High-Q integrated micro-resonators for Mid-IR photonics

Ecole Centrale de Lyon

NICOLAS BAUDIN
INTERNSHIPS IN FRANCE INITIATIVE

Name of the hosting institution in France	Ecole Centrale de Lyon
Name of the host laboratory / research team	Nanotechnology Institute of Lyon / Photonics
Address	Institut des Nanotechnologies de Lyon INL - UMR 5270 Ecole Centrale de Lyon - 36 av Guy de Collongue 69134 Ecully Cedex, France
Web site	https://eclausion.ec-lyon.fr/
Name of the supervisor	Christian GRILLET
Function	CNRS
Email	christian.grillet@ec-lyon.fr

Internship offer

Topic of the internship (title)	High-Q integrated micro-resonators for Mid-IR photonics			
Proposed dates of the internship*	**Start:**	2020-09-01	**End**	2021-01-29

* The supervisors have indicated the dates proposed are flexible and are able to be postponed subject to COVID-19 border closures.

Scientific and academic objectives of the internship (detailed description of the internship content, work expected from the intern and expected outcomes):

Domain and scientific context: The Mid-infrared (Mid-IR) wavelength range - from 3 to 15 µm - is currently experiencing a huge surge in interest for an enormous range of applications that affect almost every aspect of our society, from compact and highly sensitive biological and chemical sensors, imaging, defence and astronomy. A notable feature of the MIR is that most chemical and biological compounds that relate to our health, safety and environment have a strong spectral signature in the medium infrared. The MIR therefore offers unique opportunities for the development of technologies with a high societal (sensor applications, defence, industrial and environmental security, etc.) and fundamental impact (chemistry, biology, astrophysics, etc.). Strongly resonant (high-quality Q factor) resonators represent an essential element in photonics, for exploring the fundamental aspects of light-matter interaction, as well as for applications in filtering, wavelength demultiplexing, sensing and, combined with an active or nonlinear material, generation of light. High-Q micro-cavities in the mid-IR have been introduced only recently and the topic remains very challenging, in particular when integrating them with a photonic platform amenable to lasing. Such a platform would enable high-purity sources for sensitive detection in this spectral range based on heterodyne detection. Keywords: mid-IR, optical micro-cavities, integrated photonics, Lasers, nonlinear optics, heterogeneous integration

Scientific challenges and objectives: Despite its recognised potential, mid-IR technologies are still limited in their range of applications. Optical systems operating in the mid-IR wavelength range have long been restricted to large, cumbersome and fragile configurations of discrete components operating in free space, potentially including simple passive waveguides, generally based on multimode chalcogenide fibres. The cost of these systems also generally prohibitive due to the lack of compact mass manufacturable mid-IR optical devices. In addition, mid-IR lacks the powerful and affordable testing and measurement tools that are available in the telecom spectral range, which makes characterisation in this spectral range more demanding. Our strategy is therefore based on the development of an integrated hybrid MIR platform, involving the miniaturisation of optical components and their integration on a planar substrate made of materials with remarkable optical properties (particularly in terms of transparency and non-linearities) at Mid-IR wavelengths like SiGe alloys, LiNbO3 and high band gap semiconductor (SC) like GaP and InP. The student's project will focus on one of the key building block of an integrated optical circuit, namely a high Q resonator.

Name of industrial partner	Thales TRT
Role of the industrial partner in the internship project	The student will work closely with Thales to setup an advanced characterisation test-bed. First optical characterisations will consist of dispersion and transmission measurements performed using a swept coherent sources, e.g. tuneable Quantum Cascade Laser available at Thales. More advanced characterisation will be performed using a suitable implementation of Optical Coherence Tomography.
Main contact at the French industrial partner	Alfredo De Rossi
Email of contact at French industrial partner	alfredo.derossi@thalesgroup.com
Name of the Australian partner institution	RMIT
Name of lab/department/team involved in the collaboration at the Australian partner institution	Micro Nano Research Facility (MNRF)/Integrated Photonics and Applications Centre (InPAC)
Main contact in the Australian partner institution	Arnan Mitchell
Function	Professor, Director
Email address	arnan.mitchell@rmit.edu.au
Outside of this ongoing collaboration, will applications coming from students of other eligible Australian universities be considered by the hosting institution in France?	Yes

Expected profile of applicant

Level of study	S/he should work towards his/her Masters/honours
Discipline	Physics; Optics; Solid-state physics
Required qualities, knowledge and skills	We seek a talented and ambitious researcher with a good knowledge and a solid background in the field of solid-state physics, optics, and semiconductor devices. An experience in photonics, nonlinear optics, clean-room fabrication, material deposition or optical modelling and characterisation will be strongly appreciated.

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