Internship subject

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Nonlinear optical properties of strained silicon plasmonic structures

The performance evolution of telecommunication networks, computing systems and integrated circuits requires increasing communication bandwidth at all interconnect levels. Also, the power efficiency, i.e. the energy required to transfer data, must be considerably improved. The use of silicon photonics has been well identified as a means to overcome electrical interconnects bandwidth and power efficiency limitations. 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, germanium photodetectors, and III-V lasers on silicon, there are still some challenges to solve including their integration in a common chip and the reduction of the power consumption of electro-optical devices. Furthermore, 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. However, straining silicon can break its centrosymmetry, leading to exhibit such second order nonlinearities. Recent proofs of concept have been demonstrated based on the use of silicon nitride stress layers on top of silicon.

The objective of the internship will be to design a new type of strained silicon plasmonics waveguides for electro-optics modulation. The strong interaction between plasmonic mode and strain region into silicon will be studied to enhance second- and third- nonlinear effects in Si. The candidate will be fully involved in theoretical multi-physics studies of nonlinear effects in strained silicon photonics structures using home-made and commercial simulators.

The work will be performed in the framework of the ERC POPSTAR project.

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.

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.

BIBLIOGRAPHY RELATED TO THE TOPIC

- P. Damas et al., Bond orbital description of the strain-induced second-order optical susceptibility in silicon, Physical Review B, 93, 16 (2016)
- D. Benedikovic et al., Dispersion control of silicon nanophotonic waveguides using sub-wavelength grating metamaterials in near- and mid-IR wavelengths, Optics Express, Vol. 25(16), pp. 19468 – 19478, August 2017.
- M. Berciano et al., Fast linear electro-optic effect in a centro- symmetric semiconductor, Nature Communications Physics, 1(1) (2018).
- M. Ayata et al. High-speed plasmonic modulator in a single metal layer, Science 358, 630 (2017)

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