OPTICS

2022 Workshop on Optical/Photonic Interconnects for Computing Systems

13-14 April, 2022

Starting @ 4:00 PM Central European Time (CET): **13 April, 2022**
Starting @ 2:00 PM Central European Time (CET): **14 April, 2022**

OPTICS 2022

Online Workshop April 13 - 14, 2022

Despite the slowdown of Moore's Law, applications from machine learning and edge computing to scientific computing and mobile computing continuously demand more performance under tighter cost, energy, and size constraints. Silicon-based photonic technologies advanced rapidly in the last two decades and have become promising solutions to complement electronic technologies. The OPTICS (optical/photonic interconnects for computing systems) workshop aims at discussing the latest advances in optics/photonics for computing systems, covering topics from fabrications, photonic devices, photonic circuits, architectures, system integrations, and design automation and optimization. The workshop targets researchers and engineers working on optics/photonics, electronics, architectures, systems, applications and design automation.

Topics to be discussed include but are not limited to:

- PEDA (Photonic-Electronic Design Automation): layout, placement and routing, floorplan, crosstalk, thermal, process variation, etc.
- Photonic-electronic system integration and application: data center, HPC, automobile, aviation, etc.
- Photonics-based architecture: optical neural network, rack-scale optical network, inter/intra-chip optical network, optical switching, etc.
- Photonic/optic circuits: OE conversion, optical interconnect, optical computing circuit, etc.
- Photonic device and fabrication: laser, photodetector, modulator, switch, filter, etc

Organizing Committee

Luca Ramini received the M.S. degree in Electrical Engineering from the University of Ferrara in 2010 and the PhD from the same University in 2014. He has been technical leader of system-level cross-benchmarking efforts between optical interconnects and their electrical counterparts. Luca has been visiting researcher at Columbia University in 2011, Postdoc at the University of Ferrara and Contract Professor at the University of Verona from 2014 to 2016. From May 2016 to June 2019 he was senior silicon photonics designer at STMicroelectronics. Since July 2019 Luca joined the Large Scale Integrated Photonics Lab as a research scientist at Hewlett Packard Enterprise Labs. Luca's research interests include the design of silicon photonic circuits, network architectures, and systems. Luca is co-author of more than 35 scientific contributions including conference papers, journal papers, book chapters and US patent applications filed.

Yeyu Tong received the B.E. degree from the University of Electronic Science and Technology of China in 2016, and Ph.D. degree in Electronic Engineering from the Chinese University of Hong Kong in 2020. He was a visiting researcher at Prof. John Bowers' group at the University of California, Santa Barbara in 2019 and working on the quantum-dot-based photonic integrated devices for terabit/s optical interconnects. Since 2021 he joined Interuniversity Microelectronics Center (IMEC) as an R&D Engineer researching the next generation of silicon photonics technology for high-capacity optical I/O. His research interest includes various topics related to the photonic integrated circuits and optical interconnect, including passive photonic components, high-speed silicon and III-V-on-silicon optical modulators in datacom and optical transceivers in coherent communication. He has authored and co-authored more than 50 journal and conference publications. He also has one US patent filed and one book chapter.

Sessions Chairs (Day 1)

Yanir London received the Ph.D. degree in electrical and computer engineering from the Ben-Gurion University of the Negev, Beer-Sheva, Israel, in 2017. From 2017 to 2020, he was a Postdoctoral Research Scientist with Lightwave Research Laboratory, Columbia University, New York, NY, USA. Since 2021, he has been with Hewlett Packard Labs, Milpitas, CA, USA, as a Research Scientist (Postdoc). His main activities focus on the design of efficient silicon photonic circuits and systems.

Frédéric Boeuf, born 1972**,** obtained his M.Eng. and M.Sc. degree from Institut National Polytechnique de Grenoble in 1996 and Ph.D. in condensed matter physics from the University of Grenoble in 2000. Then he joined STMicroelectronics in Crolles working on Advanced Devices Physics and Integration. Since 2011 he's leading the Silicon Photonics program in STMicroelectronics Crolles and especially the development of 100G and 400G Silicon Photonics platforms. In 2016 he was invited researcher at the University of Tokyo. He authored and co-authored over 250 technical papers and 6 book chapters. He participated to several conference committees, gave short courses in IEDM and VLSI conferences, participated in the executive committee of IEDM until 2009 and is currently program vice chair of the SSDM conference. He is recipient of General Ferrie french Award 2012 for his work on FDSOI, SSDM best paper award 2017, and best paper award from the Silicon Technology Division of the Japanese Society of Applied Physics in 2018. He was appointed STMicroelectronics regional fellow in 2018 and is currently Photonics Innovation Technical Director inside STMicroelectonics's Technology and Design Platform organization.

