Advance Program

Wednesday, 1 September 2010

ALL SESSION WILL BE HELD IN THE MULTI FUNCTION ROOM IN BUILDING 1

08.00 - 08.15 **OPENING REMARKS**

09.00 - 09.45
Session PLE: **PLENARY SESSION**
Session Chair: TBD

PLE1 08.15 - 09.00 (Plenary)

More Than Moore's Law: CPU Architecture with Optical Interconnection, W. Hu, X. Yang, Y. Chen, and J. Xiao*, Chinese Academy of Sciences, Beijing, China*

As the core count doubles every 18 months driven by the Moore's Law, the memory and I/O bandwidth become bottleneck of CPU performance. Optical electronics provide opportunity to meet the bandwidth requirements of future CPU.

09.00 - 09.45
Session WA: **ON-CHIP LIGHT SOURCES**
Session Chair: Mario Paniccia, *Intel Corporation, Santa Clara, CA, USA*

WA1 09.00 - 09.30 (Invited)

Monolithic Ge-on-Si Lasers for Integrated Photonics, J. Liu, X. Sun, R. Camacho-Aguilera, Y. Cai, L. C. Kimerling and J. Michel*, Massachusetts Institute of Technology, Cambridge, MA, USA*

We report room temperature Ge-on-Si lasers with direct gap emission at 1590-1610 nm. Modeling of Ge/Si double heterojunction structures, which is supported by experimental results of Ge/Si LEDs, indicates the feasibility of electrically pumped lasers.

WA2 09.30 - 09.45

High-Performance 1550nm Polymer-Based LEDs on Silicon using Hybrid Polyfluorene-Based Type-II Heterojunctions, X. Ma, F. Xu and S. G. Cloutier*, University of Delaware, Newark, DE, USA*

We report on the optoelectronic properties of hybrid polymer-based light-emitting diodes integrated on silicon chip. Using a hybrid polyfluorene-based type-II heterostructure host with PbS quantum dots, we achieved efficient room-temperature electroluminescence at telecommunication wavelengths.

09.45 - 10.15 **COFFEE BREAK**

10.15 - 12.15
Session WB: **LASER INTEGRATION**
Session Chair: Daoxin Dai, *Zhejiang University, Hangzhou, Zhejiang, China*

WB1 10.15 - 10.45 (Invited)

200mm Wafer Scale III-V/SOI Technology for All-Optical Network-on-Chip and Signal Processing, L. Liu, T. Spuesens, D. J. Van Thourhout, G. Morthier*, Ghent University, Gent, Belgium*, L. Grenouillet, N. Olivier, J.-M. Fedeli*, Commissariat à l'Énergie Atomique, Grenoble, France*, P. Rojo Romeo, P. Regreny, F. Mandorlo and R. Oroubtchouck*, École Centrale de Lyon, Ecully, France*

Integrated components, including microdisk lasers, photodetectors, and wavelength selective circuits, for optical network-on-chip and all-optical signal processing are presented using a complementary metal-oxide-semiconductor compatible III-V/silicon-on-insulator integration technology at 200mm wafer scale.

WB2 10.45 - 11.00

Hybrid Si/III-V Fabry-Perot Lasers Based on Adiabatic Mode Transformers, B. Ben Bakir, N. Olivier, D. Bordel, P. Grosse and J.-M. Fedeli*, Commissariat à l'Énergie Atomique, Grenoble, France*

We report the first Si/III–V Fabry-Perot laser based on adiabatic mode transformers. The investigated device operates under quasi-continuous wave regime. The room temperature threshold current is 100 mA, the side mode suppression ratio is as high as 20dB, and the fiber-coupled output power is ~7mW.

WB3 11.00 - 11.15

A Selective Area Metal Bonding Method for Si Photonics Light Sources, T. Hong*, Peking University, Beijing, China*

A 1.55 µm hybrid InGaAsP-Si laser was fabricated by the selective area metal bonding method. Room temperature continuous lasing with a maximum output power of 0.45 mW is realized.

WB4 11.15 - 11.30

Towards a Low-Power Nanophotonic Semiconductor Amplifier Heterogeneously Integrated with SOI Waveguides, G. Roelkens, *Ghent University, Ghent, Belgium*, O. Raz*, Eindhoven University of Technology, Eindhoven, The Netherlands*, W. M. J. Green, S. Assefa*, IBM Research, Yorktown Heights, NY, USA*, M. Tassaert, S. Keyvaninia, K. Vandoorne, D. J. Van Thourhout, R. G. Baets*, Ghent University, Ghent, Belgium* and Y. A. Vlasov*, IBM Research, Yorktown Heights, NY, USA*

In this paper we propose an optically pumped nanophotonic III-V semiconductor optical amplifier heterogeneously integrated on a silicon-on-insulator waveguide circuit through wafer bonding technology. We report on the design and preliminary characterization of this novel type of high-index contrast nanophotonic device.

WB5 11.30 - 11.45

A III-V on Silicon Distributed-Feedback Laser Based on Exchange-Bragg Coupling, T. Dupont, L. Grenouillet, A. Chelnokov, S. Messaoudene, J. Harduin, D. Bordel, J.-M. Fedeli*, Commissariat à l'Énergie Atomique, Grenoble, France*, C. Seassal, P. Regreny and P. Viktorovitch*, Institut des Nanotechnologies de Lyon, Ecully, France*

We present a distributed-feedback laser that takes advantage of exchange Bragg coupling between a III-V stack and a Silicon-On-Insulator corrugated waveguide. Monomode laser emission is observed under optical pumping.

WB6 11.45 - 12.00

Heterogeneously Integrated InP/SOI Laser Using Double Tapered Single-Mode Waveguides Through Adhesive Die to Wafer Bonding, M. Lamponi*, Alcatel Thales III-V Lab, Palaiseau, France*

An InP/Silicon hybrid laser based on double taper adiabatic mode transfer and BCB bonding is demonstrated, exhibiting nearly 1 mW output power at room temperature in pulsed operation regime. Such a laser enables potentially a low threshold current and a high power conversion efficiency.

WB7 12.00 - 12.15

Electrical and Optical Properties of III-V Microdisk Based LASERs Fabricated on a CMOS Pilot Line, F. Mandorlo, P. Rojo Romeo, X. Letartre*, École Centrale de Lyon, Ecully, France* and J.-M. Fedeli*, Commissariat à l'Énergie Atomique, Grenoble, France*

Efficient sources are required for on chip optical networks in integrated circuits. Performances of the first full CMOS compatible III-V microdisk LASERs coupled to waveguides and fabricated on a 200 mm pilot line are investigated.

12.00 - 13.45 LUNCH BREAK

13.45 - 15.45
Session WC: **NANOPHOTONIC DEVICES I**
Session Chair: TBD

WC1 13.45 - 14.15 (Invited)

Silicon Nanophotonic Devices Based on Periodic Structures, Z. Zhou*, Peking University, Beijing, China*, D. S. Citrin*, Georgia Institute of Technology, Atlanta, GA, USA*, H. Wu, H. Yi, J. Hou, R. Hao*, Peking University, Beijing, China*, E. Cassan*, Institut d'Electronique Fondamentale, Orsay, France* and X. Wang*, Peking University, Beijing, China*

Periodic structures have been used extensively in optics and photonics. This paper is to report our work on manipulating optical propagation in the nanophotonics domain using silicon devices based on periodic structures.

WC2 14.15 - 14.30

Subwavelength Grating: A New Type of Microphotonic Waveguide and Implementations to Fiber-Chip Coupling, Waveguide Crossing and Refractive Index Engineering, P. J. Bock, P. Cheben, J. H. Schmid, J. Lapointe, S. Janz, D.-X. Xu, A. Densmore, A. Delage, B. Lamontagne*, National Research Council, Ottawa, ON, Canada* and T. J. Hall*, University of Ottawa, Ottawa, ON, Canada*

We demonstrate a new microphotonic waveguide principle based on subwavelength gratings. We also present several practical implementations of subwavelength grating waveguides, including a microphotonic fiber-chip coupler, a waveguide crossover and a new type of planar waveguide multiplexer.

WC3 14.30 - 14.45

Metal-Oxide-Silicon Nanophotonics: An Efficient Integration of Plasmonic Nano-Slots with Silicon Waveguides, C. Delacour*, Commissariat à l'Énergie Atomique, Grenoble, France*, S. Blaize*, Université de Technologie de Troyes, Troyes, France*, P. Grosse, J.-M. Fedeli*, Commissariat à l'Énergie Atomique, Grenoble, France*, A. Bruyant, R. Salas-Montiel, G. Lerondel*, Université de Technologie de Troyes, Troyes, France* and A. Chelnokov*, Commissariat à l'Énergie Atomique, Grenoble, France*

We demonstrate key elements of future plasmonic guided optics integrated with CMOS-compatible silicon photonics. Very efficient coupling is provided with metal nano-slot waveguides exhibiting unexpectedly low propagation losses and a broadband sub-50 nm optical confinement.

WC4 14.45 - 15.00

Dielectric Grating Reflectors with Large Focusing Power, D. Fattal*, HP Laboratories, Palo Alto, CA, USA*

We introduce a novel optical element, a dielectric resonance grating with a non-periodic pattern, able to reflect nearly 100% of incident light while shaping the reflected light phase front in an arbitrary way.

