Internship subject

Laboratoire: Centre de Nanosciences et de Nanotechnologies (UMR 9001) **Adresse: CNRS, Université Paris Saclay** **10 Boulevard Thomas Gobert, 91120 Palaiseau - France**	Centre de Nanosciences et de Nanotechnologies
Contact: Laurent Vivien and Christian Lafforgue **Phone number: 01 70 27 05 30** **e-mail : laurent.vivien@c2n.upsaclay.fr christian.lafforgue@c2n.upsaclay.fr** **https://minaphot.c2n.universite-paris-saclay.fr/en/**	

Pure phase optical modulation based on Strained silicon photonics

The performance evolution of classical and quantum optical communication networks, computing systems, sensing circuits including gyroscope and Lidar as well as integrated circuits in general requires the development of pure phase optical modulators compatible with silicon photonics platforms. That will directly address the major challenges in many applications (sending, quantum, communications) for which silicon photonics can revolutionize the future. Indeed, the use of silicon for photonics has been well identified as a means to overcome interconnects, power efficiency limitations and reliability for high volume production. This research domain has exhibited a remarkable rate of development, with current advances, which were inconceivable few years ago. This evolution is largely based on the vision that silicon as a mature integration platform can bring photonic integrated circuits closest to its electronics.

Despite the demonstration of high-performance silicon modulators based on plasma dispersion effect, germanium photodetectors, and III-V lasers on silicon, there are still some challenges to solve including their integration in a common chip, the reduction of the power consumption of optical modulators and primary the possibility to perform pure phase optical modulation. However, as silicon is a centrosymmetric material, it does not exhibit second order optical nonlinearities, i.e. there is no Pockels effects and no possible wavelength conversions using such processes. To overcome this strong limitation, straining silicon can break its centrosymmetry, leading to exhibit such second order nonlinearities. Recent proofs of concept have been demonstrated with a modulation at 20GHz based on the use of silicon nitride stress layers deposited by PECVD on top of silicon.

The objectives of the work will be to design, fabricate characterize a new generation of strained silicon photonics waveguides to strongly increase the strained induce in the Si waveguides and to perfectly control the electric field into Si. The strategies applied for microelectronics will be applied, based on the use of highly stress SiN layer and SiGe layers. The control of the electric field will be also done using PIN diode to fix carrier distribution into Si waveguide and avoid field screening.

The candidate will be fully involved in the optical and electrical simulations, the fabrication and the characterization using integrated optical and optoelectronics benches and Raman spectrometers.

The research activity will include:

- **Theoretical study and electro/optical simulations** (using commercial and home-made software) to evaluate the key metrics for tuning the optical properties of the waveguide modes
- DC and high-speed **experimental characterizations** of optoelectronic devices based on second-order nonlinearities (i.e. Pockels effect)

The work will be done in close collaboration between C2N and CEA/Leti

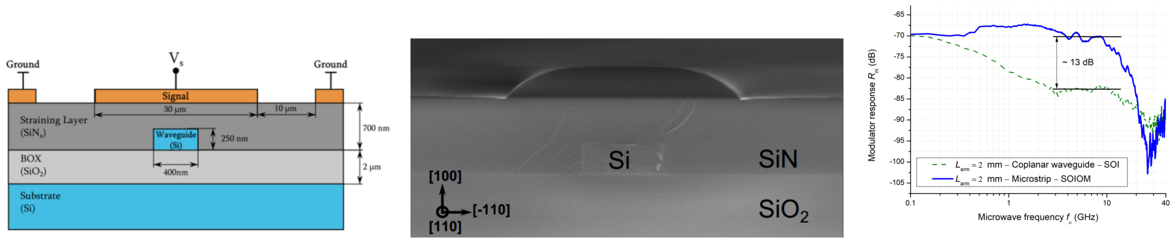

Fig. 1: *left: schematic view of a strained silicon waveguide. Middle: Grating coupler based on subwavelength structures. Right: SEM image of strained waveguide fabricated at C2N.*

VALUED QUALITIES IN THE STUDENT

- Curiosity for novel research experiences and fields.
- Creativity and pro-activity in the search for innovative solutions and approaches.
- Attractivity in experiments and simulations.
- Capability to communicate and share results in a multidisciplinary and multi-nationality environment.

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