Session 23: Optoelectronics, Displays, and Imagers - Silicon Photonics
Tuesday, December 4, 2:15 PM
Continental Ballroom 7-9
Co-Chairs: C. Doerr, Acacia Communications, Inc.
P. De Dobbelaere, Luxtera

2:20 PM - 2:45 PM
23.1 First cryogenic electro-optic switch on silicon with high bandwidth and low power tunability, *F. Eltes, J. Barreto*, D. Caimi, S. Karg, A. A. Gentile*, A. Hart*, P. Stark, N. Meier, M. G. Thompson*, J. Fompeyrine, S. Abel, IBM Research, * University of Bristol*

We demonstrate the first electro-optic switch operating at cryogenic temperatures of 4 K with a high electro-optic bandwidth of >18 GHz. Our novel technology exploits the Pockels effect in barium titanate thin films co-integrated with silicon photonics and offers low losses, pure phase modulation, and sub-pW electro-optic tuning.

2:45 PM - 3:10 PM
23.2 High Speed (*f3-dB* above 10 GHz) Photo Detection at Two-micron-wavelength Realized by GeSn/Ge Multiple-quantum-well Photodiode on a 300 mm Si Substrate, *S. Xu, W. Wang, Y.-C. Huang*, Y. Dong, S. Masudy-Panah, H. Wang**, X. Gong, and Y.-C. Yeo, National University of Singapore, *Applied Materials Inc., **Nanyang Technological University*

High speed photo detection at two-micron-wavelength has been achieved with a GeSn/Ge multiple-quantum-well (MQW) photodiode (PD), demonstrating a 3-dB bandwidth (f3-dB) above 10 GHz for the first time. The device layer stack was grown on a standard 300 mm (001) Si substrate using RPCVD, showing potential for large-scale integration. Radio frequency (RF) characterization was performed using μm RF optical measurement setup. To our knowledge, this is also the first PDs on Si with direct RF measurement to quantitatively confirm the high speed functionality at 2 μm.

3:10 PM - 3:35 PM
23.3 Quadratic electro-optical silicon-organic hybrid RF modulator in a photonic integrated circuit technology, *P. Steglich, C. Mai, A. Peczek, F. Korndörfer, C. Villringer*, B. Dietzel*, and A. Mai, IHP, *Technical University of Applied Sciences Wildau*

For the first time, an integrated electro-optical RF modulator based on the quadratic electro-optical effect with CMOS compatible sub-volt driver voltages is presented. As unique feature, this modulator provides an amplitude tuning of the modulated carrier wave. The silicon-based modulator was fabricated using process steps of an established photonic integrated circuit technology and covered by a nonlinear optical polymer in a post-process. We demonstrate a device tunability of up to 350 pm/V, surpassing state-of-the-art silicon modulators with an order of magnitude. Moreover, the ring resonator is designed to have an ultra-low per-bit energy consumption of 87 aJ/bit demonstrating the potential for high-performance photonic devices with low energy consumption.

3:35 PM Coffee Break

4:00 PM - 4:25 PM
23.4 Silicon Photonics: a Scaling Technology for Communications and Interconnects (Invited), *P. Dong, K. W. Kim, A. Melikyan, and Y. Baeyens, Nokia Bell Labs*

Silicon photonics exploits CMOS foundry processes to fabricate passive and active photonic circuits on silicon substrates. This technology offers superior scalability in terms of integration level and energy

efficiency, two key metrics to obtain sustainable capacity growths in future telecom, datacom, and chip-scale interconnects. We illustrate the advantages of compactness and low power consumption by describing two novel silicon photonic based devices, namely, microring resonators and directly reflectivity modulated lasers.

4:25 PM - 4:50 PM
23.5 InAs/GaAs Quantum Dot Lasers Monolithically Integrated on Group IV Platform (Invited), *K. Li, M. Tang, M. Liao, J. Wu, S. Chen, A. Seeds, and H. Liu, University College London*

III-V quantum dot lasers monolithically integrated on silicon platform attracts intensive interests due to its advantages on providing a promising solution for reliable and efficient light source to integrated on photonics and electronics circuits. Compared to wafer bonding technique, monolithic integration its more attractive for large scale, low cost and streamline fabrication. In this paper, we give a brief review on our recent progress of III-V quantum dot lasers monolithically integrated on 4° offcut and exact (001) Si substrates for the silicon photonic integration.

4:50 PM - 5:15 PM
23.6 Heterogeneously integrated light sources on bulk-silicon platform, *D. Shin, J. Cha, Y. Shin, K. Ha, C. B. Lee, C. Shin, D. Shim, B. L. Choi, H. Hong, K. Lee, and H.-K. Kang, Samsung Electronics,*

Heterogeneously integrated single-wavelength and wavelength-tunable light sources on bulk-silicon platform are presented. Thanks to the thermal advantage of the bulk-silicon platform, the single-wavelength source showed WPE of 8% up to 70°C, feasibility of 25Gb/s direct modulation, and 70°C MTTF of ~46000h. The wavelength-tunable source showed 42.2nm tuning range. This result completes the optical device library suite for the bulk-silicon platform used in most semiconductor products.