

**<https://hal.science/jpa-00227969>**

Submitted on 4 Feb 2008

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

### 1.5 $\mu\text{m}$ PHASE SHIFTED DISTRIBUTED FEEDBACK LASER

M. GILLERON, J. CHARIL, D. LESTERLIN, P. CORREC and J.C. BOULEY

*Centre National d'Etudes des Télécommunications, Laboratoire de Bagneux, 196, Av. Henri Ravera, F-92220 Bagneux, France*

**Résumé** - Nous présentons la conception, la technologie de fabrication et les propriétés d'émission de lasers à contre-réaction distribuée déphasée. L'utilisation d'un ruban de largeur non uniforme conduit à un pourcentage plus élevé de fonctionnement monomodal.

**Abstract** - We present the design, technology and lasing properties of phase-shifted distributed feedback lasers. The use of a non-uniform width stripe leads to a higher percentage of single-longitudinal-mode operation.

#### 1-INTRODUCTION

GaInAsP/InP distributed feedback (DFB) lasers are attractive light sources for long-haul, high bit-rate optical fibre transmission systems. In order to improve the single-mode operation yield, many structures have been proposed /1,2,3/ to introduce an optical phase-shift inside the cavity to remove the wavelength degeneracy and suppress the wavelength dependence on the facet positions usually observed in the conventional DFB lasers. In this paper, we present the technology and properties of a 1.55 $\mu\text{m}$  Phase-Shifted Buried Ridge Stripe (PS-BRS) laser easily obtained by adjusting the optical wave propagation constant with a longitudinally non-uniform stripe width.

#### 2-STRUCTURE

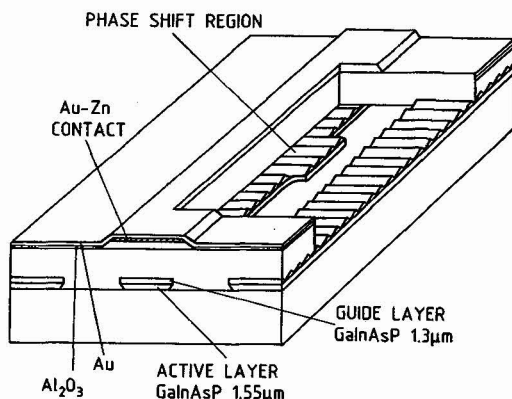


Fig. 1: Schematic view of the 1.5 $\mu\text{m}$  Phase-Shifted Buried Ridge Stripe laser.

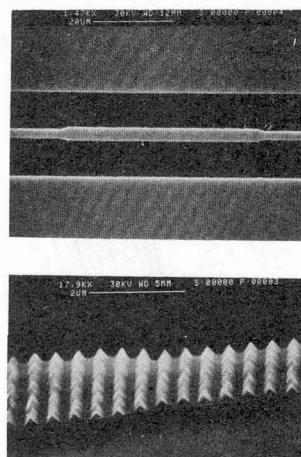


Fig. 2: SEM photograph of the phase shifter before the second epitaxy.

The PS-BRS laser, derived from the BRS structure /4/, is schematically shown in Fig. 1. The laser reported here has been entirely grown by Liquid Phase Epitaxy (LPE). First, a n-InP buffer layer, a 1.5 $\mu\text{m}$  GaInAsP active layer and a 1.37 $\mu\text{m}$  GaInAsP guide layer were successively grown by two-phase LPE. Then, a 2<sup>nd</sup> order grating was chemically etched into the guide layer and a non-uniform width stripe selectively etched into the active and guide layers (Fig. 2). Finally, single-phase, low-temperature LPE was used to overgrow the

burying p-InP and the contact p<sup>+</sup>-quaternary layers. GaAs protection cover was used to reduce the grating deformation likely to occur during the heating period prior to overgrowth. Classical technologies were used to obtain 300μm-long laser chips.

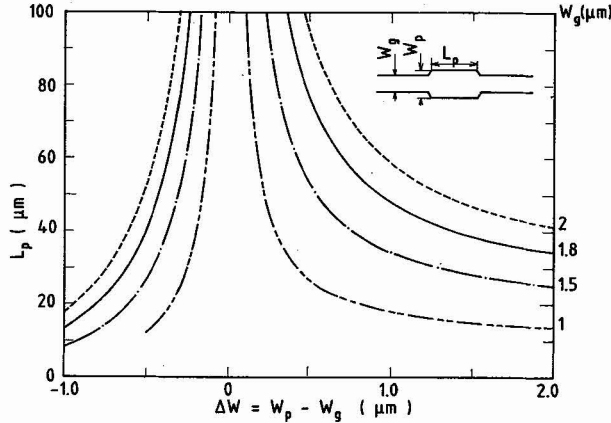


Fig. 3: Calculated relationship between the phase shifter length  $L_p$  and the stripe widening (narrowing) of the stripe  $\Delta W$ .

