Spectrometer integrated on a silicon-based chip for operation in the mid-infrared

École Centrale de Lyon

NICOLAS BAUDIN
INTERNSHIPS IN FRANCE INITIATIVE

Name of the hosting institution in France	École Centrale de Lyon
Name of the host laboratory / research team	Institut des Nanotechnologies de Lyon
Address	36 avenue Guy de Collongue 69134 Ecully
Web site	www.inl.cnrs.fr
Name of the supervisor	VILQUIN Bertrand
Function	Associate-Professor
Email	bertrand.vilquin@ec-lyon.fr
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Internship offer

Topic of the internship (title)	Spectrometer integrated on a silicon-based chip for operation in the mid-infrared			
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):

The mid-IR spectral region (from 3µm to 20µm) is attracting considerable interest in the scientific community. Many chemical compounds have vibrational resonances in the 2 to 10µm wavelength range, known as the "molecular fingerprint" region, making it particularly interesting for molecular spectroscopy. Despite its potential, mid-IR technology is limited to bulk and expensive equipment of scientific laboratories. Downsizing these devices is an ambitious objective and an integrated bright broad-bandwidth source (i.e. supercontinuum) is a fundamental building block to develop cheap, portable and fast sensing devices. A supercontinuum can be generated in an optical waveguide via nonlinear effects that broaden the spectrum of an input pulse, resulting in a white light up to one million times brighter than the conventional white-light sources. Octave spanning supercontinuum generation up to 8.5 µm has been already demonstrated by our group in a SiGe on Si waveguide[1]. Our supercontinuum is the ideal source for an integrated mid-infrared spectrometer. Spectrometers are key optical devices used to analyze the light interaction with gas or liquid. Fourier-transform spectrometers (FTS) are particularly interesting as they allow for accessing broadband infrared spectra using a single photo-detector. The integration of the FTS on a silicon-based chip is a challenging task required for the development of a low-cost molecule sensing platform[2, 3]. During his/her master thesis, the student will work on the development of an integrated FTS for operation in the mid-infrared. He/she will design components of the FTS such as tapers, Y-couplers and Mach-Zender interferometers.
The student will have support from colleagues, Milan Sinobad, and Alberto Della Torre. Devices designed will be fabricated in collaboration with our industrial partner Cea-Leti, Grenoble, France. The student will also have an opportunity to be trained in fabrication techniques benefiting from an in-house fabrication facility at INL. Finally, the student will characterize the fabricated devices using our free-space mid-infrared experimental setup.

1. Sinobad, M., et al., Mid-infrared octave spanning supercontinuum generation to 8.5 µm in silicon-germanium waveguides. Optica, 2018. 5(360): p. 360. 2. Liu, Q., et al., Integrated broadband dual-polarization Ge-rich SiGe mid-infrared Fourier-transform spectrometer. Opt. Lett., 2018. 43(20): p. 5021-5024. 3. Montesinos-Ballester, M., et al., On-chip Fourier-transform spectrometer based on spatial heterodyning tuned by thermo-optic effect. Scientific Reports, 2019. 9(1): p. 14633.

Name of industrial partner	Cea-Leti
Role of the industrial partner in the internship Project	Devices designed during this internship will be fabricated at the micro and nanotechnology research center CEA-Leti in Grenoble, France.
Main contact at the French industrial partner	Vincent Reboud
Email of contact at French industrial partner	vincent.reboud@cea.fr
Name of the Australian partner institution	RMIT
Name of lab/department/team involved in the collaboration at the Australian partner institution	The MicroNano Research Facility (MNRF) / Integrated Photonics and Applications Centre (InPAC)
Main contact in the Australian partner institution	MITCHELL Arnan
Function of the main contact in the Australian partner institution	Director (MNRF) and Distinguished Professor
Email address of the main contact in the Australian partner institution	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	He/she should work towads his/her Master degree
Discipline	Physics; optics; solid-state physics
Required qualities, knowledge and skills	We seek a talented and ambitious researcher with good knowledge and solid background in the field of solid-stage physics, optics and semiconductor devices. An experience in photonics, nonlinear optics, clean-room fabrication, optical modelling and characterization will be strongly appreciated.

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