Sessions Chairs (Day 2)

Jiang Xu is a professor at Hong Kong University of Science and Technology (HKUST) and acting Department Head of Microelectronics Thrust. He received his PhD from Princeton University and worked at Bell Labs, NEC Laboratories America, and a startup company before joining HKUST. Prof. Xu established Novel IC Exploration Center and Xilinx-HKUST Joint Lab. He currently serves as the Associate Editor for IEEE Transactions on Very Large Scale Integration Systems. He serves on the steering committees, organizing committees, and technical program committees of many international conferences. Prof. Xu was an ACM Distinguished Speaker and an IEEE Computer Society Distinguished Visitor. He authored more than 140 book chapters and papers in peer-reviewed international journals and conferences. He and his students received IEEE Technical Committee on VLSI Best Paper Award of ISVLSI in 2018, Best Paper Award from IEEE Computer Society Annual Symposium on VLSI in 2009, and Best Poster Award from AMD Technical Forum and Exhibition in 2010. His research areas include multiprocessor system-on-chip, hybrid photonic-electronic chip, hardware-software codesign, IC power management, and machine learning system.

Davide Bertozzi is currently an Associate Professor with the Department of Engineering at University of Ferrara (Italy). He has been visiting researcher at Stanford University, NEC Laboratories America, Samsung Electronics, Philips Research Labs, and STMicroelectronics. The mission of his research activity is to stay at the forefront of system innovation at different scales by leveraging the enabling features of communication architectures and technologies. He received 5 best paper awards, 1 high-impact paper award for one of the 5 most-cited papers in the first 30 years of the ICCD conference, 3 best paper award nominations, and 1 best business idea award. He has published more than 180 scientific contributions and co-edited one book on networks-on-chip. He has been assigned the 2018 Wolfgang Mehr Award by IHP Microelectronics (Germany) for his research on cross-layer design and optimization of silicon nanophotonic networks.

Workshop Overview

Time Zone: Central European Time (CET)

Day 1 Wednesday, April 13, 2022

04:00 PM **Workshop Opening**

04:10 PM

Session 1# Design Automation, Manufacturing and Emerging Applications for Integrated Photonics

- **Michael Geiselmann**: Low Loss PICs: From Fast Prototyping to High Volumes
- **Pieter Dumon**: Photonic Design IP: Implementation, Manufacturability, and Lifecycle Management
- **Antonio Fincato**: Silicon Photonics for Emerging Applications
- **Ahsan Alam**: Process Enabled Custom Component Design Flow for Photonic Integrated Circuits

05:45 PM

Session 2# Advances on Silicon Photonic Technology for High-Bandwidth Optical Interconnects

- **Johan Bauwelinck**: 100 Gbaud Transceiver Circuits for Optical Interconnects
- **Essam Berikaa**: Silicon IQ Modulators for 800G and Beyond
- **Duanni Huang**: Heterogeneous Silicon/III-V Photonics for High Bandwidth Density Optical I/O

06:45 PM **Day 1 Workshop Closing**

Day 2 Thursday, April 14, 2022

02:00 PM **Workshop Opening**

02:10 PM

Session 3#Emerging Materials/Technology for Advanced Photonic Functions

- **Cheng Wang**: Lithium Niobate Photonics for High Speed and Low Loss Data Links
- **Lin Chang**: Highly-Coherent Laser and Microcombs in Integrated Photonics
- **Siming Chen**: Epitaxial Growth of III-V Quantum Dot Lasers on Silicon

03:25 PM

Session 4# Photonic Integrated Circuits for Neuromorphic and High-Performance Computing

- **Chaoran Huang**: Silicon Neuromorphic Photonics for Intelligent Signal Processing
- **Felix Hermann**: Cascaded Mach-Zehnder Interferometers for Efficient AI Acceleration
- **Patty Stabile**: InP Photonic Integrated Neural Networks for Neuromorphic Computing
- **Bhavin Shastri**: Silicon Photonics for Machine Learning and Neuromorphic Computing
- **Marco Fiorentino**: Silicon Photonics for HPC: Devices and Tools

05:05 PM **Day 2 Workshop Closing**

Wednesday, April 13, 2022

Day 1 Workshop Opening

Time Zone: Central European Time (CET)

Time: 04:00 PM
Jiang Xu – *Hong Kong University of Science and Technology (HKUST)*
Luca Ramini – *Hewlett Packard Labs (HPE labs)*
Yeyu Tong – *Interuniversity Microelectronics Centre (imec)*

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Session 1: Design Automation, Manufacturing and Emerging Applications for Integrated Photonics