WC5 15.00 - 15.15

Group Index Engineering in Silicon Corrugated Waveguides, A. Brimont, A. Griol, J. Marti and P. Sanchis*, Universidad Politécnica de Valencia, Valencia, Spain*

We present experimental measurements of the group index in tailored silicon corrugated waveguides. Nearly constant group index as high as ng=14 ±0.5 in a 13 nm range was measured in a 50 µm long waveguide.

WC6 15.15 - 15.30

High Efficiency Broadband Polarization Rotator on Silicon-On-Insulator, D. Vermeulen*, Ghent University, Ghent, Belgium*

We demonstrate a polarization rotator fabricated using a 4 etch-step CMOS-compatible process including layer depositions on a silicon-on-insulator wafer by means of 193nm deep UV lithography. The measured polarization rotation efficiency is at least -0.5dB over a wavelength range of 80nm around 1550nm.

WC7 15.30 - 15.45

1-V_{pp} 10-Gb/s Operation of Slow-Light Silicon Mach-Zehnder Modulator in Wavelength Range of 1 nm, S. Akiyama, T. Kurahashi, T. Baba, N. Hatori, T. Usuki and T. Yamamoto*, Fujitsu Laboratories Ltd., Atsugi, Japan*

We developed a slow-light silicon Mach-Zehnder modulator utilizing cascaded ring resonators. It operates at 10 Gb/s with driving voltage of 1 V_{pp} in a wavelength range of 1 nm without adjustment for the resonant wavelengths.

15.45 - 16.15 COFFEE BREAK

16.15 - 18.00

Session WD: INTEGRATION OF ACTIVE PHOTONIC MATERIALS
Session Chair: Lorenzo Pavesi, *University of Trento, Povo, Trento, Italy*

WD1 16.15 - 16.45 (Invited)

Integration of Optical Devices based on Si, Ge and SiOx, S.-I. Itabashi, H. Nishi, T. Tsuchizawa, T. Watanabe, H. Shinojima, S. Park, K. Yamada*, NTT Corporation, Atsugi, Japan*, Y. Ishikawa and K. Wada*, University of Tokyo, Tokyo, Japan*

Monolithic integration of Si–VOAx, Ge-PDx, SiOx-based AWG filter is the key to making silicon photonics practical technology. We show the great potential of silicon photonics technology for optical devices in telecommunications.

WD2 16.45 - 17.00

Mechanical Tensile Strain Engineering of Ge for Gain Achievement, M. El Kurdi, M. de Kersauson, W. Daney de Marcillac, H. Bertin*, Institut d'Electronique Fondamentale, Orsay, France*, E. Martincic, A. Bosseboeuf*, Institut d'Electronique Fondamentale, Orsay, France*, G. Beaudouin, R. Jakomin, I. Sagnes*, Laboratoire de Photonique et de Nanostructures, Marcoussis, France*, S. Sauvage, G. Fishman and P. Boucaud*, Institut d'Electronique Fondamentale, Orsay, France*

We show that the recombination energy of the direct band gap photoluminescence of germanium can be controlled by an external mechanical stress. We will discuss the possibility to achieve lasing with n-doped Ge layers under the application of an external mechanical stress.

WD3 17.00 - 17.15

Direct-Bandgap Emission from Hydrostatically Tensile-Strained Germanium Nanocrystals, L. Nataraj, F. Xu and S. G. Cloutier*, University of Delaware, Newark, DE, USA*

We report on the high room-temperature luminescence from Germanium nanocrystals synthesized by mechanical grinding. Transients and optical spectroscopy measurements are consistent with HRTEM and electron diffraction, suggesting high tensile strains favoring direct band-to-band transitions.

WD4 17.15 - 17.30

Low-Temperature Germanium Ultra-High Vacuum Chemical Vapor Deposition for Back-End Photonic Device Integration, K. McComber, J. Liu, J. Michel and L. C. Kimerling*, Massachusetts Institute of Technology, Cambridge, MA, USA*

This work demonstrates deposition of single-crystal germanium by ultra-high vacuum chemical vapor deposition (UHVCVD) on amorphous silicon, with all critical processing performed at temperatures below 450°C. This material shows promise for the successful back-end fabrication of photonic devices.

WD5 17.30 - 17.45

Integration of Germanium Quantum Well Structures on a Silicon-on-Insulator Waveguide Platform for Optical Modulator Applications, S. Ren, Y. Rong, T. I. Kamins, J. S. Harris and D. A. B. Miller*, Stanford University, Stanford, CA, USA*

An approach is proposed, analyzed, and demonstrated to integrate selectively grown germanium quantum well structures onto a silicon-on-insulator waveguide platform. This approach is promising for compact, ultra-low power optical waveguide modulators in optical interconnects.

WD6 17.45 - 18.00

Ge/SiGe Quantum Wells Structures for Optical Modulation, P. Chaisakul, D. Marris-Morini, *Institut d'Electronique Fondamentale, Orsay, France*, G. Isella, D. Chrastina, *Politecnico di Milano, Como, Italy*, X. Le Roux, *Institut d'Electronique Fondamentale, Orsay cedex, France*, E. Gatti, *Università degli Studi di Milano Bicocca, Milano, Italy*, S. Edmond, *Institut d'Electronique Fondamentale, Orsay, France*, J. Osmond, E. Cassan and L. Vivien, *Institut d'Electronique Fondamentale, Orsay, France*

Room-temperature Quantum-confined Stark effect (QCSE) in Ge/SiGe multiple quantum wells (MQWs) is demonstrated using optical transmission and photocurrent measurements. Effective absorption spectra of the heterostructures are presented as a function of electrical field.

18.30 - 19.30 COCKTAIL HOUR

POSTER SESSION WILL BE HELD IN THE YASHI RESTAURANT IN GRAND BUILDING DURING THE COCKTAIL HOUR – COURTESY OF INTEL CORPORATION

18.30 - 19.30

Session P1: POSTER SESSION I

P1.1 Vertically Coupled Si-based Ring Resonators For Sensing Applications, W. N. Ye, K. Goshu and A. Tam, *Carleton University, Ottawa, Canada*

We report the design of a vertically coupled silicon-based ring resonator for sensing applications. Such devices can be realized with relaxed fabrication tolerances, and without the need for e-beam lithography.

P1.2 Design of Plasmon Waveguide with Strong Field Confinement and Low Loss for Nonlinearity Enhancement, G. Zhou, T. Wang, C. Pan, X. Hui, F. Liu and Y. Su, *Shanghai Jiao Tong University, Shanghai, China*

We propose a new hybrid dielectric and plasmonic waveguide offering an ultra high nonlinear coefficient which is 4 orders larger than conventional silicon waveguide with a propagation loss of 0.036 dB per micrometer.

P1.3 Emission-Wavelength Control Using A Mechanically Stressed Micro-Beam Structure: GaAs on Si-on-Insulator Beam, L. Decosterd, *École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland*, Y. Horie, K. Yoshimoto, R. Suzuki, J. Cai, J. Osaka, Y. Ishikawa and K. Wada, *University of Tokyo, Tokyo, Japan*

Mechanically stressed micro-beam structures are proposed to control the emission wavelength for III-V compounds on Si-on-insulator wafers. Based on the calculations for GaAs, the tuning of emission wavelength and the locking from temperature fluctuations are demonstrated by controlling the applied stress.

P1.4 Optical Frequency Shifter on SOI using Thermo-Optic Serrodyne Modulation, Y. Li, S. Meersman and R. G. Baets, *Ghent University, Ghent, Belgium*

An optical frequency shifter on SOI using thermooptic serrodyne modulation is fabricated. It creates a 1 kHz frequency shift in 1550 nm laser, with a second-order harmonic sideband suppression of -38.5 dB.

P1.5 Polarization Beam Splitter Based on a Slot-Groove Grating, S. Shao and Y. Wang, *Wuhan National Laboratory for Optoelectronics, Wuhan, Hubei, China*

A polarization beam splitter is proposed in this paper. Coupling efficiencies around 1550 nm for both TE and TM modes reach 50%. Extinction ratio is over 15 dB in the range of 1530-1630 nm.

P1.6 High Speed Silicon Optical Modulator with Self-Aligned Fabrication Process, D. Thomson, F. Y. Gardes, G. T. Reed, *University of Surrey, Guildford, Surrey, UK* and J.-M. Fedeli, *Commissariat à l'Énergie Atomique, Grenoble, France*

Electronic and photonic devices formed using self-aligned processes are attractive for reducing performance variations and increasing yield. In this paper a novel high speed silicon optical modulator which has self-aligned pn junction formation is introduced.

P1.7 High Q Microring Demultiplexer Filter for 60GHz Microwave Photonics Applications, P. Sanchis, C. J. Oton, J. V. Galan Conejos and J. Marti, *Universidad Politécnica de Valencia, Valencia, Spain*

A SOI microring demultiplexer filter is proposed for 60 GHz microwave photonics applications. A high Q factor of 33900 is experimentally demonstrated yielding to extinction ratios above 20dB but without degrading insertion losses which are kept below 3dB

P1.8 Design of Strain-Free GeSn/SiGeSn Quantum-Well Electroabsorption Modulators at 1550 nm Wavelength, G.-E. Chang and C.-O. Chang, *National Taiwan University, Taipei, Taiwan*

We propose and analyze a strain-free GeSn/SiGeSn quantum-well structure for electroabsorption modulators based on the quantum-confined Stark effect at 1550 nm wavelength.

