Proposition de SUJET DE STAGE M2 /Ingénieur-3A

Laboratoire : Centre de Nanosciences et de Nanotechnologies (UMR 9001)
Adresse : Bâtiment 220 de l'UFR Sciences / Université Paris-Sud

Contact: Delphine Marris-Morini
Phone number: 01 69 15 78 52
e-mail : delphine.morini@u-psud.fr http://silicon-photonics.ief.u-psud.fr/

Active photonic devices for mid IR photonic integrated circuits

Mid-infrared (mid-IR) integrated photonics (i.e. with 2µm<λ<20µm) is actually a subject of increased emphasis, with a strong potential to revolutionize different application fields. As an example mid IR spectroscopy is a nearly universal way to identify chemical and biological substances, as most of the molecules have their vibrational and rotational resonances in this wavelength range. Commercially available mid-IR systems are based on bulky and expensive equipment, while lots of efforts are now devoted to the reduction of their size down to chip-scale dimensions. The demonstration of mid-IR photonic circuits on silicon chips would benefit from reliable and high-volume fabrication to offer high performance, low cost, compact, low weight and power consumption photonic circuits, which is particularly interesting for mid-IR spectroscopic sensing systems that need to be portable and low cost. Mid-IR photonic circuits on silicon chips can also have important applications for free space telecommunications or military applications.

In this context, we develop a new route for the development of chip-scale integrated circuits on silicon for the mid-IR wavelength range, based on **Ge-rich SiGe materials**. We recently demonstrated **the strong potential of this platform for broadband operation in the mid-IR.** We also studied nonlinear properties of Ge-rich SiGe waveguides, showing that **band-gap engineering can be used to tune the non-linear effects** and to exploit diverse phenomena based on nonlinear effects.

As a next step we would like to develop active devices in the mid-IR, that can have a strong impact for all applications.

The research activity will include:

- **theoretical study and electro/optical simulations** (using commercial software) to evaluate the key metrics for coupling passive and active devices .

- **experimental characterizations** of passive devices developed within the group, using a unique mid-IR optical bench existing in the group

The work is done in the framework of the ERC INsPIRE project, in a strong collaboration with Giovanni Isella's group (L-Ness lab (Politecnico di Milano)).

During the internship, the student will be actively involved in the current research activity of the group, collaborating with PhD students, postdocs and researchers of different research backgrounds and nationalities.

This project can be continued and expanded within the frame of a PhD

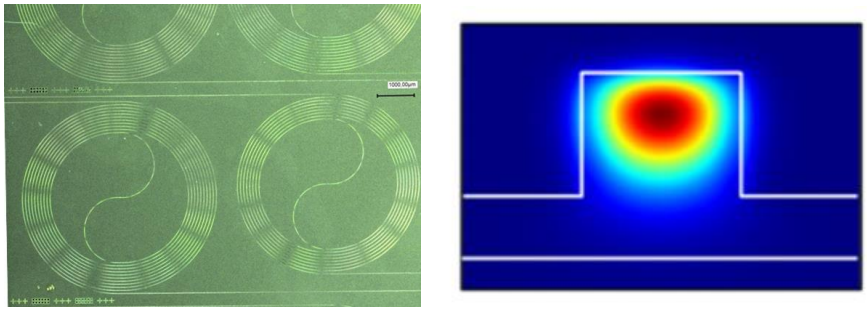

Fig. 1: left: picture of integrated mid-IR photonic integrated circuit based on Ge-rich SiGe platform / right: optical mode calculation showing the strong confinement of light in the core of a graded waveguide.

VALUED QUALITIES IN THE STUDENT

- Curiosity for novel research experiences and fields.

- Creativity and pro-activity in the search for innovative solutions and approaches.

- Capability to communicate and share results in a multidisciplinary and multi-nationality environment.

BIBLIOGRAPHY RELATED TO THE TOPIC

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