FIRST ARRAY OF 8 CG-SOA GATES FOR LARGE-SCALE WDM SPACE SWITCHES

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Abstract: We report here on an 8 CG-SOA gate array with uniform characteristics for WDM large-scale space switches operating at 1550nm. The mean fiber-to-fiber gain and noise figure n_{sp}/C_1 yield 19dB and 6.6dB at 200mA, respectively.

Introduction

A key issue for future WDM optical networks is the availability of high-capacity and large-scale optical space switches. Among other technologies, Semiconductor Optical Amplifier (SOA) devices used as optical gates have already demonstrated their high potential /1/ both for WDM routing and switching applications /2,3/, even in field-trials /2/. Today, the challenge is more to increase the size of such SOA-based switches.

One way is the monolithic integration of SOAs with a passive optical circuit. Such InP-based switching matrices with high performance have been realised /4,5/, but the largest size already demonstrated is a 4x4 device, using a complex technological processing /5/.

The SOA-array approach seems to be more attractive as it overcomes this switch size limitation, while remaining a cost effective solution. Arrays of 4 SOAs have already been fabricated and mounted either in conventional standard butterfly package /6/ or flip-chip on a silicon planar lightwave circuit /7/. SOA-based gate arrays thus appear as key building blocks for large-scale space switches.

We demonstrate here, for the first time, an array of 8 Clamped-Gain SOAs (CG-SOAs) which exhibits high performance and highly uniform characteristics.

CG-SOA basic principle and structure

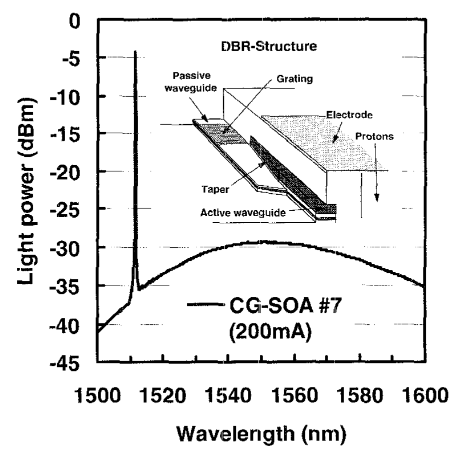
The CG-SOA structure fabricated with InGaAsP/InP layers is featured in the figure 1 (inset) /8/. The device consists in one active section between two purely passive Bragg reflectors. When lasing oscillation begins, the SOA gain is clamped providing a flat optical response over a large input power dynamic range /2,8/. Moreover, the Bragg reflectors have been designed so as to provide a single mode lasing operation at 1510nm, outside of the useful spectral bandwidth, as shown in figure 1. With these features and the large 3dB optical bandwidth (60nm), CG-SOAs are particularly suitable for WDM applications /2,8/.

The active buried ridge stripe is a SCH and has been designed to be polarisation insensitive, using a bulk-tensile approach described in details in /9/.

It is also tapered (inset of figure 1) in order to enhance the coupling between the active and passive sections. The passive output waveguide provides typical far field FWHM divergences of 18°x18° and thus is suitable for multi-pigtailing with lensed fiber ribbons /6/.

Thanks to the 7° tilted AR-coated facets, a gain ripple less than 0.2dB (figure 1) over the useful spectral bandwidth is achieved for the 8 CG-SOA array.

Fig. 1: Spectrum at the output of one CG-SOA of the array, above the laser threshold. The structure of the DBR-based CG-SOA is shown in the inset /8/.



Experimental results

Measurements have been carried out on an 8 CG-SOA array chip, at T=20°C and for a 1550nm input wavelength.

We have shown in figure 2 the measured fiber-to-fiber gain G_{ff} (dB) versus the injected current, for the TE-mode, for both the best and the worst CG-SOA gates. The gain is clamped at roughly 76mA (the laser threshold) for all the CG-SOA gates. For a 200mA injected current, the mean fiber-to-fiber gain measured on this 8 CG-SOA gate array is 19dB, with a variation lower than 1.8dB between the CG-SOA gates, as shown in figure 3.

We have also shown the noise figure n_{sp}/C_1(dB) versus the driving current for both the best and the worst CG-SOA gates. As for the gain, above the laser threshold, the value of the noise figure is nearly constant. The mean value for the noise figure yields 6.6dB, with a variation as low as 0.7dB from one CG-SOA gate to another.

Fig. 2: Fiber-to-fiber gain G_{ff}(dB) and noise figure n_{sp}/C_1(dB) versus the injected current (mA), for the best and the worst gates of the 8-array.

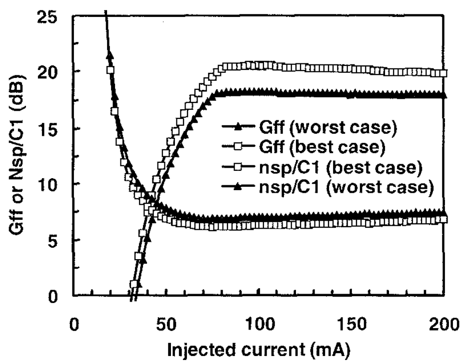
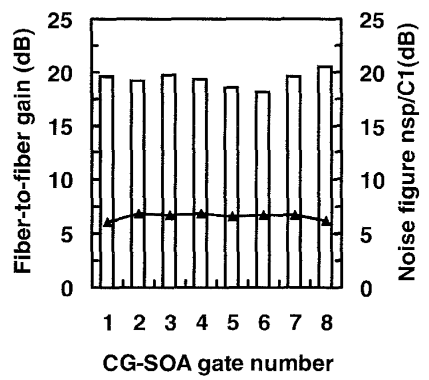


Fig. 3: Fiber-to-fiber gain G_{ff} (dB) and noise figure n_{sp}/C_1(dB) taken @200mA, for the 8 CG-SOA gates.



For this 8 CG-SOA array, the gain polarisation sensitivity remains below 2dB for 200mA injected current.

Figure 4 shows the fiber-to-fiber gain G_{ff}(dB) versus the output power (dBm) for two driving current values. The measured output saturation power (taken at -1dB) is over +8dBm @200mA, for all CG-SOA gates, and +10dBm for the best one (figure 4).

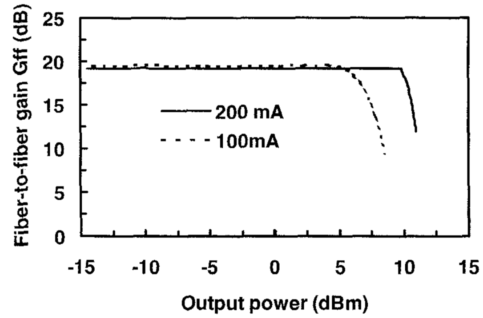
This last figure is slightly lower, compared to +12dBm previously reproted on individual components which exhibited a 14dB fiber-to-fiber gain /8/. In fact, it must be stressed that this lower output saturation power value only comes from a trade-off with the fiber-to-fiber gain, which is clamped here at a higher value (G_{ff}~19dB).

This rule must be kept in mind for the design of loss-less large-scale CG-SOA based WDM space switches.

Conclusion

We have reported here, for the first time, an array of 8 CG-SOA gates suitable for WDM routing and switching applications. The mean fiber-to-fiber gain is 19dB and the mean noise figure 6.6dB, for 200mA driving current. The achieved performances and their uniformity on one hand, as well as the integrated mode expanders on the other hand, make this array very attractive for high-capacity large-scale WDM space switches.

Fig. 4: Fiber-to-fiber gain G_{ff} (dB) versus the available output power (dBm) for two injected currents.



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