46.9-nm Wavelength-Selectable Arrayed DFB lasers with Integrated MMI Coupler and SOA

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1. Introduction

The massive growth of Internet traffic needs more and more channels in WDM systems. Rapid expansion of the number of WDM channels makes it difficult to make WDM systems with fixed-wavelength DFB lasers. Wavelength-selectable light sources are attractive in this context, especially as back-up light sources. This application requires long-term wavelength stability but allows relatively slow wavelength switching speed. In this context, a wavelength-selectable light source with temperature tuning that contains a DFB laser array, multiplexer, and booster amplifier is an attractive candidate. In this report, we demonstrate a wavelength-selectable light source integrated with 16-DFB-laser array. This array covers a wide wavelength range of 46.9-nm with a 30-degree temperature change.

2. Structure

The DFB laser array with the integrated multimode-interference (MMI) coupler and semiconductor optical amplifier (SOA) is shown in Fig. 1. The output light from each DFB laser is combined in the integrated 16x1 MMI coupler. The light from the MMI coupler is amplified in the SOA. The DFB lasers, SOA and waveguide are buried by a p-n current blocking layer. The DFB lasers have an active layer comprising compressive strained multi-quantum-wells to achieve low threshold operation in a wide temperature range. A $\lambda/4$ shifted grating is formed by EB lithography and wet etching to set the lasing wavelength precisely. The grating pitches are designed so that the wavelength difference is 3 nm, which corresponds to the wavelength tuning with a 30-degree temperature change. The κL is designed to be 1.4. The laser cavity length is 450 μm and the separation between the lasers is 30 μm. The MMI coupler and the waveguide consist of a low-loss InGaAsP layer corresponding to the energy band gap of 1300 nm, which is effective to reduce the bending radius of the waveguide and consequently reduce device size due to the high refractive index. The size of the MMI coupler is 64 x 540 μm. The length of the SOA region is 600 μm. The total size of this device is 750 x 2350 μm, which is very compact, although it has 16 DFB lasers. Both facets of the present device are coated with anti-reflective films.

3. Characteristics

The current-light output power characteristics were measured at 25 ^{o}C under CW operation. The driving current of 100 mA was applied to the SOA. The averaged threshold current and its standard deviation of 16 DFB lasers are 11.9 and 0.37 mA. The output power is above 14 mW in the case of the driving current for lasers of 100 mA.

Figure 2 shows the typical spectrum of each channel at 25 ^{o}C. The driving current for both the DFB laser and SOA is 100 mA. The lasing wavelength was set to be 1535.4 to 1579.1 nm. The side mode suppression ratio of over 40 dB was obtained for all DFB lasers. The wavelength difference between each DFB laser was measured. The averaged value is 2.9 nm (360 GHz) and standard deviation is 0.11 nm (12.8 GHz) at 25 ^{o}C, which could be obtained without any electrical control.

We measured the lasing wavelength at temperatures ranging from 19 to 48 ^{o}C (Fig 3). The change in lasing wavelength in each DFB laser was 3-nm in this temperature range. We achieved coverage of a wavelength range as wide as 46.9-nm between 1534.9 and 1581.8-nm with this16- DFB laser array.

4. Summary

We have developed a 16-DFB-laser array with an integrated MMI coupler and SOA for WDM systems. The good uniformity of DFB laser characteristics is confirmed to obtain the uniform threshold current with the standard deviation of 0.37 mA. The lasing wavelength of this integrated device covers a wavelength range as wide as 46.9-nm with a 30-degree change in temperature.

References

[1] M. G. Young et al., Electron Lett., vol. 31, pp.1835-1836 (1995). [2] K. Kudo et al., OFC2000, vol. 1, pp. 190-192 (2000). [3] M. Bouda et al., OFC2000, vol. 1, pp. 178-180 (2000). [4] C. Zah et al., IEEE J. Select. Topics Quantum Electronics, vol. 3, pp. 584-597, 1997.

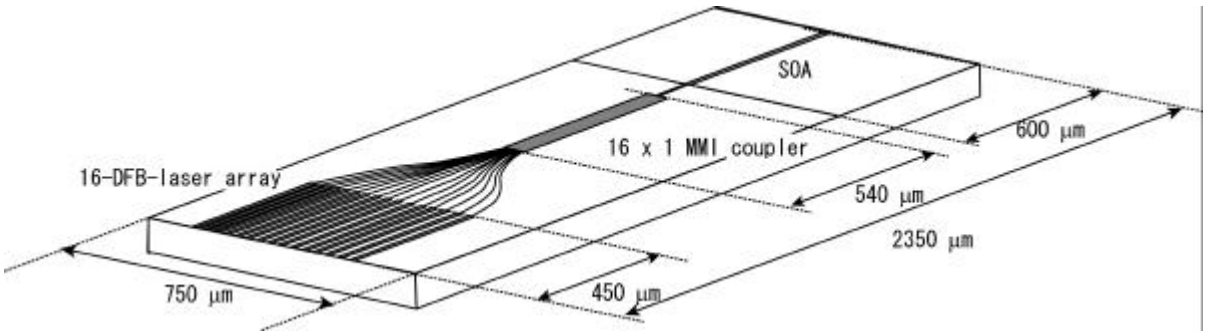

Figure 1. Structure of the wavelength-selectable DFB-laser array with the integrated MMI coupler and SOA.

