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Demonstration of Two Simultaneous Independently Controlled Wavelength Conversions Using a Novel Dual-Pump/Dual-Probe Four Wave Mixing Configuration in a Semiconductor Optical Amplifier

C.J. Scholz, L. Dubertrand and D.J. Blumenthal
Optical Communications and Photonic Networks (OCPN) Laboratory
School of Electrical and Computer Engineering
Georgia Institute of Technology, Atlanta, Georgia 30332
Tel: (404) 894-8314, Fax: (404) 894-5028, Email: Christoph.Scholz@ece.gatech.edu

Introduction: Four wave mixing (FWM) in semiconductor optical amplifiers (SOAs) has been the focus of attention of many researchers. In FWM in SOAs, a new wavelength is generated by scattering an input pump wavelength off a grating created by beating between the input pump and a probe wavelengths. Prior research has focused on broadband single channel wavelength conversion [3] or simultaneous conversion of multiple wavelengths using a single pump [2]. However, applications like multichannel switching, require more degrees of freedom than that offered by a single pump in order to independently convert different channels.

In this paper we demonstrate the first, simultaneous, independently controllable wavelength conversion of two channels in a single SOA gain medium. Two independent FWM processes are combined in the same amplifier by utilizing different portions of the gain spectrum. Each pump/probe interaction generates gratings within the SOA using different carrier populations. This architecture behaves in many respects like an acousto-optical filter (AOTF) switch with composite acoustic gratings [1].

Experimental Configuration: The experimental setup is shown in figure 1. Two pump lasers at wavelengths λp^1 and λp^2 are combined with two probe lasers at wavelengths λq^1 and λq^2 into a fiber combiner and then collinearly injected into an Alcatel polarization independent bulk buried heterostructure fiber pigtailed SOA. The input wavelengths are set to place each FWM process at different locations of the SOA gain curve with a pump probe spacing for each process given by $\Delta\lambda pq^1$ and $\Delta\lambda pq^2$ as shown in the optical spectrum shown in figure 2. The input pump and probe polarizations for each FWM process are optimized using fiber polarization rotators to maximize FWM conversion.

The probe lasers are simultaneously modulated by independent 1.0 Gbps pseudo-random bit sequences (PRBS). The FWM converted signals are recovered at the output using a 0.7nm (at -20dB) optical filter followed by an erbium doped fiber amplifier (EDFA) and displayed on a digitai lightwave oscilloscope.

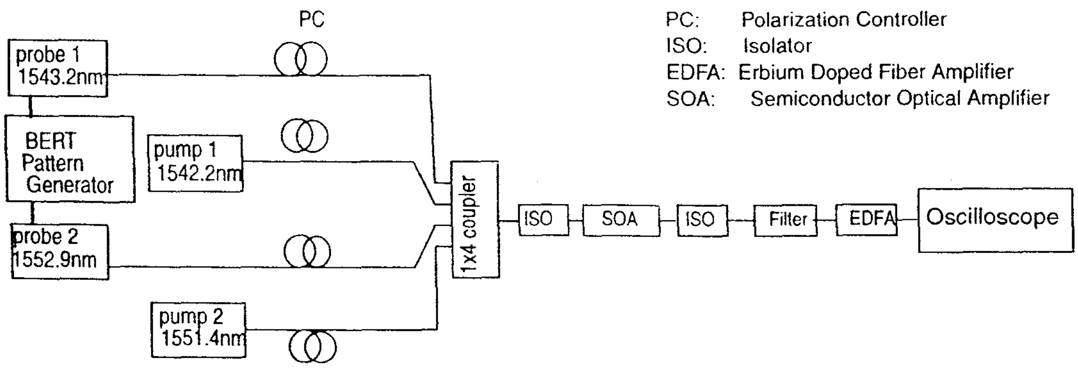

Figure 1: *Setup of the two independent pump/two probe four wave mixing experiment*

Results: We successfully recovered simultaneously independently controllable pseudo-random bit sequence light patterns with Q factors of 5.5 and 6.4, as shown in figure 2. To obtain good conversion, high pump input powers are critical, since the four wave mixing efficiency is proportional to G^3 and P^2 [4]. In the case of a single channel conversion, the highest probe modulation is desirable. In our configuration however, an adjustment of the probe input powers and modulation amplitudes was necessary to avoid crosstalk through cross gain modulation. These results were obtained with different pump/probe spacing for the two different FWM processes. Signal dependent noise at the high bit level is due to signal spontaneous beating at the output of the EDFA.

