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2016 International Conference on Optical MEMS and Nanophotonics
Conference Full Program

Sunday, July 31, 2016

Welcome Reception
Time and Venue: 16:00 - 20:00 at NUS museum

- **Registration starts at 4 PM near the entrance of NUS museum.**
- **Museum tour starts at 6:30 PM and 7:30 PM in two slots.**
- **Buffet dinner will be provided from 6 PM onwards.**

Attraction in LKCNH Museum and NUS Museum: The reception program covers interesting galleries with a wide variety of artifacts, one should preserve and knows the significance of displayed items. Step inside and be amazed by the three sets of rare sauropod dinosaur fossils, the record of marine cycles, diverse environmental animal record from land, sky and marine and Chinese arts collections.

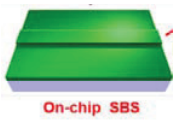
Monday, August 1st, 2016

Mo1. Keynote Session
Time and Venue: 8:30 – 10:15, LT 7A
Chair: Prof. Chengkuo Lee, National University of Singapore, Singapore

08.30 - 08.45 - **Welcome and Opening Remarks** by Prof. Chengkuo Lee, General Chair, OMN 2016, Singapore

Mo1.1 08.45 ***Keynote: Randomly Addressable Photonic Metamaterials*** ***1***
Nikolay Zheludev
The next frontier of nanophotonics research is to develop metamaterials with on-demand optical properties that may be independently controlled at any given point in space and at any moment of time. We will overview emerging technologies for meta-molecular level switching controlled by electric or magnetic signals and light.

Mo1.2 09.30 ***Keynote: Inducing and Harnessing Hypersound Acoustic Phonons in Photonic Integrated Circuits*** ***2***
Benjamin Eggleton



Compared to the almost magical impact of lasers and photonics on our lives, from the Internet to supermarket checkouts, mechanical systems can seem almost quaint. Yet one of the surprises of nonlinear optics –the field of optics with high intensity lasers – is that light may interact strongly with sound, the most mundane of mechanical vibrations. Intense laser light literally “shakes” the glass in optical fibres, exciting acoustic waves (sound) in the fibre. Under the right conditions, it leads to a positive feedback loop between light and sound termed “Stimulated Brillouin Scattering,” or simply SBS. This nonlinear interaction can amplify or filter light waves with extreme precision in frequency (colour) which makes it uniquely

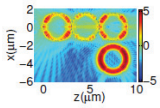
suited to solve key problems in the fields of defence, biomedicine and wireless communications amongst others.

Coffee Break (10.15 – 10.45)

Mo2. Parallel session 1 - Photonics I
Time & Venue - 10.45 - 12.30 at LT 7A
Chair - Prof. Vladimir Aksyuk, National Institute of Standards and Technology, USA

Mo2.1 10.45 ***Invited: Phoxonic Crystals for Harnessing the Interaction of Light and Sound*** **3**
Vincent Laude
Phoxonic crystals are periodic nanostructures that are simultaneously photonic and phononic crystals. Phoxonic cavities can trap visible or near infrared light and Gigahertz phonons in the same tiny volume, while phoxonic waveguides can confine their propagation to a tiny solid core, in both cases possibly promoting their interaction. This paper reviews various phoxonic nanostructures that have been proposed and discusses the interaction of light and sound within them.

Mo2.2 11.15 ***Invited: GHz Integrated Acousto-optics*** **5**
Mo Li
Integrating nanoscale electromechanical transducers and nanophotonic devices potentially can enable new acousto-optic devices to reach unprecedented high frequencies and modulation efficiency. We demonstrate acousto-optic modulation of a photonic crystal nanocavity using acoustic waves with frequency up to 19 GHz, reaching the microwave K band. Both the acoustic and photonic devices are fabricated in piezoelectric aluminum nitride thin films. Excitation of acoustic waves is achieved with interdigital transducers with periods as small as 300 nm. Confining both acoustic wave and optical wave within the thickness of the membrane leads to improved acousto-optic modulation efficiency in the new devices than that obtained in previous surface acoustic wave devices. Our system demonstrates a novel scalable optomechanical platform where strong acousto-optic coupling between cavity-confined photons and high frequency traveling phonons can be explored.

Mo2.3 11.45 ***The Fano Resonance in Photonic Molecules*** **7**
Thanh Xuan Hoang, Sara Nicole Nagelberg, Mathias Kolle and George Barbastathis


Light resonance in photonic molecules is shown to be in analogy to the Fano resonance observed in atomic physics. Light coupling and propagation in systems of coupled microspheres are discussed.

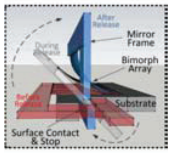
Mo2.4 12.00 ***A Large-Angle Single-Wavelength Optical Beam Steerer Based on Cascaded Ring Resonator*** **9**

Shiyang Zhu, Sing Chee Koh and Guo Qiang Lo

Free-space beam steering plays an important role in ultrafast switching and scanning applications. Optical phased array (OPA) is commonly used for this function. Here we propose an alternative method to realize two-dimensional large-angle beam steering for single-wavelength light on Si platform. The steerer consists of an electrically controlled 1×N cascaded add-drop ring resonator and N off-chip emitters. Each output of the resonator connects with one emitter to emit light to free space at a certain direction. Single-wavelength light coupled in the input bus waveguide of the cascaded ring resonator can be switched among these N outputs by means of tuning the refractive index of the cascaded rings electrically and then be emitted to different directions in far field, which behaves as beam steering apparently. The steering can be one- or two-dimension, depending on the arrangement of these N off-chip emitters on the chip. Moreover, the proposed steerer can be combined with the conventional OPA for more precisely beam steering. A 1×9 cascaded ring resonator was fabricated on hydrogen amorphous silicon platform for proof of concept demonstration.