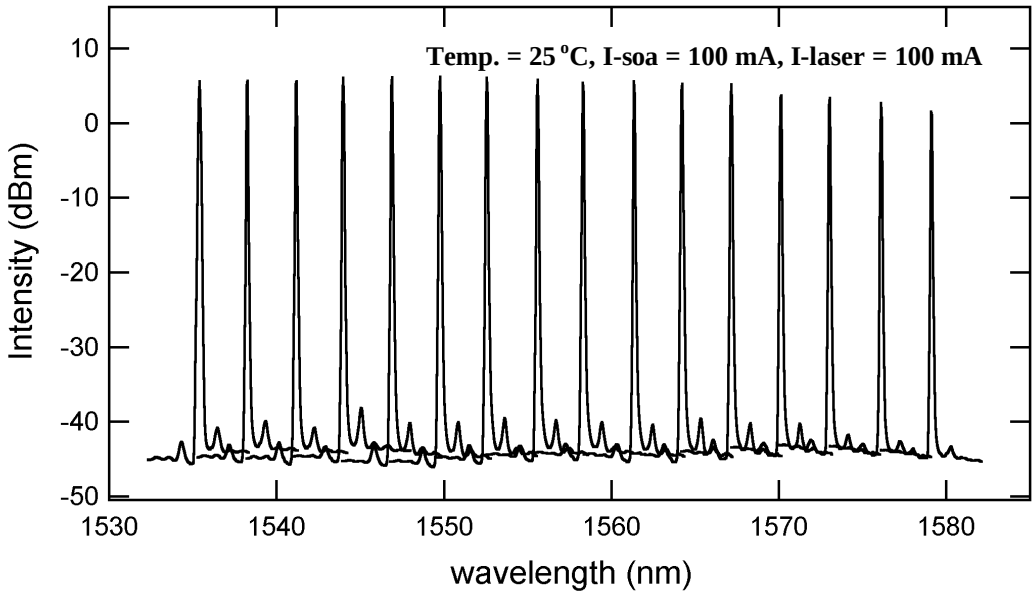

Figure 2. Spectrum of 16-wavelength-selectable DFB lasers at 25 °C.

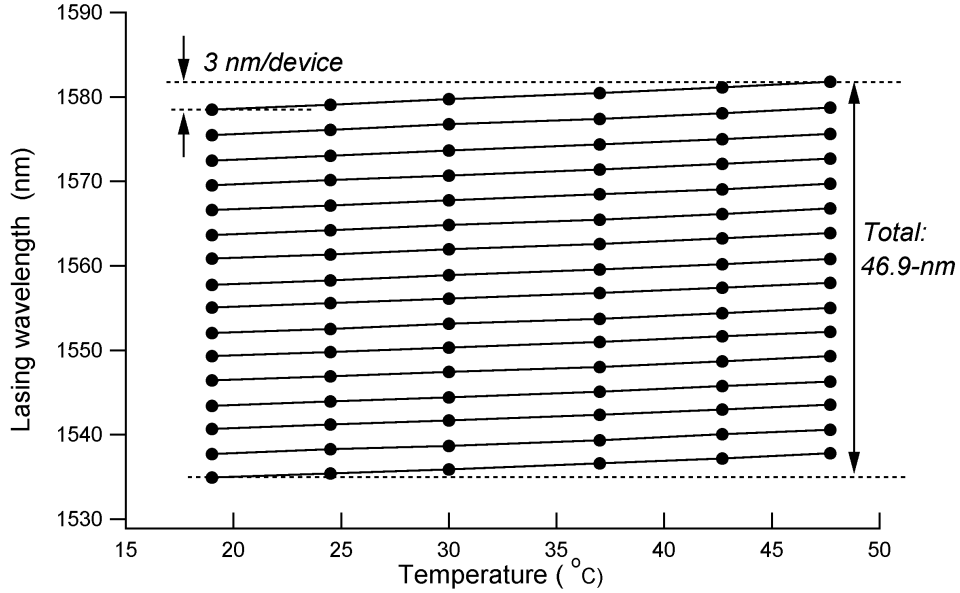

Figure 3. Wide wavelength-selectable range with the 30-degree change in temperature.