

# Advance Program

## Monday, 21 August 2006

**All Sessions to be held in Jefferson**

**8:30 AM - 10:15 AM**

**Session PLE:** PLENARY SESSION

**Session Chairs:** Lih Y. Lin, *University of Washington, Seattle, WA, USA*

Joseph J. Talghader, *University of Minnesota, Minneapolis, MN, USA*

**8:30 AM - 8:45 AM**

**OPENING REMARKS**

**PLE1 8:45 AM - 9:30 AM**

**Nanostructures for Biomolecule Detection and Analysis**, H. G. Craighead, *Cornell University, Ithaca, NY, USA*

Nanofabricated fluidic, optical and mechanical devices can be integrated into systems for molecular analysis. These systems allow new approaches and provide new tools for sensitive detection and analysis of biomolecular systems.

**PLE2 9:30 AM - 10:15 AM**

**Subwavelength Optical Elements and Nanoimprint Technology for Optical MEMS/NMES**, S. Y. Chou, *Princeton University, Princeton, NJ, USA*

The paper will present two platform technologies that significantly impact optical MEMS/NEMS: subwavelength optical elements (SOEs) --a new class of optical devices well suited for wafer level integration, and nanoimprint technology--an enabling nanopatterning method.

**10:15 AM - 10:30 AM**

**COFFEE BREAK**

**10:30 AM - 12:30 PM**

**Session MA:** TUNABLE DEVICES

**Session Chair:** Karl Bohringer, *University of Washington, Seattle, WA, USA*

**MA1 10:30 AM - 11:00 AM (Invited)**

**Tunable Infrared Sensors - Integration of MEMS with Semiconductor Detectors**, J. M. Dell, C. A. Musca, J. Antoszewski and L. Faraone, *University of Western Australia, Crawley, WA, Australia*

Tunable infrared sensors fabricated by surface micromachining with maximum thermal budget of 2 hours at 125C have been realized, demonstrating that a generic, robust, environmentally stable MEMS process is possible using maximum process temperatures <200C.

**MA2 11:00 AM - 11:15 AM**

**Micromechanically Widely Tunable VCSEL for Absorption Spectroscopy at around 1.55 $\mu$ m**, B. Koegel, H. Halbritter, *Darmstadt University of Technology, Darmstadt, Germany*, M. Lackner, M. Schwarzott, *ProcessEng Engineering GmbH, Vienna, Austria*, M. Maute, M.-C. Amann, *Technical University of Munich, Garching, Germany*, F. Winter, *Vienna University of Technology, Vienna, Austria* and P. Meissner, *Darmstadt University of Technology, Darmstadt, Germany*

Absorption spectroscopy of CO and CO<sub>2</sub> at wavelengths around 1.55 $\mu$ m via an all fiber based remote measurement setup is presented as application where a singlemode MEMS-VCSEL can feature its broadband (51nm) continuous tuning characteristics.

**MA3 11:15 AM - 11:30 AM**

**MEMS Tunable VCSEL with Concave Mirror using the Selective Polishing Method**, N. Kanbara, *Yokogawa Electric Corporation, Kamiina-gun, Nagano, Japan*

We have proposed a micromachined tunable VCSEL fabricated using the selective polishing method and two chip bonding. This VCSEL is achieved singlemode in 32nm tuning range.

**MA4 11:30 AM - 11:45 AM**

**Monolithic Integration of Piezoelectric Cantilever in Tunable VCSEL**, K. B. Cheng, M. C.-Y. Huang, Y. Zhou, S. P. Alvaro, C. J. Chang-Hasnain and A. P. Pisano, *University of California - Berkeley, Berkeley, CA, USA*

We have designed, fabricated and characterized the monolithic integrated piezoelectric actuated cantilever beam in tunable short-wavelength VCSEL. Single mode emission with continuously tuning range of 3nm and low power consumption was experimentally obtained.

**MA5 11:45 AM - 12:00 PM**

**Nanoscale High-Contrast Subwavelength Grating Integrated Tunable Surface Emitting Laser**, M. C.-Y. Huang, Y. Zhou and C. J. Chang-Hasnain, *University of California - Berkeley, Berkeley, CA, USA*

We report a novel electrostatic actuated nano-electromechanical (NEMS) tunable surface emitting lasers utilizing a movable single layer large-index-contrast subwavelength grating. Single mode emission and continuous tuning were obtained at room temperature under CW operation.

**MA6 12:00 PM - 12:15 PM**

**GaSb-based Micro-Mechanical External-Cavity Laser Emitting around 2.3 $\mu$ m**, E. Geerlings, M. Rattunde, J. Schmitz, G. Kaufel, J. Wagner, *Fraunhofer-Institut, Freiburg, Germany*, D. Kallweit and H. Zappe, *University of Freiburg, Freiburg, Germany*

We report on GaSb-based quantum-well diode lasers in a micro-machined external cavity setup using the Littrow-configuration. An electrostatically actuated Si – grating, optimized to achieve a wide tuning range in the 2.3  $\mu$ m wavelength range, is used as a tuning element.

**MA7 12:15 PM - 12:30 PM**

**Silicon Microtoroidal Resonators with Integrated MEMS Tunable Optical Coupler**, J. Yao, D. Leuenberger, *University of California - Berkeley, Berkeley, CA, USA*, M.-C. M. Lee, *National Tsing Hua University, HsinChu, Taiwan, R.O.C.* and M. C. Wu, *University of California - Berkeley, Berkeley, CA, USA*

A single crystalline silicon microtoroidal resonator with integrated MEMS tunable optical coupler is demonstrated for the first time. The coupling coefficient is continuously tuned from almost zero up to 13.3%.

**12:30 PM – 2:00 PM**

**LUNCH BREAK**

**2:00 PM - 3:30 PM**

**Session MB: DISPLAYS**

**Session Chair:** Hiroshi Toshiyoshi, *University of Tokyo, Meguro, Tokyo, Japan*

**MB1 2:00 PM - 2:30 PM (Invited)**

**Grating Light Valve Projector**, S. R. Kubota and A. Taguchi, *Sony Corporation, Shinagawa, Tokyo, Japan*

We discuss a grating light valve (GLV) projector has potential dynamic range in light intensity modulation only limited by the thermally excited random fluctuation of its membrane displacement.

**MB2 2:30 PM - 2:45 PM**

**Characterization of Piston-Tip-Tilt mirror pixels for scalable SLM arrays**, F. Pardo, *Lucent Technologies, Murray Hill, NJ, USA*

We present SLM micromirrors realized using a surface micromachining 3-structural-layer polysilicon process. High-fill-factor, flat mirrors 120 microns in size have mechanical response of the order of 10 microseconds, with +/- 4°, tip and tilt and 5 microns piston range under 110V.

