Post-doctoral Opening:
Acoustolectric amplification for integrated phononics and photonics

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We have an opening for a post-doctoral position in the Centre de Nanosciences et de Nanotechnologies (C2N) on the topic of acoustoelectric amplification of surface acoustic waves (SAW) for non-linear integrated photonic-phononic circuits.

Acoustic wave devices are ubiquitous in modern electronics, serving as delay lines, filters, but also temperature, pressure or (bio)-chemical sensors. The most famous example is the SAW delay line based on a pair of interdigitated transducers (IDTs) on a piezoelectric material that converts an applied sinusoidal voltage in an elastic wave, as exemplified below.

The aim of this project is to explore novel opportunities when coupling SAWs to a two dimensional electron gas (2DEG) through the acoustoelectric effect [1]. A simplified device architecture is presented in Fig. 1. IDTs launch a surface wave on a piezoelectric material (here GaN). The acoustic wave propagates through an electron gas hosted in a mesa structure connected with DC leads, imposing a current and thus dragging the electrons. If the electrons and acoustic wave move in opposite direction, strong absorption of the acoustic wave is observed. However, when the electrons and the acoustic waves co-propagate with an electron drift velocity greater than the acoustic wave speed, amplification of the acoustic wave can occur.

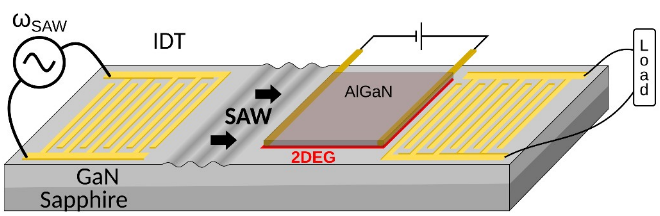

Figure 1: Sketch of an acoustic delay line with a 2DEG gain section

As an example, impressive results have been demonstrated very recently in a heterogeneous integration of a high mobility InGaAs layer on a lithium niobate on Silicium (LNOI) wafer, including non-linear wave mixing [2] and towards phonon lasing [3]. In this project, we would like to explore a well known material system combining piezoelectricity and relatively high mobility electron gas: AlGaN/GaN. This will enable additional functionalities, the first one being the ability to modulate the 2DEG electronic density using a gate. Using the transparency of GaN at near-IR and MIR wavelength we will then develop hybrid photonic-phononic integrated circuits leveraging acoustoelectric amplification to enhance the acousto-optic interaction on the micrometer scale.

The recruited person will join the project from the initial stage. Initial steps are the fabrication and characterization of passive delay lines on GaN/Sapphire, and the introduction of the 2DEG to gauge the magnitude of the acoustoelectric effect, completed by numerical simulations. The acoustoelectric active structure will then be integrated in photonic circuits at near-IR and mid-IR wavelengths. Depending on the results, development of hybrid integration of arsenide-based semiconductors on LNOI will also be considered.

Project frame:
This project extends the current activities of the group on acoustic wave devices in the frame of the Acousto-MIR ANR Project. The aim of this ANR project is to propose GaAs/AlGaAs acousto-optic devices for integrated infrared photonics in the 8-10 µm range. Notably, we already built a scanning heterodyne vibrometer allowing interferometric mapping of surface acoustic waves with sub-µm lateral resolution. Fig. 2 below shows an example of amplitude and phase mapping of a Rayleigh SAW passing through a photonic crystal. This working experiment will greatly simplify the characterization of acoustoelectric devices, allowing contactless measurement of acoustic waves.

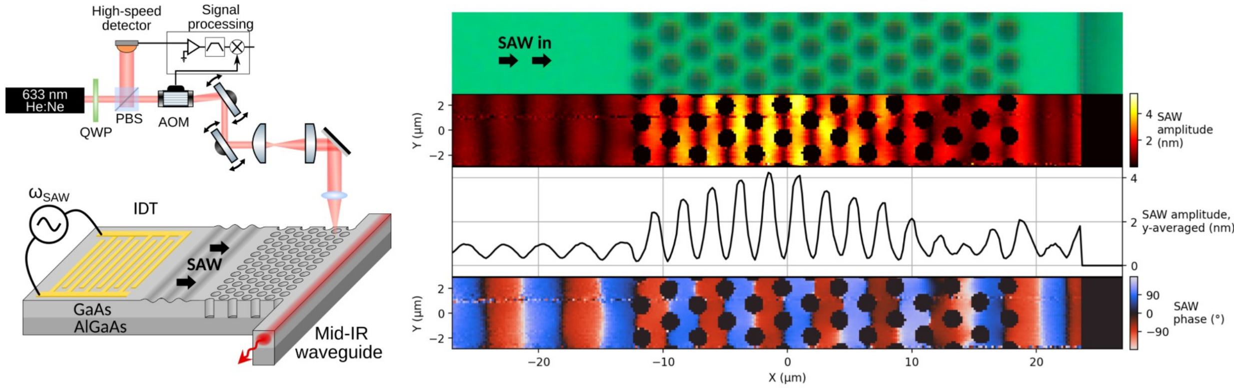

Figure 2: Sketch of the heterodyne vibrometer setup and example of an interferometric map of SAW propagating in a photonic crystal

The epitaxy of GaN/AlGaN heterostructures is performed by collaborators at CHREA (Nice), and the project will benefit from collaborations with the MiNaPhot team for integrated photonics perspectives, as well as FEMTO-ST (Besançon) for improvements on the heterodyne vibrometer.

Applicant profile:

Candidates must have a PhD in Physics with a strong cleanroom fabrication experience (preferably but not necessarily on III-V semiconductors). The project is experimental in essence, applicants are expected to have an expertise in electrical device characterization, as well as some knowledge to build and develop optical setups. Experience in numerical simulations (COMSOL in particular) as well as some coding skills will be appreciated. Prior knowledge on surface acoustic wave physics will be considered a strong asset, but is not mandatory.

Practical details:

The project is funded for 18 months (could be extended to 24 months), that covers the salary and epitaxy/cleanroom costs. The typical gross salary lies in the 3000 € - 3500 € per month, depending on experience. The perspective candidate will be part of the host team (Mid-IR and THz quantum devices team) at C2N and will benefit from constant interactions with the PhD student recruited on the ANR project, all the team members and external collaborators, and of course full access to the cleanroom and experimental setups.

How to apply:

The position is open as of January 2026. A CV and motivation letter should be sent to M. Jeannin (mathieu.jeannin@cnrs.fr).

References:

[1] D. L. White, "Amplification of Ultrasonic Waves in Piezoelectric Semiconductors," *Journal of Applied Physics*, vol. 33, no. 8, pp. 2547–2554, Aug. 1962, doi: 10.1063/1.1729015.

[2] L. Hackett *et al.*, "Giant electron-mediated phononic nonlinearity in semiconductor–piezoelectric heterostructures," *Nat. Mater.*, vol. 23, no. 10, pp. 1386–1393, Oct. 2024, doi: 10.1038/s41563-024-01882-4.

[3] A. Wendt *et al.*, "An Electrically Injected and Solid State Surface Acoustic Wave Phonon Laser," May 21, 2025, *arXiv*: arXiv:2505.14385. doi: 10.48550/arXiv.2505.14385.