

# Advance Program

## Monday, 13 August 2007

**08.30 - 10.00**

**Session PLE:** **PLENARY SESSION**  
**Session Co-Chairs:** Chennupati Jagadish, *Australian National University, Canberra, ACT, Australia*  
 Minoru Sasaki, *Toyota Technological Institute, Nagoya, Aichi, Japan*

**PLE1 08.30 - 09.00**
**Concepts of Nanophotonic Devices and Fabrications**, M. Ohtsu, *University of Tokyo, Tokyo, Japan*

Nanophotonics utilizes the optical near field that mediates the interaction between nanometric particles. To realize qualitative innovation for future optical technology, this presentation reviews novel devices, fabrications, and systems.

**PLE2 09.00 - 09.30**
**Combination of MEMS and Microoptics for New Applications**, A. Bräuer, P. Schreiber, J. Duparré, B. Hoefer and P. Dannberg, *Fraunhofer-Institut, Jena, Germany*

ABSTRACT NOT AVAILABLE

**PLE3 09.30 - 10.00**
**Photonic Band Gap Materials: Engineering Light-Matter Interactions**, S. John, *University of Toronto, Toronto, ON, Canada*

I review recent approaches to micro-fabrication of PBG materials through optical phase mask lithography. I describe their applications to all-optical switching through coherent resonant interaction with quantum dots. I also discuss the possibility of electromagnetically induced exciton mobility in a PBG quantum well hetero-structure.

**10.00 – 10.30**
**COFFEE BREAK**
**10.30 - 12.00**

**Session MA:** **MEDICAL AND BIO SENSING**  
**Session Chair:** Hans Zappe, *University of Freiburg, Freiburg, Germany*

**MA1 10.30 - 11.00 (Invited)**
**Wearable Laser Blood Flowmeter for Ubiquitous Healthcare Service**, T. Kiyokura, N. Tatara, J. Shimada and T. Haga, *NTT Corporation, Atsugi-shi, Kanagawa, Japan*

We have fabricated a wearable laser blood flowmeter that is functionally the same as a conventional desktop laser blood flowmeter. Its ability to continuously monitor changes in blood flow makes it very useful for preventive medical care.

**MA2 11.00 - 11.15**
**A Portable Two-Photon Fluorescence Microendoscope based on a Two-Dimensional Scanning Mirror**, W. Piyawattanametha, E. D. Cocker, R. P. J. Barretto, J. C. Jung, B. A. Flusberg, H. Ra, O. Solgaard and M. J. Schnitzer, *Stanford University, Stanford, CA, USA*

Towards overcoming the size limitations of conventional two-photon fluorescence microscopy for brain imaging in freely moving mice, we introduce a miniaturized and portable laser-scanning microendoscope based on a microelectromechanical systems (MEMS) two-dimensional (2-D) scanner, compound gradient refractive index micro-lenses, and a photonic bandgap fiber.

**MA3 11.15 - 11.30**
**Tunable Endoscopic MEMS-Probe for Optical Coherence Tomography**, K. Aljaseem, A. Werber and H. Zappe, *University of Freiburg, Freiburg, Germany*

A novel, miniaturized endoscopic MEMS probe based on a pneumatically-actuated tunable microlens is presented. The MEMS-probe is integrated into optical coherence tomography system to improve its performance for in-vivo applications.

**MA4 11.30 - 11.45**
**Forward-Imaging Swept Source Optical Coherence Tomography using Silicon MEMS Scanner for High-Speed 3-D Volumetric Imaging**, K. Kumar, J. C. Condit, *University of Texas at Austin, Austin, TX, USA*, A. McElroy, N. J. Kemp, *CardioSpectra, Inc., San Antonio, TX, USA*, K. Hoshino, T. E. Milner and X. Zhang, *University of Texas at Austin, Austin, TX, USA*

Swept Source 3-D OCT of biological specimens is demonstrated using miniaturized forward-imaging probe incorporating 2-axis silicon microscanner with ~95% reflectivity. Tomographic, en face views of 2mm×1mm×4mm volume with 12.5µm×12.5µm×10µm resolution are acquired at 8million voxels/sec.

**MA5 11.45 - 12.00**
**Miniaturized Optical Viscosity Sensor based on a Laser-induced Capillary Wave**, Y. Taguchi, A. Ebisui and Y. Nagasaka, *Keio University, Yokohama, Kanagawa, Japan*

A novel micro optical viscosity sensor (MOVS) by laser-induced capillary wave method enabling us non-contact, short-time (nano-second order), and small sample volume (micro-litter order) in situ / in vivo measurement, is reported in this paper.

**12.00 – 13.30**
**LUNCH BREAK**

**13.30 - 15.00****Session MB: ACTIVE NANO DEVICES****Session Chair:** Lih Y. Lin, *University of Washington, Seattle, WA, USA***MB1 13.30 - 14.00 (Invited)****High-Q Photonic Crystal Nanocavities**, S. Noda, *Kyoto University, Kyoto, Japan*

Recent progress of high-Q nanocavities is reviewed, where Q-factors more than 2 million have been successfully achieved while keeping very small modal volume of  $1.2\lambda/n^3$ . New design and dynamic tuning of Q-factor of nanocavities are also discussed.

**MB2 14.00 - 14.15****Modeling of Slow Light in Vertical Cavity Surface Emission Lasers**, R.-K. Lee, *National Tsing Hua University, Hsinchu, Taiwan, R.O.C.*

We develop a model for the slow light in the Vertical Cavity Surface Emission Lasers (VCSELs), with the combinations of cavity and the population pulsation effects. The dependences of pumping power, injection current and wavelength detuning for the group delays are demonstrated theoretically and experimentally.

**MB3 14.15 - 14.30****A Nano-scale Nanocrystal Photodetector with High Sensitivity**, M. C. Hegg and L. Y. Lin, *University of Washington, Seattle, WA, USA*

We present the design, fabrication and testing results of a nano-scale quantum dot photodetector composed of quantum dots that are positioned between a nano-gap in electrodes for high sensitivity and high-resolution photodetection.

**MB4 14.30 - 14.45****Waveforms of Terahertz Radiation Emitted from Superconducting Dipole Antenna**, S.-S. Pai, *Instrument Technology Research Center, Hsinchu, Taiwan, R.O.C.*

We have observed the ultrashort electromagnetic pulse radiation from a current-biased bow-tie structure of YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7- $\delta$</sub>  thin film dipole antenna on MgO using 100 fs, 750 nm laser pulses.