**MB3 2:45 PM - 3:00 PM**

**One Megapixel SLM with High Optical Fill Factor and Low Creep Actuators**, M. Friedrichs, J. Schmidt, P. Duerr and T. Bakke, *Fraunhofer-Institut, Dresden, Germany*

A one megapixel micromirror based SLM with two layer torsional mirror actuators was monolithically integrated on CMOS. The mirrors have a high optical fill factor and a very low level of mechanical creep when actuated.

**MB4 3:00 PM - 3:15 PM**

**A Combination of Fast Resonant Mode and Slow Static Deflection of SOI-PZT Actuators for MEMS Image Projection Display**, M. Tani, M. Akamatsu, Y. Yasuda, *Stanley Electric, Yokohama, Kanagawa, Japan*, H. Fujita and H. Toshiyoshi, *University of Tokyo, Meguro, Tokyo, Japan*

A new type of MEMS optical scanner has been developed by using the ADRIP technique of PZT. Stable and wide range 2D scan was made possible by combining resonant motion and quasi-static operation.

**MB5 3:15 PM - 3:30 PM**

**Growth of GaN Quantum Well Film on Si Substrate and Its Application to a GaN-Si Hybrid Lightning Device**, F.-R. Hu, R. Ito, Y. Zhao, Y. Kanamori, and K. Hane, *Tohoku University, Sendai, Miyagi, Japan*

A new light source monolithically composed of the GaN LEDs and Si MEMS structure is proposed. Basic research on the growth of GaN crystals on Si substrate was carried out. InGaN/GaN quantum well structures were formed. From Si substrate with GaN crystal, a micro-stage with comb actuators was fabricated.

**3:30 PM – 4:00 PM**

**COFFEE BREAK**

**4:00 PM - 6:00 PM**

**Session MC: INTEGRATED SYSTEMS**

**Session Chair:** Joseph E. Ford, *University of California - San Diego, La Jolla, CA, USA*

**MC1 4:00 PM - 4:30 PM (Invited)**

**High Confinement Micro-Ring Resonators in Silicon-on-Insulator**, L. Martinez and M. Lipson, *Cornell University, Ithaca, NY, USA*

We demonstrate high confinement silicon devices including suspended micrometer-scale ring resonators with high Q's in a CMOS platform.

**MC2 4:30 PM - 5:00 PM (Invited)**

**Mass-Producible Nano and Microphotonic Devices and Systems**, A. Stuck, M. Schnieper, and S. Obi, *CSEM, Zurich, Switzerland*

Color filters, antireflex gratings, grating polarizers, microlenses and mechanical holding structures can be manufactured with the same UV-embossing process and integrated into complex optical microsystems. It makes cost-effective wafer-scale manufacturing of optical microsystems a reality.

**MC3 5:00 PM - 5:15 PM**

**Design and Fabrication of Optical MEMS Scanners for Optically Modulated Fiber Endoscopes**, M. Nakada, *University of Tokyo, Meguro, Tokyo, Japan*, C. Chong, K. Isamoto, *Santec Photonics Laboratories, Komaki, Aichi, Japan*, H. Fujita and H. Toshiyoshi, *University of Tokyo, Meguro, Tokyo, Japan*

This paper reports a design and fabrication of micro scanner for optically modulated fiber endoscopes of medical use that are not powered through electrical wires but with a photovoltaic cell.

**MC4 5:15 PM - 5:30 PM**

**XY-Stage for Scanning Media for Optical Data Storage**, M. Sasaki, F. Bono, and K. Hane, *Tohoku University, Sendai, Miyagi, Japan*

An electrostatically driven XY-stage is fabricated. The realized displacements are 110 and 115 $\mu\text{m}$  along x- and y-axes, respectively. Two 820x950 $\mu\text{m}^2$ -size media plates are driven at the mutually opposite directions canceling the inertia force.

**MC5 5:30 PM - 5:45 PM**

**Fully-Functional Tip-Tilt-Piston Micromirror Array**, V. Milanovic, K. Castelino, *Adriatic Research Institute, Berkeley, CA, USA* and D. T. McCormick, *University of California - Berkeley, Berkeley, CA, USA*

A functional 2x2 array of tip-tilt-piston micromirrors with large deflection angles and large piston range is presented. Control system includes software that allows the user to independently control all available degrees of freedom (tip, tilt, or piston) for each individual device in the array.

**MC6 5:45 PM - 6:00 PM**

**Compact and Stress-Released Piston Tip-Tilt Mirror**, W. Noell, A. Hugi, *University of Neuchatel, Neuchatel, Switzerland*, T. Overstolz, *Centre Suisse d'Electronique et de Microtechnique, Neuchatel, Switzerland*, S. Waldis, *University of Neuchatel, Neuchatel, Switzerland*, R. P. Stanley, *Centre Suisse d'Electronique et de Microtechnique, Neuchatel, Switzerland* and N. F. de Rooij, *University of Neuchatel, Neuchatel, Switzerland*

A compact stress-compensating micromirror design was fabricated and characterized that provides optically flat surfaces and large 3D displacement. Suitable applications are tunable optical-cavity devices (lasers, filters, etc.), beam steerers and scanners, and deformable mirrors.

## Tuesday, 22 August 2006

**8:30 AM - 10:00 AM**

**Session TuA: SPECTROSCOPY**

**Session Chair:** Barry E. Cole, *Honeywell Inc., Plymouth, MN, USA*

**TuA1 8:30 AM - 8:45 AM**

**Micromirror-based Scan Range Enhancement in Fourier-Domain Optical Coherence Tomography**, K. Yu, N. Park, *Seoul National University, Seoul, Korea*, D. Lee and O. Solgaard, *Stanford University, Stanford, CA, USA*

This paper reports on a micromirror-based superresolution technique that can increase the depth scan range of Fourier-domain optical coherence tomography by improving the spectral resolution of grating-based spectrometers with pixelated image sensors.

**TuA2 8:45 AM - 9:00 AM**

**Vertical Resonant Comb Actuators for Fourier Transform Spectroscopy**, C. Ataman and H. Urey, *Koc University, Istanbul, Turkey*

A Fourier Transform Spectrometer is implemented with resonant mode out-of-plane comb actuators which are used as movable diffraction gratings. 106 $\mu\text{m}$  deflection is obtained at 28V in ambient pressure at 1.2KHz for a 3mm clear aperture device.

**TuA3 9:00 AM - 9:15 AM**

**MEMS Scanning Diffraction Grating Spectrometer**, B. Kim, J. Sinibaldi and G. Karunasiri, *Naval Postgraduate School, Monterey, CA, USA*

A new type of grating spectroscopy, using a micromachined scanning grating spectrometer is presented. We achieve resolution of 17-70 nm in the spectroscopy using a HeNe laser as a source.