Session Chair: Yanir London, *Hewlett Packard Labs (HPE labs), USA*

1.1 Low Loss PICs: From Fast Prototyping to High Volumes

Time: 04:10 PM
Michael Geiselmann – *Ligentec, Switzerland*

1.2 Photonic Design IP: Implementation, Manufacturability, and Lifecycle Management

Time: 04:30 PM
Pieter Dumon – *Luceda Photonics, Belgium*

1.3 Silicon Photonics for Emerging Applications

Time: 04:50 PM
Antonio Fincato – *STMicroelectronics, Italy*

1.4 Process Enabled Custom Component Design Flow for Photonic Integrated Circuits

Time: 05:10 PM
Ahsan Alam – *ANSYS, Canada*

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Low Loss PICs: From Fast Prototyping to High Volumes

7:10am PDT, 10:10am EDT, 3:10pm BST, 4:10pm CET, 10:10pm Asia

Michael Geiselmann,
Managing Director, Ligentec,
Switzerland

Abstract

Propagation losses in PICs are very important to have energy efficient on chip routing and are especially crucial if already very few photons are there to start with. In this webinar we will give an overview of LIGENTEC's low loss PICs based on silicon nitride and application areas in LiDAR, Quantum and sensing. We explain our Process Design Kit and different fabrication modules. Reproducibility and uniformity are of critical importance and are addressed with statistical process control in our 100mm and 200mm wafer fabrication.

Speaker Bio:

Michael Geiselmann (Managing Director) studied physics and engineering at University Stuttgart and Ecole Centrale Paris. After his PhD at ICFO in Barcelona in 2014 he joined the laboratory of Prof. Kippenberg at EPFL in Lausanne, where he advanced frequency comb generation on integrated silicon nitride chips towards applications and was involved in several international research projects. In 2016, he co-founded LIGENTEC and brought the company to the international stage of photonic integration.

Wednesday, April 13, 2022

Photonic Design IP: Implementation, Manufacturability, and Lifecycle Management

7:30am PDT, 10:30am EDT, 3:30pm BST, 4:30pm CET, 10:30pm Asia

Pieter Dumon,
Luceda Photonics,
Belgium

Abstract

The application space of photonic integrated circuits is increasing as rapidly as their complexity. The market is heavy on R&D and novel devices and circuits are entering the market every day. Re-use of design IP is becoming an important asset for any company and research center in the photonics market. We will discuss essential workflows for developing and evolving photonic design IP from its early inception and validation, through process variability analysis for manufacturability, up to careful change management.

Speaker Bio:

Pieter Dumon is CTO and co-founder of Luceda Photonics, where he is engaged in software development, PDK development, circuit and device modeling and professional services. Pieter obtained his EE master's degree from Ghent University in 2002 and a PhD in photonics in 2007. He coordinated ePIXfab, the first small-volume prototyping service for silicon photonics from 2007 until 2014 and has been involved in semiconductor technology development and design.

Wednesday, April 13, 2022

Silicon Photonics for Emerging Applications

7:50am PDT, 10:50am EDT, 3:50pm BST, 4:50pm CET, 10:50pm Asia

Antonio Fincato,
STMicroelectronics,
Italy

Abstract

Silicon photonics has been developed in ST leading to PIC25G and PIC50 technologies. Initially aiming at supporting data centre communication, there has been recently an increasing interested in new kind of applications.
After a description of 300mm Silicon Photonics platform, a few emerging applications such as LiDAR, integrated Optical Gyroscope, Biosensing and implementation of non-classical light for Quantum Cryptography will be shown. Optical Phased Array (OPA) is capable to generate an adaptive beam by tuning the individual phases and amplitudes of an array of optical emitters. Pros and cons of possible control systems of very large architectures will be discussed. Miniaturized and low-cost optical gyroscopes are required for emerging applications in consumer electronics market. Preliminary results for integrated optical gyroscope based on the Sagnac effect and realized in Silicon and Silicon Nitrate waveguide layer will be presented. Biosensing is usually based on refractive index change of waveguides due to biological molecules presence on a dedicated area of the chip properly functionalized for specific entrapment. A possible solution is a system capable of locking a tunable laser frequency to a silicon photonics microring resonator (MRR) and tracking any changes in its wavelength over time with very high speed, accuracy, and sensitivity. A way of creating non-classical light sources based on four wave mixing occurring in Silicon will be presented. The emitter has a SNR improved by two orders of magnitude with respect to the state of the art. The entanglement without background subtraction has been proven, a necessary condition for the use of frequency entangled photons in quantum communication protocols.

Speaker Bio:

Antonio Fincato obtained his degree in Physics from Pavia University in 1984. In the following years he worked at Milano University and at CERN in Geneva on an Elementary particle Physics experiment. In 1986 he joined CSELT laboratories in Turin where he started his studies in Integrated Optics. In 1988 He joined ITALTEL, in 1993 worked for one year at AT&T Bell Labs in Murray Hill and since 2000 he is working in STMicroelectronics, Milan. His research interests include various topics related to integrated photonics and micro-optics. He worked on technologies like Ionic exchange in glass, Glass on Silicon and Silicon Photonics. He developed micro-optical and integrated-optical components and architectures for Datacom and Sensing applications. He is author or co-author of more than 20 patents and 30 articles in journals and conferences.

