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Broadband All-optical Flip-Flop using Integrated SOA/DFB-SOA

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1. Introduction

Telecom system manufacturers world-wide are continuously facing the enormous challenge to provide operators with network solutions that allow flexible and rapid scaling of network capacity. The major catalyst for this evolution is of course the explosive growth of the Internet. Not only is the number of Internet users still growing rapidly, the increased use of complex graphics, audio, and even video, is also boosting the average traffic volume per user. One of the key enabling technologies for this revolution has undoubtedly been fiber-optic communication.[1,2]

In fiber-optic communication, two techniques can principally be used to combine digital signals from different sources and transmit them across a single optical fiber: time division multiplexing(TDM) and wavelength division multiplexing(WDM).

In the TDM approach, the bits of the different tributary signals are compressed in time and combined into a single high bit-rate signal. Presently available electronics however only allow multiplexing up to speeds of 40 Gbit/s. At higher bit-rates, the signals have to be multiplexed in the optical domain. The present lab record for the OTDM bit-rate stands at 320 Gbit/s, which is still only a small fraction of the available fiber bandwidth.

Using WDM, throughputs that are ten times higher have already been demonstrated. In WDM transmission, the tributary signals are time division multiplexed up to a certain level. Subsequently, each TDM signal is modulated onto an optical carrier wave with a different frequency, after which the optical signals are coupled into a single fiber. Conceptually, WDM is the same as the frequency division multiplexing used to place many radio channels on carrier waves of different frequencies.

In WDM transmission, Major goal of problem is a stable wavelength control device for signal processing system. In signal processing, it is need a device for controlled wideband wavelength.[3]

In this work, we applied optical bistability in an integrated SOA/DFB-SOA with broadband gain to demonstrate broadband all-optical flip-flop for all-optical memory, demultiplexing, packet header buffering, and retiming.

2. Device description

The device used in our experiment is a semiconductor optical amplifier (SOA) monolithically integrated with a distributed feedback(DFB) SOA. Figure 1 illustrates the schematic of a SOA/DFB-SOA, which was fabricated using the InP/InGaAsP material system. The device consists of a 200 μm SOA section, a 20 μm electrical isolation section, and a 400 μm index-coupled DFB-SOA section. The active layer in this device is the MQW structure. Each facet of the device is AR or HR coated . Bragg wavelength of the DFB-SOA is 1547.89 nm.

Figure 2 show the wideband gain of SOA/DFB-SOA in below threshold current.

3. Experimental setup and results

In experimental setup, a tunable laser output(CW) is modulated to the “set” and “reset” signal by using a pattern generator(include the modulator , optical delay and attenuator). This signal is coupled to the SOA/DFB-SOA through a variable attenuator, a circulator, and a polarization controller. The input signal in to the SOA/DFB-SOA results in all optical flip-flop operation based on optical bistability. The flip-flop output was amplified by an EDFA for accurate measurements. A tunable filter was used to remove the wideband amplified spontaneous emission(ASE) from the EDFA and to block and amplified Bragg signal. An input signal for “set” or “reset” ensure the output signal to maintain the “low” or “high” state.[4]

Figure 3 and figure 4 exhibit results of all-optical flip-flop in the same input power and different wavelegth.

Figure 3 shows the input signal and the output signal of an all-optical flip-flop at input wavelength of 1530.45 nm. Moreover, Figure 4 shows the signals of an all-optical flip-flop at 1578.12 nm.

4. Conclusions

In the generally analysis, an DFB-SOA appear to different optical bistbility by change of input wavelength.[5] Input powers are need the controlled values for optical bistability of same results in wideband. But, We have demonstrated broadband all-optical flip-flop based on optical bistability in a SOA/DFB-SOA by same input power. Input signal with the wavelength of 1530.45 nm or 1578.12 nm and the current of about 98 % of the lasing threshold is injected into the DFB-SOA. Because of broadband gain, SOA/DFB-SOA can use for broadband all-optical flip-flop.

All-optical flip-flop has various applications such as all-optical memory, demultiplexing, packet-header buffering, and retiming.

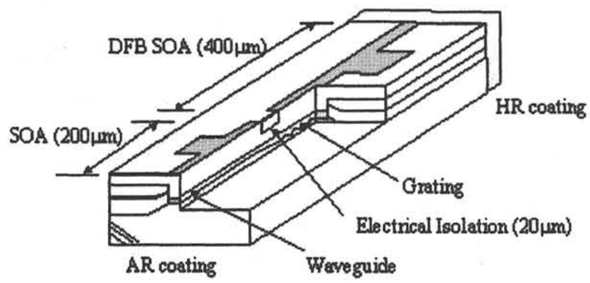

Figure 1. Schematic structure of SOA/DFB-SOA.

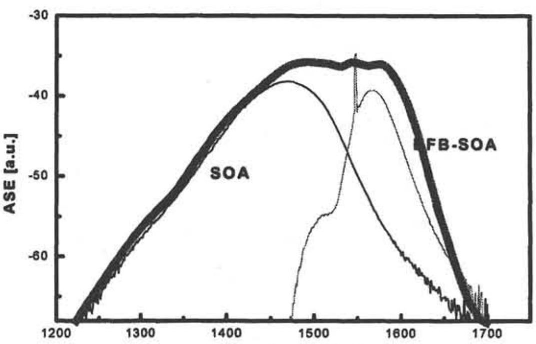

Figure 2. ASE of the SOA and DFB-SOA.

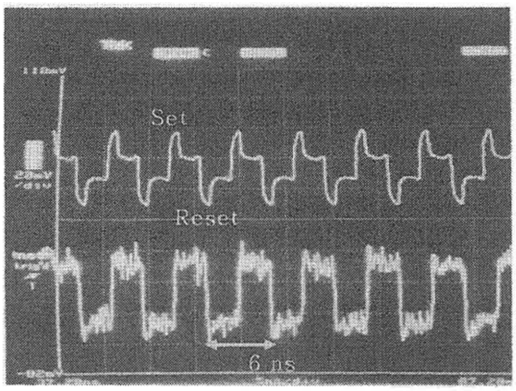

Figure 3. An all-optical flip-flop at input wavelength of 1530.45 nm.

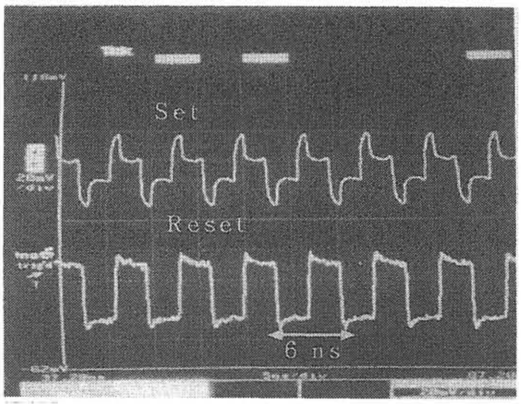

Figure 4. An all-optical flip-flop at input wavelength of 1578.12 nm.

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