**TuA4 9:15 AM - 9:30 AM**

**High Fill-Factor Arrays of Flexure Hinge Type Micromirrors for Multi Object Spectroscopy**, S. Waldis, P.-A. Clerc, W. Noell, *University of Neuchatel, Neuchatel, Switzerland*, F. Zamkotsian, *Laboratoire d'Astrophysique de Marseille, Marseille, France*, M. Zickar and N. F. de Rooij, *University of Neuchatel, Neuchatel, Switzerland*

Micromirror arrays have been fabricated dedicated to astronomical instrumentation. The 100x200 $\mu\text{m}^2$  sized micromirrors show an excellent optical surface quality and can be electrostatically tilted by 20°. A system of multiple landing beams have been implemented, which forces uniform tilt angle.

**TuA5 9:30 AM - 9:45 AM**

**A Miniature Michelson Interferometer using Vertical Bragg Mirrors on SOI**, B. Saadany, T. Bourouina, *ESIEE, Noisy-le-Grand Cedex, France*, M. Malak, *Ain Shams University, Cairo, Egypt*, M. Kubota, Y. Mita, *University of Tokyo, Tokyo, Japan* and D. Khalil, *Ain Shams University, Cairo, Egypt*

A novel Michelson Interferometer utilizing Silicon Bragg reflectors is realized. The Bragg mirrors as well as the beam splitter are realized at the same DRIE step. The fabricated interferometer and measured response are presented.

**TuA6 9:45 AM - 10:00 AM**

**Integrated Micro-Displacement Sensor that can Measure Tilting or Linear Motion for an External Mirror**, R. Sawada, *Kyushu University, Fukuoka, Japan*, E. Higurashi, *University of Tokyo, Meguro, Tokyo, Japan*, S. Sanada, D. Chino and I. Ishikawa, *Kyushu University, Fukuoka, Japan*

Developed sensor consists of a VCSEL of 1.5 mm x 1.5 mm x 1 mm that is surrounded by three photodiodes. It can measure the linear distance traveled or the tilting angle for an external mirror. The resolution is good and the measurement range is wide.

**10:00 AM – 10:30 AM**

**COFFEE BREAK**

**10:30 AM - 12:15 PM**

**Session TuB: CHARACTERIZATION**  
**Session Chair: TBD**

**TuB1 10:30 AM - 11:00 AM (Invited)**

**Characterization and Manipulation of Light Confinement in a Microcavity using Scanning Probe Technology**, V. Sandoghdar, *Swiss Federal Institute of Technology Zurich, Zurich, Switzerland*

We will discuss various experiments where high-Q photonic crystal or whispering gallery mode resonators are examined using scanning near-field optical microscopy. Furthermore, we show how a scanning probe can be used to manipulate the flow and confinement of optical energy in microcavities.

**TuB2 11:00 AM - 11:15 AM**

**Opto-Mechanical Chaotic Behaviour of Micron-Scaled On-Chip Resonators**, T. Carmon, M. C. Cross and K. J. Vahala, *California Institute of Technology, Pasadena, CA, USA*

Opto-mechanical vibration of an on-chip oscillator is experimentally excited by radiation-pressure nonlinearity to a regime where oscillation is chaotic. Period-doubling and broad power spectra are measured in spherical- and toroidal-resonators.

**TuB3 11:15 AM - 11:30 AM**

**Impact of Micromirror Seidel Aberrations on Microcavity Spectra**, J. J. Talghader, *University of Minnesota, Minneapolis, MN, USA*

The stress-induced deformation of micromirrors is examined in terms of common Seidel aberrations, and its impact on microcavity spectra is quantified. Tilt, curvature, and astigmatism cause characteristic changes in the spectra, but coma and spherical aberration are often negligible.

**TuB4 11:30 AM - 11:45 AM**

**Stiction-Free Soft Landing for Infrared Thermal Detectors**, Y. Wang and J. J. Talghader, *University of Minnesota, Minneapolis, MN, USA*

A study of electrostatic actuation scheme to minimize stiction for adaptive thermal detectors shows that the needed level of voltage pulse increases if its width is less than the device mechanical response time.

**TuB5 11:45 AM - 12:00 PM**

**Micromirror Integrated with Piezoresistive Rotation Angle Sensor for Measuring Small Signal**, M. Tabata, M. Sasaki and K. Hane, *Tohoku University, Sendai, Miyagi, Japan*

A piezoresistive rotation angle sensor is integrated in a micromirror device. The small signal is successfully measured using the time-modulation method. The accuracy of 0.03 degrees is confirmed. The improved device design is also illustrated.

**TuB6 12:00 PM - 12:15 PM**

**Integrated FET-Polysilicon Micromachining Process for Optical MEMS**, W. D. Cowan, P. J. Resnick, M. Okandan, O. Blum Spahn, D. J. Dagle, *Sandia National Laboratories, Albuquerque, NM, USA* and G. D. Grossetete, *L & M Technologies, Albuquerque, NM, USA*

Co-fabricated transistors in the SUMMIT™ process enable large scale micromirror arrays with practical pin-out. Novel drive circuitry and optical/electrical performance for initial micromirror arrays are described.

**12:15 PM – 2:00 PM**

**LUNCH BREAK**

**2:00 PM - 3:45 PM**

**Session TuC: NANO OPTICS**

**Session Chair:** Harri K. Kopola, *VTT, Oulu, Finland*

**TuC1 2:00 PM - 2:30 PM (Invited)**

**Surface Plasmon Optics**, A. Christ, G. Leveque, H. Fischer, A. Nesci, *Swiss Federal Institute of Technology Lausanne, Lausanne, Switzerland*, S. G. Tikhodeev, *A.M. Prokhorov General Physics Institute RAS, Moscow, Russia* and O. J. F. Martin, *Swiss Federal Institute of Technology Lausanne, Lausanne, Switzerland*

We study the optical properties of novel metal nanostructures supporting localized and delocalized surface plasmon modes at optical frequencies. Integration of these nanostructures with MEMS for new applications are discussed.

**TuC2 2:30 PM - 2:45 PM**

**Movable Guided-Mode Resonant Grating Filters by Four Bimorph Actuators for Wavelength Selective Dynamic Reflection Control**, Y. Kanamori, T. Kitani and K. Hane, *Tohoku University, Sendai, Miyagi, Japan*

We successfully fabricate a wavelength selective variable reflection filter driven by four bimorph actuators. As the filter, a two-dimensional doubly periodic guided-mode resonant grating filter is employed for the first time.