Wednesday, April 13, 2022

Process Enabled Custom Component Design Flow for Photonic Integrated Circuits

8:10am PDT, 11:10am EDT, 4:10pm BST, 5:10pm CET, 11:10pm Asia

Ahsan Alam,
ANSYS,
Vancouver, British Columbia, Canada

Abstract

The demand for photonic integrated circuits (PICs) is growing exponentially, with their applications ranging from consumer electronics and telecommunications to quantum computing. With several foundries enabling wafer-scale PIC fabrication, there are many off-the-shelf components readily available to photonic circuit designers. However, the offerings from these foundries are still maturing and custom components are often needed to meet strict performance requirements.
Designing a custom photonic component can be challenging because it must adhere to technology specifications, which vary from foundry to foundry. Manually setting up the various process layers for simulation of the device can be prone to error and may result in multiple cost-inefficient fabrication cycles. To simplify the simulation setup, Ansys Lumerical products for component-level design offer a Layer Builder tool, which automatically generates accurate 3D geometries from the layout of the design (typically in GDS format) and the layer information in a foundry process file. Optical, electrical, and thermal material properties are automatically assigned to the different geometry segments. For active photonic components, it also sets up doping objects for electrical simulations. Additionally, foundries can include information about their process variations in the process file which can be used to perform Monte-Carlo simulations during the component design process to create designs that are robust against variations coming from the fabrication processes.
This presentation will explain the various features of Layer Builder and demonstrate a complete simulation workflow for an electrical phase shifter with electrical simulation in CHARGE and optical simulation in MODE, using Layer Builder and a foundry process file.

Speaker Bio:

Dr. Ahsan Alam is a Lead R&D Engineer at Ansys. His fields of expertise include simulation and modeling of solid state electronic and photonic devices and circuits. As the lead in photonic foundry activities, he collaborates with foundry partners on various projects ranging from PDK generation to ecosystem development. He is also involved in the development of Ansys-Lumerical's system suite and plays the role of a product manager.

Session 2: Advances on Silicon Photonic Technology for High-Bandwidth Optical Interconnects

Time Zone: Central European Time (CET)

Session Chair: Frederic Boeuf, *STMicroelectronics, France*

2.1 100 Gbaud Transceiver Circuits for Optical Interconnects

Time: 05:45 PM
Johan Bauwelinck – *Ghent University*

2.2 Silicon IQ Modulators for 800G and Beyond

Time: 06:05 PM
Essam Berikaa – *McGill University, Canada*

2.3 Heterogeneous Silicon/III-V Photonics for High Bandwidth Density Optical I/O

Time: 06:25 PM
Duanni Huang – *Intel, Santa Clara, USA*

100 Gbaud Transceiver Circuits for Optical Interconnects

8:45am PDT, 11:45am EDT, 4:45pm BST, 5:45pm CET, 11:45pm Asia

Johan Bauwelinck,
Ghent University,
Belgium

Abstract

New circuit architectures and technologies for high-speed electronic and photonic integrated circuits are essential to realize optical interconnects with higher symbol rate. As a consequence of the increasing speeds, close integration and co-design of photonic and electronic chips have become a necessity to realize high-performance transceivers with novel packaging approaches. Extensive co-design also enables the design of new electro-optic architectures to create and process optical signals more efficiently.
This presentation will illustrate a number of recent developments of application-specific high-speed electro-optic transceiver circuits including e.g. broadband driver amplifiers, transimpedance amplifiers, analog equalizers and multiplexer circuits for signal generation and reception at 100 Gbaud and beyond. The basic concepts and architectures, technological aspects, design challenges and trade-offs will be discussed.

Speaker Bio:

Prof. Johan Bauwelinck was born in Sint-Niklaas, Belgium, in 1977. He obtained the MSc degree and the PhD degree in Electrical Engineering from Ghent University, Belgium, in 2000 and 2005, respectively. Since Oct. 2009 he is a professor in the IDLab research group of the department of Information Technology (INTEC) at the same university and imec where he is leading the Design lab since 2014 (currently 30 people strong).
His research focuses on high-speed, high-frequency (opto-) electronic circuits and systems, and their applications on chip and board level, including transmitter and receiver analog front-ends for fiber-optic communication or instrumentation systems. He was and is very active in EU-funded projects in FP6, FP7 and Horizon 2020 such as Optima, Streams, HandheldOCT, POETICS and ESA protobix conducting research on advanced electronic integrated circuits for next generation optical networks, photonic satellite payloads and integrated optical sensing.
He has promoted 27 PhDs and co-authored more than 350 publications and 10 patents in the field of high-speed electronics and fiber-optic communication. In 2020, he co-chaired the Technical Program Committee of the European Conference on Optical Communications (ECOC) and in 2022, he became Associate Editor of the IEEE Transactions on Circuits and Systems II: Express Briefs.

