SCIENTIFIC MEDIA RELEASE

Singapore's A*STAR IME will Present 9 Papers in Optical Device Innovation and Foundry-Qualified Platform Development at World-Class Optical Communications Conference

Research includes development of the world's first silicon (Si) photonics integrated platform in a commercial 0.18 µm CMOS foundry line

1. **Singapore, March 6, 2014** - A*STAR's IME will be presenting 9 papers at the upcoming Optical Fiber Communication Conference and Exposition and the National Fiber Optic Engineers Conference (OFC/NFOEC) in San Francisco, USA, confirming its position as the leading not-for-profit semiconductor R&D center in Asia.[1]

2. IME will showcase a comprehensive portfolio that covers breakthroughs in optical device innovation and packaging, as well as foundry-qualified silicon photonics platform. New devices feature the hallmarks of small footprint, competitive performance and high integration capability that can be fabricated by standard CMOS technology, which is suitable for high volume production.

3. In partnership with GLOBALFOUNDRIES, IME has developed the world's first silicon (Si) photonics integrated platform in a commercial 0.18 µm CMOS foundry line. Selected process modules have been individually qualified, thereby meeting the stringent quality standards of the industry. This work will enable low-cost access to a commercial foundry line for silicon photonics prototyping and mass production purposes targeted at bandwidths of 25 Gb/s and beyond.

4. The OFC/NFOEC is the premier destination for converging breakthrough research and innovation in telecommunications, optical networking, datacomm and computing. This year's conference will take place from March 9th – 13th, 2014.

Enclosed:

ANNEX A: Summaries of the technical presentations by A*STAR IME

[1] Compared to other not-for-profit research organizations in Asia, IME comes in 1st and 2nd position (based on first author's affiliation) for papers accepted for poster and oral presentations, respectively.

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About Institute of Microelectronics (IME)

The Institute of Microelectronics (IME) is a research institute of the Science and Engineering Research Council of the Agency for Science, Technology and Research (A*STAR). Positioned to bridge the R&D between academia and industry, IME's mission is to add value to Singapore's semiconductor industry by developing strategic competencies, innovative technologies and intellectual property; enabling enterprises to be technologically competitive; and cultivating a technology talent pool to inject new knowledge to the industry. Its key research areas are in integrated circuits design, advanced packaging, bioelectronics and medical devices, MEMS, nanoelectronics, and photonics. For more information about IME, please visit http://www.ime.a-star.edu.sg.

About the Agency for Science, Technology and Research (A*STAR)

The Agency for Science, Technology and Research (A*STAR) is Singapore's lead public sector agency that fosters world-class scientific research and talent to drive economic growth and transform Singapore into a vibrant knowledge-based and innovation driven economy.

In line with its mission-oriented mandate, A*STAR spearheads research and development in fields that are essential to growing Singapore's manufacturing sector and catalysing new growth industries. A*STAR supports these economic clusters by providing intellectual, human and industrial capital to its partners in industry.

A*STAR oversees 18 biomedical sciences and physical sciences and engineering research entities, located in Biopolis and Fusionopolis, as well as their vicinity. These two R&D hubs house a bustling and diverse community of local and international research scientists and engineers from A*STAR's research entities as well as a growing number of corporate laboratories.

For more information about A*STAR, please visit www.a-star.edu.sg.

ANNEX A

Summaries of the technical presentations by A*STAR's IME:

1. **Path to Silicon Photonics Commercialization: 25 Gb/s Platform Development in a CMOS Manufacturing Foundry Line by Andy Eu-Jin Lim et al.**

In partnership with GLOBALFOUNDRIES, IME has developed the world's first silicon (Si) photonics integrated platform in a commercial 0.18 μm CMOS foundry line. Selected process modules have been individually qualified, thereby meeting the stringent quality standards of the industry. These include low-loss Si passives and high speed germanium photodetectors (>20 GHz) with low dark current (~11nA) and high responsivity (1.06A/W) at 1550nm. This work will enable low-cost access to a commercial foundry line for silicon photonics prototyping and mass production purposes targeted at bandwidths of 25 Gb/s and beyond.

2. **Low Loss (<0.2 dB per transition) CMOS Compatible Multi-Layer Si_3N_4-on-SOI Platform with Thermal-Optics Device Integration for Silicon Photonics by Ying Huang et al.**

As optical interconnect technology moves towards application requiring large scale photonic system integration, conventional silicon-on-insulator (SOI) platform rapidly becomes insufficient due to the lack of on-chip space, fabrication tolerance and flexibility for realizing high-yield, high-performance devices.

IME has successfully developed a multi-layer SOI platform based on back-end process approach. Compared to similar reported multi-layer platforms, IME's platform offers lowest reported loss (< 0.2dB inter-layer transition loss), monolithic integration and better active device performance from SOI substrate. The CMOS-compatibility, great flexibility and high integration capability extend the platform for high volume production of a wider suite of passive and active photonic devices for next generation optical telecommunications.

