IEEE Photonics Society Benelux Chapter

Newsletter – Spring 2017

Welcome to the first newsletter of the IEEE Photonics Society Benelux Chapter. The newsletter will be published twice a year (spring and autumn) with the purpose of informing you about the last events within our scientific and industrial community.

Contents

Recently defended PhDs

Longfeu Shen – **Ultrafast photodetector on the InP-membrane-on-silicon platform** – Cum Laude, with honor – *TU Eindhoven*

Supervisors – Meint Smit and Jos van der Tol

Summary – Photonic integrated circuit (PIC) technology emerges as a promising solution for meeting the requirement for future data communication systems. In particular, the InP-membrane-on-silicon platform has been recently developed, aiming to bring high-performance InP-based PICs to silicon-based electronic ICs. A range of functional components have been realized in this platform. However, the performance of the first generation active devices, especially of the photodetectors (PDs), does not meet the requirement for future applications. The aim of this thesis is to present a significant advance of the present IMOS platform, from both the technology and device perspectives. A particular focus is placed on the realization of a photodetector with best-in-class bandwidth, which is expected to enable very advanced applications.

Weiming Yao – **Towards a high-capacity multi-channel transmitter in generic photonic integration technology** – Cum Laude, with honor – *TU Eindhoven*

Supervisor – Meint Smit and Mike Wale

Summary – This thesis presents a study into the integration density limits of high-capacity WDM transmitter PICs using generic photonic integration technology. Special attention was paid to the improvement of modulator performance and to the impact of electrical, optical and thermal crosstalk on WDM transmitter operation. By obtaining physical understanding

of these crosstalk effects we could gain insight in their limitations to the integration density in PICs and provide suitable design rules that can be used for dense WDM transmitter circuits. Applying these recommendations, we designed and presented compact transmitter demonstrators from two generic foundries and showed their successful operation. The results from the crosstalk studies are especially important for overcoming the present limits to integration density and therefore assure the continuation of steady miniaturization in the future.

Dave Utsav – **Nonlinear Optics in a-Si:H-on-Insulator and InGaP-on-Insulator Waveguide Circuits** – *UGent*

Supervisors – Gunther Roelkens and Bart Kuyken

Summary – This PhD contains an in-depth study of the linear and nonlinear waveguide losses as well as of the nonlinear refractive index in amorphous silicon on insulator waveguides and in Indium Gallium Phosphide on insulator waveguides. Nonlinear waveguide loss is measured through measurements of the transmission vs. input power, while nonlinear refractive index is derived from the self phase modulation results. The different nonlinear waveguides are then used to demonstrate supercontinuum generation.

Amin Abbasi **– High Speed Directly Modulated III-V-on-Silicon DFB Lasers** – *UGent*

Supervisors – Geert Morthier and Gunther Roelkens

Summary – Heterogeneously integrated InP-on-silicon DFB lasers with large direct modulation bandwidth have been designed and fabricated. Large modulation bandwidth is achieved by combining a high confinement factor for the active layer with low laser losses, obtained by using a high contrast diffraction grating in the silicon. The modulation bandwidth is further increased by using an external reflection in the silicon waveguide to produce a external cavity resonance. Large signal modulation up to 43 Gb/s is demonstrated in the PhD. Transmission over several tens of km of fiber is obtained by using the chirp management technique.

Weiqiang Xie – **Development of Passive and Active Integrated silicon Nitride Photonics** – *UGent*

Supervisors – Dries Van Thourhout and Zeger Hens

Summary – In this PhD, a silicon nitride photonics platform was established using a CMOS compatible approach. The developed fabrication processes included film deposition, optical contact lithography, planarization and in particular the dry etching. Secondly, the deposition of colloidal quantum dots on this silicon nitride platform was developed and studied for the

realization of active photonic components. This was obtained using a high quality Langmuir-Blodgett deposition and a unique lift-off process. Microdisk lasers using such quantum dots on silicon nitride were demonstrated.

Frédéric Descamps – **Exploitation of the polarization properties of fiber Bragg gratings for sensing applications** – *UMONS*

Supervisors – Christophe Caucheteur and Sébastien Bette

Summary – In this thesis, we exploited an original measurement technique based on the polarization properties of Bragg gratings photo-inscribed in optical fibers. The polarization properties of a fiber Bragg grating reflect the value of the birefringence of the fiber at its location. In practice, birefringence is caused by an asymmetry of the transverse section, which may result from a transverse force or a magnetic field. Determining this birefringence therefore makes it possible to estimate the transverse force or the magnetic field applied at the grating location. We focused on the measurement of non-uniform constraints (the most encountered in practice) using chirped fiber Bragg grating and on using the rotation of the diattenuation vector in a standard optical fiber for the measurement of magnetic field. In both cases, a comparison between theoretical predictions and experimental measurements was carried out and confirmed the potential of the techniques.

