Heterogeneous silicon photonics for SWIR/MWIR applications

G. Roelkens[1]

[1] *Photonics Research Group, Ghent University / imec*
Sint-Pietersnieuwstraat 41, B-9000 Ghent,
Belgium

In this paper I review our work on silicon photonic integrated circuits for spectroscopic sensing applications.

Silicon photonics is an emerging technology for the realization of high-speed transceivers. However, the application range is not limited to optical communication. The wide transparence range of group IV materials such as silicon and germanium enable photonic integrated circuits operating in the mid-infrared. Passive waveguide circuits containing spectrometers have been realzed both in the short-wave infrared (on silicon-on-insulator) and in the mid-infrared (on silicon-on-insulator and germanium-on-silicon). In order to realize chip-size spectroscopic sensors the integration of light sources (lasers, LEDs) and photodetectors are required as well. For this purpose GaSb-based layer stacks are bonded on the silicon waveguide circuits, which are then processed into opto-electronic components. This way, a InGaAsSb on silicon spectrometer with 46 channels was demonstrated, operating in the 1.5-2.5um wavelength range. Laser integration has been demonstrated as well in this wavelength range. An alternative approach for photodetection in this wavelength range is the integration of PbS and HgTe colloidal nanocrystal films on silicon waveguide circuits. Short-wave infrared photoconductors integrated on silicon were demonstrated. An alternative approach to mid-infrared light generation is the use of the large Kerr nonlinearity of silicon together with the broad dispersion engineering feasible in high index contrast silicon photonic waveguide circuits. This way, the efficient generation of mid-infrared radiation is possible using 'standard' optical pump sources. We demonstrated the generation of 3.6um radiation using a pump around 2um wavelength and a signal in the telecommunication wavelength band. Also, an octave spanning frequency comb in the 1.5-3um wavelength range using spectral broadening in a silicon photonic wire was demonstrated. Using silicon photonic technology we demonstrate the on-chip spectroscopic detection of glucose at physiologically relevant concentrations.

*corresponding author: gunther.roelkens@intec.ugent.be

Foreword

Welcome to the 12th "Mid-Infrared Optoelectronics: Materials and Devices" (MIOMD-XII) conference in Montpellier, France!

The Mid-Infrared Optoelectronics Materials and Devices (MIOMD) conference series has been established in 1996 with a first conference organized in Lancaster. MIOMD is now held on a bi-annual basis and rotates between Europe, America and Asia. The last three conferences were held in Freiburg (2008), Shanghai (2010) and Chicago (2012).

The conference brings together researchers and scientists from all over the World working in the area of mid-infrared optoelectronics, from materials to applications. It covers all aspects of materials (theory, growth, property), optoelectronic devices (lasers, LEDs, photodetectors, modelling, fabrication, characterization) as well as practical applications (sensing, imaging, defense and security applications...). Last years the scope of the conference has been enlarged compared with its first editions and includes now all aspects of infrared technology from near-IR to THz.

This issue of MIOMD is a very special one. Indeed, exactly 20 years ago, in 1994, a new mid-infrared semiconductor laser, the quantum cascade laser (QCL), was invented in the group of F. Capasso at Bell labs. One of the co-inventors, **Prof. Jérôme Faist**, now with ETH Zurich, will open the scientific sessions of MIOMD-XII with a keynote presentation on "20 years of Quantum-Cascade Lasers".

In addition, a total of 16 invited talks, ~40 contributed oral papers and ~30 posters will be presented during the three days of the conference, from Monday 6th October to Wednesday 8th October. We are confident that you will find a lot of interesting papers and that active discussion will take place as usual. We wish to express our sincere gratitude to the members of Scientific Committee for their support. They invested an important amount of their time selecting invited speakers and reviewing abstracts.

Several social events have also been planned. A welcome reception will be offered on Sunday 5th October evening while the conference dinner will take place on Tuesday 7th October in a superb estate. In addition, guided visits of Montpellier or of a vineyard will be possible on Wednesday 8th October afternoon. Finally, a special full-day excursion will be proposed on Thursday 9th October. It will take you to the Pont du Gard, a stunning Roman aqueduct, and to Nîmes, a rich heritage city.

We want to particularly thank the *Agglomération de Montpellier, Région Languedoc-Roussillon, the OPTITEC cluster, the French National Research Agency* and the European Union for their support, as well as our sponsors and exhibitors. Last but not least, we also wish to thank our colleagues of the local-arrangement committee who made it possible to practically happen.