**MB5 14.45 - 15.00****Loss and Crosstalk in Quantum Dot Waveguides**, C.-J. Wang and L. Y. Lin, *University of Washington, Seattle, WA, USA*

We find ~3dB/3 $\mu$ m loss for throughput in 500 nm wide devices, which is lower than plasmonic waveguides. The crosstalk between waveguides with 500 nm separation is not measurable.

**15.00 – 15.30****COFFEE BREAK****15.30 - 17.00****Session MC: NOVEL FABRICATION TECHNIQUES****Session Chair:** Hiroshi Toshiyoshi, *University of Tokyo, Tokyo, Japan***MC1 15.30 - 16.00 (Invited)****Towards the Fabrications Platforms for MOEMS**, W. Fang, M. Wu, H.-Y. Lin and J. Hsieh, *National Tsing Hua University, Hsinchu, Taiwan, R.O.C.*

Fabrication platform is one of the key factors to accelerate the progress of MOEMS (Micro opto-electro-mechanical systems). The two poly-Si MUMPs process is recognized as one of the most popular fabrication platforms for MOEMS. This study intends to introduce three fabrication platforms.

**MC2 16.00 - 16.15****FR-4 as a New MOEMS Platform**, H. Urey, S. Holmstrom, *Koc University, Istanbul, Turkey*, A. D. Yalcinkaya, *Bogazici University, Istanbul, Turkey*, S. Isikman and C. Ataman, *Koc University, Istanbul, Turkey*

FR4 is demonstrated as a novel MOEMS platform that integrates optical and electro-mechanical functions. Two different approaches to 2D laser scanning using a single electromagnetic actuation coil and application to Fourier Transform spectroscopy are presented.

**MC3 16.15 - 16.30****Optically Flat Micromirror Using Stretched Membrane with Crystallization-Induced Stress**, M. Sasaki, *Toyota Technological Institute, Nagoya, Aichi, Japan*, T. Sasaki, K. Hane and H. Miura, *Tohoku University, Sendai, Miyagi, Japan*

The optically flat and light-weighted micromirror is realized using the tense poly-Si film across a rigid c-Si drum. The crystallization-induced stress from a-Si generates the large stress and stabilizes the shape against the high temperature.

**MC4 16.30 - 16.45****Polarization-Transmissive Thin-Film Solar Cell with Photodiode Nanowires**, K. Hirose, Y. Mita and S. Sakai, *University of Tokyo, Tokyo, Japan*

The Polarization-Transmissive Thin-Film Solar Cell, which consists of a 400nm-wide silicon photodiode-nanowire grid, transmits the light polarized in one direction and generates photocurrent from the light polarized in the other direction. It can efficiently use light energy. The achieved extinction-ratio was 4 for the 675nm-laser.

**MC5 16.45 - 17.00****Micro Knife-Edge Optical Measurement Devices Fabricated by SOI and CMOS MEMS Processes**, T.-L. Chang, V. F.-G. Tseng and Y. Chiu, *National Chiao Tung University, Hsinchu, Taiwan, R.O.C.*

The knife-edge method is a commonly used technique to characterize laser beams and focused optical spots. In this paper, we present a MEMS-based knife-edge device fabricated by SOI and CMOS-MEMS processes. Optical measurement of focused spots size is close to the diffraction limit.

## Tuesday, 14 August 2007

**08.30 - 10.00**

**Session TUA: BIO NANO DEVICES**

**Session Chair:** Yves-Alain Peter, *École Polytechnique de Montréal, Montreal, QC, Canada*

**TuA1 08.30 - 09.00 (Invited)**

**Linear Tactile Nanodevice with Resolution on Par with Human Finger**, R. Saraf, V. Maheshwari and C. Nguyen, *University of Nebraska-Lincoln, Lincoln, NE, USA*

A large area thin-film nanodevice made by self-assembly containing electroluminescent nanoparticles is reported. The ~100 nm thick device on application of potential across the top and bottom surface of the film converts local pressure to light. The intensity of the electroluminescent light is linearly proportional.

**TuA2 09.00 - 09.15**

**Optical NEMS Based Force Sensor Using Silicon Nanophotonics**, C. Lee, *National University of Singapore, Singapore*

A novel nanoelectromechanical system (NEMS) device using a suspended beam embedded with silicon nanophotonics is proposed and studied in this paper. It shows that a small strain of 0.004% with respect to force load of 0.25  $\mu$ N could be detected.

**TuA3 09.15 - 09.30**

**Photostable Single KTiOPO<sub>4</sub> Nanocrystals for Second-Harmonic Generation Microscopy**, L. Le Xuan, C. Zhou, A. Slablab, D. Chauvat, N. Sandeau, *Laboratoire de Photonique Quantique & Moléculaire, Cachan, France*, S. Brasselet, J.-F. Roch, *École Normale Supérieure de Cachan, Cachan, France*, C. Tard, S. Perruchas, T. Gacoin, *Laboratoire de Physique de la Matière Condensée, Palaiseau, France* and P. Villeval, *Cristal Laser S.A., Messein, France*

We isolate nonlinear KTiOPO<sub>4</sub> nanocrystals exhibiting photostable second-harmonic generation under laser illumination. These nanoparticles are characterized in size, orientation and coherent light emission at the single-object level. They will find applications as near-field vectorial probes.

**TuA4 09.30 - 09.45**

**Iridescent Photonic Nano-Silica for Chemical and Biological Sensing**, J. Y. Chyan, *National Tsing Hua University, Hsinchu, Taiwan, R.O.C.*

The validity and the sensitivity of the proposed iridescent photonic nano-silica are demonstrated for organic solution and proteins at 20pg/ml concentrations.

**TuA5 09.45 - 10.00**

**A Novel Single-Cell Surgery Tool Using Photothermal Effects of Metal Nanoparticles**, T.-H. Wu, P.-Y. Tseng, S. Kalim, M. Teitell and P.-Y. Chiou, *University of California - Los Angeles, Los Angeles, CA, USA*

We demonstrate a novel single-cell surgery tool that integrates photothermal effects of gold nanoparticles with microcapillary techniques. A transient hole opening of the cell membrane at the tip of the micropipette was accomplished using laser-induced localized heating of nanoparticles.

**10.00 – 10.30**

**COFFEE BREAK**

**10.30 - 12.00**

**Session TUB: ACTUATION**

**Session Chair:** Hakan Urey, *Koc University, Istanbul, Turkey*

**TuB1 10.30 - 11.00 (Invited)**

**Optically Controlled, Holographic Micro-Hand**, M. J. Padgett, G. Gibson, J. Leach, *University of Glasgow, Glasgow, Scotland, UK*, D. Carberry and M. Miles, *University of Bristol, Bristol, UK*

A video image of the operators fingers defines the position of optically trapped micron-sized beads, any movement of the fingers causing a corresponding movement of the beads. The resulting micro-hand is used to position both inert and bio-material with nano-metre precision.