P1.9 Photovoltaic Properties of Si Nanostructure Based Solar Cells Fabricated on Quartz, Z. Yuan, C. Schuster, *University of Trento, Trento, Povo, Italy*, G. Pucker, *Fondazione Bruno Kessler - Irst, Trento, Italy*, A. Anopchenko, A. Marconi and L. Pavesi, *University of Trento, Povo, Italy*

Solar cells with different silicon nanostructures have been fabricated on quartz wafers. A correlation between their photovoltaic properties and the conductivity was clearly found. The best results are achieved for amorphous silicon based nanostructures.

P1.10 Slow light with silicon photonic crystal ring microcavities, J. Y. Lee and P. M. Fauchet, *University of Rochester, Rochester, NY, USA*

We experimentally demonstrate one-dimensional photonic crystal microring cavities coupled to straight waveguide in silicon-on-insulator. Near the photonic band edge, we measure large group index of ~14 by optimizing the evanescent coupling with different waveguides widths.

P1.11 Bulk Silicon Photonic Wire for One-Chip Integrated Optical Interconnection, H.-C. Ji, K. H. Ha, K. W. Na, S. G. Kim, I.-S. Joe, D. J. Shin, K. H. Lee, S. D. Suh, J. K. Bok, Y. S. You, Y. W. Hyung, S. S. Kim, Y. D. Park and C. H. Chung*, Samsung Electronics Co. Ltd, Yongin, Korea*

We report a nano-sized silicon waveguide by forming partial silicon-on-insulator structure with SPE on bulk silicon substrate. The propagation loss is as low as 6.1 dB/cm, which is close to that of silicon-on-insulator based waveguide.

P1.12 Step Waveguide Design for Efficient Coupling to Integrated Ge/Si Avalanche Photodetectors, J. Liu*, Massachusetts Institute of Technology, Cambridge, MA, USA* and X. Wang*, Thayer School of Engineering at Dartmouth, Hanover, NH, USA*

We report a new step waveguide design for efficient coupling with integrated Ge/Si avalanche photodetectors, which offers high responsivity with a short horizontal absorption length.

P1.13 Free Charge Carrier Induced Refractive Index Modulation of Crystalline Silicon, A. Singh*, Monash University, Melbourne, Australia*

New relationships for the free carrier induced refractive index modulation of crystalline silicon at 1.3 and 1.55 µm are derived. Free electrons are more effective in perturbing the refractive index compared to free holes.

P1.14 High-Speed SOI Microring Modulator Integrated with Grating Couplers, X. Xiao*, Chinese Academy of Sciences, Beijing, China*

We demonstrate a high-speed SOI microring modulator integrated with grating couplers. Wafer-level measurements were set up for the device characterizations. 60 nm 3-dB coupling bandwidth and 10 Gb/s NRZ modulation are finally realized.

P1.15 Upper Limit for the Amplifiable Stokes Power in Saturated Silicon Waveguide Raman Amplifiers, H. Renner*, Technische Universität Hamburg-Harburg, Hamburg, Germany*

We derive upper limits for the amplifiable Stokes power in saturated silicon Raman amplifiers and the tolerable product of scattering-loss and FCA coefficients. Optimal pump conditions are given analytically and optimized amplifier designs are presented.

P1.16 A Low-voltage Two-wavelength Light Emitter in Standard CMOS Technology, W. Wang, B. Huang, Z. Dong, X. Zhang, N. Guan, J. Chen, Y. Gui and H. Chen*, Chinese Academy of Sciences, Beijing, China*

A silicon light emitting device is fabricated in standard CMOS technology. It can emit visible light under reverse Zener breakdown and emit near infrared light under forward injection, both with low-voltage operation and enhanced efficiency.

P1.17 Enhanced Electroluminescence from nc-Si/SiO_2 Pillar Arrays using Nanosphere Lithography, Z. Ma*, Nanjing University, Nanjing, Jiangsu Province, China*

Intensive electroluminescence could be observed from nc-Si/SiO_2 pillars. The electroluminescence intensity is increased by 30 times of magnitude compared to that of nc-Si/SiO_2 multilayers. The enhancement of EL can be attributed to the improved extraction efficiency of emission light and the high carrier-injection efficiency.

P1.18 A Monolithic Integration Optoelectronic Integrated Circuit in Standard CMOS Technology, B. Huang, X. Zhang, W. Wang, Z. Dong, N. Guan, Y. Gui and H. Chen*, Chinese Academy of Sciences, Beijing, China*

A monolithic integration optoelectronic integrated circuit (OEIC) is realized in standard CMOS technology. It consists of LED, waveguide, photodetector and receiver circuit. The LED-emitted light transmits through the waveguide and can be detected by photodetector.

P1.19 Fabrication Variations in SOI Microrings for DWDM Networks, Z. Peng, D. Fattal, M. Fiorentino and R. G. Beausoleil*, HP Laboratories, Palo Alto, CA, USA*

We present a statistical analysis of fabrications defects in microring resonators fabricated using 248 nm lithography. We measure the scatter of the resonators' quality factor, extinction ratio, and resonant wavelength and how they influence DWDM networks.

P1.20 Silicon Light Emitting Device based on Rare Earth Oxide Superlattice, D. J. Williams, A. Clark, E. Arkun, A. Jamora, G. Vosters and M. S. Lebby*, Translucent, Inc., Palo Alto, CA, USA*

Electrically pumped light emitting devices have been fabricated that employ a superlattice of rare earth oxide (erbium oxide) interleaved between thin silicon films. Erbium is excited via exciton overlap into the rare earth layer.

P1.21 Hybrid-integrated silicon photonic circuit with an InGaAs photodetetor, H. Xu, Y. Hu, Y. Zhu, Y. Li, Z. Li, Z. Fan, Y. Yu and J. Yu*, Chinese Academy of Sciences, Beijing, China*

Flip-chip bonding and grating-assisted coupling techniques are proposed to integrate silicon photonic circuit with an InGaAs photodetector. Coupler-to-photodetector coupling efficiency of ~ 4 dB and data transmission of 1 Gbps are demonstrated.

P1.22 Surface Plasmon Enhanced Electroluminescence of SiN_x film based MIS Device, C. REN, D. Li and D. Yang*, Zhejiang University, Hangzhou, Zhejiang, China*

Enhanced EL of SiN_x films based MIS devices was investigated. The existence of Ag islands film in the MIS devices increased injected current and enhanced the extraction of EL by the excitons-LSPs coupling.

P1.23 Design of a T-shaped Grating Coupler used in Silicon-based Hybrid Photodetector Integration, S. Shao, T. Yuan, Z. Shi, X. Li and Y. Wang*, Wuhan National Laboratory for Optoelectronics, Wuhan, China*

a T-shaped grating coupler used in silicon-based hybrid photodetector integration is designed. Power absorption efficiencies for TE and TM modes reach 72% and 81% respectively at 1550 nm with a detector length of 14 µm.

P1.24 Si-based Polarization-Extinguished Waveguide Couplers, M.-S. Shie, S.-J. Lin, K.-N. Ku, H.-Y. Liang, M.-C. M. Lee, *National Tsing Hua University, Hsinchu, Taiwan,* and J.-M. Shieh, *National Nano Device Laboratory, Hsinchu, Taiwan*

We presented polarization-extinguished waveguide couplers for silicon photonic wires. The structure is made by an asymmetric Si waveguide clad by SiC and SiO_2. A preliminary result shows the polarization-extinction-ratio can be more than 17 dB.

P1.25 Crosstalk Suppression in Silicon Nanowire Arrayed Waveguide Grating by Cascaded Grating Filter, D. Gao, Y. Liu, Y. Deng and X. Zhang, *Wuhan National Laboratory for Optoelectronics, Wuhan, China*

Cascaded grating filters are proposed to cut the side lobes of silicon nanowire arrayed waveguide grating introduced by fabrication error. Numerical simulation shows that the crosstalk level can be improved by about 15dB.

P1.26 Study on Ge Content of Intermediate Layer in Growing Relaxed Ge Films on Si, Y. Huangfu and H. Ye, *Zhejiang University, Hangzhou, Zhejiang, China*

The growth of relaxed Ge films was carried out in MBE equipment. We focused on the influence of Ge content of intermediate layer between LT and HT Ge films and achieved Ge film with threading dislocation density of 5Î10^5 cm^{-2} and surface roughness of 1.5nm.

P1.27 Effect of Doping-Induced Defect Concentration on the Characteristics of Si-Quantum-Dot Solar Cells, D. H. Shin, S. H. Hong, C. O. Kim, S.-H. Choi, *Kyung Hee University, Yongin, Korea* and K. J. Kim, *Korea Research Institute of Standards and Science, Daejeon, Korea*

We fabricate B-, P-, and Sb-doped p- and n-type Si QDs/SiO_2 superlattices for solar cells. We characterize the variations of defect concentrations due to doping by photoluminescence and thermally-stimulated current, and compare them with the photovoltaic characteristics of the solar cells

P1.28 Optical Gain from Luminescent a-SiN_xO_y Waveguide, K. Chen, H. Dong, D. Wang, R. Huang, W. Li, Z. Ma, J. Xu, X. Huang, *Nanjing University, Nanjing, China*, G.-R. Lin and C.-L. Wu, *National Taiwan University, Taipei, Taiwan*

We report the optical gain from a-SiN_xO_y strip-loaded waveguide. The optical gain of 46cm^{-1} at 525 nm has been determined under top-pumping with He-Cd laser. The luminescent and gain mechanism is mainly attributed to the O-Si-N bond related radiative state.