Xuehao Hu – **Bragg gratings in step-index polymer optical fibers: photo-inscription and characterization for sensing applications** – *UMONS*

Supervisors – Christophe Caucheteur and Patrice Mégret

Summary – In this thesis, both uniform fiber Bragg gratings (FBGs) and tilted fiber Bragg gratings (TFBGs) have been first successfully photo-inscribed in poly(methyl methacrylate) (PMMA) polymer optical fibers (POFs) using a Helium-Cadmium (He-Cd) continuous wave (CW) laser with 30 mW power at 325 nm and the phase mask technique. Then, special characterizations of FBGs in POFs for temperature, axial force, transverse force and saline concentration sensing were conducted. Finally, surrounding refractive index (SRI) sensing applications were performed using TFBGs with and without a coating. Since PMMA POFs have large bending tolerance and good biocompatibility, both FBGs and TFBGs in POFs have a great potential for *in vivo* sensing applications.

Frédéric Musin – **Few-mode interferometric fiber optic sensor** – *UMONS*

Supervisor – Marc Wuilpart

Summary – Commercial solutions for distributed fiber optic temperature sensing mainly rely on Brillouin and Raman scatterings. Such systems require complex optical equipment based on wavelength detection like spectrum analyzer, filters or tunable lasers. Their high cost prevents to disseminate the technology over a large geographical area and limits their application to high

priority infrastructures. In response to these limitations, a novel fiber optic interferometric temperature variation sensor is proposed in the frame of this thesis. The basic principle of the sensor consists in the image processing of an interference pattern at the output of an optical fiber interrogated by a laser. The analysis of the dynamics of the pattern leads to the measurement of the spatially integrated temperature variation of the fiber. This sensor was successfully used in the electricity transport domain for overheating joint detection, in the gas transport domain for leak detection and in the fire safety domain.

Min Cen – **Advanced monitoring systems for next generation passive optical networks** – *UMONS*

Supervisors – Marc Wuilpart and Véronique Moeyaert

Summary – In the frame of this thesis, we focus on the development of simple and effective next generation passive optical network (NG-PON) monitoring schemes. We propose two transmission reflection analysis (TRA) based PON monitoring techniques, accordingly, two fast and simple monitoring schemes are developed for various NG-PONs. The proposed solution was numerically studied and successfully tested in laboratory for a time- and wavelength division multiplexing (TWDM) - long reach (LR)-PON configuration for both feeder and distributed fibers monitoring. Both theoretical analyses and experimental validations show that the proposed two solutions are able to monitor the PON system with a good spatial accuracy, a high detection speed and a low impact on data traffic.

Simon Boivinet – **Innovative solutions for stable and reliable ultra-short pulses lasers** – *UMONS and MULTITEL*

Supervisors – Patrice Mégret and Yves Hernandez

Summary – The main objective of this thesis (SIRIUS project) was the development of a new all-fiber passive mode-locked laser. The proposed lasers are based on the nonlinear polarization evolution occurring during the propagation along long spans of PM fiber. We studied both numerically and experimentally the operation of different cavity designs in various pulsed and dispersive regimes. A deep understanding of the cavity enabled to design low repetition rate laser sources while sustaining picosecond pulses duration at 1 μm wavelength in a fully reliable and reproductive way.

<u>Starting PhDs</u>

Jorn van Engelen – **InP membrane platform for next generation photonic-electronic integration** – *TU Eindhoven*

Supervisors – Yuqing Jiao and Jos van der Tol

Summary – In the Photonic Integration group at TU Eindhoven active research is done on exploring the next generation PICs: a photonic membrane platform to obtain a revolution in

performance. The key idea is to detach the photonic layer from the substrate. This results in enhanced optical confinement in the waveguide (implying a much higher integration density), miniaturized device spot size (leading to faster operation speed and lower energy consumption) and possibility to integrate with CMOS electronics (giving reduced packaging cost). This research project sets up the basics of the InP membrane platform with full active/passive functionalities. The project will explore the essential technologies required for the membrane platform, then focus on the optimization of membrane-based lasers and detectors, aiming for leading level performances.