**TuB2 11.00 - 11.15**

**A Thermo-Pneumatically Actuated Tip-Tilt-Piston Mirror**, A. Werber and H. Zappe, *University of Freiburg, Freiburg, Germany*

A novel, high stroke tip-tilt-piston micro-mirror actuated by thermo-pneumatic forces is presented. A circular silicon mirror plate, mounted on top of three balloons, achieves 3D-motion, including tip-tilt of 5° and stroke of 385  $\mu$ m.

**TuB3 11.15 - 11.30**

**Bi-directionally Driven Metal Cantilevers Developed for Optical Actuation**, H. Kwon, *Kanagawa Academy of Science and Technology, Kawasaki, Kanagawa, Japan*, M. Nakada, *University of Tokyo, Tokyo, Japan*, Y. Hirabayashi, *Kanagawa Industrial Technology Research Institute, Ebina, Japan*, A. Higo, M. Ataka, H. Fujita and H. Toshiyoshi, *University of Tokyo, Tokyo, Japan*

We report a silicon solar-cell array to generate voltage (about 4.8V by 16 series PIN diode) to drive cantilever actuators made of stress-controlled combination of chromium-gold-chromium layers for electro-thermal pull-up and electrostatic pull-down motion. The reverse sputtering process was utilized to minimize the performance variation.

**TuB4 11.30 - 11.45**

**Reconfigurable Nanophotonic Systems by Tunable Alignment between Nanomagnet Arrays**, A. J. Nichol, W. J. Arora and G. Barbastathis, *Massachusetts Institute of Technology, Cambridge, MA, USA*

We demonstrate self-alignment and tunable displacements of nanopatterned membranes using nanomagnet arrays. The membranes self-align at multiple stable positions when using a periodic nanomagnet pattern. They are shifted between positions with an external magnetic field.

**TuB5 11.45 - 12.00**

**High-Accuracy Digital-to-Analog Actuators using Parallel Spring Array**, W. Han and Y.-H. Cho, *Korea Advanced Institute of Science and Technology, Daejeon, Korea*

The paper presents a digital-to-analog (DA) actuator using parallel spring array for high-accuracy optical manipulation. The present DA actuator generates the output displacement with the accuracy of  $0.29 \pm 0.20 \mu\text{m}$  reduced by 55.4% of the previous results.

**12.00 – 13.30****LUNCH BREAK****13.30 – 14.30****HAND PUPPET SHOW****14.30 - 17.30****Session TUP: POSTER SESSION****Session Chair:** Fumikazu Oohira, *Kagawa University, Takamatsu, Kanagawa, Japan*

**TuP1 Novel Large Area Applications Using Optical MEMS**, V. Viereck and H. H. Hillmer, *University of Kassel, Kassel, Germany*

We focus on the potential of Optical MEMS for large area applications and discuss the benefits of using Optical MEMS on large scale. We present micromirror applications for daylight guiding and the corresponding technological approaches.

**TuP2 Characterization of an Improved, Real-Time MEMS-Based Phase-Shifting Interferometer**, R. Kant, *Stanford University, Stanford, CA, USA*, D. Garmire, H. Choo and R. S. Muller, *University of California - Berkeley, Berkeley, CA, USA*

We describe and characterize an enhanced version of our MEMS-Based Phase-Shifting Interferometer (MBPSI) that achieves 13 times denser motion reconstruction than our original system, and successfully tracks real-time motion of a piezo-driven actuator.

**TuP3 Fast Tracking of Light Source with Micromirror and Associated Feedback Circuit**, J.-H. Park, T. Chung, I.-H. Park, J.-A. Jeon, *Ewha Women's University, Seoul, Korea*, B.-W. Yoo, M. Kim and Y.-K. Kim, *Seoul National University, Seoul, Korea*

In this paper, a closed-loop feedback control of a micromirror has been demonstrated to track a moving light source and to stabilize fast the tilting angle to follow the light source. An electrostatically actuated torsional micromirror was used as a test device.

**TuP4 Parallel and Selective Trapping in a Patterned Plasmonic Landscape**, M. Righini, A. Zelenina and R. Quidant, *Institut de Ciències Fotoniques, Barcelona, Spain*

Here, we report on novel 2D SP-based optical tweezers formed by finite gold areas fabricated at a glass surface. We demonstrate that SP enable stable trapping of single dielectric beads under unfocused illumination with considerably reduced laser intensity compared with conventional optical tweezers. We show that the method can be extended to parallel trapping over any predefined pattern. Finally, we demonstrate how SP tweezers can be designed to selectively trap one type of particles out of a mixture, acting as an efficient optical sieve.

**TuP5 Laser Doppler Vibrometer Using a 45°-Angled Optical Fiber for In-Plane Dynamic Measurement of MEMS Actuators**, M. G. Kim, K. Jo, *Gwangju Institute of Science and Technology, Gwangju, Korea*, Y. Park, W. Jang, *Korea Photonics Technology Institute, Gwangju, Korea* and J.-H. Lee, *Gwangju Institute of Science and Technology, Gwangju, Korea*

A laser Doppler vibrometer using a 45°-angled optical fiber with a self-aligned micro lens was proposed to measure in-plane motion of microactuator. This system features a high immunity to external disturbance and easy alignment.

**TuP6 A Dielectrically Driven Liquid Lens with Optical Packaging**, C.-M. Chang, C.-C. Cheng, C. Tsai, C.-L. Peng, and J. Yeh, *National Tsing Hua University, Hsinchu, Taiwan, R.O.C.*

A focus tuning dielectric liquid lens with optical packaging was demonstrated. The focal length varies from 33mm to 15mm when the voltage changes from 0V to 140Vrms.

**TuP7 Fully-Integrated Optofluidic Trap with Linear Microsphere Array**, R. Gordon, *University of Victoria, Victoria, BC, Canada*

A linear array of micron-diameter polystyrene spheres is trapped using a dual-beam fiber-optic trap fully-integrated within a microfluidic chip. Maxwell's stress tensor is used to reproduce the experimental particle spacing. The fully-integrated fiber-optic trap may be applied to biological analysis in the future.

**TuP8 Electrowetting-Based Total Internal Reflection Chip for Optical Switch and Display**, H. C. Hu, *Instrument Technology Research Center, Hsinchu, Taiwan, R.O.C.*

We present a novel electrowetting-based microchip for optical switch and display. Electrowetting on dielectric layer (EWOD), using an electrode covered by an insulating film as the substrate for a conducting water drop, enables production of large and reversible contact angle variations, opening a wide field of applications in microphysics.

