Integrated Photonics

Session Co-chairs: Lynford L. Goddard, University of Illinois at Urbana Champaign, USA; Pavel Peterka, Institute of Photonics and Electronics of the Czech Academy of Sciences, Prague, Czech Republic

Photonics is the technology of generating, controlling, and detecting photons, which are particles of light. In short, photonics is the science of light. Photonics is a young word; its use become widely accepted only at the end of 1980-ies. However, it quickly became the name of an important industrial sector and a part of everyday life. We find it in smartphones, sustainable energy sources, medical instruments, lighting and display technology, and many other systems. Some photonics devices astonish by their brute force (e.g., distant cutting by fiber lasers) and others by their delicate precision (e.g., the official definition of distance in terms of light propagation speed and the accurate measurement of time by optical frequency combs). The importance of photonics in everyday life was recognized recently by the UNESCO: last year, we celebrated the International Year of Light 2015.

Integrated photonics incorporates multiple photonic elements (e.g. light sources, amplifiers, couplers, multiplexers, switches, and detectors) on a single substrate. The elements are connected through waveguides and then entire photonics integrated circuits can be connected to each other by optical fibers. In contrast to electronic integrated circuits with silicon as the prevailing material, integrated photonics use many different materials, including indium phosphide or gallium arsenide semiconductors, silicon, silica on silicon, lithium niobate crystal, polymers, or hybrid organic-inorganic materials and non-traditional substrates such as paper, textiles or glass. Moreover, unlike electronics that relies on a single fundamental building block, namely the transistor, photonic integrated circuits utilize numerous device elements to achieve functionality. The photonic integrated circuit is a promising technology that may provide the key for taming the sky-rocketing increase of energy consumption in telecommunications and datacenters and for matching the ever-increasing demand for high speed information processing and transmission capacity. Integrated photonics are also enabling a wide range of compact sensors with applications in medicine, biosensing, security, and safety.

The first speaker, Prof. Keren Bergman from Columbia University, will give an overview about photonic systems ranging from the physical layer to networks to new photonic based architectures for datacom and for exascale computing and beyond. She will also introduce the newly launched AIM Photonics, discuss application areas, and answer questions on how researchers can use this manufacturing capability. The second speaker, Prof. Katia Gallo from KTH Stockholm in Sweden, will address recent developments bringing together the fields of ferroelectric and photonic sciences, with the tools of nanotechnology and integrated optics in lithium niobate and discuss their implications for ultrafast signal processing, as well as new potential applications to sensing and life sciences.

The third speaker, Prof. Mircea Guina from ORC, Tampere University of Technology in Finland, will focus on integration of III-V optoelectronics and Si photonics and new developments and application opportunities in this field. The fourth speaker, Prof. Adrienne Stiff-Roberts from Duke University, will introduce non-traditional photonic integration methods using organic and hybrid organic-inorganic materials and devices and present some of their applications in biomedical sensors, digital displays, and solar cells. She will also discuss the challenges and opportunities for high volume manufacturing using this platform.

List of topics (for the attendees):

Integrated Photonics:

- The vision, challenges, and opportunities for the field
- Applications
    - Power efficient ultra-high-speed transmission of signals for the internet, data centers, telecommunications, and within next generation computing systems
    - New high-performance information-processing systems
    - Compact sensor applications enabling dramatic medical advances in diagnostics and treatment
    - Multi-sensor applications including urban navigation, free space optical communications, quantum information sciences, and biomedical sensors
    - Emerging applications of waveguide and fiber lasers in industry and medicine
    - Analog RF sensing
    - Chemical/biological detection
    - Digital displays and solar cells
- Manufacturing: development of an end-to-end integrated photonics ecosystem, including foundry access, integrated design tools, and automated packaging, assembly, and testing