**TuC3 2:45 PM - 3:00 PM**

**Nanoimprint Patterned Aluminum Photonic Grating for Refractive Index Measurement**, J. L. Skinner, L. L. Hunter, A. A. Talin, *Sandia National Laboratories, Livermore, CA, USA*, J. Provine, *University of California - Berkeley, Berkeley, CA, USA* and D. A. Horsley, *University of California - Davis, Davis, CA, USA*

The first reported square array of subwavelength holes patterned with nanoimprint lithography in an aluminum film is presented. Optical modes vary linearly with the refractive index of the fluid in contact with the aluminum grating.

**TuC4 3:00 PM - 3:15 PM**

**A Photonic Crystal Waveguide Switch with a Movable Bridge Slab**, K.-I. Umemori, Y. Kanamori, and K. Hane, *Tohoku University, Sendai, Miyagi, Japan*

A photonic crystal waveguide switch with a movable slab was fabricated by silicon micromachining. Driving the switching slab with an electrostatic micro-electro-mechanical actuator, the transmission between the waveguides was modulated. The switching characteristics were explained by the calculation results using the finite-difference time-domain method.

**TuC5 3:15 PM - 3:30 PM**

**Fabrication and Testing of Nano-Photonic Quantum Dot Waveguides**, C.-J. Wang, B. A. Parviz and L. Y. Lin, *University of Washington, Seattle, WA, USA*

We present test results for straight and corner nanophotonic waveguides constructed from colloidal quantum dots. Elevated signal levels compared to control measurements on the substrate are observed across devices of 20 $\mu$ m transmission length.

**TuC6 3:30 PM - 3:45 PM**

**CMOS-compatible Biological Surface Plasmon Resonance Nanosensor**, J. Y. Chyan, *National Tsing Hua University, Hsinchu, Taiwan, R.O.C.*

A CMOS-compatible chemical and biological SPR nanosensor is reported. It can be integrated with other electronic circuits using standard CMOS process to receive signals and to perform signal processing on one chip.

**3:45 PM – 4:00 PM**

**COFFEE BREAK**

## **Madison**

**4:00 PM - 6:00 PM**

**Session P: POSTER SESSION**

**P1 Design and Fabrication of Optical MEMS Modulators with Silicon Wire Waveguide**, A. Higo, H. Fujita and H. Toshiyoshi, *University of Tokyo, Meguro-ku, Tokyo, Japan*

This paper presents design and theoretical analysis of a silicon optical waveguide modulator with an electrostatic micromechanical structure actuated in the evanescent range over a silicon wire waveguide.

**P2 High Fill-Factor Paraboloidal Microlens Arrays**, S.-I. Chang, J.-H. Lee, and J.-B. Yoon, *Korea Advanced Institute of Science and Technology, Daejeon, Korea*

A fabrication method for a high fill-factor MLA with paraboloidal profiles using a 3-D diffuser lithography was proposed. The profiles of the fabricated microlenses fit very well with the ideal parabolic profiles.

**P3 Characteristics of Buckled Bridges and Lifted Micromirror using Film Stress**, M. Sasaki, K. Hane, *Tohoku University, Sendai, Miyagi, Japan*, D. Briand, W. Noell and N. F. de Rooij, *University of Neuchatel, Neuchatel, Switzerland*

Bridges buckled by the film stress are useful for realizing three-dimensional structures. We have reported that its deflection agrees with an approximate model. The detailed characteristics of the bridge and the lifted micromirror are examined.

**P4 Design and Fabrication of a MEMS X-ray Optic using Anisotropic Wet Etching of Si Wafers**, M. Koshiishi, Y. Ezoe, *ISAS/JAXA, Sagamihara, Kanagawa, Japan*, M. Mita, *Japan Aerospace Exploration Agency, Sagamihara, Kanagawa, Japan*, K. Mitsuda, *ISAS/JAXA, Sagamihara, Kanagawa, Japan*, T. Takano, R. Maeda, *National Institute of Advanced Industrial Science & Technology, Tsukuba, Ibaraki, Japan* and Y. Ishisaki, *Tokyo Metropolitan University, Hachioji, Japan*

We report on our development of X-ray optics using anisotropic wet etching on silicon wafers. Both X-ray mirrors and an optics mount are fabricated fully using MEMS technologies.

**P5 Electrostatically-tuned Optical Filter Based on Silicon Bragg Reflectors**, B. Saadany, *ESIEE, Noisy-le-Grand Cedex, France*, M. Malak, *Ain Shams University, Cairo, Egypt*, F. Marty, *ESIEE, Noisy-le-grand, France*, Y. Mita, *University of Tokyo, Tokyo, Japan*, D. Khalil, *Ain Shams University, Cairo, Egypt* and T. Bourouina, *ESIEE, Noisy-le-Grand Cedex, France*

A Tunable Fabry-Perot cavity composed of two Bragg mirrors is realized using enhanced DRIE process. Filter tuning is achieved by moving one of the mirrors using SOI electrostatic parallel plate fine step actuation. Measured filter response in c&L bands is presented.

**P6 Tailored Stress in InP/GaNAs Layers for InP/Air-Gap DBR-Filters with Photonic Crystals**, T. Kusserow, D. Nethaji, H. Hillmer, *University of Kassel, Kassel, Germany*, T. Nakamura, T. Hayakawa, and V. Balasubramanian, *Canare Electric Co. Ltd., Nagoya, Aichi, Japan*

Residual stress in freestanding InP cantilevers is investigated to improve the performance of multiple InP-membrane/air-gap structures with photonic crystals. Stress compensation was achieved by evaluation of several samples with increasing compensation layer thickness.

**P7 Calibration Procedure of a Multifibre Sensor for Density Measurement inside the Battery**, A. M. Cao y Paz and J. Marcos Acevedo, *University of Vigo, Vigo, Spain*

A multifibre optic sensor was developed in order to measure the battery electrolyte density at several heights. In this paper, the sensor calibration procedure is presented after temperature compensation on the optoelectronic components.

**P8 Non-Contact Bias Voltage Measurement on Analog Microelectronic Circuits via a Special Side-Electrode-Equipped Electro-Optic Tip**, W.-K. Kuo and J.-Y. Kuo, *National Formosa University, Yunlin, Taiwan, R.O.C.*

We propose a method to extend the non-contact electro-optic probing technique to measure bias voltages on analog microelectronic circuits. An example circuit was tested and the result has a good agreement with actual value.

**P9 An All Silicon Micro-Machined Add-Drop Optical Filter**, B. Saadany, *ESIEE, Noisy-le-Grand Cedex, France*, D. Khalil, M. Malak, *Ain Shams University, Cairo, Egypt*, M. Kubota, *University of Tokyo, Tokyo, Japan*, F. Marty, *ESIEE, Noisy-le-grand, France*, Y. Mita, *University of Tokyo, Tokyo, Japan* and T. Bourouina, *ESIEE, Noisy-le-Grand Cedex, France*

A tilted 45° Bragg mirror acts as a wavelength selective reflector. This allows for the add and drop of the desired wavelengths simultaneously. The Bragg mirrors are realized by DRIE of the Silicon substrate thus producing successive vertical Si/Air interfaces. The fabricated device and measured results are presented.

