Fast Power Control and Wavelength Switching in a Tunable SOA-Integrated SGDBR Laser

Hui Lv [1], Tan Shu [1], Yonglin Yu[1], Dexiu Huang[1], Lei Dong[2] and Ruikang Zhang [2]
[1] Wuhan National Laboratory for Optoelectronics, College of Optoelectronic Science and Enginnering, Huazhong University of Science & Technology, Wuhan, 430074, China
Phone: +(27)87792242-808, Fax: +(27)87792225,
Email: simonlv76@smail.hust.edu.cn, yonglinyu@mail.hust.edu.cn
([2] Accelink Technologies Co., Ltd., Wuhan, 430074, China)

Abstract
We demonstrated fast optical power control and wavelength switching in a tunable SOA-integrated SGDBR laser. With our design, output power of the laser can be precisely controlled within 0.1 dB and rapidly shuttered within 2 ns.

Introduction

Sampled grating distributed Bragg reflector (SGDBR) lasers have attracted attentions for their applications in dense wavelength division multiplexing (DWDM) systems and optical packet switching networks, due to their wide wavelength tuning range, high side mode suppression ratio (SMSR) and the advantage to be easily monolithically integrated with other devices such as semiconductor optical amplifier (SOA) and electro-absoption modulator (EAM) [1].

In DWDM applications, however, less variation of output power between wavelength channels is desired. Integrated-SOA could help to precisely control output power by changing the driving current to SOA. For optical switching and wavelength routing architectures, integrated-SOA can be used as a beam shutter to eliminate interference due to wavelength switching transients [2-3].

We demonstrated fast optical power cotrol and wavelength switching in a tunable SOA-integrated SGDBR laser. With our design, output power of the laser can be precisely controlled within 0.1 dB and the laser can be shuttered within 2 ns.

Optical Variable Power Control

Previously we have reported a ridge waveguide sampled-grating distributed Bragg reflector laser with quasi-continuous wavelength coverage over 35nm [4]. Here, a SOA section is integrated in the front of the front mirror section of the SGDBR laser, as shown in Fig. 1. To facilitate fast control of the device, a high-speed current driving board was developed, which is simliar design with the report in [5]. In this case, an additional current driving circuit for the SOA section is included.

Fig. 2 shows superimposed output spectra of selected five ITU wavelength channels, where the gain and SOA currents are set first at constant values of 110 mA and 140 mA respectively. Form Fig.2(a), we can see that the maximum power difference among the five wavelength channels is nearly 4 dB. This is caused by inherent design and imperfections during fabrication of the sampled gratings. The situation, however, could be improved by introduction of the integrated-SOA. With changing the current to the SOA, variable optical power control can be achieved. As shown in Fig. 2(b), the output power of about 5 dBm for different channels has been achieved. Comparing to Fig. 2(a), the power difference between different channels can be restrained

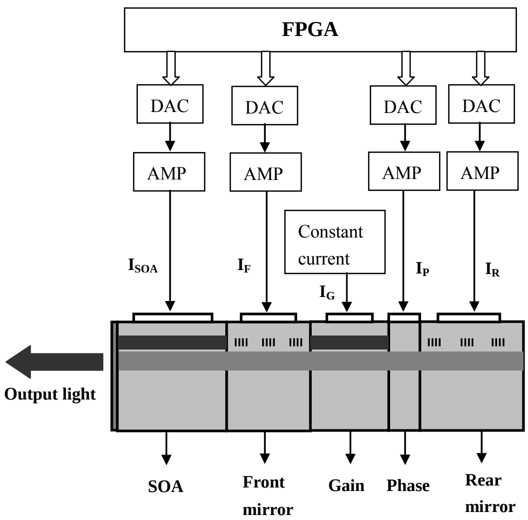
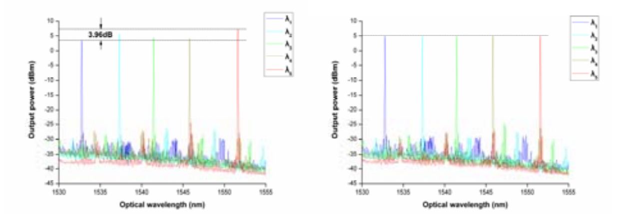


Fig. 1. Schemiatic diagram of the integrated laser and high speed control board.



(a) (b)

Fig. 2. Superimposed optical spectra of five wavelength channels. (a) Gain and SOA currents are set at constant values of 110 mA and 140 mA respectively for all channels, (b) Gain current is set at a constant value of 110 mA and SOA current is adjusted for levelling power of all channels. (λ_1=1532.68 nm, λ_2=1537.40nm, λ_3=1541.35nm, λ_4=1545.72nm, λ_5=1551.72 nm)

to a very little scale of less than 0.1 dB by adjusting the current to the SOA section.