3. **An Ultra-Compact and Alignment-Tolerant Si Polarization Rotator by Haifeng Zhou et al.**

Polarization rotator is a critical component in ultra-compact photonic circuits to relieve the polarization issues. However, the fabrication of most polarization rotators is

subjected to stringent alignment requirements, making them unsuitable for mass production.

IME has demonstrated a polarization rotator made with an alignment-tolerant design scheme. The polarization rotator features compactness (around 10 μm length), simple fabrication (2 lithography steps) and large misalignment tolerance (typically >300nm), making it a suitable candidate for photonic- or electronic-photonic ICs for next generation high speed telecommunications.

4. Waveguide Ge/Si Avalanche Photodetector with a Unique Low-Height-Profile Device Structure by Tsung-Yang Liow et al.

Most silicon photonics avalanche photodetectors (APDs) with germanium (Ge) as the absorption material use intricate device structure designs that pose challenges to integration and are limited in performance scalability.

IME is reporting the first demonstration of a germanium/silicon avalanche photodetector (APD) that features a unique structure design and streamlined fabrication process. The simplicity of the structure design allows ready monolithic integration for aggressive miniaturization and performance scalability, while keeping excess noise to a minimum. The speed (>20 GHz) and sensitivity improvement (up to 9 dB) demonstrated by the APD, as well as its high amenability for integration with other advanced silicon photonic components position it favorably for short reach applications such as Ethernet local area networking (LAN) and active optical cables (AOCs).

5. Silicon-Based Parallel-Fed Traveling-Wave Photodetector Array by Xianshu Luo et al.

Conventional single-input photodetectors with large operation bandwidth require small active areas, which consequently results in saturation at low optical power, making them unsuitable for radiofrequency (RF) photonic applications.

IME is reporting the first demonstration of traveling-wave photodetector array integrating multiple germanium photodetectors By employing a parallel feeding scheme and matching the velocity to the travelling-wave electrodes, the photodetectors offer ~ 15 GHz (or 3-dB) bandwidth with enhanced responsivity of 1.2 A/W. The optical power handling capability is also improved, with more than 10 mA linear current detected.

6. High-Efficiency Thermal-Tunable Microring Resonators Made of Cu-Dielectric-Si Hybrid Plasmonic Waveguides by Shiyang Zhu et al.

Optical switcher based on silicon microring resonator typically suffers from large footprint, low thermal efficiency, and low speed.

IME is reporting the first demonstration of an optical switcher made of Cu-dielectric-Si hybrid plasmonic waveguides using standard CMOS technology. The new switcher exhibits smaller footprint of ~10 μm^2, higher tuning efficiency of ~1.1nm/mW and competitive speed of ~17.2 μs. The new switcher is highly suitable for dense Si electronic and photonic integrated circuits.

7. High Tolerance, Low Loss Mode Converter Between SiN Waveguide and Cleaved Single Mode Fiber by Lianxi Jia et al.

The modal size mismatch issue between silicon waveguide and single mode fiber results in high coupling loss, which is not desirable for optimum optical telecommunication operation. Conventional approaches to reduce the coupling loss include lensed fiber and reverse nanotapers, which are not suitable for high volume production.

IME is reporting the demonstration of an efficient silicon nitride mode converter with novel structure design. Compared to conventional approaches, the converter enables competitive coupling loss (1.2dB/facet) and ±4μm alignment tolerance with cleaved single mode fiber, featuring dimensions of 200nm that are compatible with standard lithography tools and can be fabricated with CMOS-compatible processes. These distinct attributes translate into considerable cost-advantage that will be appealing to product-developers.

8. High Efficiency Silicon Nitride Grating Coupler with DBR by Huijuan Zhang et al.

Silicon nitride (Si_3N_4) platform possesses inherent desirable characteristics that impose less stringent conditions for fabricating photonic devices. Few grating couplers have been reported for the Si_3N_4 platform, mostly with limited coupling efficiency.

IME is reporting a grating coupler with the highest coupling efficiency of -2.6 dB demonstrated on Si_3N_4 platform for single mode fiber coupling to date. Using CMOS-compatible technology, the fabrication process is simple and cost-effective, making the grating coupler an attractive choice for photonics device packaging.

9. 2D Asymmetric Silicon Waveguide Grating for Optical Transceiver by Chao Li et al.

The difference in polarization requirements between the inlet and outlet of optical transceivers presents design challenges to symmetry-based conventional 2D waveguide gratings, placing tight limits on the gratings' wavelength multiplexing potential.

IME has demonstrated the world's first asymmetric 2D waveguide grating. Unlike conventional approaches using free-space package or planar light wave circuit, the new grating design combines fiber-waveguide coupling with wavelength multiplexing to offer very small-form factor for ready integration with other silicon photonic components. The grating fabricated with CMOS-compatible technology demonstrates wavelength triplexing capability (near 1310/1490/1550 nm) with minimum coupling loss of -5.7 dB. These distinct attributes will bring compact, cost-effective optical transceivers a step closer towards market deployment to support advanced optical networks.