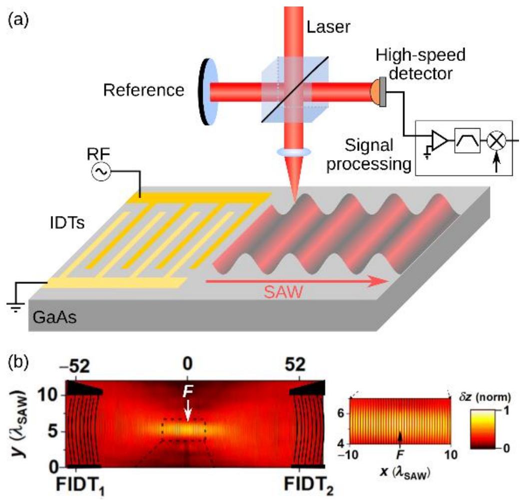
Departement/Team: Photonique/ODIN
Person in charge of the internship: Mathieu Jeannin
Contact: mathieu.jeannin@universite-paris-saclay.fr **- 01 70 27 03 93**

Optical Mapping of Surface Acoustic Waves

Surface acoustic waves (SAWs) are elastic waves that propagate at the surface of a solid. On piezoelectric materials, they can be generated with interdigitated transducers (IDTs). Beyond their widespread use in electronic filtering, they can modulate a light field through the acousto-optical (AO) interaction, and especially imprint on it a sinusoidal phase variation. This concept is widely used in AO modulators using *bulk* acoustic waves in a crystal to diffract a light beam. Recent research has shown the extreme potential of SAWs in integrated photonics, where they can be used to modulate complex photonic circuits. Innovative devices have recently been proposed using a SAWs and integrated photonic circuits to demonstrate AO modulation in semiconductor waveguides, but also much more complex functions such as optical isolation [1]. The current state-of-the-art is confined to the near-infrared spectral range where photonic integrated circuits are mature and can rely on a plethora of materials. On the contrary, **such devices do not exist in the mid-infrared (mid-IR) part of the spectrum (3 µm < λ < 12 µm)**. This wavelength range is of particular interest for many applications from industrial control and pollution detection, optical communication to astronomical sciences. The field of integrated mid-IR photonics is currently booming, sustained by recent breakthroughs in integrated Si-photonics and III-V semiconductor platforms. Advanced integrated devices are needed, amongst which optical phase modulators.



To design and characterize efficient AO photonic circuits, a visualization of the SAW propagation is a valuable tool. This internship constitutes a first step on this ambitious project: building an optical interferometer allowing the mapping of SAW on GaAs substrate. The idea is to measure the out-of-plan vibration of the semiconductor surface with sub-nm precision in a modified Michelson interferometer [2]. This allows directly imaging the propagation of the SAW with unprecedented precision: the lateral resolution is given by the laser spot size (< 1 µm) and the amplitude is a fraction of the wavelength, with the Angstrom as a first target. After building the interferometer, characterizations of SAWs on GaAs substrates will be performed. Time will be dedicated to interface the instrument to a computer to automatize measurements through a home-made Python interface tool. If time permits, numerical simulations of novel SAW devices will be initiated, as well as first cleanroom fabrication steps.

[1] Sarabalis et al., Optica 8, 477 (2021)
[2] Knuuttila et al., Optics Lett. 25, 613 (2000)

Methods and techniques: Optical alignment, RF electronics and signal processing, instrument control (Python).

Possibility to go on a PhD: Yes
Funding: Doctoral school scholarship or research grant