Fast Wavelength Switching With SOA Blanking

Fast wavelength switching is implemented by simultaneously changing the driving currents for front mirror, rear mirror, phase and SOA section. The tuning section currents are changed for addressing destination wavelengths, while the SOA section current is changed for regulating power level. Examples of wavelength switching between λ_4 and λ_5 are shown in Fig. 3. Fig. 3(a) and Fig. 3(b) show power variation during wavelength switching between λ_4 and λ_5, forward and backward respectively. Power surges can be clearly observed, which are caused by output power of transient emitting modes during the switching process. To measure wavelength switching time, a tunable filter was used in Fig.3(c) and Fig. 3(d), the filter was centred at λ_4 and λ_5, respectively. Switching time is less than 30ns.

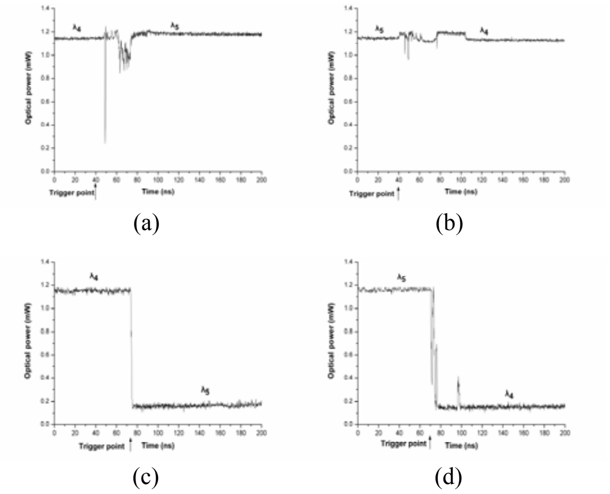


Fig. 3. Measured results of wavelength switching between λ_4 to λ_5 : (a) from λ_4 to λ_5 without of a filter, (b) from λ_5 to λ_4 without of a filter, (c) from λ_4 to λ_5 with a filter centred at λ_4 and (d) from λ_5 to λ_4, with a filter centred at λ_5.

To eliminate the harmful impact of the intervening channels, the SOA section can be controlled as a shutter to blank the output of the laser during the switching process. The blanking time for channel switching is always set according to the longest switching time for all channel combinations. A blanking time of 100 ns is set for the SOA section. Dynamics of switching for all wavelength channel combinations are measured. Example of the switching between λ_4 and λ_5 is displayed in Fig. 4. In Fig. 4(a) and Fig. 4(b), the zero-biased state of the SOA section is first applied to switch off the output light during the switching process. Then the switching events between λ_4 and λ_5 are tried again in which the SOA section is reverse-biased to -2V to achieve power shuttering of the laser, as shown in Fig. 4(c) and Fig. 4(d). Improved switching characteristics can be observed. It takes less time to perform switching and to reach stable power level for the destination channels, which are because of increase of switching depth of the SOA. The laser can be shuttered within 2 ns.

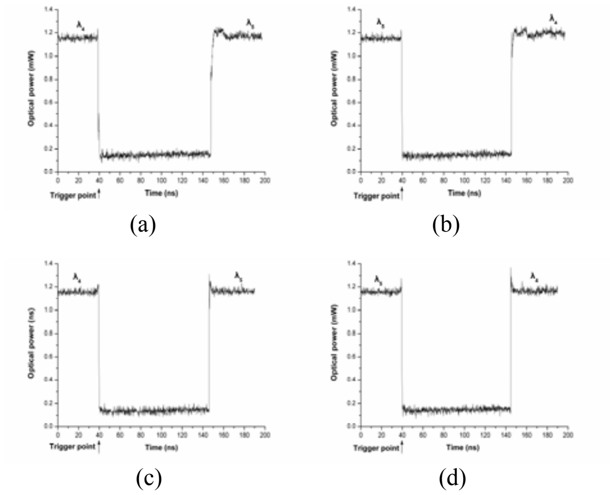


Fig. 4. Measured results of wavelength switching with SOA blanking: (a) from λ_4 to λ_5 and (b) from λ_5 to λ_4 with SOA switched off at zero-biased state, (c) from λ_4 to λ_5 and (d) from λ_5 to λ_4 with SOA switched off at reverse-biased state.

Conclusions

We demonstrated the improved performance of an SGDBR laser with a monolithically integrated SOA. The introduced SOA section could help to regulate output power for wavelength channels of the laser. By shuttering the SOA section during the channel switching process, channel-crosstalks due to switcing transients can be effectively switched off. Appropriate setting of the shuttering time and switching depth for the SOA section can achieve fast dark switching for all channel combinations of the SGDBR laser.

Acknowledgment

This work was supported in part by the National Natural Science Foundation of China under Grant No. 60677024， in part by the National High Technology Developing Program of China under Grant No. 2006AA0320427.

References

1. L. A. Coldren et al., J. Lightw. Technol. 39 (2004), p. 193.
2. Beck Mason et al., Photon. Techno. Lett. 12 (2000), p. 762.
3. L Ponnampalam et al., Proc. Optical Fiber Conf. 2 (2005), Pap. OTuE3.
4. R. Zhang et al., Chin. J. Semicond. 29 (2008), p. 2301.
5. Hui Lv et al., Electron Dev. Lett. 30 (2009), p. 353.