Perspectives on the Silicon Photonics and Photonic Integrated Circuit Frontier

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SAN FRANCISCO, Jan. 26, 2011 — Because a new market of miniaturized low-cost photonics will soon be created that can leverage the vast scale of CMOS manufacturing to revolutionize industries from computing and communications to biomedicine and imaging, panelists representing different aspects of the industry gathered Tuesday afternoon at SPIE Photonics West to discuss what they have discovered from their positions at the forefront of silicon photonics and photonic integrated circuits.

Panelists, who began the session with brief overviews of their companies' work in the area of silicon photonics and photonic integrated circuits, included Andy Weirich, vice president of product line management for OneChip Photonics; Michael Hochberg, electrical engineering professor at the University of Washington; Peter De Dobbelaere, vice president of engineering at Luxtera; Bert-Jan Offrein of the Science and Technology Group at IBM Zurich Research Lab; Mehrdad Ziari of Infinera; and Ashok Krishnamoorthy, a distinguished engineer at Oracle/Sun Labs. The panel was moderated by Peter Hallett of SPIE.

Weirich told the audience of his business's work in optical transceivers and photonic integrated circuits (PICs). Older technologies such as free-space optics and planar lightwave circuits involve the need for many separate parts (up to 20 for free-space optics, up to 10 for PLCs) and offer low levels of integration, while photonic integrated circuits can incorporate all functions, both passive and active, on a single indium phosphide-based chip. OneChip's PICs are designed for automated mounting on a silicon optical bench using industry-standard automated assembly processes.

The next frontier for optical transceivers is cost reduction and unprecedented scalability in volume manufacturing, he said.

De Dobbelaere said Luxtera's silicon CMOS photonics technology, which was bought earlier this month by Molex as part of its acquisition of Luxtera's active optical cable business, is shipping in volume now, meaning "silicon CMOS photonics is here," he said.

Luxtera says it is the first company to overcome the technical challenges of integrating high-performance optics directly with silicon electronics on a standard CMOS chip. The advantages of such integration, De Dobbelaere said, is that you can couple light in and out of the chip, resulting in near surface normal coupling and low coupling loss, and also have a manufacturing process that is compatible with CMOS and allows wafer-level testing and for polarization diversity.

IBM's Offrein talked about the important role optical interconnects will play in future computing systems. He discussed the use of optical fibers in supercomputers, such as IBM's Roadrunner, a machine capable of petaflop speed but that has only some optical fiber.

In 2012, Blue Waters, part of the National Center for Supercomputing Applications at the University of Illinois and funded by the National Science Foundation and DARPA, is expected to be 10 times faster than Roadrunner thanks to its 1 million optical interconnects.

In 2012, optical fiber will be across computer circuit boards and by 2016, there will be optical waveguides in or on the boards, Offrein said. By 2020, it is expected that optical interconnects will be integrated with the processor.

The issue of a “Moore's Law” for silicon photonics was brought up by several speakers. Gordon Moore’s Law states that the number of transistors that can be placed inexpensively on an integrated circuit will double about every two years.

Krishnamoorthy commented that, while optical tools continue to get better because “they still have 100s of nanometers to go,” but “electrical tools are getting worse.”