The wider stripe region of width  $W_p$  and length  $L_p=50\mu m$  acts as a phase shifter and has been designed to produce a  $\pi/2$ -phase shift /1,3/. The nominal stripe width of the mask is  $2\mu m$  but, because of underetching, the actual uniform stripe width  $W_g$  is  $1.8\mu m$ . To avoid parasitic reflections at the ends of the phase shifter, tapered regions were introduced to connect it smoothly to the uniform regions and the widening of the stripe  $\Delta W=W_p - W_g$  was set to  $1\mu m$ . Fig. 3 shows the calculated relationship between the phase shifter length  $L_p$  and the widening (narrowing) of the stripe  $\Delta W$ . We notice that  $L_p$  is rather sensitive to  $W_g$ . For example, if, because of excessive etching,  $W_g$  decreases from  $1.8$  to  $1.5\mu m$ , the optimum phase shifter length decreases from  $50$  to  $35\mu m$  and a  $50\mu m$ -long phase shifter designed for  $W_g=1.8\mu m$  and  $\Delta W=1\mu m$  will produce a total phase-shift of  $0.7\pi$ . Hence, the lasing properties of the resulting lasers will be severely degraded.

**3-LASING CHARACTERISTICS**

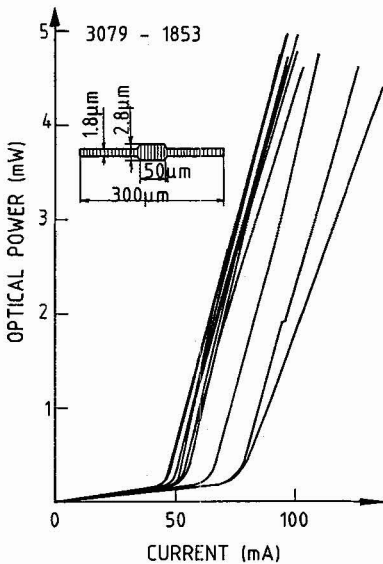


Fig. 4: Typical light-current characteristics of a PS-BRS.

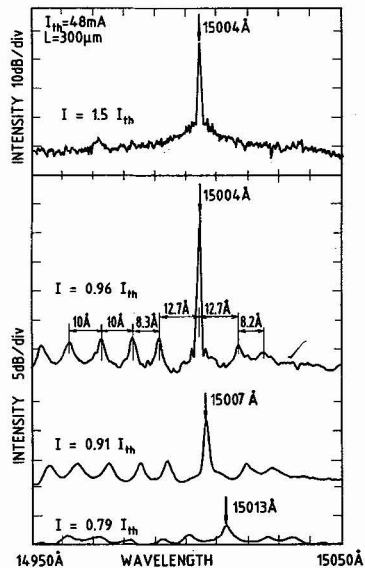


Fig. 5: Sub- and above-threshold spectra of a PS-BRS laser with an anti-reflection coated front facet

Fig. 4 shows the light-current characteristics of 12 unselected lasers measured from the same cleaved bar. Threshold currents range between 40 and 50 mA. Almost 90% of the mounted lasers exhibited CW single longitudinal mode (SLM) operation with a side mode suppression ratio greater than 30 dB.

Fig. 5 shows typical sub- and above-threshold spectra of a PS-BRS laser with an anti-reflection coated front facet. Above threshold, the laser exhibits mode hopping free SLM operation up to the optical power saturation due to the current leakage of the BRS structure. SLM operation is also observed with a main mode and side modes located symmetrically to the main mode. This symmetry demonstrates the effect of the phase shifter on mode selection and validates the stripe design.

#### **4-CONCLUSION**

We have reported on the design, technology and lasing characteristics of PS-BRS lasers. We have experimentally observed that the percentage of SLM operation is higher for such lasers than for conventional lasers with uniform width stripes.

#### **5-REFERENCES**

- /1/ H. Soda, Y. Kotaki, H. Sudo, H. Ishikawa, S. Yamakoshi and H. Imai, IEEE J. Quantum Electron., QE-23 (1987) 804.
- /2/ K. Utaka, S. Akiba, K. Sakai and Y. Matsushima, IEEE J. Quantum Electron., QE-22 (1986) 1042.
- /3/ B. Broberg, S. Koentjoro, K. Furuya and Y. Suematsu, Appl. Phys. Lett. 47 (1985) 4.
- /4/ D. Lesterlin, J. Charil, B. Rose, M. Gilleron, P. Correc and J.C. Bouley, Proc. ESSDERC'87 (Sept. 1987) 803.