Mo2.5 12.15 ***A monolithic Michelson Interferometer with a Large Piston MEMS Micromirror*** **11**

Wei Wang, Jiapin Chen, Quentin Tanguy and Huikai Xie

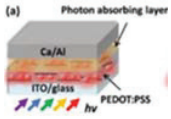


A MEMS-based Monolithic Michelson interferometer with both movable mirror and fixed mirror vertically oriented and integrated on a silicon-optical-bench. Both mirrors' vertical orientation is attained by a proper bimorph design and unique stopper mechanism.

Mo2. Parallel session 2: Plasmonics I
Time & Venue - 10.45 - 12.30 at EA A
Chair - Prof. Cheng Wei Qiu, National University of Singapore, Singapore

Mo2.6 10.45 ***Plasmonic Effects of Amphiphilic Gold Nanoparticles in Polymer Optoelectronic Devices*** **13**

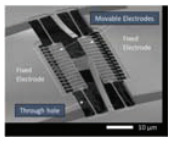
Ming-Kai Chuang, Chun-Hao Lin and Fang-Chung Chen



Amphiphilic gold nanoparticles have been synthesized and employed for improving the performance of polymer optoelectronics devices. Such nanocomposites could be readily incorporated into the buffer and/or photoactive layers, resulting in obvious enhancements in device efficiencies.

Mo2.7 11.00 ***A Tunable Plasmonic Color Filter by Nanomechanical Stretch using MEMS Electrostatic Actuator*** **15**

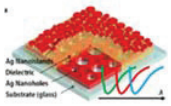
Mitsudome Masato, Honma Hiroaki, Sawada Kazuaki and Takahashi Kazuhiro



This paper reports an evaluation of electromechanical properties of the tunable plasmonic color filter by means of a nanomechanical in-plane motion of free-standing Al subwavelength grating. The maximum 707 nm pitch expansion was obtained at an applied voltage of 60 V, which provides a continuous peak shift of transmitted light. The frequency response was achieved up to 1 kHz.

Mo2.8 11.15 ***Nanoplasmonic Color Filter on Large Area at Visible Region 17***

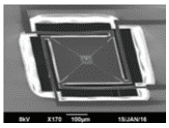
Youngseop Lee, Charles Hwang, Myeong-Su Ahn and Ki-Hun Jeong



This work presents plasmonic nanostructures comprised of silver nanoholes, ultrathin dielectric film, and silver nanoislands on a large area for visible color filtering. The plasmonic nanostructures have reflective colors from red to blue under white-light illumination.

Mo2.9 11.30 ***MEMS Deforbable Mirror Actuated By Electrostatic Piston Array 19***

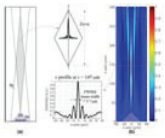
Akiko Uno, Yoshikazu Hirai, Toshiyuki Tsuchiya and Osamu Tabata



A new electrostatically deformable mirror was proposed for convex deformation and low-voltage actuation. Fabricated device confirmed 3µm displacement at 30V. Simple mathematical model was provided for real-time control and optimization of device design.

Mo2.10 11.45 ***Nano-Thin 2D Axicon Generating Nondiffracting Surface Waves 21***

Myun-Sik Kim, Richa Dubey, Elsie Barakat and Hans Peter Herzig



A new electrostatically deformable mirror was proposed for convex deformation and low-voltage actuation. Fabricated device confirmed 3µm displacement at 30V. Simple mathematical model was provided for real-time control and optimization of device design.

Mo2.11 12.00 ***Invited: Nonlinear Optics and Optomechanics with Plasmonic Metamaterials 23***

Luke Nichols, Tomasz Stefaniuk, Giovanni Sartorello, Giuseppe Marino, Alexey V. Krasavin, Francisco Rodriguez Fortuno, Wayne Dickson and Anatoly V. Zayats

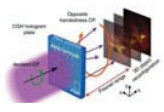
Plasmonic metamaterials and metasurfaces open up possibility to design the enhanced second- and third-order nonlinear optical properties in a desired spectral range beyond nonlinear optical response of their constituents. Here we overview optical nonlinearities and optomechanical effects enabled by metamaterials.