**TuP9 Self-Alignment Micro-Lens by Gradient of Surface Tension**, C.-S. Yu, *Instrument Technology Research Center, Hsinchu, Taiwan, R.O.C.*

A method for manufacturing a micro-lens is provided. The method for manufacturing a micro-lens comprises the steps of (1) providing a substrate having a surface energy gradient; (2) providing a liquid onto the substrate; and (3) causing the liquid to form a micro-lens.

**TuP10 Design of a Holding System for Micro-Coil based MRI**, N. Ekekwe, B. Armiger and K. Murray, *Johns Hopkins University, Baltimore, MD, USA*

We report the design and fabrication of a holding cell system that enables concurrent image visualization of a single cell during planar micro-coil based magnetic resonance imaging (MRI) at cellular level. The system is fabricated on a poly-dimethyl-siloxane structure using soft lithography on glass substrate.

**TuP11 Glass Reflowed Microlens Array and its Optical Characteristics**, S.-K. Lee, M. G. Kim, K. Jo and J.-H. Lee, *Gwangju Institute of Science and Technology, Gwangju, Korea*

We have demonstrated glass microlens array fabricated by thermal reflow process to take advantage of durable lens material and simple process. The fabricated microlens was evaluated in terms of focal length and beam waist.

**TuP12 Photothermally Actuated Microcantilever Beams using Nanoparticles**, C.-N. Chen, C. M. Hsieh, C. Tsai, J. Yeh, *National Tsing Hua University, Hsinchu, Taiwan, R.O.C.* and C. Lee, *National University of Singapore, Singapore*

Photothermally actuated microcantilever beams based on localized surface plasmons (LSPs) of nanoparticles (NPs) were used to modulate absorption efficiency.

**TuP13 Vertical Comb-Drive MEMS Mirror for Optical Spectrum Sensing**, D. Inoue, *Kagawa University, Takamatsu-shi, Kagawa, Japan*

We have proposed a vertical comb-drive MEMS mirror which can be applied for a spectrometer with phase-shifting method, and fabricated the mirror device using micro fabrication technology. We have confirmed that the fabricated MEMS mirror can be applied to the spectrometer with phase-shifting method.

**TuP14 Drift-Free Single Crystalline Silicon Micromirror with Floating Field Limiting Shields**, B.-W. Yoo, *Seoul National University, Seoul, Korea*, Y.-H. Jang, *Samsung Electronics Co. Ltd, Ki-Heung, Kyung-Ki-Do, Korea*, K. Yu, *Seoul National University, Seoul, Korea*, J.-H. Park, *Ewha Women's University, Seoul, Korea* and Y.-K. Kim, *Seoul National University, Seoul, Korea*

Floating metallic shields reduce the potential gradient out of charges in dielectric so that the tilt angle drift from the charging effect seems to largely disappear in the micromirror.

**TuP15 A Two-Axis MEMS Scanner Driven by Radial Vertical Combdrive Actuators**, S.-J. Chiou, T.-L. Hsieh, J.-C. Tsai, *National Taiwan University, Taipei, Taiwan, R.O.C.*, C.-W. Sun, *Industrial Technology Research Institute, Hsinchu, Taiwan, R.O.C.*, D. Hah, *Louisiana State University, Baton Rouge, LA, USA* and Ming C. Wu, *Department of Electrical Engineering and Computer Sciences and Berkeley Sensor and Actuator Center (BSAC), University of California, Berkeley, CA 94720-1774, USA*

We report a two-axis micromirror driven by radial vertical combdrive actuators. A cross-bar spring structure with lower and upper torsion springs is designed to achieve two rotational DOFs. Rotation angles of  $\pm 5.4$  deg. (42V) and  $\pm 2.4$  deg. (63V) are obtained for the two axes, respectively.

**TuP16 Pull-in Analysis of Scanners Actuated by Electrostatic Vertical Combdrives**, D. Lee and O. Solgaard, *Stanford University, Stanford, CA, USA*

This paper presents an analysis of pull-in due to in-plane twist in MEMS scanners actuated by vertical combdrives with general comb gap arrangements and cross-sections.

**TuP17 Micromirrors for Multiobject Spectroscopy: Large Array Actuation and Cryogenic Compatibility**, S. Waldis, *University of Neuchatel, Neuchatel, Switzerland*, F. Zamkotsian, *Laboratoire d'Astrophysique de Marseille, Marseille, France*, P. Ayyalasomayajula, W. Noell and N. F. de Rooij, *University of Neuchatel, Neuchatel, Switzerland*

Micromirror arrays are being developed dedicated for astronomical instrumentation. We report on the strategy to handle a large number of micromirrors needed for covering a 0.5m x 0.5m large active surface and on cryogenic characterization.

**TuP18 Improved Control of the Vertical Axis Scan for MEMS Projection Displays**, V. Milanović, *Adriatic Research Institute, Berkeley, CA, USA*

We demonstrate a MEMS projection display system with high speed, broadband, open-loop driving of the vertical axis which improves displayed image quality, increases the refresh rate capability and image brightness/efficiency.

**TuP19 High Temperature Operation of Gimbal-less Two Axis Micromirrors**, A. Miner and V. Milanović, *Adriatic Research Institute, Berkeley, CA, USA*

We demonstrate seamless operation of gimbal-less two axis micromirror devices at high temperatures up to 200°C by characterizing the temperature stability of the mirror tilt angle and first resonant mode.

**TuP20 Mechanical-Contact-Based Submicron-Si-Waveguide Optical Microswitch at Telecommunication Wavelengths**, E. Bulgan, Y. Kanamori and K. Hane, *Tohoku University, Sendai, Miyagi, Japan*

We report design, fabrication and testing of a mechanical-contact-based 260 nm-thick Si-waveguide optical microswitch. The switching occurs when a movable waveguide closes submicron lateral gap and causes contact between identical input and output waveguides mechanically.

**TuP21 Two-Wavelength Grating Interferometry for Extended Range MEMS Metrology**, M. F. Toy, O. Ferhanoglu and H. Urey, *Koc University, Istanbul, Turkey*

Grating interferometers integrated with MEMS offer shot-noise limited sub-nm displacement detection sensitivities but are limited in range. A two-wavelength readout method is developed that maintains sensitivity while increasing the detection range by more than 10-fold.

**TuP22 A New Fast Infrared Tracking System with Thermopile Array Implementation**, P.-H. Chang, *National Changhua University of Education, Tainan, Taiwan, R.O.C.*

This paper proposes a novel design and implementation of a tracking infrared system with a 12x2 CMOS thermopile linear array. Without complicated image processing circuits, the tracking system compares four signal outputs from the linear thermopile array with two chopper amplifiers.