Silicon IQ Modulators for 800G and Beyond

9:05am PDT, 12:05pm EDT, 5:05pm BST, 6:05pm CET, 00:05am Asia

Essam Berikaa,
McGill University,
Montreal, Canada

Abstract

Despite the inherent advantages of silicon photonics (SiP) in terms of low manufacturing costs, CMOS compatibility, and compact footprints, its deployment in coherent optical communication networks is limited because of its fundamental constraints in terms of the high driving voltage requirements and limited electro-optic bandwidth. In this presentation, we summarize the research done by our group in designing and characterizing SiP modulators for IMDD and coherent transmission systems. Finally, we highlight our recent demonstration of net 1 Tbps transmission using a single-segment travelling-wave SiP IQ modulator over 80 km of SSMF using only electronic equalization.

Speaker Bio:

Essam received his B.Sc. with honor in Nanotechnology and Nanoelectronics Engineering from the University of Science and Technology at Zewail City in 2019. Directly afterward, he has joined McGill University for a direct Ph.D. program under the supervision of Prof. David V. Plant. Essam's Ph.D. research focuses on the design and testing of Silicon photonic transceivers for high-speed optical communication.

Wednesday, April 13, 2022

Heterogeneous Silicon/III-V Photonics for High Bandwidth Density Optical I/O

9:25am PDT, 12:25pm EDT, 5:25pm BST, 6:25pm CET, 00:25am Asia

Duanni Huang
Intel,
Santa Clara, USA

Abstract

Optical I/O is an application that requires very high optical bandwidth density, low energy consumption, and the ability to scale to high-volume production. To meet these challenging demands, tight integration is required between the laser, modulators, detectors to form a highly function photonic integrated circuit with small footprint. We demonstrate all the necessary elements for high bandwidth density optical I/O including high optical bandwidth ring modulators, multi-wavelength laser sources, as well as polarization division multiplexing, all fabricated using Intel's 300mm hybrid silicon photonics platform.

Speaker Bio:

Dr. Duanni Huang received his B.S. degree in electrical engineering from the Massachusetts Institute of Technology, Cambridge, MA, USA, in 2013, and the M.S. and Ph.D. degrees in electrical engineering from the University of California, Santa Barbara, Santa Barbara, CA, USA, in 2015 and 2019, respectively. He is currently a senior research scientist with Intel Labs in Santa Clara, working on silicon photonic integrated circuits with an emphasis on heterogeneous integration of III-V and other materials with silicon.

Day 2 Workshop Opening

Time Zone: Central European Time (CET)

Time: 02:00 PM
Jiang Xu – *Hong Kong University of Science and Technology (HKUST)*
Luca Ramini – *Hewlett Packard Labs (HPE labs)*
Yeyu Tong – *Interuniversity Microelectronics Centre (imec)*

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Session 3: Emerging Materials/Technology for Advanced Photonic Functions

Session Chair: Jiang Xu, *Hong Kong University of Science and Technology, Hong Kong, China*

3.1 Lithium Niobate Photonics for High Speed and Low Loss Data Links

Time: 02:10 PM
Cheng Wang – *City University of Hong Kong, Hong Kong, China*

3.2 Highly-Coherent Laser and Microcombs in Integrated Photonics

Time: 02:30 PM
Lin Chang – *Peking University, China*

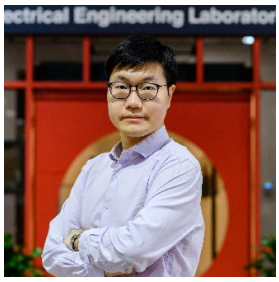
3.3 Epitaxial Growth of III-V Quantum Dot Lasers on Silicon

Time: 02:50 PM
Siming Chen – *University College London, UK*

Thursday, April 14

Lithium Niobate Photonics for High Speed and Low Loss Data Links

5:10am PDT, 8:10am EDT, 1:10pm BST, 2:10pm CET, 8:10pm Asia



Cheng Wang,
City University of Hong Kong,
Hong Kong, China

Abstract

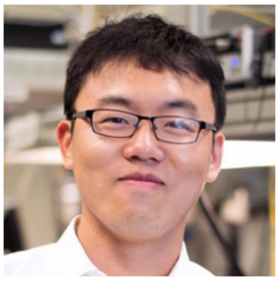
Lithium niobate (LN) is an excellent electro-optic material widely deployed for telecommunications. While its high Pockels effect, wide transparency window and low optical loss offer unique advantages, conventional LN devices are bulky and discrete due to the low index-contrast in ion-exchanged waveguides. In this talk, I will provide a summary of our recent results in integrated LN photonics that overcomes this limitation by direct etching thin-film LN. We show that waveguides and resonators with sub-wavelength light confinement and extremely low propagation loss (< 0.03 dB/cm) can be fabricated using standard lithography techniques. Together with the strong electro-optic and nonlinear responses, we demonstrate electro-optic modulators with CMOS-compatible driving voltage of 1.4 V and electro-optic bandwidths up to 300 GHz, promising for future intra- and inter-datacenter optical links.