Amir Kashi – **Electro-optic modulator on an InP membrane platform for a high speed transceiver** – *TU Eindhoven*

Supervisors – Yuqing Jiao and Jos van der Tol

Summary – In the Photonic Integration group at TU Eindhoven active research is done on exploring the next generation PICs: a photonic membrane platform to obtain a revolution in performance. The key idea is to detach the photonic layer from the substrate. This results in enhanced optical confinement in the waveguide (implying a much higher integration density), miniaturized device spot size (leading to faster operation speed and lower energy consumption) and possibility to integrate with CMOS electronics (giving reduced packaging cost). This research project pursues the integration of a fast electro-optic modulator in this photonic membrane platform. It builds on previous work in which a slot waveguide modulator with an electro-optic polymer is developed. The project will bring the technology and design of the modulator in line with the requirements for other platform devices. This will be applied in the realization of a high data rate optical transceiver chip.

Raimond Frentrop **– Fabrication of high-contrast self-generating Raman waveguide lasers in $KY(WO_4)_2$** – *UTwente*

Supervisor – Sonia Garcia-Blanco

Short bio – My name is Raimond Frentrop. I've done my studies Applied Physics at the University of Twente, specializing in the field of optics and photonics for the master. After my master thesis in the Optical Sciences group on the fabrication of waveguides in $KY(WO_4)_2$ using ion irradiation, supervised by Sonia García-Blanco, I'm now continuing on the same crystal for the PhD, trying to fabricate high-contrast self-generating Raman waveguide lasers in $KY(WO_4)_2$ as part of the RENOS ERC grant.

***Michiel de Goede* – GLAM: Glass Laser Multiplexed Biosensor** – *UTwente*

Supervisor – Sonia Garcia-Blanco

Summary – The international consortium GLAM aims to develop ultra-sensitive, multiplexed, portable, easy-to-use, low-cost biosensors for applications in medical diagnostics. To achieve this, on-chip lasers based on rare-earth-ion doped alumina microring resonators are being developed, whose lasing wavelength varies with the sensing analyte. This work started at University of Twente under the supervision of dr. Sonia García Blanco in 2015. Ph.D. candidate Michiel de Goede works fulltime on the GLAM project. He received the M. Sc. degree in physics from Vrije Universiteit Amsterdam, the Netherlands, in 2014. Currently he works towards the Ph.D. in the Optical Sciences group of Twente University.

***Simen Mikalsen Martinussen* – Development highly confined dispersion engineered waveguides for supercontinuum generation and/or frequency combs –** *UTwente*

Supervisor – Sonia Garcia-Blanco

Summary – Potassium yttrium tungstate has long been in use for bulk lasers. However, its parametric nonlinear properties have not yet been exploited outside of Kerr lens modelocking. My project aims to develop highly confined dispersion engineered waveguides for supercontinuum generation and/or frequency combs. Such devices can be used for example in spectroscopy, interferometry or simply as high power, broadband, spatially coherent light sources.

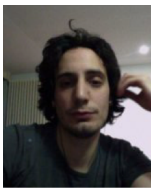
***Anton Miazin* – Polarization optical time-domain reflectometry for the measurement of plasma current in thermonuclear fusion reactors –** *UMONS and SCK.CEN (in collaboration with the CEA)*

Supervisor – Marc Wuilpart, Patrice Mégret and Andrei Gusarov

Summary – The objective of this new thesis is to develop a plasma current and magnetic field sensor for the diagnosis of Tokamak thermonuclear fusion reactors (like the future ITER reactor). The sensor will be based on the measurement of the Rayleigh-backscattered signal polarization state obtained when an optical pulse is launched in a fibre surrounding the plasma current. The Faraday effect induced by the magnetic field indeed interacts with the optical beam by rotating its polarization state. Efforts will be dedicated to find techniques to counteract the detrimental effects of intrinsic and extrinsic birefringences.