Buffet Lunch (12.30 – 13.30)

Mo3. Parallel Session 1: Metamaterials I
Time & Venue - 13.30 - 15.15 at LT 7A
Chair - Prof. Anatoly Zayats, King's College London, UK

Mo3.1 13.30 ***Invited: Low Dimensional Metasurface 25***

Cheng-Wei Qiu

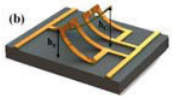


I will report some of our recent developments in engineering and manipulating light-matter interactions, via the artificially constructed metamaterials of ultrathin thickness compared to the wavelength. In particular, the low-dimension and high-frequency scaling may promise a lot more interesting applications, while the challenges in design principle and fabrication capability will become critical limits. Nano-patterned surfaces to modulate and structure novel light behavior will be studied and the following advanced functionalities will be discussed, e.g., farfield super-resolution imaging, 3D meta-hologram, dynamic OAM generation, plasmonic high-resolution prints, etc. Our work paves a roadmap to design

sophisticated and advanced optical devices, with low dimension, miniaturization, randomness, and scaled-up capability

Mo3.2 14.00 ***Invited: Active Control of Electromagnetically Induced Transparency analogue and Slow Light Phenomena via MEMS Based Terahertz Metamaterials*** **27**

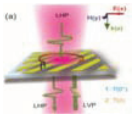
Prakash Pitchappa, Manukumara Manjappa, Chong Pei Ho, Ranjan Singh, Navab Singh and Chengkuo Lee



Classical analogue of electromagnetically induced transparency mediated by near field coupling in meta-atom resonators form the basis for design of slow light metamaterial devices. Here, we experimentally demonstrate the active control of individual resonators in the near-field coupled system. This allows for active modulation and spectral tuning of the transparency peak and hence the slow light behavior in terahertz spectral range.

Mo3.3 14.30 ***Tunable dispersion-free polarization control with terahertz metamaterials*** **29**

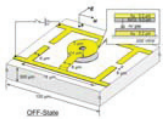
Longqing Cong, Ningning Xu, Jiaguang Han, Weili Zhang and Ranjan Singh



A novel scheme of dispersion-free metamaterial is proposed to control the polarization states of terahertz waves in a broadband regime. The artificially engineered phase delay is tunable with the space-variant P-B phase.

Mo3.4 14.45 ***Coupling Mechanism Analysis for MEMS Reconfigurable Metamaterial Device*** **31**

Zhengli Han and Hiroshi Toshiyoshi



We analyze the electromagnetic wave coupling mechanism of MEMS reconfigurable metamaterial towards the design for narrow band filter performance in terahertz frequency. A comparison between two metamaterial structures is presented for the study.

Mo3.5 15.00 ***Multiband Terahertz Metamaterials with Double Split-ring Resonators on Flexible Substrates*** **33**

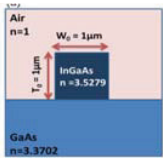
Yan Gui, Bin Yang and Xiaoqing Zhao

This paper presents a double split-ring resonators array fabricated on parylene-C substrates. We designed four structures with different angles of the outer and inner split-ring resonators to achieve tunability of the metamaterial and investigated the effect of polarization direction of terahertz waves on the transmission of metamaterials.

Mo3.Parallel Session 2: Photonics II
Time & Venue - 13.30 - 15.15 at EA A
Chair - Prof. Ming-Chang M. Lee, National Tsing Hua University, Taiwan

Mo3.6 13.30 ***Nano-magnetic-field Generator Using Surface Plasmon Polaritons*** **35**

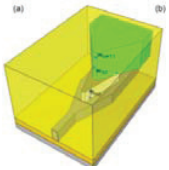
Shih-Ya Lin, Dong-Po Cai and Chii-Chang Chen



We propose a magnetic field generator using surface plasmon on a metallic microring. The positive charge is excited on the metallic microring. The propagating surface plasmon drives the charge flow to generate the magnetic field.

Mo3.7 13.45 ***CMOS-Compatible Multi-Layered Waveguide Platform for Silicon Hybrid Integrated Circuits 37***

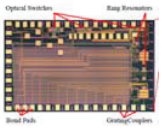
Xianshu Luo



We propose CMOS-compatible multi-layered waveguide system for silicon hybrid integration. Numerical simulation of vertical light coupling between different layers, and fabrication of dual-layered waveguide devices for multiple die-to-wafer bonding are performed, suggesting the integration feasibility.

Mo3.8 14.00 ***Die Level Release of Silicon Photonic MEMS 39***

Jonas Jacobs, Teodoro Graziosi, Marcell Kiss, Sangyoon Han, Tae Joon Seok, Ming C. Wu and Niels Quack



We demonstrate a die level release process for silicon photonic MEMS structures, that is compatible with dies from a standard silicon photonics foundry process which are only several square millimeters in size.

Mo3.9 14.15 ***Invited: Light-matter Interactions at the Nanoscale: Challenges and Opportunities 41***

Kenneth B. Crozier

Optical methods are challenging to apply at the nanoscale, due to the large mismatch between the wavelength and the sizes of nanoscale objects. I will describe projects that have addressed this challenge for various applications.

Mo3.10 14.45 ***Invited: Deployment of Silicon Photonics Technology in Data Communication Applications 43***

P. De Dobbelaere

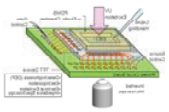
In this paper we address silicon photonics based optical transceiver technology for applications in advanced data communications such as high performance computing and hyperscale data centres.