Speaker Bio:

Dr. Cheng Wang received his B.S. degree in Microelectronics from Tsinghua University in 2012. Afterwards, he joined Harvard University as a Ph.D. student in the School of Engineering and Applied Sciences, advised by Prof. Marko Loncar. He received his S.M. and Ph.D. degrees, both in Electrical Engineering from Harvard University, in May 2015 and May 2017, respectively. From 2017 – 2018, Cheng conducted research as a postdoctoral fellow at Harvard, before joining City University of Hong Kong as an Assistant Professor in June 2018. Dr. Wang's research focuses on the design and nanofabrication technology of integrated photonic devices and circuits. His current research effort focuses on realizing integrated lithium niobate photonic circuits for applications in optical communications, millimeter-wave/terahertz technologies, nonlinear optics, and quantum photonics. Since joining CityU, Dr. Wang has received a number of awards including the NSFC Excellent Young Scientist Fund (HK & Macau) (2019), the Croucher Innovation Award (2020), The President's Award, CityU (2020), and 35 Innovators Under 35 (China), MIT Technology Review (2021).

Highly-Coherent Laser and Microcombs in Integrated Photonics

5:30am PDT, 8:30am EDT, 1:30pm BST, 2:30pm CET, 8:30pm Asia



Lin Chang,
Peking University,
China

Abstract

The generation of highly coherent light source, including single-wavelength lasers and optical frequency combs, is invaluable in a wide range of applications, spanning communications, metrology and sensing. However, previously the state-of-the-art coherent systems have to rely on bench-top equipment, which are expensive and power hungry. To transfer the high-coherence capabilities from the research lab to the wider world, integrated photonics plays a key role, which can leverage the modern manufacturing infrastructure for high volume and low cost productions. In this talk, the recent breakthroughs in on-chip coherent light generation will be discussed. By bridging the diode laser with ultra-high-Q microresonator, sub-Hz linewidth laser and microcombs are demonstrated, which opens a new door to precise metrology, communications and sensing in integrated photonics.

Speaker Bio:

Lin Chang is an assistant professor from department of electronics, Peking University. Lin's research primarily focuses on the development of photonic integrated circuits, especially the integrated nonlinear photonic devices. He successfully demonstrated many state-of-the-art high efficient nonlinear photonic devices using heterogeneous bonding technology in both Gallium Arsenide and Lithium Niobate on insulator platforms, the first integrated microcomb soliton source and the first Hz level narrow linewidth laser. Those demonstrations have opened the door to a revolutionary nonlinear PICs and are poised to enable quantum PICs in the near future. In system level, he and his team has demonstrated first optical synthesizer based on integrated photonics. Lin has published over 30 refereed international papers in top journals including Nature, Science, Nature Photonics, Nature Communications, Laser Photonics Review, Physics review letters, Optica... He has given invited/post deadline talks in many top international conferences like Conference on Lasers and Electro-Optics (CLEO), IEEE Photonics Conference (IPC), Nonlinear Congress (NLO) and so on.

Epitaxial Growth of III-V Quantum Dot Lasers on Silicon

5:50am PDT, 8:50am EDT, 1:50pm BST, 2:50pm CET, 8:50pm Asia

Siming Chen
University College London,
London, UK

Abstract

The availability of silicon-based lasers is a critical technology for the whole silicon photonics industry. But the indirect bandgap of silicon is a severe limitation, and, despite recent advances, Group IV-based light emitters will not outperform their III-V counterparts in the foreseeable future. Therefore, much effort has been directed toward the hybrid integration of III-V lasers with silicon photonics platforms. Although impressive results have been achieved, in the longer term, the direct epitaxial growth of III–V semiconductor lasers on silicon remains the 'holy grail' for full-scale deployment of silicon photonics with reduced cost and added flexibility. Semiconductor lasers with active regions made from quantum dots (QDs) have superior device performance than conventional quantum well (QW) counterparts and offer new functionalities. Furthermore, there are other advantages of QDs for monolithic III–V-on-Si integration over QWs, such as QD devices being less sensitive to defects and optical feedback.
This talk focuses on 1310 nm InAs/GaAs quantum dot lasers in silicon photonics. The challenges and Strategies for developing high-quality III-V materials on silicon using direct epitaxy methods are discussed.