P1.29 Photoluminescence From Dislocations in Silicon Induced by Irradiation of Electron Beams, L. Xiang, D. Li, L. Jin and D. Yang, *Zhejiang University, Hangzhou, Zhejiang, China*

Dislocations were induced controllably by irradiation of electron beam. And dislocation related luminescence was observed. This method may lead to the silicon based light emitting device with the compatibility of integrated circuit technology.

P1.30 Preparation for Si/Se/Si Sandwich Structure on Si (001), S. Pan, *Xiamen University, Xiamen, Fujian, China*

A Si/Se/Si sandwich structure was prepared by ultra-high vacuum chemical vapor deposition. A red photoluminescence with narrow width was observed in the Si/Se/Si structure, which may be related to the band-to-band transition.

P1.31 Optical Properties of $Er_xYb_{2-x}Si_2O_7$ Thin Film Grown by RF Magnetron Sputtering Method, J. Zheng, *Chinese Academy of Sciences, Beijing, China*

ErxYb2-xSi2O7 thin films are synthesized on thermally oxidized n-Si substrates by RF-magnetron co-sputtering and subsequent annealing process. The photoluminescence properties of $Er_xYb_{2-x}Si_2O_7$ thin films with 488 nm and 974 nm pumping lasers have been investigated.

P1.32 Luminescence of Tm^{3+} in Dislocation Engineering Silicon Substrates, M. A. Lourenco, L. Wong, R. M. Gwilliam and K. P. Homewood, *University of Surrey, Guildford, Surrey, UK*

Photoluminescence at 1.2 to1.4 µm is demonstrated in dislocation engineered silicon substrates doped with Tm^{3+} leading to the development of forward biased light emitting devices operating at a turn-on voltage of only 1 V.

Thursday, 02 September 2010

08.00 - 09.45

Session ThA: **OPTICAL SIGNAL PROCESSING**
Session Chair: Graham T. Reed, *University of Surrey, Guildford, Surrey, UK*

ThA1 08.00 - 08.30 (Invited)

Silicon-Organic Hybrid - A Solution for Next Generation Ultra-Compact, Ultra-Fast Active Photonics, J. Leuthold, W. Freude, C. Koos, L. Alloatti, J.-M. Brosi, D. Korn, *Karlsruhe Institute of Technology, Karlsruhe, Germany,* M. Fournier, J.-M. Fedeli, *Commissariat à l'Énergie Atomique, Grenoble, France,* W. Bogaerts, P. Dumon, R. Baets, *Ghent University, Gent, Belgium,* A. Barklund, R. Dinu, *GigOptix, Inc., Bothell, WA, USA,* and J. Wieland, *GigOptix-Helix AG, Zurich, Switzerland*

The silicon organic hybrid (SOH) platform is re-viewed. It comprises of CMOS compatible silicon waveguides in combination with a cladding of $\chi^{(2)}$ or $\chi^{(3)}$-nonlinear organic ma-terials. Electro-optic and all-optical modulation at 40 Gbit/s and beyond is shown.

ThA2 08.30 - 08.45

Slow-light Enhanced Optical Signal Processing on a Silicon Chip at 640Gb/s, D. J. Moss, B. Corcoran, C. Monat, M. D. Pelusi, C. Grillet, B. J. Eggleton*, University of Sydney, Sydney, Australia*, T. P. White*,* L. O'Faolain and T. F. Krauss*, University of St. Andrews, St. Andrews, Fife, UK*

We demonstrate residual dispersion and optical signal-to-noise ratio monitoring of optical data via slow-light enhanced third harmonic generation in dispersion engineered 2D silicon photonic crystal waveguides, at data rates up to 640Gb/s.

ThA3 08.45 - 09.00

Nonreciprocal Raman Scattering in Silicon Waveguides, M. Krause*,* J. Mueller, T. Pagel*,* H. Renner and E. Brinkmeyer*, Technische Universität Hamburg-Harburg, Hamburg, Germany*

Raman-induced optical nonreciprocity in silicon photonic wires is demonstrated experimentally for the first time. Depending on crystallographic orientation, the ratio of counter- and co-propagating Raman efficiencies varies between 1.63 and 4.35.

ThA4 09.00 - 09.15

Four-wave mixing in Hydrogenated Amorphous Silicon Waveguides at 1.55 µm, S. Suda*,* K. Tanizawa*,* T. Kamei, Y. Sakakibara, Y. Shoji, K. Kintaka, H. Kawashima, M. Mori, T. Hasama, H. Ishikawa and S. Namiki*, National Institute of Advanced Industrial Science and Technology, Tsukuba, Ibaraki, Japan*

We report the observation of four-wave mixing in hydrogenated-amorphous-silicon waveguides. The maximum conversion efficiency is -19 dB for 4.0-mm-long hydrogenated-amorphous-silicon waveguide and 10-GHz repetition pump. The operation bandwidth is estimated to be over 60 nm.

ThA5 09.15 - 09.30

Ultrafast All-Optical Logic Gates with Silicon Nanocrystal-Based Slot Waveguides, C. J. Oton, J. Matres*,* A. Martinez, P. Sanchis*, Universidad Politécnica de Valencia, Valencia, Spain*, J.-P. Colonna*,* C. Ratin*,* J.-M. Fedeli*, Commissariat à l'Énergie Atomique, Grenoble, France* and J. Marti*, Universidad Politécnica de Valencia, Valencia, Spain*

We report an ultrafast (<40ps) all-optical XOR logic gate based on a silicon nanocrystal-based horizontal slot waveguide. The device consists of a Mach-Zehnder interferometer with three input ports, and is driven by 200mW peak power.

ThA6 09.30 - 09.45

Pump-Induced Optical Nonlinearities in Hydrogenated Amorphous Silicon Waveguides, Y. Shoji, T. Ogasawara, T. Kamei, Y. Sakakibara, S. Suda, K. Kintaka, H. Kawashima, M. Okano, T. Hasama, H. Ishikawa and M. Mori*, National Institute of Advanced Industrial Science and Technology, Tsukuba, Ibaraki, Japan*

We characterize optical nonlinear properties in hydrogenated amorphous silicon (a-Si:H) wire waveguides at telecom wavelengths using a heterodyne pump-probe measurement. Optical nonlinear coefficients of the phase shift and absorption change are estimated and discussed.

09.45 - 10.15 COFFEE BREAK

10.15 - 12.15

Session ThB: **BIOSENSING AND SOLAR CELLS**
Session Chair: Jinsong Xia, *Tokyo City University, Tokyo, Japan*

ThB1 10.15 - 10.45 (Invited)

Commercial Success of Silicon Photonics in Biosensing, C. Gunn and M. Iqbal*, Genalyte, San Diego, CA, USA*

A commercially viable biosensing platform based on silicon photonics ring resonators is presented. Design and development of optical scanning instrumentation is discussed, and results of proof-of-concept experiments are described. It is shown that ring resonators offer high sensitivity, wide dynamic range, compact form factor as well as cost effective means to label-free biosensing.

ThB2 10.45 - 11.00

Detection of Lead Contamination of Water and VOC Contamination of Air Using SOI Micro-Optical Devices, H.-P. Loock, J. Saunders, J. A. Barnes, C. M. Crudden, M. A. Dreher, J. Du*, Queen's University, Kingston, Canada*, D.-X. Xu, A. Densmore, S. Janz, R. Ma, M. Vachon, A. Delage, J. H. Schmid and P. Cheben*, National Research Council, Ottawa, Canada*

Micro-optical SOI ring-resonators and interferometers were coated with solid-phase micro-extraction materials derived from polydimethylsiloxane to enable sensing of volatile organic compounds of the BTEX class in air. A different coating based on functionalized mesoporous silicates is used to detect lead < 100 ppb Pb(II).

ThB3 11.00 - 11.15

Single Strand DNA Hybridization Sensing Using Photonic Crystal Waveguide Based Sensor, J. Garcia-Ruperez, V. Toccafondo*,* M. J. Bañuls, A. Griol, J. G. Castello, S. Peransi-Llopis and A. Maquieira*, Universidad Politécnica de Valencia, Valencia, Spain*

We report an experimental demonstration of single-strand DNA detection at room temperature using a photonic crystal waveguide based optical sensor. A detection limit of 19.8nM is obtained.

ThB4 11.15 - 11.30

Ultra-Highly Sensitive Digital Optical Sensor Based on Cascaded Si-Nanowire Rings, J. Hu and D. Dai*, Zhejiang University, Hangzhou, Zhejiang, China*

Digital double-ring sensor based on silicon nanowires is demonstrated experimentally for the first time. An ultrahigh sensitivity Δλ/Δn up to 1.46×105 nm/RIU is achieved. And the detection limit is close to 2×10^{-6}.

ThB5 11.30 - 11.45

Optical Manipulation and Transport of Microparticles on a Silicon Nitride Microracetrack Resonator Add-Drop Device, H. Cai and A. W. Poon*, Hong Kong University of Science and Technology, Kowloon, Hong Kong*

We demonstrate optical manipulation of 1-µm-sized polystyrene particles on a silicon nitride microracetrack resonator add-drop device in an integrated optofluidic chip. We present the particle coupling and transport from the resonator to the drop-port waveguide.