**TuP23 Self-Supported Pitch-Variable Guided-Mode Resonant Grating Filters at Telecom Wavelengths**, Y. Kanamori, N. Matsuyama, J.-S. Ye and K. Hane, *Tohoku University, Sendai, Miyagi, Japan*

We fabricate a pitch-variable guided-mode resonant grating filter. The initial grating period of 860nm is designed for a wavelength-selective filter at telecom wavelengths. By controlling the grating period, the resonant wavelength can be tuned.

**TuP24 An Optical MEMS Pressure Sensor based on Phase Demodulation**, Y. Ge and M. Wang, *Nanjing Normal University, Nanjing, Jiangsu, China*

A novel optical fiber pressure sensor based on Fabry-Perot (FP) interferometer and phase demodulation method is described. Experimental results demonstrate that the sensor has reasonable linearity, sensitivity and a wide pressure measurement range from 0.1MPa to 3MPa.

**TuP25 A MEMS-based Organic Deformable Mirror with Tunable Focal Length**, T.-Y. Chen, *National Taiwan University, Taipei, Taiwan, R.O.C.*

In this paper, we present a deformable mirror with circular membrane (diameter=3.5mm) combined with single transparent electrode which can be used as concave or convex mirrors. The mirror's focal length is adjustable by tuning the applied voltage. The fabrication process, mirror's tunable range, and experiment result will be discussed.

**TuP26 Novel Adaptive Optics System with an Electrostatically-Driven Deformable Mirror and Wavefront Compensation Algorithm**, A. Kobayashi, H. Kawashima, N. Saito, M. Momiyuchi, *Topcon Corporation, Tokyo, Japan*, A. Koga, R. Furukawa and K. Masunishi, *Toshiba Corporation, Kawasaki, Japan*

We have fabricated a membrane deformable mirror (DM) for ophthalmologic adaptive optics. An algorithm is demonstrated to compensate wavefront aberration of eyes, effectively. We have developed analysis systems that can predict the DM characteristics.

**TuP27 Reflectance Study of Nano-Scaled Textured Surfaces**, C.-C. Chen, *National Chiao Tung University, Hsinchu, Taiwan, R.O.C.*

An algorithm based on rigorous coupled wave analysis is used to calculate the reflectance of two kinds of nano-scaled textured surfaces, periodic pyramid and random pillar structures. The device dimension and angular dependence are investigated.

**TuP28 Experimental Observation of Self-Propelled Cavity Soliton-like Evolutions in VCSELs with Photonic-Crystal Micro-Structures**, T.-D. Lee, *National Yunlin University of Science & Technology, Douliu, Yunlin, Taiwan, R.O.C.*

We report experimental observation of transverse optical pattern distribution and its evolution in photonic-crystal-structured VCSELs by using near-field scanning optical microscope. With fixed driving current but different distances above the emitting surface of the cavity, self-propelled soliton-like cavity patterns are demonstrated.

**TuP29 Elastic-like Collision of Gap Solitons in Nonlinear Nonlocal Photonic Crystals**, R.-K. Lee, *National Tsing Hua University, Hsinchu, Taiwan, R.O.C.*

We analyze the existence, stability, and mobility of gap solitons in photonic crystals with diffusion mechanism of the nonlinearity numerically. We show that gap solitons can revive an elastic-like collision even in the photonic systems due to non-locality.

**TuP30 Wide-Angle Low-Loss 1x2 Multimode Interference Optical Power Divider with Tilted Input and Output Waveguides**, Y.-B. Lin, *Lunghwa University of Science and Technology, Taoyuan, Taiwan, R.O.C.*, T.-L. Ting and W.-S. Wang, *National Taiwan University, Taipei, Taiwan, R.O.C.*

Multimode interference (MMI) coupler with tilted input/output waveguides is proposed. The output fields have tilted phase fronts and direct toward the branching waveguides. The loss is only 0.24 dB with a twenty-degree branch angle.

**TuP31 Double Reflection in the Blazed Grating**, C.-H. Ko, *Yuan Ze University, Chungli, Taiwan, R.O.C.*

In simulations for the blaze angle design in the blazed grating, we discover the phenomenon of the double reflection diffraction. The spectrometer utilizing the phenomenon has similar performance to the grating with the ordinary diffraction.

**TuP32 Effect of a Vertical Stack of Aligned Subwavelength Metal Hole Arrays on Extraordinary Transmission Spectra**, J. Provine, R. Kant, *Stanford University, Stanford, CA, USA*, D. A. Horsley, *University of California - Davis, Davis, CA, USA* and R. T. Howe, *Stanford University, Stanford, CA, USA*

We report on the effect of a pair of metallic subwavelength hole arrays on the extraordinary transmission spectrum. For films within the coupling region of the evanescent surface modes of the metal films, minor sharpening of the various transmission was observed.

**TuP33 The Measurement of Liquid Refractive Index by D-Shaped Fiber Bragg Grating**, H.-W. Chen, C.-L. Tien, W. F. Liu and S.-W. Lin, *Feng Chia University, Taichung, Taiwan, R.O.C.*

The purpose of removing a part of fiber cladding to form a D-shaped FBG is to improve the sensing sensitivity. By using different types of liquids with different refractive index for the experiment, the Bragg wavelength shift of side-polished FBG is measured.

**TuP34 A Compact Silicon-on-Insulator MMI-based Polarization Splitter**, Y.-F. Ma, *National Taiwan University, Taipei, Taiwan, R.O.C.*

A MMI-based polarization splitter is designed using SOI channel waveguides. The slab-like geometry of MMI induce significant birefringence for polarization splitting. We demonstrate it successfully by BPM simulation.

**TuP35 Near-Field Images of Surface Plasmon Eigenmodes in Gold Nanogratings**, F. H. Ho, S. Y. Chen, Y. H. Lin and J. Y. Su, *Instrument Technology Research Center, Hsinchu, Taiwan, R.O.C.*

In this study, we have fabricated gold nanograting structures by using a focused-ion-beam system. The optical near fields and eigenmodes of surface plasmons were examined by using both the scattering- and transmission-mode NSOM.

**TuP36 Surface Plasmon Leakage in Its Coupling with an InGaN/GaN Quantum Well through an Ohmic Contact**, D.-M. Yeh, C.-F. Huang, Y.-C. Lu, C.-Y. Chen, T.-Y. Tang, J.-J. Huang, K.-C. Shen, Y.-J. Yang and C.-C. Yang, *National Taiwan University, Taipei, Taiwan, R.O.C.*

We demonstrate the loss of surface plasmon (SP) energy through oscillating electron leakage via the Ohmic contact of either p-type or n-type GaN layer in the coupling process between SP and an InGaN/GaN quantum well.