**P10 Design and Characterization of MEMS Micromirrors for Ion Trap Quantum Computation**, C. Kim, C. Knoernschild, B. Liu and J. Kim, *Duke University, Durham, NC, USA*

Realization of large scale quantum computers based on atomic systems requires optical integration technologies. We design and characterize beam shifting optical elements using micromirrors targeted for quantum computers based on ion traps or neutral atoms.

**P11 Rotary Comb Drive Actuator with an Optical Fiber Encoder**, S. Nagao, F. Oohira, M. Hosogi, and G. Hashiguchi, *Kagawa University, Takamatsu, Kagawa, Japan*

We propose the rotary type electrostatic comb drive actuator with a sensor scale for an optical fiber encoder. This actuator can be expected to measure the amount of the movement of the actuator precisely by using the optical fiber encoder.

**P12 A Liquid Crystal Droplet Lens Driven by Dielectric Force**, C.-C. Cheng, *National Tsing Hua University, Hsinchu, Taiwan, R.O.C.*

A focus tunable dielectric liquid droplet lens was demonstrated using a liquid crystal droplet and concentric electrodes. This lens was a shape-changed lens with a tuning ratio of 16% in the range of 200V.

**P13 Digital Optical 1xN MEMS Switch Utilizing Microassembled Rotating Micromirror**, M. A. Basha, *University of Waterloo, Waterloo, ON, Canada*, N. Dechev, *University of Victoria, Victoria, BC, Canada*, S. Safavi-Naeini and S. Chadhuri, *University of Waterloo, Waterloo, ON, Canada*

We present a new novel design for 1xN digital optical space MEMS switch. The switch consists of a rotating micromirror. The rotating micromirror consists of a novel electro-static rotary motor, onto which a 3D mirror structure is assembled using a robotic-based microassembly process.

**P14 Gimbaled 2D Scanning Mirror with Vertical Combs for Laser Display**, Y.-C. Ko, J.-H. Lee, J.-W. Cho, Y.-H. Park, J.-O. Kim, J. Sunu, *Samsung Advanced Institute of Technology, Suwon, Korea* and J.-B. Yoo, *Sungkyunkwan University, Suwon, Korea*

We designed a gimbaled 2D scanning mirror (GSM) which is driven electrostatically by vertical comb fingers. The horizontal scanning mirror with a diameter of 1mm is rotating with respect to y-axis in the eye-shaped frame. For vertical scanning, the eye-shaped frame is rotating with respect to x-axis.

**P15 A Large Rotation Angle Electrothermal Micromirror with Integrated Platinum Heater**, L. Wu and H. Xie, *University of Florida, Gainesville, FL, USA*

We report a single-crystal-silicon electrothermal micromirror with an integrated platinum heater. A large rotation angle of 124° has been achieved at a dc voltage of 12.5 V. The resonant frequency of the device is 336 Hz.

**P16 Micromirror with Thin Film Torsion Bar and Vertical Comb using Tensile Poly-Si**, M. Fujishima, M. Sasaki and K. Hane, *Tohoku University, Sendai, Miyagi, Japan*

A micromirror device is developed using the tensile poly-Si film for realizing the thin film torsion bar and the vertical comb. The crystallization of amorphous Si generates the tensile stress. The temperature characteristics is stabilized.

**P17 Light Emission by Dislocations in Silicon**, M. Reiche, *Max Planck Institute for Microstructure Physics, Halle, Germany*, M. Kittler, *IHP Microelectronics, Frankfurt, Germany*, T. Wilhelm, *Max Planck Institute for Microstructure Physics, Halle, Germany*, T. Arguirov, *IHP/BTU Joint Lab, Cottbus, Germany*, W. Seifert and X. Yu, *IHP Microelectronics, Frankfurt, Germany*

Different approaches for Si-based light emitters were studied. The D band emission of dislocations formed by wafer bonding is a promising candidate for spatially confined emitters at  $1.3 \mu\text{m} \leq \lambda \leq 1.5 \mu\text{m}$ .

**P18 Thermo-Mechanical Detector Array with Optical Readout**, H. Torun, *Georgia Institute of Technology, Atlanta, GA, USA*, O. Ferhanoglu and H. Urey, *Koc University, Istanbul, Turkey*

An uncooled thermal detector array with low NETD is designed and fabricated using MEMS bimaterial structures that bend in response to thermal change. A diffraction grating placed underneath each pixel allows sensing sub-nm mechanical deflections.

**P19 In-Line Fiber Optic Chemical Sensor with Gold Coated, Self-Aligned Epoxy Waveguide**, S.-S. Yun and J.-H. Lee, *Kwang-Ju Institute of Science and Technology, Gwangju, Korea*

We describe a low cost, simply fabricated in-line fiber optic chemical sensor with gold coated, self-aligned epoxy waveguide for sensing the concentration of chemical solutions.

**P20 Large Displacement Deformable Mirrors Made by Low Stress Polyimide Membrane**, W.-W. Yeh, C.-W. Chiu and G.-D. Su, *National Taiwan University, Taipei, Taiwan, R.O.C.*

The paper describes the design and fabrication of a micro-electro-mechanical systems (MEMS) deformable mirror made by a compliant organic thin film. The residual stress and Young's modulus of a polymer film are measured and discussed. The deformation as large as  $41 \mu\text{m}$  is achieved by electrostatic force with 170 V applied.

**P21 Micromechanic Effects and their Impact on the Characteristics of MEMS-tunable Lasers**, H. Halbritter, C. Sydlo, B. Koegel, *Darmstadt University of Technology, Darmstadt, Germany*, F. Riemenschneider, *Two-Chip Photonics, Darmstadt, Germany*, S. Jatta, H. L. Hartnagel and P. Meissner, *Darmstadt University of Technology, Darmstadt, Germany*

The impact of micromechanic effects, e.g. thermal noise and radiation pressure on the performance of MEMS-tunable lasers are studied in theory and verified for the first time by the parameters linewidth and chirp.

**P22 High-Reflectivity Two-Axis Vertical Comb Drive Microscanners for Confocal Imaging Applications**, K. Kumar, K. Hoshino, *University of Texas at Austin, Austin, TX, USA*, H.-J. Shin, R. R. Richards-Kortum, *Rice University, Houston, TX, USA* and J. X. J. Zhang, *University of Texas at Austin, Austin, TX, USA*

We present  $500 \times 700 \mu\text{m}$  metal-coated scanning micromirrors fabricated from bonded SOI-Si wafers with  $\sim 90\%$  reflectivity at 633nm. Confocal images with  $1 \mu\text{m}$  resolution were generated using single axis actuation of  $\pm 2.5$  deg. at 1.87 KHz.