ThB6 11.45 - 12.15 (Invited)

Silicon based Solar Cells: Research Progress and Future Perspectives, S. Binetti*, Università degli Studi di Milano Bicocca, Milano, Italy*

The future leading role of silicon solar cells is up to cost. The strategy is both to increase the efficiency by surface modification or nanostructered devices and using low cost feedstock; both approaches are reviewed.

12.15 - 13.45 LUNCH BREAK

13.45 - 15.45
Session ThC: MODULATORS AND SWITCHES
Session Chair: Laurent Vivien, *Institut d'Electronique Fondamentale, Orsay, France*

ThC1 13.45 - 14.15 (Invited)

Undertaking Research in the Field of Silicon Optical Modulators in the Framework of the Helios and UK Silicon Photonics Projects, F. Y. Gardes, D. Thomson, G. T. Reed*, University of Surrey, Guildford, Surrey, UK*, L. O'Faolain, T. F. Krauss*, University of St. Andrews, St. Andrews, UK*, L. J. M. Lever, R. W. Kelsall, Z. Ikonic*, University of Leeds, Leeds, UK*, D. Marris-Morini, G. Rasigade, L. Vivien*, Institut d'Electronique Fondamentale, Orsay, France*, A. Brimont, P. Sanchis Kilders*, Universidad Politécnica de Valencia, Valencia, Spain*, F. Milesi and J.-M. Fedeli*, Commissariat à l'Énergie Atomique, Grenoble, France*

We report recent experimental results of research in different type of modulation in silicon developed in the framework of the UK project UK silicon phononics and European project HELIOS.

ThC2 14.15 - 14.30

Silicon High-Speed Electro-Optic Modulator, L. Alloatti*, Karlsruhe Institute of Technology, Karlsruhe, Germany*

A 40 Gbit/s electro-optic modulator is demonstrated. The modulator is based on a slotted silicon waveguide filled with a nonlinear organic material. A modulation voltage-length product of $V\pi L = 0.21$ Vcm can be achieved.

ThC3 14.30 - 14.45

Feedback-Controlled Resonance and Temporal Response Modulations in Silicon Microring Resonators, S. Feng, X. Luo and A. W. Poon*, Hong Kong University of Science and Technology, Kowloon, Hong Kong*

We report feedback-controlled electro-optically tunable resonances and time delay in silicon microring resonators. We demonstrate tunable extinction ratio of up to 25 dB and time delay modulation from 90 ps to 19 ps.

ThC4 14.45 - 15.00

A Low VπL Modulator with GHz Bandwidth Based on an Electro-optic Polymer-Clad Silicon Slot Waveguide, R. Ding, T. Baehr-Jones, Y. Liu, R. Bojko, J. Witzens, S. Huang, J. Luo, S. Benight, P. W. Sullivan*, University of Washington, Seattle, WA, USA*, J.-M. Fedeli, M. Fournier*, Commissariat à l'Énergie Atomique, Grenoble, France*, L. R. Dalton, A. K.-Y. Y. Jen and M. Hochberg*, University of Washington, Seattle, WA, USA*

We demonstrate a near-infrared modulator with a bandwidth exceeding 1GHz, based on a silicon strip-loaded slot waveguide clad in a nonlinear electro-optic polymer. Our device achieves a VπL figure of merit of 0.8V-cm.

ThC5 15.00 - 15.15

High-speed Silicon Microring Modulator with a 1 V Drive Voltage, P. Dong, S. Liao, W. Qian, H. Liang, R. Shafiiha, X. Wang, N.-N. Feng, D. Feng*, Kotura, Monterey Park, CA, USA*, G. Li, X. Zheng, A. V. Krishnamoorthy*, Oracle, San Diego, CA, USA* and M. Asghari*, Kotura, Monterey Park, CA, USA*

We present a silicon microring modulator with a 1 V drive voltage to achieve a 6.8 dB modulation depth at 10 Gbps. This drive voltage enables the modulator to be directly driven by CMOS electronics.

ThC6 15.15 - 15.30

A CMOS Compatible 1×3 Optical Switch Based on Silicon on Insulator, W. Wang, Y. Zhao, Y. Li, Y. Hao, J. Yang, M. Wang and X. Jiang, *Zhejiang University, Hangzhou, Zhejiang, China*

A 1×3 optical switch is demonstrated utilizing the 0.8-µm standard CMOS technology. Extinction ratios higher than 21dB are obtained for three states. It is with low power consumption (~7.4mW) and switching time (~15.3ns).

ThC7 15.30 - 15.45

Mach-Zehnder Silicon Modulator on Bulk Silicon Substrate; Toward DRAM Optical Interface, D. Shin, *Samsung Electronics Co. Ltd, Yongin, Korea*

We present a Mach-Zehnder silicon modulator fabricated on a bulk silicon substrate featuring active length of 200um, modulation speed up to 5Gb/s, power consumption of 2pJ/bit, and extinction ratio of 10dB.

15.45 - 16.15 COFFEE BREAK

16.15 - 17.15

Session ThD: NANOPHOTONIC DEVICES II
Session Chair: Yude Yu, *Chinese Academy of Sciences, Beijing, China*

ThD1 16.15 - 16.30

Simulation and Demonstration of Directed XOR Logic Gate using Two Cascaded Microring Resonators, L. Zhang, R. Ji, L. Jia, L. Yang, P. Zhou, Y. Tian, P. Chen, Y. Lu, Z. Jiang, Y. Liu, *Chinese Academy of Sciences, Beijing, China*, Q. Fang and M. B. Yu, *Agency for Science, Technology and Research, Singapore*

A directed logic architecture consisting of two silicon microring resonators which can perform XOR operation is proposed. Two electrical modulating signals applied to the microring resonators represent the operands of the logical operation. Bitwise XOR operation at 20 kbit/s is demonstrated.

ThD2 16.30 - 16.45

Design, Fabrication and Characterization of Cascaded SOI Rib Waveguide Microring Resonators, J. Yu and H. Yingtao, *Chinese Academy of Sciences, Beijing, China*

We demonstrate a three-stage double channel cascaded microrings integrated with grating couplers based on SOI rib waveguide. The resonant frequencies were well matched at the drop-port and still splitting at the through-port which was considered to be due to fabrication variations.

ThD3 16.45 - 17.00

High Efficieny and Long-Term Stability of Nanocrystalline Silicon Based Devices, A. Marconi, *University of Trento, Povo, Italy*

High efficiency of silicon nanocrystal based devices is shown through energy-band gap engineering of the nanocrystal ensemble. By using bipolar tunneling, improved electrical and opto-electronic stabilities after long storage time and under aging experiments are demonstrated.

ThD4 17.00 - 17.15

Experimental Demonstration of Ultrasmall Si-Nanowire-Based Arrayed-Waveguide Grating (de)Multiplexers with Novel Layouts, X. Fu and D. Dai, *Zhejiang University, Hangzhou, Zhejiang, China*

The measurement results for two types of ultrasmall arrayed-waveguide grating (AWG) (de)multiplexers with novel layouts based on silicon-on-insulator nanowires are presented. The ultrasmall AWG has 9-chnnanel and the channel spacing is 400GHz.

POSTER SESSION WILL BE HELD IN THE YASHI RESTAURANT IN GRAND BUILDING – COURTESY OF INTEL CORPORATION

17.15 - 19.00

Session P2: POSTER SESSION II

P2.1 Si Ring Optical Modulator with Multi-Cascade p/n Junctions, Y. Amemiya, *Hiroshima University, Hiroshima, Japan*

Si ring resonators with multi-cascade p/n junctions have been proposed and its performance is simulated as a function of carrier concentration of Si. The modulation takes a maximum at the carrier concentration between 5E17 and 1E18 cm^{-3} when the propagation loss is 2 dB/cm.

P2.2 Design of High-Speed Ultra-Low Vπ Slot Waveguide Modulators, J. Witzens, T. Baehr-Jones, R. Ding, Y. Liu and M. Hochberg, *University of Washington, Seattle, WA, USA*

Slot waveguides allow joint confinement of the RF electrical and optical fields in a narrow slot and enable ultra-low driving voltage polymer based modulators with projected Vπ below 250 mV for 10 GHz devices.

P2.3 The Study on Strain-Induced Second-Harmonic Generation in Si(111)Surface and Native SiO_2/Si(111)Interface, J. Zhao, W. Su, Q. Chen, Y. Jiang, Z. Chen, G. Jia and H. Sun, *Jilin University, Changchun, Jilin Province, China*

The mechanism of strain-induced second-harmonic generation (SISHG) has been studied and by this means the intrinsic strain build-in native Si/SiO_2 interface has been determined as a tensile with a magnitude of $3.07*10^{-4}$.

P2.4 Nonreciprocal Silicon Waveguides and Ring Resonators with Gyrotropic Cladding, A. Petrov, D. Jalas, M. Krause, J. Hampe and M. Eich, *Technical University of Hamburg-Harburg, Hamburg, Germany*

Concepts are demonstrated for nonreciprocal Mach-Zehnder interferometers (MZIs) and ring resonators with polymer gyrotropic cladding. The isolation with -20 dB suppression is theoretically demonstrated in a 2μm radius ring resonator.