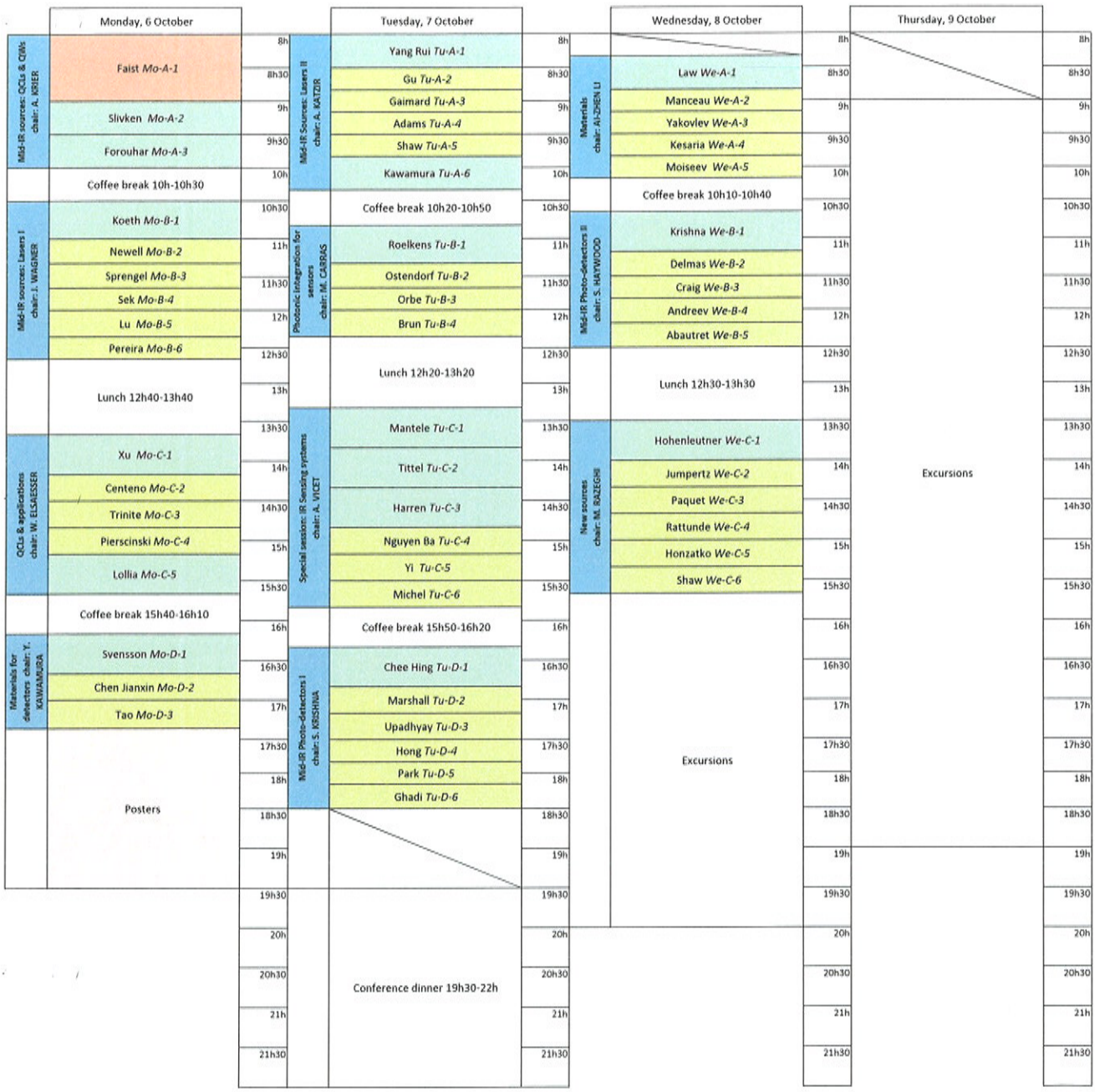
We hope you have a very rewarding and enjoyable conference in the shiny city of Montpellier!

Alexei N. Baranov
Conference Chair

Eric Tournié
Conference Chair

Thierry Taliercio
Program Chair

Aurore Vicet
Local Committee Chair


Monday, 6 October
Tuesday, 7 October
Wednesday, 8 October
Thursday, 9 October
Mid-IR sources: QCLs & QWs chair: A. KRIER
Faist Mo-A-1
Slivken Mo-A-2
Forouhar Mo-A-3
Coffee break 10h-10h30
Mid-IR sources: Lasers I chair: J. WAGNER
Koeth Mo-B-1
Newell Mo-B-2
Sprengel Mo-B-3
Sek Mo-B-4
Lu Mo-B-5
Pereira Mo-B-6
Lunch 12h40-13h40
QCLs & applications chair: W. ELSAESSER
Xu Mo-C-1
Centeno Mo-C-2
Trinite Mo-C-3
Pierscinski Mo-C-4
Lollia Mo-C-5
Coffee break 15h40-16h10
Materials for detectors chair: Y. KAWAMURA
Svensson Mo-D-1
Chen Jianxin Mo-D-2
Tao Mo-D-3
Posters
Mid-IR Sources: Lasers II chair: A. KATZIR
Yang Rui Tu-A-1
Gu Tu-A-2
Gaimard Tu-A-3
Adams Tu-A-4
Shaw Tu-A-5
Kawamura Tu-A-6
Coffee break 10h20-10h50
Photonic integration for sensors chair: M. CARRAS
Roelkens Tu-B-1
Ostendorf Tu-B-2
Orbe Tu-B-3
Brun Tu-B-4
Lunch 12h20-13h20
Special session: IR Sensing systems chair: A. VICET
Mantele Tu-C-1
Tittel Tu-C-2
Harren Tu-C-3
Nguyen Ba Tu-C-4
Yi Tu-C-5
Michel Tu-C-6
Coffee break 15h50-16h20
Mid-IR Photo-detectors I chair: S. KRISHNA
Chee Hing Tu-D-1
Marshall Tu-D-2
Upadhyay Tu-D-3
Hong Tu-D-4
Park Tu-D-5
Ghadi Tu-D-6
Conference dinner 19h30-22h
Materials chair: AI-ZHEN LI
Law We-A-1
Manceau We-A-2
Yakovlev We-A-3
Kesaria We-A-4
Moiseev We-A-5
Coffee break 10h10-10h40
Mid-IR Photo-detectors III chair: S. HAYWOOD
Krishna We-B-1
Delmas We-B-2
Craig We-B-3
Andreev We-B-4
Abautret We-B-5
Lunch 12h30-13h30
New sources chair: M. RAZEGHI
Hohenleutner We-C-1
Jumpertz We-C-2
Paquet We-C-3
Rattunde We-C-4
Honzatko We-C-5
Shaw We-C-6
Excursions
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