Ph.D. in Information Technology: Theses Defenses

July 18th, 2018

Room Conferenze Emilio Gatti (building 20) - 11.00 am

First Ph.D. presentation and discussion:

Faisal Ahmed MEMON – XXX Cycle

"Silicon Oxycarbide Technology for Integrated Photonics"

Advisor: Prof. **Andrea Melloni**

Abstract:

The primary theme of this doctoral dissertation was to develop a dielectric platform for integrated photonics that is widely refractive index tunable, low loss, efficiently reconfigurable and can be integrated with typical dielectrics. To this aim, silicon oxycarbide (SiOC) a novel class of glass compounds has been exploited. Reactive RF magnetron sputtering was employed to deposit a system of silicon oxycarbide thin films over a wide composition range and large refractive index window from silica to amorphous silicon carbide. The films properties were investigated in greater detail to assess its potential for micro-photonic device fabrication. Further to advance the development of the platform, medium-to-high contrast photonic waveguides in silicon oxycarbide system were realized employing microfabrication process. The classical characteristics of the waveguides have been measured in the commercial telecom window to reveal its transparency and potential for photonic applications.

Silicon oxycarbides have been investigated for possible application in reconfigurable photonic integrated systems. The record high thermo-optic effect in silicon oxycarbides has been discovered that is one order of magnitude larger than typical dielectric platforms. As a further exploitation, integration of silicon oxycarbide with conventional dielectrics resulted in power efficient phase actuators that is a great achievement.

Within the scope of this doctoral work, we have been successful in developing a versatile platform with appealing characteristics of refractive index tunability providing low losses in the telecom wavelength range and efficient reconfigurability that was not possible with other typical dielectric platforms.

Second Ph.D. presentation and discussion:

Abi WAQAS – XXIX Cycle

“Stochastic Methods for Performance Prediction of Photonic Integrated Circuits”

Advisor: Prof. **Andrea Melloni**

Abstract:

Technology progress in integrated photonic has resulted in the implementation of complex photonic circuits combining many functions on a single chip, significant production volumes and reduced fabrication costs. While standard fabrication technologies are an essential condition for the commercial exploitation of photonic, they still have to face an unavoidable reality of uncertainties. As photonic devices are much longer when compare to wavelength, a slight variation in device geometry can cause a dramatic phase error, especially for devices based on interferometers. Each fabrication run is subject to several possible variations (waveguide width or height deviation, improper gap opening, change in material composition and surface roughness) that may eventually cause a fabrication deviations that reduce the yield at too low levels to be economically sustainable. Therefore, statistical data and efficient statistical tools to include this data to predict the statistical behavior of the final circuit are becoming fundamental instruments in photonic. In this doctoral dissertation, we focus on exploration and development of statistical tools with the aim to enhance the capabilities for the stochastic analysis and performance prediction of integrated photonic circuits in the presence of unavoidable fabrication uncertainties.

In the case of traditional Monte Carlo analysis, thousands of repeated simulations are required to study the effect of stochastic uncertainties on photonic circuit. Even if we use more complex techniques based on spectral methods to represent uncertainty, we still normally need to run several simulations to sample the device uncertain response. In this work, we have subverted this approach by proposing the novel framework that can obtain a full description of the behaviour of a circuit under stochastic uncertainties with a single deterministic simulation, enabling an unprecedented simulation efficiency thus saves time and computational resources. We have also introduced advanced sensitivity analysis methods to estimate the post-fabrication correction (e.g. thermal tuning) cost and to reduce the power consumption for the mitigation of statistical variation of circuits’ parameters and increase the yield.

PhD Committee:

Prof. **Francesco Morichetti**, DEIB

Prof. **Bhawani Chowdhry**, Mehran University of Engineering & Technology

Prof. **Federica Poli**, Universita' di Parma