**P23 Monolithic Bi-directional Linear Microactuator for Light Beam Manipulation**, H.-D. Cheng, S.-Y. Hsiao, M. Wu and W. Fang, *National Tsing Hua University, Hsinchu, Taiwan, R.O.C.*

This study monolithically fabricates a bi-directional linear microactuator on SOI wafer. The actuator is driven by both thermal and magnetic means. This actuator provides  $\pm 44$  microns and  $\pm 53$  microns displacements in the in-plane and out-of-plane directions, respectively.

**P24 Plastic-Type OPLEAF as High Density Fiber Array for Minimized Lateral Device Spacing Optical ICs**, T. Sonobe, N. Hiroi, *Namiki Precision Jewel Co., Ltd., Tokyo, Japan*, M. Takenaka, Y. Nakano and H. Fujita, *University of Tokyo, Meguro, Tokyo, Japan*

We have developed an OPLEAF that serves as the interface between optical fibers and a high density optical IC. Improved from our previous report in which a plastic type of OPLEAF has fabricated for cheap and mass production.

**P25 Optical Switch using Thermo-Optic Effect of Micromachined Silicon Hemispheres**, A. Liu, T. Zhong, X. Zhang, *Nanyang Technological University, Singapore* and J. Li, *Institute of Microelectronics, Singapore*

A new optical switching design using a pair of micromachined silicon hemispheres by means of thermo-optic effect and total internal reflection, obtaining modulation depths of 89.2% and 89.8% for two output states, respectively.

**P26 Micromirror Array of Monocrystalline Silicon**, T. Bakke, B. Völker, M. Friedrichs and D. Rudloff, *Fraunhofer-Institut, Dresden, Germany*

A  $240 \times 281$  array of micromirrors made of monocrystalline silicon is presented. The absence of stress gradients makes it possible to achieve mirrors of unsurpassed planarity and the high elasticity of silicon allows creep free actuation.

**P27 Silicon-Based On-Chip Micromirrors for DWDM Wavelength-Selective Crossconnects**, C.-H. Chi, C. Hou, *University of California - Berkeley, Berkeley, CA, USA*, C.-H. Lee, *National Chiao Tung University, Hsinchu, Taiwan, R.O.C.*, D. Hah, *Louisiana State University, Baton Rouge, LA, USA* and M. C. Wu, *University of California - Berkeley, Berkeley, CA, USA*

We report on a silicon-based on-chip micromirror array for monolithic wavelength-selective crossconnects. The  $75\text{-}\mu\text{m}$  mirror pitch matches to the DWDM grids with 100 GHz spacing. A maximum mechanical scan angle of 6.5 degree has been achieved.

**P28 A Micromirror with Large Static Rotation and Piston Actuation**, C.-F. Kuo, J.-C. Chiou, Y. J. Lin and H.-P. D. Shieh, *National Chiao Tung University, Hsinchu, Taiwan, R.O.C.*

A micromirror with large static rotation and piston actuation is developed. Experiment result had indicated that the micromirror could achieve  $\pm 12.5$  degree rotation angle and  $45 \mu\text{m}$  vertical displacement.

**P29 Extended Tuning Range Fabry-Perot Etalon with Doubly-Supported Beam Actuators**, J. Milne, *University of Western Australia, Perth, WA, Australia*, J. M. Dell, *University of Western Australia, Crawley, WA, Australia*, A. Keating, *University of Western Australia, Perth, Australia* and L. Faraone, *University of Western Australia, Crawley, WA, Australia*

A MEMS based Fabry Perot etalon that uses doubly-supported beams for actuation is shown to have a wider tuning range than conventional designs using parallel plates.

**P30 Individually Tunable Silicon Bragg Reflectors**, F. B. Kone and Y.-A. Peter, *École Polytechnique de Montreal, Montreal, QC, Canada*

We introduce an innovative design of a tunable optical filter. The design constitutes of a vertical Bragg grating microfabricated in the device layer of a silicon-on-insulator wafer and whose silicon walls can be independently operated to select the desired response of the filter. Design concept and detailed microfabrication process are presented.

**P31 Characterization of Silicon Nitride Micromachined Beams via Remote Optical Interrogation**, A. Shelton, *North Carolina State University, Raleigh, NC, USA*

We demonstrate that mechanical characterization of the motion of micromachined double-clamped silicon nitride beams is possible via remote optical interrogation. Using Fabry-Perot interferometry, information about the absolute displacement and resonant frequency of various mechanical modes is determined.

**P32 Integration of SOI and SU-8 in a Surface-Micromachining-like Process and Its Application in Micro-Optical Systems**, Y. Chiu, C.-W. Wu, Z.-W. Zhuang, J.-C. Chiou, and H.-P. D. Shieh, *National Chiao Tung University, Hsinchu, Taiwan, R.O.C.*

This paper reports a novel surface-micromachining-like process to integrate SU-8 on Silicon-On-Insulator (SOI) substrates. The single-crystalline SOI device layer and transparent SU-8 are ideal for the integration of opto-mechanical structures, photo detectors, and signal processing circuits. Devices in a micro optical bench for data storage applications are demonstrated.

**P33 Electrowetting-Based Total Internal Reflection Chip for Optical Switch and Display**, H. C. Hu, *National Applied Research Laboratory, Hsinchu, Taiwan, R.O.C.*

We present a novel electrowetting-based TIR micro chip for optical switch and display. Utilize the total internal reflection (TIR) occurs inside micro droplet, we can control the droplet curve by electrowetting to determinate light pass through or not.

**P34 A Fabrication Method for Micro/Nanostructures**, S.-M. Seo, T.-I. Kim, and H. H. Lee, *Seoul National University, Seoul, Korea*

A simple fabrication method is presented that can be used to form imbedded and inverted micro/nanostructures that cannot be readily built by other methods. The technique is applied to fabricating organical light-emitting diodes.

**P35 A New Method for Microlens Fabricated by a Heating Compressed Air Process**, C. Tsou and C. Lin, *Feng Chia University, Taichung, Taiwan, R.O.C.*

This paper reports a new method to fabricate microlens molding on silicon substrate by a heating compressed air process. The fabrication provides an alternative way to manufacture microlens molding with good surface roughness.

## Wednesday, 23 August 2006

**8:30 AM - 10:00 AM**

**Session WA: ADAPTIVE OPTICS**

**Session Chair:** Scot S. Olivier, *Lawrence Livermore National Laboratory, Livermore, CA, USA*

**WA1 8:30 AM - 8:45 AM**

**Two Dimensional MEMS Piston Array for DUV Optical Pattern Generation**, D. Lopez, *Lucent Technologies, Murray Hill, NJ, USA*

We describe the design, fabrication and dynamics of a two dimensional array of MEMS piston mirrors that fulfill the requirements needed to modulate Deep Ultraviolet radiation for maskless pattern generation.