Speaker Bio:

Dr. Siming Chen obtained his PhD in Electrical Engineering from the University of Sheffield in 2014. In September 2013, upon submitting his PhD thesis, he joined the UCL as a Research Associate and was awarded a Royal Academy of Engineering Research Fellowship in 2017 in recognition is pioneering work on Si-based QD light sources. Dr Chen is now a Lecturer and a member of the Photonics Group in the Department of Electronic & Electrical Engineering at UCL. He has published more than 80 refereed papers and 4 patents and has an h-index of 23.

Session 4: Photonic Integrated Circuits for Neuromorphic and High-Performance Computing

Time Zone: Central European Time (CET)

Session Chair: Prof. Davide Bertozzi, *University of Ferrara, Italy*

4.1 Silicon Neuromorphic Photonics for Intelligent Signal Processing

Time: 03:25 PM
Chaoran Huang – *Chinese University of Hong Kong, Hong Kong, China*

4.2 Cascaded Mach-Zehnder Interferometers for Efficient AI Acceleration

Time: 03:45 PM
Felix Hermann – *IBM Research Institute, Switzerland*

4.3 InP Photonic Integrated Neural Networks for Neuromorphic Computing

Time: 04:05 PM
Patty Stabile– *Eindhoven University of Technology, Netherland*

4.4 Silicon Photonics for Machine Learning and Neuromorphic Computing

Time: 04:25 PM
Bhavin Shastri – *Queen's University, Canada*

4.5 Silicon Photonics for HPC: Devices and Tools

Time: 04:45 PM
Marco Fiorentino – *Hewlett Packard Enterprise, USA*

Silicon Neuromorphic Photonics for Intelligent Signal Processing

6:25am PDT, 9:25am EDT, 2:25pm BST, 3:25pm CET, 9:25pm Asia

Chaoran Huang,
Chinese University of Hong Kong,
Hong Kong, China

Abstract

Machine learning can solve many applications in optical communications, but its benefits are largely validated offline using conventional computers. We will introduce a radically new hardware platform, neuromorphic photonics, for machine learning, and review its applications in different optical communication systems.

Speaker Bio:

Chaoran Huang is an assistant professor at the Chinese University of Hong Kong (CUHK). Before joining CUHK in 2021, she was a postdoctoral research associate at Princeton University. Her ongoing work is dedicated to developing integrated photonic hardware for neuromorphic computing and related applications. She was the recipient of the 2019 Rising Stars Women in Engineering Asia. She has published three book chapters on neuromorphic photonics, one US patent, and more than 40 peer-reviewed journal and conference papers. She was the invited speaker of several international conferences including Optical Fiber Communication Conference, IEEE Photonics Conference, Photonics in Switching and Computing, Asia Communications and Photonics Conference etc.

Cascaded Mach-Zehnder Interferometers for Efficient AI Acceleration

6:45am PDT, 9:45am EDT, 2:45pm BST, 3:45pm CET, 9:45pm Asia

Felix Hermann,
IBM Zurich,
Switzerland

Abstract

The worldwide need for computing power for AI technology is recently growing faster than ever. In contrast to that, rising climate awareness demands energy-efficient computing power. Integrated Optics provides a tool box for establishing building blocks for neuromorphic computing. In this presentation, we show our progress to tackle the novel demands by means of optical effects. Therefore, we build Finite Impulse Response Filters utilizing cascaded Mach-Zehnder-Interferometers to compute convolution operations for AI networks at a rate of Giga samples per sec.

Speaker Bio:

Mr. Felix Hermann is a predoctoral researcher in the ‘’Neuromorphic devices & systems’’ Group at IBM Research Europe - Zurich, where he focuses on novel neuromorphic computing technologies and applications. He studied Physics at the ‘Karlsruher Institut für Technologie’ KIT in Germany with focus on experimental solid state physics. For his Master Thesis he participated in an exchange program at Aalto University, Finland, and worked on active control of spin waves in YIG-based magnetic structures. He received his M.Sc. degree in 2020.

InP Photonic Integrated Neural Networks for Neuromorphic Computing

7:05am PDT, 10:05am EDT, 3:05pm BST, 4:05pm CET, 10:05pm Asia

Patty Stabile,
Eindhoven University of Technology,
Netherland

Abstract

Photonic neural networks have been proposed, using a combination of SOA and AWG technology. The foreseen architecture is shown using WDM input signals, and an all-optical monolithically integrated neuron and a multi-layer optical neural network are demonstrated, opening to all-optical neural networks. Finally, a new concept for a 3D neuron and neural network will be shown, together with predicted performance, opening to a promising and feasible technology for neuromorphic photonics.