**TuP37 Temperature-dependent Behaviors of the Surface Plasmon Coupling with an InGaN/GaN Quantum Well**, Y.-C. Lu, C.-Y. Chen, D.-M. Yeh, C.-F. Huang, T.-Y. Tang, J.-J. Huang and C.-C. Yang, *National Taiwan University, Taipei, Taiwan, R.O.C.*

We demonstrate the temperature dependent behavior of the surface plasmon coupling with an InGaN/GaN quantum well. The coupling efficiency relies on the availability of carriers with sufficient momentum for transferring the energy and momentum.

**TuP38 The Role of the Quantum-Confined Stark Effect in an InGaN/GaN Quantum Well During Its Coupling with Surface Plasmon for Light Emission Enhancement**, C.-Y. Chen, Y.-C. Lu, D.-M. Yeh and C.-C. Yang, *National Taiwan University, Taipei, Taiwan, R.O.C.*

We analyze the contribution of the screening of the quantum-confined Stark effect to the light emission enhancement behavior in the surface plasmon coupling process with an InGaN/GaN quantum well.

**TuP39 Passivation of Silicon Wafer Patterned by Aluminum for Micromachining**, A. Duan, *Vestfold University College, Tønsberg Norway*, E. Poppe, *SINTEF Electronics & Cybernetics, Oslo, Norway* and X. Chen, *Vestfold University College, Tønsberg, Norway*

After Al metallization, pinholes are formed on SiN because Al crystal hillocks. SiN passivation can be done by optimizing PECVD process at 300°C, adding Si powder in etchant to protect Al, and designs with SiO<sub>2</sub>.

## Wednesday, 15 August 2007

**08.30 - 10.00**

**Session WA:** MICROLENSSES

**Session Chair:** Lorenzo Faraone, *University of Western Australia, Crawley, Australia*

**WA1 08.30 - 09.00 (Invited)**

**MEMS-based Microspectrometers for Infrared Sensing**, C. A. Musca, J. Antoszewski, A. J. Keating, K. J. Winchester, K. K. M. B. D. Silva, T. Nguyen, J. M. Dell and L. Faraone, *University of Western Australia, Crawley, WA, Australia*

This work will describe the realisation of devices designed to select a specific wavelength band from within the short-wavelength infrared (SWIR), or the mid-wavelength infrared (MWIR) spectrum with the ability to electrically tune the selected wavelength.

**WA2 09.00 - 09.15**

**Fabrication and Characterization of a Repositionable Liquid Micro Lens System**, R. P. Shaik, *University of Freiburg, Freiburg, Germany*

In this paper, a novel method to improve both the lateral positioning and focal length tuning accuracy of a liquid lens in a micro lens system, based on the electrowetting on dielectrics (EWOD) principle, is described.

**WA3 09.15 - 09.30**

**A Lateral-shift-free LVD Microlens Scanner for Confocal Microscopy**, L. Wu and H. Xie, *University of Florida, Gainesville, FL, USA*

We report a lateral-shift-free (LSF) large-vertical-displacement (LVD) microlens scanner. The focal plane of the integrated polymer lens moves vertically 0.7mm at only 7.5V. The lateral shift is less than 2% of the vertical displacement.

**WA4 09.30 - 09.45**

**Implementation of CMOS-MEMS Compound Lens**, W. Fang, *National Tsing Hua University, Hsinchu, Taiwan, R.O.C.*

This study demonstrates the possibility of implementing lens system via CMOS process. The ever first CMOS based optical focusing system successfully demonstrated focusing capability, with 5µm by 6µm focus spot size at 614µm, and capable of moving focal point 12µm in axial direction.

**WA5 09.45 - 10.00**

**Low Cost Adaptive Silicone Membrane Lens**, F. Schneider, C. Mueller and U. Wallrabe, *University of Freiburg, Freiburg, Germany*

We present the first adaptive silicone membrane lens with an integrated piezoelectric actuator. The focal length ranges from 30 to 500 mm. The lens shows a maximum resolution of 100 linepairs/mm.

**10.00 – 10.30**

**COFFEE BREAK**

**10.30 - 12.00**

**Session WB:** MICRO AND NANO LITHOGRAPHY

**Session Chair:** Renshi Sawada, *Kyushu University, Fukuoka, Japan*

**WB1 10.30 - 10.45**

**Vortex Generation and Pixel Calibration Using a Spatial Light Modulator for Maskless Lithography**, I. W. Jung, *Stanford University, Stanford, CA, USA*, J.-S. Wang, *Briion Technologies Inc., Santa Clara, CA, USA* and O. Solgaard, *Stanford University, Stanford, CA, USA*

We present aerial images demonstrating the generation of an optical vortex and its through-focus characteristics using a spatial light modulator for maskless lithography. We also present improvement in pixel calibration sensitivity for a maskless lithography system.

**WB2 10.45 - 11.00**

**The Study on 3D Electron Beam Lithography for Sub-Micrometer Diffractive Optics**, H.-L. Yin, Y.-C. Hu and C.-S. Yu, *Instrument Technology Research Center, Hsinchu, Taiwan, R.O.C.*

This paper reports on 3D electron beam lithography for fabricating hologram, Fresnel lens, and antireflective structure. Integrating with electroforming and hot embossing for massively producing these sub-micrometer featured elements has also been demonstrated.

**WB3 11.00 - 11.15**

**Fabrication of a Multi-Level Lens Using Independent-Exposure Lithography and FAB Plasma Etching**, D. K. Woo, *Gwangju Institute of Science and Technology, Gwangju, Korea*, K. Hane, *Tohoku University, Sendai, Miyagi, Japan*, C. B. Lee, and S. K. Lee, *Gwangju Institute of Science and Technology, Gwangju, Korea*

The independent-exposure of electron beam lithography and FAB plasma etching method presented for the fabrication of a multi-level lens has the advantages which are the non-repetitive process and the precise fabrication.

**WB4 11.15 - 11.30**

**Self-Assembled Two-Dimensional Block Copolymers on Pre-Patterned Templates with Laser Interference Lithography**, C. Y. Wu, *National Chung Cheng University, Chia-Yi, Taiwan, R.O.C.*

We present an result of the self-assembling for cylindrical nanostructures of PS-b-PMMA block copolymers on pre-patterned templates. The templates are fabricated by two-beam interference lithography at 325 nm into negative SU-8 photoresist. Homopolymer polystyrene layer is brushed on the patterns for modifying the interfacial energys.