**WA2 8:45 AM - 9:00 AM**

**Spatial Light Modulators for Maskless Lithography**, I. W. Jung, J.-S. Wang and O. Solgaard, *Stanford University, Stanford, CA, USA*

We present a piston-type SLM (spatial light modulator) as a programmable pattern generator for maskless lithography. Large arrays of up to 40,000 mirrors with 20 $\mu$ m pixels have been fabricated. Using the SLM in a simple imaging system, we demonstrate the generation of aerial images of dark line patterns.

**WA3 9:00 AM - 9:15 AM**

**Single-Crystal-Silicon Continuous Membrane Deformable Mirror Array for Adaptive Optics**, I. W. Jung, *Stanford University, Stanford, CA, USA*, Y.-A. Peter, *École Polytechnique de Montreal, Montreal, QC, Canada*, E. J. Carr, *Lawrence Livermore National Laboratory, Livermore, CA, USA*, J.-S. Wang and O. Solgaard, *Stanford University, Stanford, CA, USA*

We present a single-crystal-silicon continuous membrane deformable mirror array with applications as a corrective adaptive optics element for space-based telescopes. The continuous membrane is made from a thin SOI layer with good optical surface quality and is able to deform locally by 125nm at 100V with resonance frequency of 25kHz.

**WA4 9:15 AM - 9:30 AM**

**MEMS Mirror Arrays for Adaptive Optics Applications**, O. Blum Spahn, W. D. Cowan, D. J. Dagel, P. J. Resnick, B. Jokiel, *Sandia National Laboratories, Albuquerque, NM, USA* and G. D. Grossetete, *L & M Technologies, Albuquerque, NM, USA*

A high fill-factor 61-element array containing 0.5 mm hexagonal mirrors that tip, tilt and piston with a 27 micron stroke has been fabricated in SUMMiT V technology. Design, fabrication and performance will be discussed.

**WA5 9:30 AM - 9:45 AM**

**Piezoelectric Deformable MEMS Mirror for Adaptive Optics Composed of PZT Thin Films**, I. Kanno, *Kyoto University, Kyoto, Japan*

We fabricated the piezoelectric-driven deformable mirror composed of a piezoelectric PZT film deposited on a SOI substrate. The large displacement more than 5µm was obtained by the application of low voltage of 10V.

**WA6 9:45 AM - 10:00 AM**

**Nanolaminate Deformable Mirrors**, A. P. Papavasiliou, *Lawrence Livermore National Laboratory, Livermore, CA, USA*

Deformable mirrors with nanolaminate foil mirror surfaces and electrostatic actuators are being developed to provide optical correction over a wide range of size scales.

**10:00 AM – 10:30 AM**

**COFFEE BREAK**

**10:30 AM - 12:30 PM**

**Session WB:** MICROSCOPY

**Session Chair:** Ming C. Wu, *University of California – Berkeley, Berkeley, CA, USA*

**WB1 10:30 AM - 11:00 AM (Invited)**

**Analyses of Functions and Interactions of Protein Molecules by Single Fluorescent Molecular Imaging**, T. Funatsu, *University of Tokyo, Tokyo, Japan*

Single-molecule imaging is a useful technique for analyzing functions and interactions of protein molecules. We visualized protein folding assisted by chaperonin GroEL. And we are developing a biomolecular sorter using a thermosensitive polymer as microvalve.

**WB2 11:00 AM - 11:15 AM**

**A MEMS based Optical Coherence Tomography Imaging System and Optical Biopsy Probes for Real-Time, High Resolution In-Vivo and In-Vitro 2-D or 3-D Imaging**, D. T. McCormick, *University of California - Berkeley, Richmond, CA, USA*, W. Jung, Y.-C. Ahn, *University of California - Irvine, Irvine, CA, USA*, V. Milanovic, *Adriatic Research Institute, Berkeley, CA, USA*, Z. Chen, *University of California - Irvine, Irvine, CA, USA* and N. C. Tien, *Case Western Reserve University, Cleveland, OH, USA*

A fully-functional, high resolution, real-time "optical biopsy" system realized via MEMS based optical coherence tomography (OCT) systems is presented. Artifact free imaging speeds of 33µs per voxel have been achieved while imaging a 1.4mm x 1.4mm x 1.4mm region with 5µm x 5µm x 5µm sampling resolution (SD-OCT system.)

**WB3 11:15 AM - 11:30 AM**

**MEMS Based Dual-axes Confocal Reflectance Handheld Microscope for *in vivo* Imaging**, W. Piyawattanametha, J. T. C. Liu, M. J. Mandella, H. Ra, L. K. Wong, P.-L. Hsiung, T. D. Wang, G. S. Kino and O. Solgaard, *Stanford University, Stanford, CA, USA*

We demonstrate a MEMS based dual-axes confocal reflectance microscope in a 10-mm diameter handheld package with image acquisition rate of 30 frames/second. The FWHM transverse and axial resolutions are 8 µm and 10 µm, respectively.

**WB4 11:30 AM - 11:45 AM**

**Dual-Axes Confocal Fluorescence Microscopy with a Two-Dimensional MEMS Scanner**, H. Ra, W. Piyawattanametha, Y. Taguchi and O. Solgaard, *Stanford University, Stanford, CA, USA*

We present the first dual-axes confocal fluorescence imaging system based on a two-dimensional MEMS scanner. Fluorescence images with a transverse resolution of 5.63µm are acquired at 8 frames per second.

**WB5 11:45 AM - 12:00 PM**

**Endoscopic Microprobe with a LVD Microlens Scanner for Confocal Imaging**, A. Jain and H. Xie, *University of Florida, Gainesville, FL, USA*

We report a large-vertical-displacement (LVD) microlens-scanner packaged inside a 5-mm diameter endoscopic probe for confocal microscopy. The LVD microscanner can vertically displace the focal length of the integrated polymer microlens by 0.7mm at 23V.

**WB6 12:00 PM - 12:15 PM**

**Focus Tracking in Time Domain Optical Coherence Tomography using Membrane Mirrors Operated Near Snap-Down**, D. L. Dickensheets, M. Overcast, P. A. Himmer, *Montana State University, Bozeman, MT, USA*, A. Vitkin and V. Yang, *University of Toronto, Toronto, ON, Canada*

We describe MEMS membrane mirrors for dynamic focus tracking in time-domain OCT. We demonstrate stable, distortion-compensated nearly sinusoidal motion at 10 kHz at an amplitude of ~50% of the air gap.