Poster Presentations + Snacks Break (15.15 – 16.00)

Mo4. Parallel session 1: Optical MEMS I
Time & Venue - 16.00 - 16.45 at LT 7A
Chair - Prof. Eiji Higurashi, University of Tokyo, Japan

Mo4.1 16.00 ***Invited: MEMS on TFT 45***

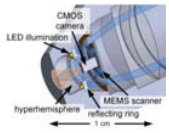
Hiroshi Toshiyoshi, Satoshi Ihida and Agnès Tixier-Mita



Benefits of using TFT (thin film transistor) technology for integrated MEMS is discussed from viewpoints of design rule, device dimension, output voltage, and post-process. TFT-MEMS for biochemical and optical applications are presented.

Mo4.2 16.30 ***3-Dimensional Beam Scanner for a Handheld Confocal Dermoscope 47***

Tianbo Liu and David Dickensheets

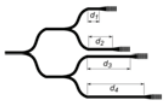


A MEMS active optical element delivers dual axis pointing and scanning with dynamic focus control for a handheld in vivo confocal microscope. This paper describes the design, processing steps and preliminary fabrication results of the new device.

Mo4. Parallel session 2: Photonics III
Time & Venue - 16.00 - 16.45 at EA A
Chair - Prof. Vincent Laude, Université de Bourgogne Franche-Comté, France

Mo4.3 16.00 ***Loss Characterization of Waveguides in Lithium Niobate on Insulator 49***

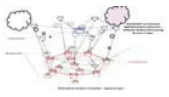
Shawn Yohanes Siew, Eric Jun Hao Cheung, Mankei Tsang and Aaron James Danner



Single crystal lithium niobate is a commonly used in optical electronic applications due to its variety of optical effects. However, it is a fairly difficult material to pattern and etching typically induces rough sidewalls. As a result of these limitations, commercial devices are typically use diffusion-type processes which only creates a small index increase. These devices have large footprints and therefore are costly. Lithium niobate on insulator (LNOI) is a technology created to circumvent some of these problems. It consists of a thin film of lithium niobate bonded to an insulating layer, which is then bonded to a host substrate. This allows compact structures due to the higher index confinement achievable. However, propagation loss is still prohibitive, due to the roughness induced by etching processes. We seek to characterize the propagation loss of waveguides in LNOI, and also to reduce the propagation losses.

Mo4.4 16.15 ***Multi-Peta-bps integrated photonic interconnection technology for flexible data-centric optical networks 51***

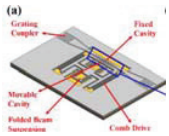
Le Nguyen Binh



We present the optical interconnection systems employing optical switching devices and integrated nano photonic matrices for flexible-bandwidth optical channels leading novel optical switching and interconnecting technologies for massive capacity of multi-Pb/s.

Mo4.5 16.30 ***Lateral Shearing Tuning of Dual Coupled Photonic Crystal Nanobeam Cavities*** **53**

Han Du, Xingwang Zhang, Jie Deng, Fook Siong Chau and Guangya Zhou



This paper reports a novel tunable photonic device. The device is based on dual coupled nanobeam photonic crystal (PhC) cavities. Different from other studies, where the cavities are mechanically tuned by varying the coupling gap, here the cavities are tuned by lateral shearing while maintaining a constant coupling gap. In experiments, both electrostatic force and optical gradient force are used to realize the device tuning.

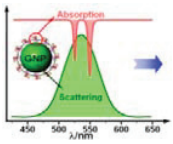
End of Day's Program

Tuesday, August 2nd, 2016

Tu1. Keynote Session
Time and Venue: 08.30 – 09.15, LT 7A
Chair: Prof. Chengkuo Lee, National University of Singapore, Singapore

Tu1.1 08.30 ***Keynote: Quantum Bio photonics and Its Applications in Life Sciences and Medicine 55***

Luke P. Lee

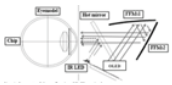


Quantum bionanophotonics is making headways into the life sciences, enabling in–vivo interrogation at the molecular level and in–vitro applications for diagnostics and analysis. These and other emerging biomedical application will be discussed.

Tu1. Parallel session 1: Biomedical application I
Time & Venue - 09.15 - 10.15 at LT 7A
Chair - Prof. Wibool Piyawattanametha, King Mongkut's Institute of Technology Ladkrabang, Thailand

Tu1.2 09.15 ***Invited: Self-Powered Subretinal Prosthetic Devices Using Optoelectronic Technologies 57***

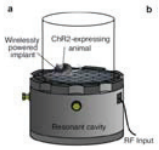
Chung-Yu Wu , Po-Han Kuo, Chi-KuanTzeng, Chuan-Chin Chiao, Jui-Wen Pan and Yueh-Chun Tsai



The design of subretinal prosthetic devices including a self-powered implantable chip and an extraocular optical goggle is presented. Various optoelectronic and biological technologies are adopted in the device design to enhance both performance and biocompatibility. Experimental results and initial animal test results are described. Future development are also discussed.

Tu1.3 09.45 ***Fully Internal, Wirelessly Powered Systems for Optogenetics 59***

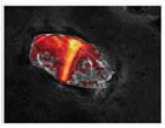
John Ho



Optogenetic manipulation of neural circuits in mice during natural behaviour is important for understanding neural function. Conventional systems for optogenetics require tethers or large head-mounted devices for light delivery that disrupt natural animal behaviour.