The effect of crosstalk on the recovered signals can be seen by misaligning the optimal configuration as shown in figure 3. This crosstalk is manifested as superimposed eye diagrams on the recovered signals. We can see a significant amount of crosstalk in the high levels of both recovered signals. This crosstalk is due to gain compression in the SOA which leads to cross gain modulation.

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Conclusions: We have successfully demonstrated the first simultaneous wavelength conversion of two independent controllable FWM processes within a single SOA. Conversion of PRBS 1Gbps channels is performed. By optimizing the input power levels and detuning the pump-probe spacing between the processes the conversion quality is improved significantly. Cross gain modulation that leads to crosstalk has been avoided. This technique shows promise for performing multiple independent wavelength switching processes within a single SOA.

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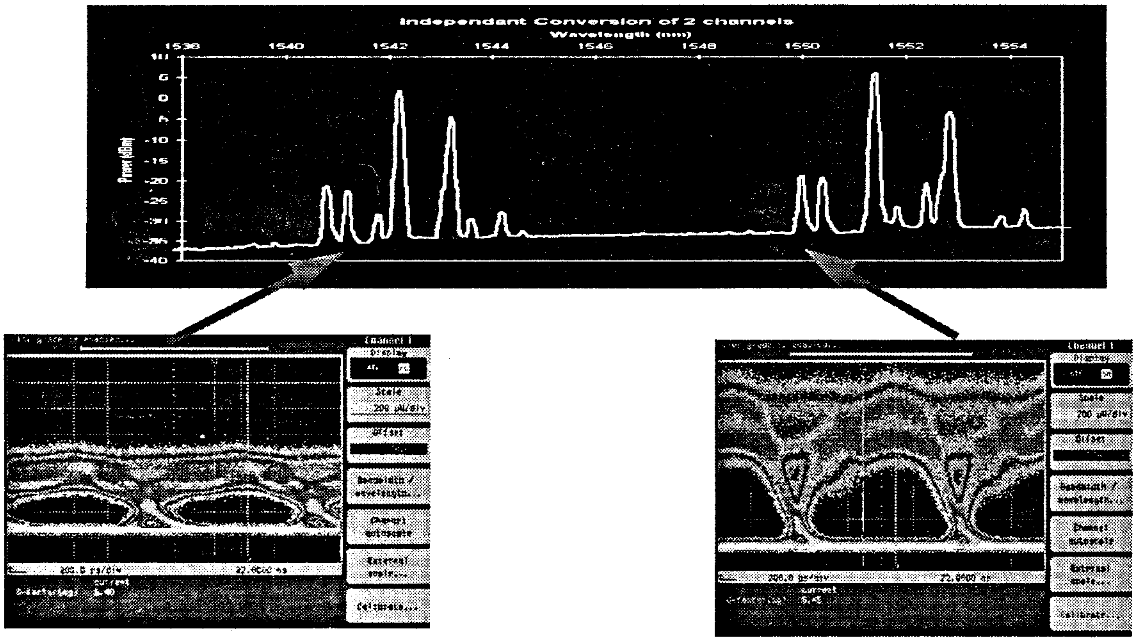

Figure 2: *Optical spectrum at the SOA output and eye diagrams of converted signals at 1GBps.*

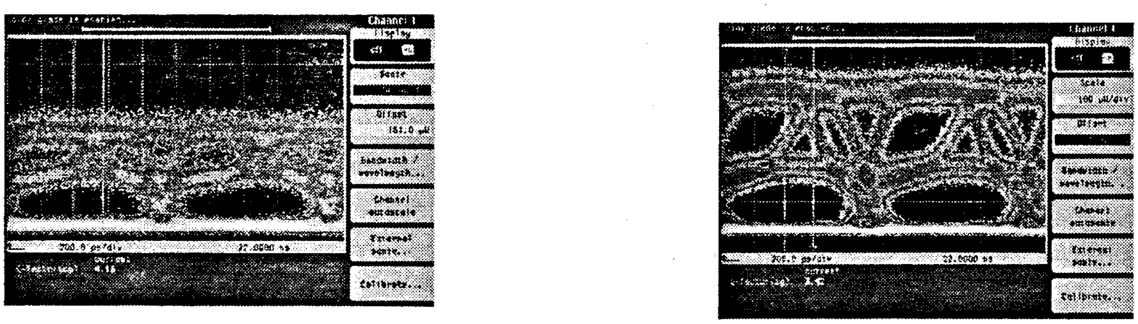

Figure 3: *Eye diagrams of converted signals at 1GBps before optimization of input powers.*

References

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