P2.5 Photonic Band-Gap Anomaly in SOI Photonic-Wire Bragg-Grating Filter, T. Kita, R. Ishikawa and H. Yamada, *Tohoku University, Aoba-ku, Sendai, Japan*

We have systematically studied Bragg Grating Filters in Si photonic-wire waveguides. We found a photonic band-gap anomaly on the numerical calculations and verified it on the experimental measurements.

P2.6 High Speed Electro-Optic Modulation in Hybrid Silicon on Insulator Slotted Photonic Crystal, S. Prorok, J. H. Wülbern, J. Hampe, A. Petrov, M. Eich, *Technical University of Hamburg-Harburg, Hamburg, Germany*, J. Luo, A. K.-Y. Y. Jen, *University of Washington, Seattle, WA, USA*, J. Bruns and K. Petermann, *Technical University Berlin, Berlin, Germany*

We demonstrate GHz electro-optic modulation in a slotted silicon photonic crystal infiltrated with nonlinear optical polymer material.

P2.7 Chip-to-chip Optical Wireless Link Feasibility Using Optical Phased Arrays on Silicon-On-Insulator., K. Van Acoleyen, H. Rogier and R. G. Baets, *Ghent University, Ghent, Belgium*

One- and two-dimensional integrated optical phased arrays (OPAs) on silicon-on-insulator have been fabricated and measured having directivities of more than 40dBi and steering ranges up to 10°. These OPAs would allow data rates of 100Mbps at distances up to 0.5m.

P2.8 Coupled-Resonator-Induced-Transparency Concept for Wavelength Router Applications, M. Mancinelli, *University of Trento, Povo, Trento, Italy*

We investigated the presence of high quality factor resonances due to Coupled Resonator Induced Transparency in complex sequences of coupled resonators devices, and proposed a new concept of wavelength router based on this effect

P2.9 Birefringence Characterization on SOI Waveguide using Optical Low Coherence Interferometry, S.-H. Hsu, S.-C. Tseng and H.-Z. You, *National Taiwan University of Science and Technology, Taipei, Taiwan*

An optical low-coherence interferometry was utilized to characterize the birefringence on 5-um thick silicon-on-insulator waveguides. The SMF-28 fiber was taken as a baseline to demonstrate 2.6×10^{-3} waveguide birefringence with 5-um width and 2.5-um etch depth.

P2.10 Demonstration of High Resolution SOI Spectrometer with Miniaturized Disks, Z. Xia, M. Soltani, A. A. Eftekhar, Q. Li, M. Chamanzar, S. Yegnanarayanan, B. Momeni and A. Adibi, *Georgia Institute of Technology, Atlanta, GA, USA*

An ultra-compact 81-channel infrared spectrometer with high resolution (~ 0.6 nm) and low crosstalk (<-10dB) is demonstrated on the SOI platform using a large-scale array of miniaturized microdisk resonators with a large free-spectral range.

P2.11 Numerical Analysis of Surface-plasmon-enhanced Light Emission in Fin Silicon Light-emitting Diode, I. Jeong, C. Kim and Y. J. Park, *Seoul National University, Seoul, Korea*

We propose an ultra thin fin-shaped vertical silicon light-emitting diode with metal film deposition on each side for surface plasmonic resonance coupling, and numerically investigated its emission property.

P2.12 Optical Biosensing using Horizontal Slot Microdisk Resonator, S. Lee, S. C. Eom, J. S. Chang, *Korea Advanced Institute of Science and Technology, Daejon, Korea*, G. Y. Sung, C. Huh, *Electronics & Telecommunications Research Inst., Daejeon, Korea* and J. H. H. Shin, *Korea Advanced Institute of Science and Technology, Daejeon, Korea*

Biosensor using a horizontal slot microdisk resonator as a biosensor is demonstrated. Surface sensitivity of as high as 5.55 nm/nm is expected, and more than 9 nm shift upon sensing is demonstrated.

P2.13 Polarization Characteristics of Low-Loss Nano-Core Buried Optical Waveguides and Directional Couplers, D. Dai, *Zhejiang University, Hangzhou, Zhejiang, China*, Z. Wang, J. F. Bauters, M.-C. Tien, M. Heck, D. J. Blumenthal and J. E. Bowers, *University of California - Santa Barbara, Santa Barbara, CA, USA*

The characterization of a low loss buried optical waveguide with a nano-core-layer of SiN is analyzed. With such a low-loss optical waveguide, directional couplers are also designed, fabricated and characterized.

P2.14 Demonstration of Compact 2x2 Multimode Interference coupler on Silicon Nanomembrane, A. Hosseini, D. Kwong, *University of Texas at Austin, Austin, TX, USA*, H. Subbaraman, *Omega Optics Inc., Austin, TX, USA* and R. T. Chen, *University of Texas at Austin, Austin, TX, USA*

We designed and fabricated a 2x2 tapered multimode interference coupler on silicon-on-insulator with dimensions of 12.88μm×3μm. The device keeps a 50/50 splitting ratio over a 50nm bandwidth. To our best knowledge this is the most compact 2x2 MMI demonstrated.

P2.15 As-grown Ge pin-diode on Si with Ultralow Dark Current Achieved by the H Desorption, Y. Takada, R. Suzuki, *University of Tokyo, Tokyo, Japan*, S. Park, *NTT Corporation, Atsugi-shi, Kanagawa, Japan*, J. Osaka, Y. Ishikawa and K. Wada, *University of Tokyo, Tokyo, Japan*

The as-grown Ge pin-diode on Si with a low dark current (4.6×10^{-2} A/cm^2 at -1V) can be achieved by the H desorption growth. The H desorption should be an enabler to implement the Ge growth in CMOS backend process.

P2.16 Propagation Loss of Amorphous Silicon Optical Waveguides at the 0.8 μm-Wavelength Range, T. Asukai, *Kanazawa University, Kanazawa, Ishikawa, Japan*

We fabricated optical waveguides using amorphous silicon deposited by catalytic chemical vapor deposition method. The waveguides were fabricated by photolithography and wet chemical etching. The propagation loss of 15 dB/cm at 830 nm was measured.

P2.17 High Performance of Silicon-Based Resonant-Cavity-Enhanced (RCE) Photodetectors Using Sol-Gel Bonding, L. Zhang, *Chinese Academy of Sciences, Beijing, China*

We report Si-based InGaAs RCE photodetectors. The detector without top mirror exhibits saturation output current higher than 19.8mA, and the responsivity is 0.33A/W. The full width at half maximum of the RCE photodetector is 4.8nm.

P2.18 Practical Integration Method of Active Devices on SOI Photonic Integrated Circuits, T. Kita, M. Abe, Y. Ohtera and H. Yamada, *Tohoku University, Aoba-ku, Sendai, Japan*

We propose a method of mounting LD chips on SOI substrate and discuss about the optical coupling loss between LDs and Si photonic-wire waveguides.The simulations show that a minimum optical coupling loss of 1.6 dB and a large offset tolerance.

P2.19 Intervalley Scattering and Field Screening in Germanium/Silicon-Germanium Quantum Wells, E. Tasyurek, S. A. Claussen, *Stanford University, Stanford, CA, USA*, J. E. Roth, *Aurrion, Santa Barbara, CA, USA* and D. A. B. Miller, *Stanford University, Stanford, CA, USA*

The scattering time of electrons from the direct to the indirect valley in the conduction band of germanium/silicon-germanium quantum wells is measured to be ~250 fs. Carrier field screening is also observed and modeled.

P2.20 Packaging of SOI Motherboards for High-Speed all Optical Router Applications, L. Zimmermann, *Innovations for High Performance Microelectronics, Frankfurt, Germany*, K. Voigt, G. Winzer, *Technical University Berlin, Berlin, Germany*, K. Landles, J. J. Lynn, and S. Duffy, *Optocap Limited, Livingston, UK*

In this paper we present packaging developments around SOI high speed all optical router boards. We shall prove the feasibility of our approach by experimental figures for pigtailing power penalty.

P2.21 Influence of Electronic Nonlinear Process in Silicon Raman Wavelength Converter, Y. Huang, M. Tang, P. Shum and C. Lin, *Nanyang Technological University, Singapore*

Electronic nonlinear processes such as SPM, XPM and FWM cause dynamic phase shifting and enhance wavelength conversion efficiency in silicon Raman wavelength converter. Waveguide miniaturization to 4cm yields optimized conversion efficiency of -9.1dB.

P2.22 SiGe CANCELLED **ted with CMOS,** C. J. R. Augusto, L. Forester and P. Diniz, *Quantum Semiconductor LLC, San Jose,*

A CMOS-integr under avalanche breakdown emits white light perpendicularly to the SiGeC layers. It can be used as an optical pump for devices such as Raman or Er-based lasers.

P2.23 On CANCELLED **tices having a Broken-Gap,** C. J. R. Augusto, L. Forester and P. Diniz, *Quantum Semiconductor*

A CMOS-compatible SiGeC superlattice design is proposed that offers the possibility of generating a range of direct bandgaps smaller than Ge's, down to brokengap provided that sufficient substitutional carbon content can be incorporated.