Tu1.4 10.00 ***A New Strategy for Simultaneous Full-field Neurovascular Imaging and Its In Vivo Application 61***

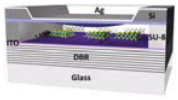
Han-Chi Pan, Jia-Wei Chen, You-Yin Chen and Lun-De Liao



We developed a dual-wavelength optical imaging with laser speckle contrast imaging (LSCI) and intrinsic optical signals imaging (IOSI) for cerebral blood flow (CBF) and hemoglobin oxygenation simultaneously recording, and examined the effects of AUDA in ischemia.

Tu1.Parallel session 2: Plasmonics II
Time & Venue - 09.15 - 10.15 at EA A
Chair - Prof. Wei-Chuan Shih, University of Houston, USA

Tu1.5 09.15 ***Invited: Enhancement of 2D Nonlinearity in an Optomechanical Cavity 63***



Fei Yi and Ertugrul Cubukcu

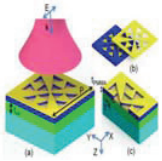
Emerging two-dimensional materials exhibit interesting optical properties. Here, we will summarize some of our recent work on the integration of 2D materials such as graphene and MoS_2 with an electromechanical platform for achieving novel optical functionality for hybrid devices and sensors.

Tu1.6 09.45 ***Complementary Plasmonic Structures of Nanohole and Nanodisk Arrays with High Angular Sensitivity 65***

Myeong-Su Ahn and Ki-Hun Jeong

This work demonstrates angle-sensitive plasmonic filters using complementary plasmonic structures of nanohole and nanodisk arrays. The plasmonic structures facilitates the incident angle-sensitivity of nanohole arrays by exploiting the resonance coupling between nanohole and nanodisk arrays

Tu1.7 10.00 ***Thermoresponsive Absorption Induced Transparency (AIT) for Nonplasmonic Sensing on a Quasi-3D Platform 67***



Dihan Hasan, Chong Pei Ho and Chengkuo Lee

We demonstrate a nonresonant transmission process namely absorption induced transparency (AIT) in a quasi 3D bow-tie nanostructure that possesses thermoresponsive characteristics and volumetric sensitivity at mid IR spectrum for the first time in the literature.

Coffee Break (10.15-10.45)

Tu2. Parallel session 1: Biomedical application II
Time & Venue - 10.45 - 12.30 at LT 7A
Chair - Prof. Huikai Xie, University of Florida, USA

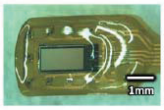
Tu2.1 10.45 ***Invited: Neurophotonics by Laser Speckle and Photoacoustic Imaging 69***

Nitish V. Thakor

Neurophotonics involves optical techniques for brain imaging –in health and disease. This review will present two technologies, laser speckle imaging and photoacoustic imaging. Laser speckle contrast can be correlated with blood flow and therefore can be used for imaging brain blood flow and microcirculation in applications such as stroke. Further, speckle imaging can be combined with electrophysiological monitoring. Photoacoustic imaging is a more recent technique suitable for imaging deeper into brain tissue, and for studying cortical structures and function in applications such as angiogenesis accompanying tumors. Further improvements in contrast and specificity may come from using nanoparticles. These technologies are advancing rapidity towards clinical applications.

Tu2.2 11.15 ***Invited: Micro-Optoelecronic Devices for Biomedical Applications 71***

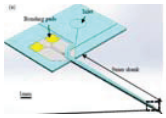
Jun Ohta



This talk presents recent progress of microoptoelectronic devices for biomedical applications. They are mainly based on the advancement of CMOS image sensors and light emitting devices. Retinal prosthesis and implantable micro imaging devices are demonstrated as application examples of micro-optoelectronic devices.

Tu2.3 11.45 ***A Hybrid Silicon-PDMS Multifunctional Neural Probe 73***

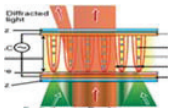
Ximiao Wen, Tingyi Liu and Pei-Yu Chiou



We demonstrate a 3-in-1 hybrid silicon-PDMS neural probe with electrochemical sensing, directional optical stimulation, and drug delivery capabilities. A liquid channel is bonded with the silicon probe using a novel PDMS thin-film transfer process.

Tu2.4 12.00 ***Study on High-Speed and Compact Optical Bio-Sensor for Sample Size Analysis 75***

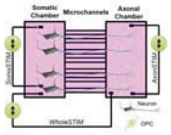
Makoto Kamata, Kan Yamada, Yoshihiro Taguchi and Yuji Nagasaka



A MEMS diffusion sensor utilizing the laser-induced dielectrophoresis is developed, and the photoconductive layer is deposited by the plain reactive RF magnetron sputtering method. The nano-scale size difference is observed using the newly fabricated sensor.

Tu2.5 12.15 ***Compartmentalized Microfluidic Platform Integrated with Subcellular Electrical Stimulation for Studying Activity-Dependent Axon Myelination 77***

Agata Blasiak, Hae Ung Lee, Sudip Nag and In Hong Yang

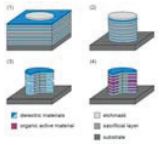


Myelination is governed by a neuron/glia interaction – whole neuron electrical stimulation enhances myelination. We integrated a compartmentalized microfluidic platform with electrical stimulation and demonstrated that subcellular activity input is sufficient to induce activity-dependent myelination.