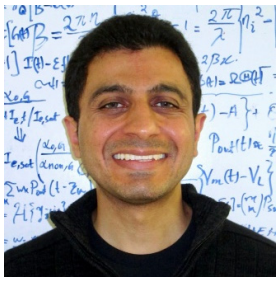
Speaker Bio:

Dr. Patty Stabile, after receiving her PhD in Nanoscience in 2008 at the National Nanotechnology Laboratory of Lecce (IT), moved to the TU/e COBRA Research Institute (NL), now Institute for Photonic Integration (IPI), where she has worked on large-scale photonic integrated circuits and designs for high-capacity nodes for next generation optical networks, for which she was awarded the Early Career Women in Photonics – Special Recognition in 2016. She has been visiting scientist for 1 month in 2011 at University of Cambridge (UK), hosted by prof. Ian White, and in 2018 at MIT at the Quantum Photonics group, hosted by prof. Dirk Englund. She is chair of the IEEE Photonics Benelux Chapter since 2021 and member of the TU/e Young Academy of Engineering. Patty is now an Associate Professor at Eindhoven University of Technology. She is author and co-author of more than 100 journal and conference papers in prestigious photonics conferences. She has been involved with various EU H20 projects (such as QAMeleon, Passion, Twilight) as well as several national programs. She is now considering her state-of-the-art photonic integrated matrices for application in optical computing and designing architecture which see the system co-integration of electronics and photonics.

Thursday, April 14

Silicon Photonics for Machine Learning and Neuromorphic Computing

7:25am PDT, 10:25am EDT, 3:25pm BST, 4:25pm CET, 10:25pm Asia



Bhavin J. Shastri,
Queen's University,
Kingston, Ontario, Canada

Abstract

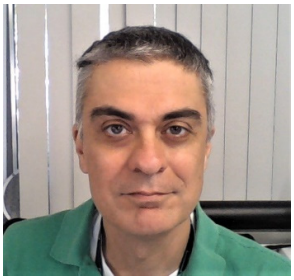
Research in photonic computing has flourished due to the proliferation of optoelectronic components on photonic integration platforms. Photonic integrated circuits have enabled ultrafast artificial neural networks, providing a framework for a new class of information processing machines. Algorithms running on such hardware can address the growing demand for machine learning and artificial intelligence in areas such as medical diagnosis, telecommunications, and high-performance and scientific computing. In parallel, the development of neuromorphic electronics has highlighted challenges in that domain, mainly related to processor latency. Neuromorphic photonics enabled by silicon photonics offers sub-nanosecond latencies, providing a complementary opportunity to extend the field of artificial intelligence and neuromorphic computing with applications in high-performance computing, nonlinear programming, and intelligent signal processing. We discuss the recent advances in integrated photonic neuromorphic systems, discuss current and future challenges.

Speaker Bio:

Prof. Bhavin J. Shastri is an Assistant Professor of Engineering Physics at Queen's University and a Faculty Affiliate at the Vector Institute. He was an Associate Research Scholar (2016-2018) and Banting and NSERC Postdoctoral Fellow (2012-2016) at Princeton University. He received a Ph.D. degree in electrical engineering (photonics) from McGill University in 2012. He is a co-author of the book Neuromorphic Photonics, a term he helped coin. Dr. Shastri is the recipient of the 2022 SPIE Early Career Achievement Award and the 2020 IUPAP Young Scientist Prize in Optics "for his pioneering contributions to neuromorphic photonics." He is a Senior Member of Optica and IEEE.

Silicon Photonics for HPC: Devices and Tools

7:45am PDT, 10:45am EDT, 3:45pm BST, 4:45pm CET, 10:45pm Asia



Marco Fiorentino,
Hewlett Packard Enterprise,
USA

Abstract

In my talk I will discuss progress toward an open Silicon photonics ecosystem targeted at High-performance computing applications. The ecosystem is centered around a development kit comprising verified devices that can be laid out and simulated using industry-standard tools. I will discuss the HPC requirements and describe specific devices and tools designed to be fit those needs.

Speaker Bio:

Marco Fiorentino received the Ph.D. degree in physics from the University of Naples, Naples, Italy, in 2000. His doctoral work focused on quantum optics. He is currently a Research Scientist with Large Scale Integrated Photonics Lab, Hewlett Packard Enterprise Labs, Milpitas, CA, USA. Before working with the HP/HPE Labs, in 2005, he was with the Northwestern University, Evanston, IL, USA, University of Rome, Rome, Italy, and MIT. In the past, he has worked on optics, high-precision measurements, and optical communications. He has authored or coauthored more than 50 papers in peer-reviewed journals and given numerous contributed and invited talks to international conferences. He is a Senior Member of the Optical Society of America.

Registration Information

OPTICS 2022 will be conducted virtually using Zoom. Access information will be sent to all registered participants by April 12th.

To attend, please register yourself here: OPTICS22 Registration

Registration deadline: April 11, 23:59 PDT.