PhD position at University of Montpellier, France

Mid-infrared lasers on Si and SiGe-based photonic circuits

Tunable-diode laser absorption spectroscopy in the mid-infrared (MIR) allows the detection and concentration measurements of many biological and chemical species. This is of crucial interest for many societal applications such as health monitoring and diagnosis, detection of biological compounds, monitoring of toxic gases emitted by industries, or of greenhouse gas emission responsible for global warming, to name but a few.

Appropriate laser sources have been demonstrated in the past, and consist mainly of III-V GaSb-based semiconductor lasers for the 1.8 – 3 µm wavelength range\(^1\) and III-V interband cascade lasers\(^1\) or quantum cascade lasers\(^2\) at longer wavelength. Although efficient discrete lasers have been demonstrated, there is an increasing demand for smaller and smarter sensors in view of establishing non-invasive, connected sensor grids. These sensors will surely rely on Si photonic integrated circuits (PICs) where lasers and/or photodetectors are coupled to Si/SiO\(_2\) or Si/SiGe-based circuits.

One of the main challenges is the integration of III-V devices. Epitaxial integration of III-V lasers on Si wafers has shown much progress in the past few years.\(^3\) We have demonstrated GaSb-based laser diodes grown on off-axis Si wafers in the 1.5 µm\(^4\) and 2.0 µm\(^4\) range, pulsed operation of quantum cascade lasers near 11 µm,\(^4\) and high-performance laser diodes\(^5\) and QCLs on on-axis Si.\(^6\) The next step is the development of PICs including these laser sources.

In this thesis the PhD candidate will work on the processing of GaSb-based lasers (diodes or QCLs) on Si and SiGe-based platforms adapted to the MIR wavelength range. Indeed, while the Si/SiO\(_2\) platforms absorbs above 3 µm, a Ge-based platform is transparent until 15 µm and is thus perfectly adapted to devices operating in the whole MIR. The final objective will be the demonstration of a laser grown on a SiGe PIC and emitting a few mW of output power coupled into a Ge waveguide.

The PhD candidate will be mainly involved in device processing, and to a lesser extent in the growth by molecular-beam epitaxy of the heterostructures.

The work will be carried out in the framework of a French National Research Agency project (LightUp), in collaboration with C2N, CNRS, U Paris-Saclay, France and L-Ness, Italy.

For more information, contact:
Dr. Jean-Baptiste Rodriguez, CNRS, IES, jean-baptiste.rodriguez@umontpellier.fr
Pr. Eric Tournié, U. Montpellier, IES, eric.tournie@umontpellier.fr

---