Tu2. Parallel session 2: Photonics V
Time & Venue - 10.45 - 12.30 at EA A
Chair - Prof. Yves-Alain Peter, Ecole Polytechnique de Montreal, Canada

Tu2.6 10.45 ***Hybrid Vertical Cavity Surface-Emitting Laser in the Ultraviolet Spectral Range 79***

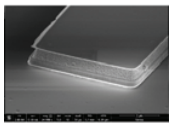
Hans Wilke, Christine Heume, Salman Alfihed, Nicolai Hoinka, Thomas Fuhrmann-Lieker, Thomas Kusserow and Hartmut Hillmer



We present a hybrid solid-state laser with alternating passive inorganic and active organic materials. The fabrication by subsequent infiltration of the organic material into a prefabricated air-gap structure is shown and discussed.

Tu2.7 11.00 ***Mid-infrared Waveguides in Ge-on-SOI 81***

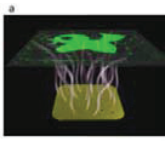
Usman Younis, Andrew A. Bettiol and Kah-Wee Ang



Strip waveguides have been developed in Ge-on-SOI. The propagation loss has been improved up to 4 dB/cm by increasing the Ge core quality using high temperature rapid thermal annealing. This demonstrates methods towards achieving low-loss mid-infrared photonics.

Tu2.8 11.15 ***Nano-sieve Meta-holograms 83***

Kun Huang, Hong Liu and Jinghua Teng



Metasurfaces have drawn much attention in optics and nanophotonics due to the powerful capability of full control of light. We introduce nanosieve-based metasurfaces for realizing optical holography and multiple-dimensional information encryption.

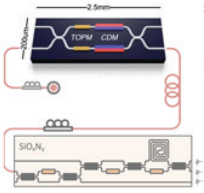
Tu2.9 11.30 ***Invited: Tailoring Light Emission with All-Silicon Optical Antennas 85***

Nicolas Bonod

Silicon particles hosting Mie resonances are used to design all-dielectric optical antennas. Silicon-based optical antennas are used to enhance the decay rates of quantum emitters, detect individual molecules, and to tailor the chirality of light emission.

Tu2.10 12.00 ***Invited: Silicon Quantum Photonics 87***

Mark Thompson



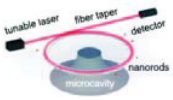
Silicon integrated quantum photonics has recently emerged as a promising approach to realising complex and compact quantum circuits, where entangled states of light are generated and manipulated on-chip to realise applications in sensing, communication and computation. Recent highlights include chip-to-chip quantum communications, programmable quantum circuits, chip-based quantum simulations and routes to scalable quantum information processing.

Lunch Break (12.30-13.30)

Tu3. Parallel session 1: Photonics VI
Time & Venue - 13.30 - 15.15 at LT 7A
Chair - Prof. Mo Li, University of Minnesota, USA

Tu3.1 13.30 ***Invited: Optical microcavity sensing: from reactive to dissipative interactions 89***

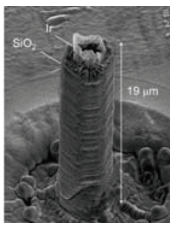
Yun-Feng Xiao



Single nanoparticle detection is demonstrated using reactive and dissipative interactions in a high-Q optical microcavity. The combination of those two methods adds new dimensions in microcavity sensing.

Tu3.2 14.00 ***Invited: 3D microtube and2D flexible film waveguide devices 91***

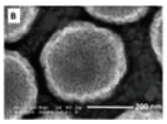
Takeshi Kawano



This paper reports microscale three-dimensional (3D) tube-like waveguide array and two-dimensional (2D) flexible waveguide array devices. Such microdevices will offer a new class of optogenetic applications, including light stimuli for specific regions of a neuron (e.g., axons or dendrites) and numerous spherical bio-tissues (e.g., brain and spinal cord).

Tu3.3 14.30 ***Nanoplasmonic Sensing on DNA Topological Structure Functionalized Nanoporous Gold Disks 93***

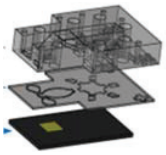
Fusheng Zhao, Suyan Qiu and Wei-Chuan Shih



We present nanoplasmonic sensor designs and implementations based on DNA topological structures functionalized nanoporous gold disks. Using conformational changes, low abundance breast cancer DNA biomarkers can be detected via a homogeneous assay. Using G-quadruplex, small molecules can be detected in a label-free fashion.

Tu3.4 14.45 ***Demonstration of using surface plasma enhanced magneto-optic Kerr effect to implement a compact micro-optofluidic sensor 95***

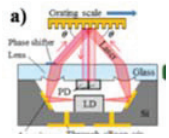
Chia-Peng Lin, Ming-Chang Lee and Gwo-Bin Lee



A high-sensitivity biosensor is demonstrated by exploiting surface plasma (SP) enhanced transverse magneto-optical Kerr effect (TMOKE) on a packaged micro-optofluidic chip to implement a compact system for detecting chemical or biological objects.