**WB5 11.30 - 11.45**

**Fabrication of Large Size Photonic Crystal Templates by Holographic Lithography Technique**, C. C. Hsu, N. D. Lai and J. H. Lin, *National Chung Cheng University, Chia Yi, Taiwan, R.O.C.*

Multi-exposure two-beam interference technique was employed to fabricate large size defect-free 2D and 3D polymer photonic crystal (PhC) templates. Combining with a double-step laser scanning technique, designed defects could be precisely embedded to a 2D PhC template.

**WB6 11.45 - 12.00**

**Extraordinary Transmission Through A Poly-SiC Membrane with Subwavelength Hole Arrays**, J. Provine, P. B. Catrysse, *Stanford University, Stanford, CA, USA*, C. Roper, R. Maboudian, *University of California - Berkeley, Berkeley, CA, USA*, S. Fan and R. T. Howe, *Stanford University, Stanford, CA, USA*

We report on the experimental observation of extraordinary transmission in the infrared through a suspended polycrystalline silicon carbide membrane with a subwavelength hole array. The array was fabricated with LPCVD, RIE, and contact photolithography. Simulation of the mid-infrared transmission is broadly consistent with measurements.

**12.00 – 13.30****LUNCH BREAK****13.30 - 15.00**

**Session WC:** SPECTROSCOPY

**Session Chair:** Wilfried Noell, *University of Neuchatel, Neuchatel, Switzerland*

**WC1 13.30 - 14.00 (Invited)**

**Compact Spectroscopic Sensor Using an Arrayed Waveguide Grating**, K. Kodate, Y. Komai, *Japan Women's University, Tokyo, Japan* and K. Okamoto, *University of California - Davis, Davis, CA, USA*

We have proposed a compact spectroscopic sensor using the arrayed waveguide grating and constructed a new planar sensor using a visible AWG for spectroscopic sensing of absorption characteristics with multiple grooves. A parabola-shaped sample injection improves sensitivity because diffraction loss is reduced.

**WC2 14.00 - 14.15**

**A Micro-Optic-Fluidic Spectrometer with Integrated 3D Liquid-Liquid Waveguide**, W. Z. Song, A. Liu, C. S. Lim, *Nanyang Technological University, Singapore* and P. Yap, *Defence Medical & Environmental Research Institute, Singapore*

A micro-optic-fluidic spectrometer is demonstrated for the fluorescence detection of moving particles in a microfluidic chip. The object is excited within an integrated 3D liquid-liquid waveguide and its fluorescence spectrum is real-time recorded with the resolution of 10 nm.

**WC3 14.15 - 14.30**

**A Disposable Grating-integrated Multi-channel SPR Sensor Chip for Real-time Monitoring of Biomolecule Binding**, Y.-H. Jin and Y.-H. Cho, *Korea Advanced Institute of Science and Technology, Daejeon, Korea*

The paper presents a multi-channel real-time monitoring of biomolecule binding using a disposable grating-integrated SPR sensor chip. We monitored the kinetics of biotin-streptavidin binding and characterized the refractive index sensitivity of the SPR sensor chip.

**WC4 14.30 - 14.45**

**Tunable Resonant Cavity Enhanced Detectors using Vertical MEMS Mirrors**, N. Quack, S. Blunier, J. Dual, M. Arnold, F. Felder, C. Ebnetter, M. Rahim and H. Zogg, *Swiss Federal Institute of Technology Zurich, Zurich, Switzerland*

Results on the design, simulation and fabrication of a tunable detector for the mid-IR using an electrostatically actuated vertical MEMS mirror.

**WC5 14.45 - 15.00**

**Two-state Optical Filter Based on Micromechanical Diffractive Elements**, H. Sagberg, T. Bakke, I.-R. Johansen, M. Lacolle and S. T. Moe, *SINTEF Electronics & Cybernetics, Oslo, Norway*

We have designed, fabricated, and characterized a two-state optical filter based on micromechanical diffractive elements. The filter is intended for gas measurements. Compared to existing devices, it is simpler to fabricate and operate and requires fewer external components.

15.00 – 15.30

COFFEE BREAK

15.30 - 17.00

**Session WD:** TUNABLE DEVICES**Session Chair:** George Barbastathis, *Massachusetts Institute of Technology, Cambridge, MA, USA***WD1 15.30 - 16.00 (Invited)**

**MEMS Tunable Filters for LWIR Spectral Imaging**, J. F. DeNatale, R. Borwick, P. Stupar, W. Gunning, P. Kobrin, *Teledyne Scientific Company, Thousand Oaks, CA, USA* and S. Laxtermann, *Teledyne Imaging Sensors, Camarillo, CA, USA*

An Adaptive Focal Plane Array (AFPA) has been developed integrating an array of MEMS tunable filters with a dual-band IR focal plane array. This enables spectrally-tuned LWIR imaging while preserving broadband MWIR imaging.

**WD2 16.00 - 16.15**

**Tunable Erbium Doped Fiber Laser Using a Silicon Micro-Electro-Mechanical Fabry-Perot Cavity**, J. Masson, S. Bergeron, A. Poulin, N. Godbout, and Y.-A. Peter, *École Polytechnique de Montréal, Montreal, QC, Canada*

We propose a novel tunable erbium-doped fiber laser using a silicon MEM Fabry-Perot cavity. The cavity is made of two Bragg mirrors, one being actuated by comb drives. The fiber-laser has a tuning range of 7.7nm in the C-band and a spectral width of 0.1nm.

**WD3 16.15 - 16.30**

**Design and Fabrication of Photonic MEMS Waveguide Modulators**, A. Higo, H. Fujita, Y. Nakano and H. Toshiyoshi, *University of Tokyo, Tokyo, Japan*

We report the design and fabrication process of photonic MEMS actuators for optical attenuators integrated with a silicon photonic wire waveguide. This paper presents design and theoretical analysis of the silicon optical waveguide modulator with an electrostatic micromechanical structure actuated in the evanescent range.

**WD4 16.30 - 16.45**

**A Study on Optical Diffraction Characteristics of Skewed MEMS Pitch Tunable Gratings**, K. Takahashi, *University of Tokyo, Tokyo, Japan*, K. Suzuki, H. Funaki, K. Itaya, *Toshiba Corporation, Kanagawa, Japan*, H. Fujita and H. Toshiyoshi, *University of Tokyo, Tokyo, Japan*

This paper presents a pitch tunable grating integrated with high-voltage driver circuits that target for projection display. In addition, we newly developed a grating light valve with a skewed angle for better image quality without inter-spot crosstalk and successfully demonstrated ON-OFF operation.