P2.24 Optical Activity and Population Inversion of Er Doped in Silicon-Rich Silicon Nitride, J. S. Chang, I. Y. Kim, *Korea Advanced Institute of Science and Technology, Daejeon, Korea*, G. Y. Sung, *Electronics & Telecommunications Research Inst., Daejeon, Korea* and J. H. Shin, *Korea Advanced Institute of Science and Technology, Daejeon, Korea*

Optical activity and population inversion of Er doped in silicon-rich silicon nitride (SRSN) is investigated. Transmission measurements of SRSN waveguide shows that nearly all of doped Er is optically active even after high temperature anneals.

P2.25 Re CANCELLED **ermal Impedance using Poly Si Thermal Shunts,** M. N. Sysak, *Intel Corporation, Santa Clara, CA, U* *ty of California - Santa Barbara, Santa Barbara, CA, USA*, O. Raday, *Numonyx Israel Ltd, Qiryat Gat, Israel*, J. E. Bowers, *University of California - Santa Barbara, Santa Barbara, CA, USA* and R. Jones, *Intel Corporation, Santa Clara, CA, USA*

We present a hybrid silicon evanescent laser that uses poly-silicon thermal shunts to improve the 800μm long device's thermal impedance from 42 to 33.5°C/W.

P2.26 Photoluminescence and Electroluminescence from B-Doped Nanocrystal Si/SiO2 Multilayers, H. Sun, *Nanjing University, Nanjing, Jiangsu, China*

B-doped nc-Si/SiO_2 multilayers were formed using a PECVD system with subsequent thermal annealing. Room temperature photoluminescence and electroluminescence was investigated and compared with that of undoped nc-Si/SiO_2 samples

P2.27 1.1 to 1.6 μm Silicon Light Emitting Diodes and Optical Gain, K. P. Homewood, M. A. Lourenco and R. M. Gwilliam, *University of Surrey, Guildford, Surrey, UK*

We report silicon LEDs from 1.1 to 1.6 μm and gain by incorporating optically active impurities. Nano-engineering enables room temperature operation. Gain values offer a route to electrically pumped silicon optical amplifiers and lasers.

P2.28 Strong Er emission from Er doped nc-Si/SiO_2 multilayers, Y. Fu, H. Krzyzanowska, K. Ni, *University of Rochester, Rochester, NY, USA*, J. LaRose, M. Huang, *University at Albany, Albany, NY, USA* and P. M. Fauchet, *University of Rochester, Rochester, NY, USA*

We demonstrate strong Er emission from Er doped SiO_2/nc-Si multilayer structures. Compared to reference samples, Er emission is enhanced and nc-Si emission is quenched, indicating energy transfer is the reason behind this enhancement.

P2.29 Direct Demonstration of Sensitization at 980nm Optical Excitation in Erbium-Ytterbium Silicates., M. Vanhoutte, *Massachusetts Institute of Technology, Cambridge, MA, USA*, B. C. Wang, Z. Zhou, *Peking University, Beijing, China*, J. Michel and L. C. Kimerling, *Massachusetts Institute of Technology, Cambridge, MA, USA*

Sensitization of erbium by ytterbium in erbium-ytterbium silicates at 980nm optical excitation is demonstrated. It is shown that detrimental Er-Er interactions increase non-radiative decay rates at high erbium concentrations. Dilution of erbium by ytterbium decreases these interactions and increase internal quantum efficiency.

P2.30 Highly oriented $Er_xY_{2-x}SiO_5$ crystalline thin films fabricated by pulsed laser deposition, H. Isshiki*, University of Electro-Communications, Chofu, Tokyo, Japan*

We propose layer-by-layer deposition approach to fabricate $Er_xY_{2-x}SiO_5$ crystalline thin films. Highly oriented $Er_xY_{2-x}SiO_5$ thin films with high crystallinity have been obtained by rapid thermal annealing (RTA) crystallization following pulsed-laser deposition (PLD).

P2.31 Optical Losses and Cooperative Upconversion in Ion Beam Sputter-Deposited $Er_xY_{2-x}SiO_2$ Waveguide Amplifiers, M. Lee and J. H. H. Shin*, Korea Advanced Institute of Science and Technology, Daejeon, Korea*

Factors leading to optical losses in ion-beam sputter deposited $Er_xY_{2-x}SiO_2$ waveguide amplifiers are investigated. By improving the film fabrication conditions and device design, lower scattering loss and cooperative upconversion coefficients are achieved.

P2.32 Stimulated Emission from Silicon Nanocrytals by Two-Photon Excitation in CW Operation, X. Xu*, Chinese Academy of Sciences, Beijing, China* and S. Yokoyama*, Kyushu University, Kasuga, Fukuoka, Japan*

The superlinear emission of two-photon excited fluorescence from the silicon particles are observed under CW laser excitation, and the emission is attributed to stimulated emission. The silicon particles were produced by a ns pulse laser.

Friday, 03 September 2010

08.00 - 09.45

Session FA: **PHOTODETECTION**
Session Chair: Jean-Marc Fedeli, *Commissariat à l'Énergie Atomique, Grenoble, France*

FA1 08.00 - 08.30 (Invited)

Waveguide-Integrated Germanium Avalanche Photodetector for Low-Noise and High-Speed Operation, S. Assefa, F. Xia and Y. A. Vlasov*, IBM Research, Yorktown Heights, NY, USA*

A waveguide-integrated Germanium avalanche photodetector with 10dB gain and excess-noise factor with keff below 0.2 was demonstrated. Gain-bandwidth-product of 350GHz was achieved at 3V. The single-crystalline Ge waveguide was integrated utilizing rapid melt growth technique.

FA2 08.30 - 08.45

Ge/Si Waveguide Avalanche Photodiodes, Z. Huang*, Intel Corporation, Santa Clara, CA, USA*

Evanescent-coupled and butt-coupled waveguide Ge/Si avalanche photodiodes are demonstrated. Bandwidth as high as 29.5GHz is achieved from a 6x30μm^2 butt-coupled APD. Internal responsivity of 0.81A/W at 1550nm is also accomplished from 50μm-long devices.

FA3 08.45 - 09.00

High Responsivity and Low Dark Current Operation of Ultra-Small InGaAs MSM Photodetector Integrated on Si Waveguide, K. Ohira, K. Kobayashi, N. Iizuka, H. Yoshida, T. Suzuki, N. Suzuki and M. Ezaki*, Toshiba Corporation, Kawasaki, Kanagawa, Japan*

We demonstrate small footprint of 2×10μm² InGaAs MSM photodetectors integrated on Si-waveguide with direct wafer bonding. The detector exhibits a high-responsivity of 0.94A/W, low dark current of 20nA, and a capacity of 10Gbps.

FA4 09.00 - 09.15

Two-Photon-Absorption-Based Optical Power Monitor in Silicon Rib Waveguides, I. Hsieh, H. Rong and M. Paniccia*, Intel Corporation, Santa Clara, CA, USA*

Utilizing two-photon-absorption effect, we demonstrate an in-situ scheme for monitoring optical power using p-i-n diode in silicon rib-waveguides. We show accurate waveguide propagation loss measurements and improved responsivity with reverse-bias for this square-law detector.

FA5 09.15 - 09.30

Franz-Keldysh Effect in Germanium p-i-n Photodetectors on Silicon, M. Schmid, M. Oehme, M. Kaschel, J. Werner, E. Kasper and J. Schulze*, University of Stuttgart, Stuttgart, Germany*

Ge on Si p-i-n photodetectors were grown by molecular beam epitaxy minimizing tensile strain. The slope of the absorption curve changes by a factor of 2 under varying voltages due to the clearly observable Franz-Keldysh-Effect.

FA6 09.30 - 09.45

Silicon-based LED Display Array in Standard CMOS Technology, Z. Dong, W. Wang, B. Huang, X. Zhang, N. Guan, J. Chen, Y. Gui, H. Liu and H. Chen*, Chinese Academy of Sciences, Beijing, China*

Silicon-based light emitting diode (LED) display arrays, the static array and the dynamic array, are designed based on silicon p-n junction in standard 0.35-μm CMOS technology. The LED optical spectrum shows main peak at 760nm.

09.45 - 10.15 COFFEE BREAK

10.15 - 12.15

Session FB: **LIGHT EMISSION IN NANOMATERIALS**
Session Chair: Deren Yang, *Zhejiang University, Hangzhou, Zhejiang, China*

FB1 10.15 - 10.45 (Invited)

Electrically Pumped Random Lasing from ZnO Materials, X. Ma, P. Chen, Y. Tian, D. Li and D. Yang, *Zhejiang University, Hangzhou, Zhejiang, China*

In this presentation, the realization of electrically pumped random lasing from ZnO materials by means of metal-insulator-semiconductor structure is introduced. Moreover, the mechanism we have proposed for the electrically pumped random lasing is elucidated.

FB2 10.45 - 11.00

Silicon-Based Light Emission in Ultraviolet, J. M. Sun, *Nankai University, Tianjin, China*

Efficient UV electroluminescence from Gd-doped SiO_2 gate oxide was reported with quantum efficiency larger than 5%. The efficiency and stability was improved by flash lamp annealing, co-doping with F- ions and K+ ions.

FB3 11.00 - 11.15

Photon Energy Harvesting by Rare-Earth Doping into Blue-Phosphorescent Nanosilicon, B. J. Gelloz and N. Koshida, *Tokyo University of Agriculture and Technology, Koganei, Tokyo, Japan*

Indications of energy transfer from long-lived blue-emitting centers to rare-earth ions was found in rare-earth doped oxidized nanosilicon. High-pressure water vapor annealing drastically improves the luminescence of the rare-earth ions as compared to conventional annealing.