Tu3.5 15.00 ***Evaluation of Local Relative Slip in a narrow space in Hydrogen Gas Using MEMS Optical Encoder 97***

Nobutomo Morita, Ryosuke Komoda, Fumiya Nakashima, Masanobu Kubota, Eiji Higurashi and Renshi Sawada

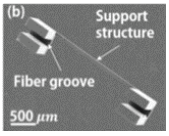


We will report evaluation of micrometer-order local relative slip range in mechanical property testing in a narrow space in hydrogen gas using developed MEMS optical encoder. An alignment method of the sensor is also developed.

Tu3.Parallel session 2: Optical MEMS II
Time & Venue - 13.30 - 15.15 at EA A
Chair - Prof. Joseph Talghader, University of Minnesota, USA

Tu3.6 13.30 ***High resolution and high frame rate Lissajous scanning using MEMS fiber scanner 99***

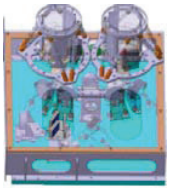
Kyungmin Hwang, Yeong-Hyeon Seo and Ki-Hun Jeong



High reolution and high frame rate Lissajous scanning was achieved by the selection rule of scanning frequencies, i.e., optimizing the greatest common divisor of transverse driving frequencies and the sum of transverse driving frequency ratios.

Tu3.7 13.45 ***BATMAN and ROBIN: DMD-based spectro-imagers 101***

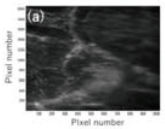
Patrick Lanzoni, Harald Ramarijaona and William Bon



In Universe Observation, we propose BATMAN, an innovative DMD-based spectro-imager instrument to be installed by 2017 on a 4m-class telescope, the Telescopio Nazionale Galileo. ROBIN, BATMAN pathfinder, demonstrates the instrument abilities.

Tu3.8 14.00 ***Wide-field Heterodyne Vibrometry for Measurement of Surface Vibrations in Biological Tissues 103***

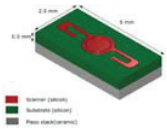
Samuel Choi, Fumiaki Nin, Takamasa Suzuki and Hiroshi Hibino



Nanovibrations in bio-tissues play pivotal roles in organ functions, but techniques for their measurement have been premature. To address this, a wide-field vibrometry is adopted in a laser microscope. 2D surface vibration distributions of paw tissues of rats could be measured without x-y mechanical beam scanning. The measurable vibration frequency and amplitude were 10 kHz and approximately 240 nm.

Tu3.9 14.15 ***A Compact Architecture for High-Frequency Resonant Microscanners with Low Dynamic Deformation 105***

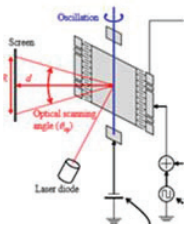
Shunyao Zhang, Caglar Ataman and Hans Zappe



We present a compact mechanical micro-scanner architecture which has low dynamic deformation. We demonstrate ±15° mechanical rotation angle via external piezoelectric actuation at 36 KHz with simulated peak-to-valley dynamic deformation of 200 nm.

Tu3.10 14.30 ***Very Stable MEMS Electrostatic Comb-Driven Scanning Mirror by Feedbacking the Comb Electrostatic Capacitance 107***

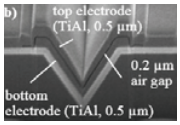
Noriaki Ishikawa, Koji Okazaki, Ayumu Kudo and Renshi Sawada



Very stable electrostatic comb-driven scanner enabled by feeding back the electrostatic capacitance between comb-shaped electrodes of the mirror and the fixed electrodes to the driving voltage applied to the comb-driven mirror is reported.

Tu3.11 14.45 ***Invited: Novel electrostatic micro-actuator class and its application potential for optical MEMS 109***

H. Schenk, H. Conrad, M. Gaudet, S. Uhlig, B. Kaiser, S. Langa, M. Stolz and K. Schimmanz



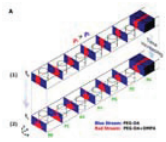
Electrostatic actuation is highly efficient at micro and nanoscale. However, due to pull-in instability large deflection requires large electrode separation and thus large driving voltages. We report on a novel electrostatic actuator class, which allows deflections in the µm-range based on electrode separations of a few 100 nm, only. Specifically designed and fabricated actuators allow for a large variety of motion patterns including out-of-plane and in-plane motion as well as membrane deformation. A CMOS compatible and RoHs compliant fabrication process enable straight-forward integration. The potential for actuator based Optical MEMS devices is discussed.

Poster Presentations + Snacks Break (15.15 – 16.00)

Tu4. Parallel session 1: Photonics VII
Time & Venue - 13.30 - 15.15 at LT 7A
Chair - Prof. Kenneth Crozier, University of Melbourne, Australia

Tu4.1 16.00 ***Invited: Non-spherical particle Generation from 4D Optofluidic Fabrication 111***

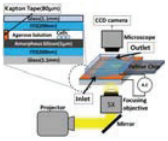
Kevin S. Paulsen, and Aram J. Chung



To create asymmetric three-dimensional shaped particles, density mismatched precursor streams are first shaped by fluid inertia, and then further shaped by gravity. Finally, patterned UV light polymerizes complex shaped asymmetric 3D particles.

