Fondazione INPHOTEC
Integrated Photonic Technologies Center

SiGe: A MATERIAL PLATFORM FOR NEAR- AND MID-INFRARED PHOTONICS

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Abstract:

The recent interest towards chemical and biological sensing in the mid-infrared has fostered the need of high performance photonic integrated circuits operating in this spectral region. Germanium and silicon germanium alloys hold the potential to become the material platform of choice for waveguide-integrated near and mid-IR photonics, thanks to their wide transparency in this wavelength range. In this context epitaxy offers the unique possibility of avoiding silicon oxide cladding layers, which have limited transparency in the mid-IR, and of controlling the refractive index profile within the waveguide. In this framework, we are investigating Ge-rich SiGe as a promising material platform to develop passive optical devices operating in the mid-IR. The key elements of our approach are SiGe graded buffers, epitaxially grown on Si, where the linear grading of the Ge concentration from Si to Si1 xGex with a properly designed grading rate, allows a unique flexibility to engineer the refractive index profile of the structure. This ensures a strong confinement of the optical mode in the Ge-rich region and leads to the realization of SiGe waveguides and Mach-Zehnder interferometers operating between 5.5-8.5 µm with 2 dB/cm losses. Moreover, heavily n-doped Ge has demonstrated a strong potential for the realization of plasmonic devices operating in the same spectral region, opening a path toward the integration of plasmonic and photonic devices within the same material platform. As an additional example of the role played by epitaxial growth in Ge based near-IR photonics we will discuss the possibility of integrating Ge-based single photon detectors on Si substrates.

Short bio:

Giovanni Isella graduated in Nuclear Engineering at the Politecnico di Milano, Italy in 1997 and holds a Ph.D. in Physics from the same institution. Between 2001 and 2002 G. I. has been working on the deposition and characterization of silicon-germanium heterostructures at the ETH-Zürich. In 2002 he obtained a faculty researcher position at the Physics Department of the Politecnico di Milano-Italy where he continued to work in the field of SiGe epitaxy. Since 2007 he is leading the SiGe epitaxy team at the laboratory for nanostructures epitaxy and spintronics on silicon (LNESS-Politecnico di Milano). In 2014 he became Associate Professor at Polimi and in 2017 the director of the laboratory for nanostructures, epitaxy and spintronics on silicon (LNESS). His current interests and expertise include: spin dynamics in Ge quantum wells, infrared light detection and modulation in SiGe heterostructures, Ge deposition on patterned substrates, integration of III-V semiconductors on Ge/Si, SiGe heterostructuctures for thermoelectric power generation. Since 2017 he is the director of the LNESS centre.