**WD5 16.45 - 17.00**

**Tunable MEMS Actuated Microring Resonators**, M.-C. Tien, *University of California - Berkeley, Berkeley, CA, USA*, S. Mathai, *HP Laboratories, Palo Alto, CA, USA*, J. Yao, *University of California - Berkeley, Berkeley, CA, USA* and M. H. Wu, *Hamamatsu Corp, Bridgewater, NJ, USA*

A simplified CMOS compatible process has been developed to fabricate MEMS tunable microring resonators on six-inch silicon-on-insulator wafers. The transmission spectra for different coupling regimes (under-coupling and over-coupling) are explained by coupled mode theory.

17.30

CONFERENCE BANQUET

## Thursday, 16 August 2007

08.30 - 10.00

**Session THA:** NANOFABRICATION**Session Chair:** Gong-Ru Lin, *National Taiwan University, Taipei, Taiwan, R.O.C.***ThA1 08.30 - 09.00 (Invited)**

**One-Way Waveguide and Strong Photon-Photon Interaction in Nanophotonic Structures**, S. Fan, J.-T. Shen, Z. Yu, G. Veronis and Z. Wang, *Stanford University, Stanford, CA, USA*

Here we discuss two examples of unusual nanophotonic effects: a one-way electromagnetic waveguide that fundamentally suppresses the effects of disorder-induced backscattering, as well as the possibility of creating strong photon-photon interactions at a few photon level with the use of photonic crystals.

**ThA2 09.00 - 09.15**

**Flower-Structured InGaN/GaN Quantum-Well Nanodisk Crystals on Micromachined Si Pillars**, F.-R. Hu, *Tohoku University, Sendai, Miyagi, Japan*

Unique flower-structured InGaN/GaN quantum-well nanodisk crystals were deposited on the micromachined periodic Si pillars. Detailed optical properties and microstructure were evaluated by scanning electron microscopy, optical microscopy, Laser scanning confocal microscopy and photoluminescence measurements.

**ThA3 09.15 - 09.30**

**Fabrication of Wafer-level Antireflective Structures in Optoelectronic Applications**, C.-H. Hsieh, J. Y. Chyan, W.-C. Hsu, and J. Yeh, *National Tsing Hua University, Hsinchu, Taiwan, R.O.C.*

Moth-eye structure (MES) can be regarded as an impedance-matching layer in optoelectronic applications. The wafer-level MES achieved using chemical etching with metal catalyst has been demonstrated.

**ThA4 09.30 - 09.45**

**Structural and Optical Properties of III-V Nanowires and Nanowire Heterostructures Grown by Metalorganic Chemical Vapour Deposition**, H. J. Joyce, Q. Gao, *Australian National University, Canberra, ACT, Australia*, Y. Kim, *Dong-a University, Busan, Korea*, H. H. Tan and C. Jagadish, *Australian National University, Canberra, ACT, Australia*

We have investigated the structural and optical properties of III-V nanowires grown by metalorganic chemical vapour deposition. These include binary GaAs, InAs and InP nanowires, ternary InGaAs and AlGaAs nanowires, axial GaAs/InGaAs heterostructure nanowires, and GaAs/AlGaAs core-shell and core-multishell nanowires.

**ThA5 09.45 - 10.00**

**Magnetic Alignment of Carbon Nanotube Interconnects**, H. J. In, A. J. Nichol and G. Barbastathis, *Massachusetts Institute of Technology, Cambridge, MA, USA*

A novel magnetic alignment method is introduced for precisely anchoring both ends of a carbon nanotube (CNT) in three-dimensional (3-D) space. This technique will enable establishing CNT interconnections in a 3-D device and will be compatible with various nanoelectronic, subwavelength photonic, and energy storage systems.

**10.00 – 10.30**

**COFFEE BREAK**

**10.30 - 12.00**

**Session THB: MICROMIRRORS**

**Session Chair:** Hiroshi Miyajima, *Olympus Corporation, Hachioji, Tokyo, Japan*

**ThB1 10.30 - 11.00 (Invited)**

**Optical MEMS for Future Instruments in Astronomy**, F. Zamkotsian, A. Liotard, P. Lanzoni, *Laboratoire d'Astrophysique de Marseille, Marseille, France*, S. Waldis, W. Noell, N. F. de Rooij, *University of Neuchatel, Neuchatel, Switzerland*, V. Conedera and N. Fabre, *Laboratoire d'Analyse & d'Architecture des Systèmes, Toulouse, France*

MOEMS devices are under study in order to be integrated in next-generation astronomical instruments for ground-based and space telescopes. Two key components are programmable slit masks for multi-object spectroscopy and micro-deformable mirrors for wavefront correction.

**ThB2 11.00 - 11.15**

**Passivated Piezoresistive Rotation Angle Sensor Integrated in Micromirror**, M. Sasaki, *Toyota Technological Institute, Nagoya, Aichi, Japan*, M. Tabata and K. Hane, *Tohoku University, Sendai, Miyagi, Japan*

A piezoresistive rotation angle sensor integrated in a micromirror is improved with the passivation film. The sensor detects the shear stress inside the torsion bar. The sensor shows the better performance of the smaller hysteresis.

**ThB3 11.15 - 11.30**

**Integrated Piezoresistive Positionsensor for Microscanning Mirrors**, T. Sandner, H. Conrad, T. Klose and H. Schenk, *Fraunhofer-Institut, Dresden, Germany*

Microscanning mirrors with integrated piezoresistive angular position sensors are presented. The novel sensor approach is based on intrinsic piezoresistivity of SOI material. It is fully compatible to microscanner technology and requires no additional technological efforts, enabling a cost efficient fabrication process.

**ThB4 11.30 - 11.45**

**Ultra Flat High Resolution Microscanners**, S.-T. Hsu, *Fraunhofer-Institut, Dresden, Germany*

We present a high frequency micro-scanner with 27 nm dynamic deformation at  $\pm 10$  degrees mechanical scan angle. To achieve that, a dry-wet combination process is utilized to fabricate reinforcement frames for scanner flatness improvement.

**ThB5 11.45 - 12.00**

**Combined Device of Optical Microdisplacement Sensor and PZT-Actuated Micromirror**, K. Akase, R. Sawada, *Kyushu University, Fukuoka, Japan*, H. Eiji, *University of Tokyo, Meguro-ku, Tokyo, Japan*, T. Kobayashi, R. Maeda, *National Institute of Advanced Industrial Science and Technology, Tsukuba, Ibaraki, Japan*, M. Inokuchi, S. Sanada and I. Ishikawa, *Kyushu University, Fukuoka, Japan*

A combined device of a PZT-film-actuated micromirror and micro sensor that can detect linear movement and rotation angle of the mirror has been developed. The device can feed back the mirror position obtained from the sensor.

**END OF PROGRAM**