Ph.D. in Information Technology
Thesis Defenses

March 20, 2023
at 10:30
Room Seminari “Nicola Schiavoni”

Christian DE VITA – XXXV Cycle

Multilayers for Photonics and MEMS applications from VIS to LWIR
Supervisor: Prof. **Andrea Melloni**

Abstract:

The interest in new materials and technologies for light manipulation is higher than ever. Either if you want to measure the temperature of your children, to transmit a signal through an optical fiber or a free space channel, or to monitor the working point of a complex circuit in different points all along it, you will need a light detector. The work focused on light detection at different wavelength ranges, covering all the aspects that bring to the final device, from the modelling to experimental characterization, not limiting on all-optical sensors but also optimizing MEMS sensors, doubling its sensitivity, and tuning its field of view as required by industry standards.You will find the design, fabrication and characterization of a monolithically integrated detector working in Visible range, with a validation on a developed Si_3N_4 platform at = 660 nm and 532 nm, the latter for both TE and TM polarization, achieving a responsivity of > 30 mA/W and a maximum dynamic range of 40 dB, making it able to work in very low-power applications. In the Near-Infrared spectrum we have developed a Power Thermal Stabilizer (PTS) integrated in a TiO_2waveguide. The device was developed exploiting a plasmonic approach based on Surface Plasmons, this allowed to obtain a very compact device (few µm) achieving a reponsivity of 7.5 µV/mW while driven by a current of only 25 µA and a dynamic range of 15 dB. Both the detectors just described demonstrated also fast time responses in the order of few µs, making them able to work in feedback control loops. Finally, in the LWIR wavelength range (8 ÷ 12 µm), we have optimized a CMOS- SOI thermal and free space detector, developed by STMicroelectronics by means of a deep analysis of the multiple reflections occurring inside the multi layers that compose the device. The result of these analysis is a new stack for the device that experimentally demonstrated an increase in the sensitivity of more than 80%.

Andrea MADASCHI – XXXIV Cycle

Fiber Optic Current Sensors for System Monitoring
Supervisor: Prof. **Pierpaolo Boffi**

Abstract:

Nowadays, almost all devices, such as smartphones, household appliances and industrial machines, require a source of electrical energy in order to work. Even in sectors where fossil energy sources were traditionally used, such as the automotive sector, a gradual transition to electricity sources is underway. A particular area of interest is represented by the electrical industry, where accurate analyses and measurements are required to evaluate performance and safety of power systems. To

achieve this aim, it is often necessary to perform measures in very high current conditions and/or in presence of strong electromagnetic interference. Moreover in power systems where high voltages are used, even hundreds of kV, more and more stringent safety measures and guarantees of perfect insulation are required. A current sensor based on fiber optic technology, being made of non-conductive material, is practically immune to electromagnetic interference and can also easily meet the requirement of complete isolation, which is particularly critical in high-voltage applications. During the PhD period, two fiber optic current sensor configurations have been deeply studied and improved: one based on a polarimetric approach and one based on a Michelson interferometer.

Matteo PETRINI – XXXV Cycle

Mixed Signal Generic Testing in Photonic Integration

Supervisor: Prof. **Andrea Melloni**

Abstract:

This thesis aims to develop novel testing approaches for complex photonic integrated circuits (PICs). Effective and fast testing, in fact, is becoming an urgent need in photonic integration, especially for volume productions. Two aspects make photonic testing challenging. First, a photonic circuit usually has to be tested from both optical and electrical standpoints, since it usually embeds electronic actuators and sensors. Then, due to unavoidable imperfections, typically complex PICs require (pre-)calibration, before performing the actual assessment of the optical features. Two different categories of fairly complex (silicon) PICs, with unprecedented features, are described and characterized, namely Optical Add/Drop Multiplexers (based on Ring Resonators) and True Time Delay Lines (based on Mach-Zehnder Interferometers). The electronic infrastructure to perform the electrical validation and the optical calibration is designed and successfully exploited to implement a novel testing technique. This approach, validated through numerical simulations and experimental measurements, enables the evaluation of deviations (in frequency domain) between the device under test (DUT) and a reference circuit (REF). It also allows for the tuning of the DUT, to replicate the spectral response of the REF. If the PIC under test is properly calibrated and compliant with the given (optical and electrical) specifications, the working points of its actuators can be stored in LookUp Tables (LUTs), that can be even updated upon environmental changes or the presence of high power signals, causing nonlinear effects in silicon platforms.

PhD Committee

Prof. **Francesco Morichetti,** DEIB - Politecnico di Milano
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Prof. **Mariangela Gioannini**, Politecnico di Torino