Visiting period: Dec 18th 2016 – Jan 2nd 2017

Title: Demonstration of integrated photonics low-power, high-speed silicon-based optical modulators for on-chip and board-level applications

Abstract: There is an ever increasing demand for larger bandwidths and higher capacities in telecommunication and datacom networks. Data centers can require tens of thousands of optical modulators to handle the data traffic, and the need for higher modulation rates increases the power consumption per optical modulator. Moreover, power consumption can limit the density of equipment. Mach-Zehnder interferometers (MZIs) are often used as optical modulators to address the capacity challenge because of their wide bandwidth and performance at high data rates. The design of the optical waveguides used to implement MZI modulators, particularly the length of the phase shifting region, the configuration of the driving electrodes, and the required voltage to actuate the electro-optic (EO) modulator have significant impacts on the modulating speed and power consumption. Currently, state-of-the-art MZI modulators in lithium niobate ($\mathrm{LiNbO_3}$) running at 10Gb/s-20Gb/s have drive voltages in the range of 6-10 volts, those in indium phosphide (InP) operating at 10Gb/s-40Gb/s have drive voltages between 1.2-3 volts, and silicon photonic MZI modulators with data rate of 10Gb/s–40Gb/s have drive voltages that can be as low as sub-1 volts. Different approaches to develop low-power, high-speed, power-efficient EO modulators are reviewed in literature. These approaches include optimization of the waveguide geometry, the carrier injection density, the depletion region position, and the electrode configurations. In this work, we demonstrate that by modifying the MZI structure, it is possible to create a modulator with significantly reduced power consumption. The main advantage of this configuration in comparison with standard MZIs is a reduction of 50% in the phase shift required to obtain complete intensity modulation. The reduction in the phase shift needed to achieve complete modulation translates into a decrease in the voltage required to actuate the modulator. Consequently, the device has lower power consumption.

Bio: Ms. Fatemeh Soltani is PhD student in Electrical Engineering, Photonics - Optical telecommunication at McGill University, Montreal, Quebec, Canada. She got her M.Sc. in Physics, Solid state − Experimental Condensed Matter and Nanofabrication from University of Victoria (UVic), Victoria, British Columbia, Canada (2010). She done her B.Sc. in Physics, Solid state − Experimental electron microscopy in Iran University of Science and Technology (IUST), Tehran, Iran (2007). Her research projects are focused on optical devices and systems, short-reach and optical interconnects design, optical telecommunications, nanophotonics, hybrid electro-optic devices, MEMS based devices and clean room fabrication. She is also currently working as senior optical engineer R&D in research for algorithms and analytics at Lumentum (previously JDS Uniphase corporation), Ottawa, Ontario, Canada. She is experienced with coherent transmission products, InP and LiNBO3 modulators, SG-DBR lasers and free space optics.