



UNIVERSITÀ  
DI PAVIA

**Ph.D. Program in Electronics, Computer Science and Electrical Engineering**

## **SEMINAR**

# **Graphene-Based Integrated Photonics: From Material Properties to Global Connectivity**

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**Abstract:** Graphene stands as an ideal candidate for next-generation optoelectronic applications, offering unique advantages and synergies that complement traditional Silicon Photonics. Its exceptional properties enable both electro-absorption and electro-refraction modulation, achieving an electro-optical index change exceeding  $10^{-3}$ . By leveraging these characteristics, graphene facilitates optical add-drop multiplexing via voltage control, effectively eliminating the power dissipation typically associated with the thermal tuning of microresonators. Furthermore, it allows for the development of ultrafast, thermoelectric-based optical detectors capable of generating voltage without the need for transimpedance amplifiers.

In this presentation, we outline a comprehensive vision for graphene-based integrated photonics. We review the current state of graphene transceivers, benchmarking them against existing technologies while addressing critical strategies for power efficiency, manufacturability, and wafer-scale integration. A detailed roadmap is presented to align graphene's technological evolution with the rigorous demands of the datacom and telecom markets. Ultimately, we demonstrate how graphene-based platforms can enable ultrahigh spatial bandwidth density and low-power connectivity across the entire communication spectrum—from board-level interconnects and data centers to access networks and long-haul optical infrastructures.

**Bio:** Marco Romagnoli, began his career at the IBM Research Center in San Jose, and soon after joined the Fondazione Ugo Bordoni in the Optical Communications Department, working on optical components and transmission systems. In 1998, he moved to Pirelli R&D Photonics, where he served as Director of Design and Characterization and Chief Scientist, spearheading pioneering programs in photonic technologies. As early as 2001, he was among the first to foresee the disruptive potential of Silicon Photonics, launching innovative platforms for optical components based on silica PLCs, SiN, and Si. In 2010, he took on the role of Director of Boston Operations at PhotonIC Corp, while also serving as a visiting scientist at MIT. Later, as Head of Advanced Technologies for Photonic Integration and Scientific Responsible at CNIT PNTLab in Pisa, he continued to drive forward the frontiers of photonic integration. At present he is Chief Scientific Officer and Co-Founder of 2D Photonics (holding company) and Camgraphic (affiliate)

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