All-optical de-multiplexing using III-V/SOI microdisk resonators

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Silicon-on-insulator technology has emerged as a promising platform for the fabrication of ultra-compact passive optical devices. But due to the indirect band gap of silicon and germanium, active photonic functionalities cannot be realized with the satisfactory performance on pure silicon or germanium-on-silicon platform, at least in the foreseeable future. To overcome this limitation, the use of III-V material integrated on top of SOI has been very widely used to realize active functionalities such as hybrid silicon lasers, all-optical flip-flops, and wavelength conversion etc. Since the use of III-V-on-silicon has become necessary for the realization of fully functional photonic chips, it is also necessary that other advanced functions such as time domain de-multiplexing and logic gates etc. are implemented using the III-V-on-silicon platform. Electric-bias free implementation of optical functionalities relaxes the need of electrical pins and wires required on a chip. Although many all-optical functions can be implemented in pure silicon, the two photon absorption generated free-carrier effects in silicon are slow compared to free carrier effects in III-V materials. Moreover, two-photon absorption and four wave mixing effects are energy inefficient.

Recently, we have demonstrated bias-free all-optical wavelength conversion in a 7.5 micron diameter III-V-on- silicon microdisk. Application of such devices is being investigated for other bias free all-optical functions. Here, we report the time domain de-multiplexing using 10Gbits/s non-return-to-zero (NRZ) data controlled by a 5GHz clock.

To fabricate the microdisk resonators III-V material (InP/InGaAsP) is bonded on top of an SOI waveguide circuit using a molecular bonding process and the complete fabrication run is done in a 200 mm CMOS pilot line. Details about the fabrication process can be found elsewhere.2,3 The microdisk used here has a diameter of 7.5micron while the underlying silicon waveguide has a thickness between the microdisk and the silicon waveguide is 130nm. The silicon waveguide rests on the buried oxide (silica) layer of 2 micron depth.

The transmission characteristic of the microdisk resonator around one resonance can be controlled by the use of a pump tuned around another resonance. The de-multiplexing experiment reported here is based on the same effect. The data signal is essentially a probe while the clock signal is a pump.

The schematic of the experimental set-up is shown in figure 1.

![Fig. 1: Schematic of experimental set-up. OS: optical switch, PCW: Polarization Controlling Wheels, MDR: Microdisk Resonator.](image)

A 10Gbits/s NRZ optical data signal of the pattern 0011001100..... is generated using a pulse pattern generator (PPG), a first electro-optic LiNbO3 modulator (LN MOD1) and a first tunable laser (TL1) tuned around a longer wavelength (1580.9nm) resonance of the microdisk. An optical clock signal having a repetition rate of 5 GHz is generated using a second tunable laser (TL2) tuned around a shorter wavelength (1550.1nm) resonance, second electro-optic LiNbO3 modulator (LN MOD2) and the electric clock from the PPG. An optical delay line is used for the synchronization of the optical clock with the optical data signal. A circulator is used to collect the de-multiplexed data and an EDFA is used to amplify the de-multiplexed data. A band pass filter is used to suppress the ASE noise generated from the EDFA. A variable optical attenuator (VOA) is used to control the input power.
FRIDAY MORNING, September 23\textsuperscript{rd} 2011

11:30 - 12:50
SESSION C
NEW RESONATORS

Chair: Dr. Guido GIULANI
Dipartimento di Elettronica, University of Pavia, Italy

C1 11:30
Optical modes of an optofluidic microparticle VCSEL sensor
P. Debernardi\textsuperscript{1}, W. Schwarz\textsuperscript{2}, and R. Michalzik\textsuperscript{2}
\textsuperscript{1} IEEIT-CNR, c/o Politecnico di Torino, Italy
\textsuperscript{2} Ulm University, Institute of Optoelectronics, Ulm, Germany

C2 11:50
All-optical de-multiplexing using III-V/SOI microdisk resonators
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C3 12:10
Tunable semiconductor ring laser with on-chip filtered feedback
I. Ermakov\textsuperscript{1}, S. Beri\textsuperscript{1}, M. Ashour\textsuperscript{1}, X. Leijtens\textsuperscript{2}, J. Bolck\textsuperscript{2}, B. Docter\textsuperscript{2}, G. Verschaffelt\textsuperscript{1}, J. Danckaert\textsuperscript{1}
\textsuperscript{1} Applied Physics research group, Vrije Universiteit Brussel, Brussels, Belgium
\textsuperscript{2} COBRA Research Institute, Eindhoven University of Technology, Eindhoven, The Netherlands

C4 12:30
Active-Passive Integrated Microring Lasers
A. Kapsalis, C. Mesaritakis and D. Syvridis
Dpt. of Informatics and Telecommunications, National and Kapodistrian University of Athens, Greece
European Semiconductor Laser Workshop

September 23-24 2011
Lausanne, Switzerland

Abstract Proceedings

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