Alessio Parisi – **Space dosimetry with luminescent detectors** – *UMONS and SCK.CEN*

Supervisor – Patrice Mégret, Olivier Van Hoey and Filip Vanhavere



Summary – There are different types of radiation monitors present in the ISS (International Space Station), like active monitors and microdosimetric spectrometers. However, there is also a need for small and passive dosemeters to do mapping of the radiation field, to accompany small experiments (like biological samples) and to monitor the astronauts. It is still a challenge to measure the whole particle and energy range with small passive detectors. With thermoluminescent (TL) and optically luminescent(OSL) detectors it is relatively easy to measure the low LET part of the spectrum. For the high LET part mostly track etch detectors are used, which is a cumbersome and not very robust technique. However, also with TL and OSL detectors information from the high LET part can be obtained, e.g. from the ratio of the high temperature peaks of the TL detectors. Some research on this has been done, but nobody has ever developed an algorithm to calculate the equivalent doses based on the combination of different TL and OSL detectors.
To do this, characterization of the responses is needed in high energy fields. Part of such characterization has already been done at SCK•CEN, and also a large data set from exposures at the ISS is available for analyses. The PhD will focus on the development of an algorithm to measure the equivalent doses in space using different types of passive detectors. For this also simulations will be needed, and the interaction of the specific space radiation field in different locations on the detectors will need to be simulated. The method should not be limited to exposures in the ISS alone, but should also be usable in interplanetary missions, where the radiation field is different. It should be investigated if a good dosemeter for the astronauts can be developed using different luminescent detectors.

Mattias Verstuyft **– Opto-acoustical Spectroscopic Sensors –** *UGent*

Supervisors – Bart Kuyken and Roel Baets

Summary – Food quality control is nowadays performed by extrapolating individual tests to the whole, using a worst case scenario. This leads to a lot of wasting of good food. An obvious and good alternative is individually testing each sample. This has to be done without destroying the low-oxygen environment in which the food is kept in. The solution is performing spectroscopy in the terahertz region since food packaging is typically transparent here. The lack of cheap photodetectors in this frequency range is solved by transducing the signal. Light absorption results in an increase in gas temperature which is able to create a pressure wave, this is opto-acoustical spectroscopy. Providing such a sensor for each package of food is only viable when it is small and very cheap, this is why silicon photonic integrated circuits will be used.

Conferences, seminars and invited talks

Upcoming events

TU Delft – The 22nd **Annual Symposium of the IEEE Photonics Benelux Chapter** will be organized the 27th and 28th of November 2017 in Delft, The Netherlands. The local organizing committee consists of Jaap Caro, Paddy French, Lun Cheng, Peter Harmsma, Paul Urbach, and Jeroen Kalkman.

ULB – The conference **Dynamical Systems and Brain Inspired Computing** will take place at Brussels from 31 may to 2 june 2017. Significant part of the conference will be devoted to Photonic Reservoir Computing. Consult the web site of the conference for a detailed description of the conference, the list of invited speakers, the call for contributed talks, and how to register: http://liq.ulb.ac.be/index.php?option=com_content&view=article&id=39

UMONS – The 2017 edition of the **General Scientific Meeting of the Belgian Physical Society Conference** will take place in UMONS on the 17th of May 2017. This conference aims at gathering all the physicists in Belgium from different disciplines. Plenary sessions and more specific parallel sessions will be organized. Website: http://hosting.umons.ac.be/php/sbp/

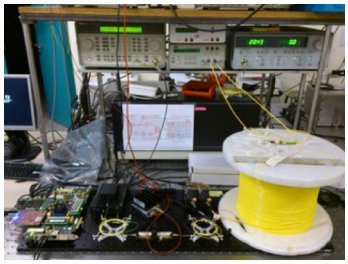
Conference plenary and invited talks

- Meint Smit, "Photonic Integrated Circuits for All: How Foundries are Transforming the Prototyping of Exciting New Devices", Plenary tak, OFC 2017, San Diego, USA. http://www.ofcconference.org/en-us/home/program-speakers/plenary-session/meint-k-smit/
- Kevin Williams, "Indium phosphide integrated photonics", Photonics West 2017, USA.
- Erwin Bente, "Mode-locked lasers in indium phosphide photonic-integrated circuits", Photonics West 2017, USA.
- Sylwester Latkowski, "Monolithic photonic integration technology platform and devices at wavelengths beyond 2µm for gas spectroscopy applications", Photonics West 2017, USA.
- M. Wuilpart, A. Goussarov, Ph. Moreau and P. Mégret, "Plasma current measurement in thermonulcear fusion reactors using a reflectometry technique", OSA Optical Sensors 2017, New Orleans, USA.
- M. Wuilpart, R. Hontinfindé, S. Coulibaly, P. Mégret and M. Taki, "Spatially-resolved measurement of supercontinuum generation along optical fibers", ICTON 2017, Gerona, Spain.
- M. Wuilpart, A. Goussarov, Ph. Moreau et P. Mégret, "Measurement of plasma current in Tokamaks using an optical fibre reflectometry technique", ANIMMA 2017, Liège, Belgium.

