

Effects of assist light injection at gain transparency wavelength on transmission and performances of SOAs

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Semiconductor optical amplifiers (SOAs), which are all-optical multifunctional compact components, are likely to play an important role in tomorrow's metropolitan optical network applications. However, improving the SOAs characteristics is an essential issue to deal with the increased growth of data rates in high-speed all-optical systems. Several works have studied optical beam injection effects at gain transparency in SOAs [1-2]. In this work, we experiment with the injection effects of a continuous wave (CW) assist light into the SOA cavity at the gain transparency wavelength on transmission and SOA performances. Experimental results are carried out on a 500 μm long low-polarization-sensitive bulk SOA having a 10.6 dB fiber-to-fiber gain at a bias current of 120 mA. The assist light beam, which has an optical power of 19 dBm at wavelength 1480 nm, has been injected into the SOA in the counter-propagative direction with respect to an optical input signal injected at wavelength 1535 nm.

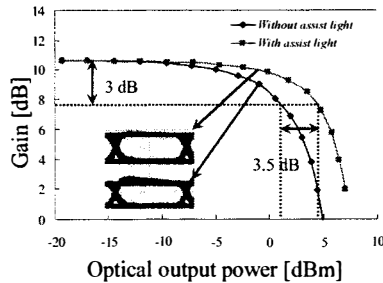


Figure 1: SOA gain saturation curves and eye diagrams for $P_{in,sig} = -10$ dBm.

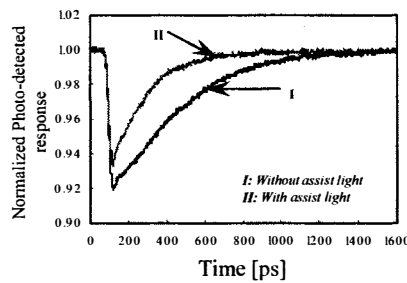


Figure 2: Normalized gain recovery photo-detected response, $\lambda_{in,sig} = 1535$ nm.

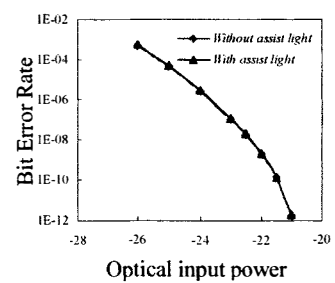


Figure 3: Bit error rate in absence and in presence of the assist light.

Figure 1 shows the SOA gain saturation curves and eye diagrams obtained with and without the assist light. We notice that the SOA saturation output power is improved by 3.5 dB in presence of the assist light while maintaining the unsaturated gain. Furthermore, the eye diagrams of the optical output signal obtained for an optical input signal power of -10 dBm modulated at 2.5 GHz, show that the assist light suppresses the overshoot time which appears when no assist light is used.

Pump-probe measurements have been performed to characterize the SOA gain recovery time. Here the pump is a 5 ps pulse of about 275 fJ with a repetition rate of 454 MHz at 1540 nm. The probe signal is generated by a tunable laser set at 1535 nm with a weak cw power (-12 dBm) in order to leave the SOA gain nearly unsaturated. A filter of 0.2 nm bandwidth is used at the SOA output to select the probe signal which is detected by a fast photodiode of 32 GHz bandwidth and then displayed on a 20 GHz bandwidth oscilloscope. Figure 2 illustrates the SOA gain recovery time evolution. The injection of an assist light power of 19 dBm reduces the gain recovery time to 400 ps, which is around 750 ps without any assist light. Indeed, the pump saturates the SOA gain and the assist light will be included in the absorption region, so its absorbed power decreases the carrier lifetime which speeds up the SOA gain recovery.

In addition, to evaluate the transmission performance in presence of the assist light, the optical input signal has been modulated by PRBS signal at 2.5 GHz with an extinction ratio of 12 dB and transmitted via the SOA. The Bit Error Rate (BER) has been measured in absence and in presence of the assist light and for weak optical input signal powers. Figure 3 points out that the presence of the assist light does impose any power penalty on the optical input signal.

In conclusion, we have demonstrated that the injection of a CW assist light high power into the SOA cavity at the gain transparency wavelength improves the SOA saturation output power, accelerates the dynamic gain recovery time and reduces the optical signal waveform distortion.

References:

- [1]. R. J. Manning and D. A. O. Davies, *Opt. Lett.*, Vol. 19, (1994), pp. 889-891.
- [2]. M. Amaya, A. Sharaiha, and T. Rampone, (*ISMOT'03*), SPIE Vol. 5445, August 11-15, (2003), pp. 144 - 147.