**WB7 12:15 PM - 12:30 PM**

**Multi-Probe SPM using Fringe Patterns for a Parallel Nano Imaging**, H. Koyama, F. Oohira, M. Hosogi, and G. Hashiguchi, *Kagawa University, Takamatsu, Kagawa, Japan*

This paper proposes multi-probe SPM using fringe patterns which is able to measure the large area. The composition of the chip accumulates 50,000 probes to the area of 5mm x 5mm. We fabricate the multi probes, and using the chip, the fringe patterns could be taken an image with the CCD camera.

**12:30 PM – 2:00 PM**

**LUNCH BREAK**

**2:00 PM - 3:15 PM**

**Session WC:** MICROFLUIDICS

**Session Chair:** George Barbastathis, *Massachusetts Institute of Technology, Cambridge, MA, USA*

**WC1 2:00 PM - 2:30 PM (Invited)**

**Optofluidics**, D. Psaltis, *California Institute of Technology, Pasadena, CA, USA*

Optofluidics refers to a class of adaptive optical circuits that integrate optical and fluidic devices. Familiar examples include liquid crystals and dye lasers. The introduction of liquids in the optical structure enables flexible fine-tuning and reconfiguration of circuits so they can perform tasks optimally in a changing environment. I will discuss how the emergence of fluidic transport technologies at the micron and nanometer levels opens possibilities for novel adaptive optical devices.

**WC2 2:30 PM - 2:45 PM**

**Light-Actuated Push/Pull Manipulation of Liquid Droplets**, F. Krogmann, H. Qu, W. Moench and H. Zappe, *University of Freiburg, Freiburg, Germany*

An opto-electrowetting system allowing both pushing and pulling a droplet is presented for the first time. Experimentally demonstrated and described theoretically, the technique allows new flexibility in the design of freely reconfigurable two-dimensional liquid micro-lens arrays.

**WC3 2:45 PM - 3:00 PM**

**Thermal Characterization of Liquid Core Optical Ring Resonators**, J. D. Suter, I. M. White, H. Zhu and X. Fan, *University of Missouri, Columbia, MO, USA*

We have investigated experimentally and theoretically the temperature dependence of the liquid core optical ring resonator (LCORR) for development of label-free lab-on-a-chip optical bio/chemical sensors.

**WC4 3:00 PM - 3:15 PM**

**Thermo-Pneumatically Actuated, Membrane-based Micro-Mirrors**, A. Werber and H. Zappe, *University of Freiburg, Freiburg, Germany*

Thermo-pneumatically actuated, membrane-based micro-mirrors providing a large range in tilting motion, with angles up to 13°, and piston motion with strokes up to 80 µm are presented. Single mirrors as well as mirror arrays are realizable.

## Thursday, 24 August 2006

**9:00 AM - 11:00 AM**

**Session ThA:** COMMUNICATIONS

**Session Chair:** Norman C. Tien, *Case Western Reserve University, Cleveland, OH, USA*

**ThA1 9:00 AM - 9:30 AM (Invited)**

**Wavelength Filter with Integrated Thermal Control used as an Intracavity DWDM Laser Tuning Element**, M. McDonald, A. Daiber, M. Finot and S. Xu, *Intel Corporation, Newark, CA, USA*

A thermally tuned Si filter placed within an external cavity semiconductor laser enables full-band tuning that meets all requirements for deployment in DWDM telecommunication systems.

**ThA2 9:30 AM - 9:45 AM**

**A Reconfigurable Optical Demultiplexer based on a MEMS Deformable Blazed Grating**, C. Antoine, X. Li, J.-S. Wang and O. Solgaard, *Stanford University, Stanford, CA, USA*

The operation of a cyclic reconfigurable opticalwavelength multiplexer/demultiplexer based on a micromachinedtunable blazed grating (TBG) is introduced and a 1x3demultiplexer is experimentally demonstrated in the C-band.

**ThA3 9:45 AM - 10:00 AM**

**A 3D Optical Crossconnect using Microlens Scanner with Topologically Layer Switching Architecture**, K. Takahashi, *University of Tokyo, Meguro, Tokyo, Japan*, H. N. Kwon, *Kwang-Ju Institute of Science and Technology, Gwangju, Korea*, M. Mita, *Japan Aerospace Exploration Agency, Sagami, Kanagawa, Japan*, K. Saruta, *University of Tokyo, Tokyo, Japan*, J.-H. Lee, *Kwang-Ju Institute of Science and Technology, Gwangju, Korea*, H. Fujita and H. Toshiyoshi, *University of Tokyo, Meguro, Tokyo, Japan*

We report a 3-dimensional optical crossconnect using microlens scanners with double-deck XY-stage by layer switching technique and a telescope system to amplify the optical angle, and optical coupling loss of 13.8 dB was obtained.

**ThA4 10:00 AM - 10:15 AM**

**Wavelength-Selective 1x4 Switch for Switching Groups of 8 Channels with a Linked Micromirror Array**, D. Marom, *Hebrew University of Jerusalem, Jerusalem, Israel*, D. Lopez, F. Pardo, F. P. Klemens, E. Bower, E. Ferry and V. A. Aksyuk, *Lucent Technologies, Murray Hill, NJ, USA*

A modified MEMS micromirror array with linked mirrors is utilized for switching groups of 8 WDM channels simultaneously. The solution requires few high-voltage driving circuits, and mitigates the mirror curvature issue that would arise had large mirrors have been used.

**ThA5 10:15 AM - 10:30 AM**

**Polarization Control via Tunable Nano-Structures in PDMS**, B. Wilson and L. Y. Lin, *University of Washington, Seattle, WA, USA*

We propose a compact and low-cost design for polarization control using tunable form-birefringence on PDMS nanostructures fabricated by Nano-Imprint Lithography (NIL). The operation principle is demonstrated in a fabricated device by changing the nanostructure electrostatically.

**ThA6 10:30 AM - 10:45 AM**

**Deep-Trench Vertical Si Photodiode Towards Active-Device Integrated OMEMS**, K. Hirose, Y. Mita, M. Kubota and T. Shibata, *University of Tokyo, Tokyo, Japan*

This paper proposes to integrate "active electro-optical devices" on the Deep-Etched vertical walls. Vertical photodiodes were fabricated on the 40 $\mu$ m-deep trench sidewalls and showed 20 to 100% of efficiency improvement.

**ThA7 10:45 AM - 11:00 AM**

**>1GHz Optically Excited Vibrations of a Micron-Scale On-Chip Sphere**, T. Carmon and K. J. Vahala, *California Institute of Technology, Pasadena, CA, USA*

>1GHz optically-induced vibrations are demonstrated in an on-chip micron-scaled device in which radiation pressure of a (CW) optical input pushes the structure to mechanically oscillate. Many mechanical eigen-modes are investigated.

**END OF PROGRAM**