Research highlights

ULB – Photonic Computation Device capable of Self-Learning

The Reservoir Computing team at ULB reports in Physical Review Letters a brain inspired analogue photonic computing device that can be used both to solve tasks such as speech recognition, and to improve its own performance. The main idea is to use the same system



to carry out the "reservoir computing" artificial intelligence algorithm, and to implement the "error backpropagation" algorithm for improving its performance. A proof of principle demonstration that a single system is capable of implementing both algorithms was realised previously by the team at UGent. The ULB team has now implemented the idea in photonics, and shown that with this approach error rates can be decreased below what is traditionally achieved in reservoir computing.

These results were published in
Michiel Hermans, Piotr Antonik, Marc Haelterman, and Serge Massar, Embodiment of Learning in Electro-Optical Signal Processors, Phys. Rev. Lett.117, 128301, Sept. 2016
https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.117.128301

A broad audience presentation of the results can be found on the phys.org web site :
http://phys.org/news/2016-10-self-learning-tackles-problems-previous.html

Vacancies

1. Several positions are opened in ***UGent***:

- PhD Position on Ring Resonator Molecules
- PhD Position on Optomechanical Coupling of 2D-materials and Integrated Photonic Devices
- Post-Doc Position on Wafer-Scale Heterogeneous Integration of III-V Opto-Electronic Components by means of Transfer Printing
- Postdoc position on Nanophotonic switches on silicon photonics platform

More information can be found on the following webpage: http://www.photonics-benelux.org/index.php/positions

2. A position for an epitaxy engineer in opened in ***SmartPhotonics*** (see in appendix).

3. Four positions are opened in ***LioniX International***

- Electronic design engineer
- Process engineer PIC packaging
- Production operator PIC modules
- Microwave photonics system engineer

See on http://www.lionix-international.com/new-jobs/

SMART Photonics B.V. is an independent developer and producer of photonic components based on Indium Phosphide (InP). The company was founded in 2012 and is located in Eindhoven. In order to produce these photonic semi-conductor components SMART Photonics masters a new and unique technology and offers this technology as the first and only independent foundry worldwide. This technology has the potential to play a huge role in enabling the future 5G network, Internet of Things (IoT), Smart Mobility and many other applications for example in aviation, automotive and health.
By combining the unique SMART Photonics' business model with the extensive knowledge of and experience in photonics, the company is very well positioned in responding to these opportunities successfully. In order to meet future customer demand, we established our production facility in 2015 at the High Tech Campus Eindhoven. Furthermore, we expect to realize a new and fully equipped state of the art foundry within a couple of years. On our website (www.smartphotonics.nl) more background information on SMART Photonics can be found.

SMART Photonics is a fast growing company and in order to prepare for the increasing demand we are hiring an enthusiastic fulltime

Process Engineer Epitaxy

Name of function: Process Engineer Epitaxy
Location: Eindhoven (several locations, like the High Tech Campus and Science Park at Eindhoven University of Technology)
Contract hours: full-time 40 hrs. p/w

Function description, inclusive responsibilities:
You will be responsible for all the Epitaxy work in engineering and production for Photonic devices.
You will report to the manager Engineering

Tasks:

- Development of processes and procedures for the production of wafers.
- Processing using the MOVPE reactor, including setting up and controlling epitaxy recipes.
- The chemical etching and handling of InP wafers.
- Characterisation of InP wafers using e.g. XRD and PL. including analysis and reporting.
- Responsible for the reliable and reproducible processes, including statistical process control (SPC) and continuous improvement
- Responsible for the uptime of the epitaxial reactors, including planned maintenance and assisting in repair of the tool.

Requirements for the function:

- BSc or MSc degree in Physics, Chemical Technology or similar
- 5-10 years working experience with MOVPE processes with III-V semiconductors
- Working experience in a production environment
- Experience with process improvement
- Hands-on mentality and pragmatic attitude
- Accurate and precise working attitude

- Can work under pressure
- Team player
- Good command of Dutch and English, verbally as well as in writing

What we offer
We offer a challenging function in a fast growing company using newly developed technology in a very dynamic environment. We offer a salary that is up to standard in the market.

Are you the pragmatic team player who is looking for a challenge?

Then please send your application to Edith van Nunen (careers@smartphotonics.nl) with reference to the vacancy Process Engineer Epitaxy. For further information, please contact Kitty Jochem, manager Engineering of SMARTPhotonics at tel. 040-247 54 53.