Editorial

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Special issue on 'integrated photonic devices: sensors, materials, systems'

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Photonics is related to the generation, control and detection of light. Photonic technologies are becoming more pervasive in the world, with applications ranging from energy efficient lighting or high speed telecommunications to minimally invasive medical devices or specialized materials processing. As photonic systems become more complex, driven by the demands of such emerging applications, there is a move towards higher levels of integration, much like the developments made in previous decades in microelectronic integration.

However, unlike microelectronics, photonic systems can be fabricated from a wide variety of diverse materials, from semiconductors including InP, GaAs, GaN and silicon, to dielectrics and advanced polymers. In addition, there is an increasing demand to integrate both photonic and electronic functions on the same device which presents additional technological challenges and which can result in extremely high chip and package manufacturing costs. Therefore, production of these devices is non-trivial and access to fabrication and packaging services is an issue, especially for companies and researchers who do not have their own in-house expertise or advanced cleanroom facilities. These issues combined present major roadblocks which impede the development, uptake and commmercialisation of photonic technologies, especially highly integrated photonic systems.

In this issue of *Advanced Optical Technologies*, we focus on recent developments in the fields of photonic devices, sensors, materials and systems. A major theme throughout the articles is the drive towards integration. We also present reviews of advanced foundry services in silicon, InP and dielectric photonic materials. These foundries give users unique access to state-of-the-art photonic device fabrication capabilities, bridging the gap between initial concepts and fully functioning prototypes.

Silicon photonics enables the production of highly integrated photonic sub-systems leveraging-off many of the advances made in CMOS electronics. This offers the potential for cost reduction through mass manufacture using well-established wafer processing techniques. Articles in this issue review the latest developments in silicon photonic devices for high speed telecommunications and in process design kits which enable the fabrication of highly integrated silicon photonics devices.

III–V photonic technologies including InP and GaAs materials are essential for coherent light emission and a critical component in all photonic communication systems. In this issue we review developments in III–V photonic materials and sources. We also review access to state-of-the-art InP foundry services which help meet the need for highly integrated photonic systems. Finally, we review a low loss dielectric platform suitable for integrated photonic systems ranging from UV to mid-IR wavelengths.

This issue should be of interest to a wide audience as it presents highly informative articles that address a broad range of technologies and applications. We expect these articles will benefit not only those familiar with photonics, but also readers interested in understanding the potential of photonics for their particular application, even if they are not photonics experts.

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Engineering and Degree in Physics from Trinity College Dublin. He was a postdoctoral scholar at the California Institute of Technology and NASA's Jet Propulsion Laboratory in Pasadena. In 2006 Dr. O'Brien founded Epi-Light limited, a photonics company developing speciality optical systems for medical device and bio-imaging applications. He sold the company in 2009 and returned to the Tyndall National Institute to establish a research activity in advanced photonic packaging and integration. His group of 20 researchers is involved in a wide range of international academic and direct industry funded projects. The group has state-of-the-art photonic packaging and integration laboratories and much of their research has a special focus on packaging and integration of photonic devices for ICT and biomedical applications. Dr. O'Brien is also deputy director of the recently funded €30 M Science Foundation Ireland, Irish Photonic Integration Centre (www.ipic.ie).

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Meint K. Smit graduated in Electrical Engineering from the Delft University of Technology in 1974, and received his PhD in 1991, both with honours. In 1974 he started work on radar and radar remote sensing. He joined the Delft University of Technology in 1976. He switched to optical communications in 1981, his research field was Integrated Optics. He became leader of the Photonic Integrated Circuits group at the Delft University in 1994. He is the inventor of the Arrayed Waveguide Grating for which he received a LEOS Technical Achievement award in 1997. He was appointed professor in 1998. In that year his group, together with the groups of Prof. Wolter and Prof. Khoe (COBRA, TU Eindhoven) received a research grant of €40 M to establish a National Research Center on Photonics. In 2002 he moved with his group to the Technical University of Eindhoven, where he was a leader of the Opto-Electronic Devices group at the COBRA Research Institute until 2014. In 2002 he was appointed LEOS Fellow for contributions in the field of Opto-Electronic Integration.

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Christian Koos is affiliated with Karlsruhe Institute of Technology (KIT), where he is director of the Institute of Photonics and Quantum Electronics (IPQ) and co-director of the Institute of Microstructure Technology (IMT). His research focusses on integrated photonics and the associated applications in optical communications, teratronics, biophotonics, and optical metrology. Christian Koos received the PhD (Dr.-Ing.) degree in Electrical Engineering from the University of Karlsruhe in 2007. From 2008 to 2010, he was affiliated with the Corporate Research and Technology Department of Carl Zeiss AG, where he led the technology forecast in area of nanotechnology. In 2012, Christian Koos was awarded the Alfried-Krupp Prize for Young University Teachers, one of the most highly endowed prizes for young researchers at German universities, and in 2014, he received the Research Award of the State of Baden-Wuerttemberg, the most highly endowed research prize of a German federal state. Christian Koos is the coordinator of the Helmholtz International Research School of Teratronics (HIRST), which offers an interdisciplinary training programme for PhD researchers that links the traditional disciplines of physics, electrical engineering, computer science, and nanotechnology.