FB4 11.15 - 11.30

MBE Growth of High Sn-Percentage GeSn Alloys with a Composition-Dependent Absorption-Edge Shift, Y. Huo, R. Chen, H. Lin, T. I. Kamins and J. S. Harris, *Stanford University, Stanford, CA, USA*

Low-temperature MBE growth of up to $Ge_{0.926}Sn_{0.074}$ alloys on lattice-matched $In_{0.10}Ga_{0.90}As$ resulted in high-quality material as determined by AFM, TEM, and XRD. Samples show longer wavelength absorption-edge shifts with increasing Sn incorporation.

FB5 11.30 - 11.45

High Quality Epitaxial $Ge_{1-x}Sn_x$ Alloy Films on Si with a Ge Buffer by Molecular Beam Epitaxy with Combined Sources, W. Wang, *Chinese Academy of Sciences, Beijing, Beijing, China*

Epitaxial $Ge_{1-x}Sn_x$ alloys were grown on Si(100) by MBE at low temperature with a Ge buffer layer. The Ge buffer was grown in the same system by two step method using GeH_4 as gas source.

FB6 11.45 - 12.00

Enhancement of Light Emission from Silicon by a Photonic Crystal Nanocavity and High-Pressure Water Vapor Annealing, M. Fujita, *Kyoto University, Kyoto, Japan*, B. J. Gelloz, N. Koshida, *Tokyo University of Agriculture and Technology, Koganei, Tokyo, Japan* and S. Noda, *Kyoto University, Kyoto, Japan*

We propose and demonstrate the application of high-pressure water vapor annealing (HWA) to silicon photonic-crystal nanocavities for surface passivation. We find that HWA boosts light emission due to the reduction of surface recombination beyond simply using the cavity effect.

FB7 12.00 - 12.15

Visible Photoluminescence and Electroluminescence from a-SiN_x:H/SiO_2 Multilayers With Lateral Carrier Injection, L. Kamyab, E. Rusli, *Nanyang Technological University, Singapore, Singapore* and M. B. Yu, *Agency for Science, Technology and Research, Singapore*

We report photoluminescence (PL) and electroluminescence (EL) from a-SiN_x:H/SiO_2 multi-layers. The PL peak and optical bandgap are tunable by varying the a-SiNx:H thickness. We report a lateral current injection method to enhance the EL efficiency of the multilayer structures.

12.15 - 13.45 LUNCH BREAK

13.45 - 15.45

Session FC: **PHOTONICS INTEGRATION AND RF PHOTONICS**
Session Chair: Thierry J. Pinguet, *Luxtera, Inc., Carlsbad, CA, USA*

FC1 13.45 - 14.15 (Invited)

Next Generation of Optical Integration - The Impact of CMOS Photonics, D. D'Andrea, *Lightwire, Inc., Allentown, PA, USA*

CMOS Photonics is currently used to provide standards based products such as SFP+. These modules consume one third to one half the power of existing solutions with the added benefit of low dispersion over directly modulated devices.

FC2 14.15 - 14.30

Photonics and Electronics Integration in the HELIOS project, J.-M. Fedeli*, Commissariat à l'Énergie Atomique, Grenoble, France*

The objective of the European project HELIOS is to combine a photonic layer with a CMOS circuit by different innovative means, using microelectronics processes. Bonding of AWG + Ge Photodiodes on CMOS wafer is achieved

FC3 14.30 - 14.45

Optical Power Stabilization using a Germanium Photodiode and a Variable Optical Attenuator Integrated on a Silicon Wire Waveguide Platform, K. Yamada*,* T. Tsuchizawa*,* T. Watanabe*,* H. Shinojima*,* H. Nishi*,* R. Kou*,* S. Park*, NTT Corporation, Atsugi-shi, Kanagawa, Japan*, Y. Ishikawa, K. Wada*, University of Tokyo, Tokyo, Japan* and S.-I. Itabashi*, NTT Corporation, Atsugi-shi, Kanagawa, Japan*

Optical power stabilization was demonstrated using a germanium photodiode and a silicon variable optical attenuator monolithically integrated. The optical output was stabilized within an error of 3.7 dB for 20-dB input power variation. Response time was about 100 ns.

FC4 14.45 - 15.00

A Narrowband Reconfigurable RF-Photonic Filter with Efficient Thermal Tuning Structures, N.-N. Feng, P. Dong, D. Feng, W. Qian, H. Liang, D. C.-H. Lee*,* J. B. Luff*,* M. Asghari*, Kotura, Monterey Park, CA, USA*, A. Agarwal, T. Banwell*,* R. Menendez*,* P. C. Toliver and T. K. Woodward*, Telcordia Technologies, Inc., Red Bank, NJ, USA*

We present the design and fabrication of thermally-efficient tuning structures integrated into a narrowband reconfigurable radio-frequency-photonics filter using silicon-on-insulator waveguide optical delay lines. We are able to achieve IIR, FIR or mixed responses with < 100mW total tuning power.

FC5 15.00 - 15.15

Silicon Nanowire Based Radio-Frequency Spectrum Analyser, D. J. Moss, B. Corcoran*,* T. Vo*,* M. D. Pelusi, C. Monat, B. J. Eggleton*, University of Sydney, Sydney, Australia*, D.-X. Xu, S. Janz, A. Densmore and R. Ma*, National Research Council, Ottawa, Canada*

We demonstrate a silicon nanowire based radio-frequency spectrum analyzer capable of characterizing ultrahigh speed optical data. Through measurement of 640GBit/s on-off-keyed data we show that although nonlinear loss affects device efficiency, free-carrier dispersion is negligible.

FC6 15.15 - 15.30

Compact Fully Reconfigurable Multi-Stage RF Photonic Filters Using High-Q Silicon Microdisk Resonators, P. Alipour, A. A. Eftekhar, A. H. Atabaki, Q. Li, S. Yegnanarayanan*, Georgia Institute of Technology, Atlanta, GA, USA*, C. K. Madsen*, Texas A&M University, College Station, TX, USA* and A. Adibi*, Georgia Institute of Technology, Atlanta, GA, USA*

We present a fully reconfigurable four-pole, four-zero SOI RF photonic filter with a 3dB bandwidth <5 GHz, out-of-band rejection >38 dB, FSR >600 GHz, and a compact size (<0.15 mm2) using high-Q resonator-based components.

FC7 15.30 - 15.45

Two-dimensional Dispersive Beam Steerer Fabricated on Silicon-On-Insulator., K. Van Acoleyen*,* W. Bogaerts*,* H. Rogier*,* and R. G. Baets*, Ghent University, Ghent, Belgium*

A two-dimensional beam steerer on silicon-on-insulator is presented. Steering ranges of 5.5° in one direction and 50° in the other direction have been shown for a wavelength shift of 40nm. The largest measured sensitivity was 10.7° per nanometer wavelength shift.

15.45 - 16.15 COFFEE BREAK

16.15 - 17.15

Session FD: LONGWAVE PHOTONICS AND QUANTUM CONTROL
Session Chair: Andrew W. Poon, *Hong Kong University of Science and Technology, Kowloon, Hong Kong*

FD1 16.15 - 16.45 (Invited)

Waveguides for Mid-Infrared Group IV Photonics, G. Z. Mashanovich, W. R. Headley, M. M. Milosevic, N. Owens, E. J. Teo, B. Q. Xiong, P. Y. Yang, M. Nedeljkovic, J. Anguita, I. P. Marko and Y. Hu*, University of Surrey, Guildford, Surrey, UK*

In this paper we present preliminary work on group IV photonic waveguides that may be suitable for mid-infrared wavelengths. Fabrication and experimental results for two waveguide structures are given.

FD2 16.45 - 17.00

Silicon Waveguides and Ring Resonators at 5.5 μm, Y. Liu, A. Spott, T. Baehr-Jones*, University of Washington, Seattle, WA, USA*, R. Ilic*, Cornell University, Ithaca, NY, USA* and M. Hochberg*, University of Washington, Seattle, WA, USA*

We fabricate and characterize silicon waveguides and ring resonators around 5.5 μm on the Silicon-on-Sapphire (SOS) platform. The waveguide loss is 4.1 ± 0.7 dB/cm, and a Q value of 1.4k is achieved.

FD3 17.00 - 17.15

Quantum Control of Phosphorus Donor Rydberg States in Silicon, S. A. Lynch*, University College London, London, UK*, T. Greenland*, London Centre for Nanotechnology, London, London, UK*, L. van der Meer*, FOM Institute, Nieuwegein, Utrecht, The Netherlands*, B. N. Murdin*, University of Surrey, Guildford, Surrey, UK*, C. R. Pidgeon*, Heriot-Watt University, Edinburgh, UK*, B. Redlich*, FOM Institute,*

Nieuwegein, Utrecht, The Netherlands, N. Q. Vinh*, University of California - Santa Barbara, Santa Barbara, CA, USA* and G. Aeppli*, University College London, London, UK*

We demonstrate the first observation of a THz photon echo. We exploit the photon echo as an experimental tool to investigate the quantum coherence properties of excited donor Rydberg states of phosphorus in silicon.

17.15 - 18.00 **POST DEADLINE SESSION**

18.00 - 18.15 **CLOSING REMARKS**

END OF PROGRAM