Tu4.2 16.30 ***Cell Patterning in a Hydrogel Using Optically Induced Dielectrophoresis 113***

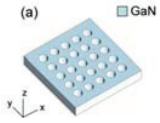
Wenqi Hu, Kelly Ishii and Aaron Ohta



Cell patterning followed by three-dimensional tissue culture in a hydrogel is demonstrated using optically induced dielectrophoresis. Single-cell patterning is achievable using this method, which has applications in drug discovery and tissue engineering.

Tu4.3 16.45 ***The Design of LED Backlight Structure for Multi-view Angle Display Application 115***

Yu-Ming Weng, Chien-Chang Chiu and Fu-Li Hsiao

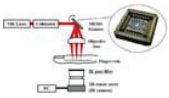


This research aims to enhance the directivity of two-dimensional photonic crystal slab, the results of research will be applied toward the display technology of multi-view angle.

Tu4. Parallel session 2: Optical MEMS III
Time & Venue - 13.30 - 15.15 at EA A
Chair - Prof. Harald Schenk, Fraunhofer Institute for Photonic Microsystems, Germany

Tu4.4 16.00 ***A finger-vein imaging and liveness detection for identity authentication using 2-axis MEMS scanner 117***

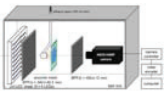
Jaekwon Lee, Seunghwan Moon, Juhun Lim, Kwanghyun Kim, Jong-Hyun Lee, Min-Joo Gwak and Kyung-Su Kim



A novel finger-vein imaging system based on a laser and scanner is proposed to improve identity authentication. Imaging of vein pattern with an enhanced resolution and speckle-based blood flow for liveness detection are experimentally demonstrated.

Tu4.5 16.15 ***Fluorometric Imaging System "Sniffer Camera" for Monitoring of Alcohol Metabolism from Human Transdermal Gas 119***

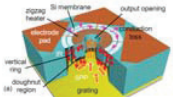
Takahiro Arakawa, Kenta Iitani, Toshiyuki Sato, Koji Toma and Kohji Mitsubayashi



Various volatile organic compounds can be found in human transpiration, breath and body odour. Therefore, a novel two-dimensional fluorometric imaging system, known as a "sniffer camera" for gaseous ethanol emissions from human breath and palm skin was constructed and validated. This imaging system measures ethanol vapour concentrations as intensities of fluorescence through an enzymatic reaction induced by alcohol dehydrogenase (ADH). The imaging system consisted of multi UV-LED excitation sheet and a high-sensitive CCD camera. This imaging system uses ADH for recognition of ethanol vapour. It measures ethanol vapour by measuring fluorescence of NADH, which is produced by an enzymatic reaction on the mesh. This NADH fluorometric imaging system achieved the two-dimensional real-time imaging of ethanol vapor distribution (0.5-200 ppm). The system showed a rapidly and accurately responses and a visible measurement, which could lead an analysis to metabolism function at real time.

Tu4.6 16.30 ***Invited: Silicon MEMS for Two Different Light Sources 121***

Minoru Sasaki



The semiconductor silicon is known as the material which is not suitable for the light source. Outside the visible light region, we try two different light sources. One is the infrared light source. The surface plasmon polariton is combined with the basic thermal emission from the microheater for the wavelength selectivity. Another is vacuum UV light source using the atmospheric pressure plasma. The wavelength is decided by the gas species mixed together in He discharging gas. In both devices, MEMS structures play the important roles for the efficiency.

End of Day's Program

Wednesday, August 3rd, 2016

We1. Keynote Session
Time and Venue: 08.30 – 09.15, LT 7A
Chair: Prof. Chengkuo Lee, National University of Singapore, Singapore

We1.1 08.30 ***Keynote: Towards Integrated Sagnac Gyros and Photonic Clocks Using Optical Micro Resonators 123***

Kerry Vahala

Like a tuning fork for light, optical resonators have a characteristic set of frequencies at which it is possible to confine light waves. At these frequencies, optical energy can be efficiently stored for lengths of time characterized by the resonator Q factor, roughly the storage time in cycles of oscillation. In the last ten years there has been remarkable progress in boosting this storage time in micro and millimeter-scale optical resonators. Chip-based devices have attained Q factors of nearly 1 billion and micro-machined crystalline devices have provided Qs exceeding 100 billion. The resulting long, energy-storage times combined with

small form factors have made it possible to access a wide range of nonlinear phenomena and to create laser devices that operate with remarkably low turn-on powers. Also, new science has resulted from radiation-pressure coupling of optical and mechanical degrees-of-freedom in the resonators themselves.

We1. Parallel session 1: Photonics IV
Time and Venue: 09.15 - 10.15, LT 7A
Chair: Prof. Yun-feng Xiao, Peking University, China

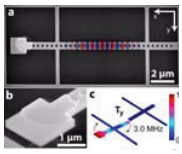
We1.2 09:15 ***Invited: Towards 3D metamaterials at optical frequencies 124***

Gwanho Yoon, Inki Kim, Minkyung Kim, Jungho Mun, Sunae So, and Junsuk Rho

Recent development of hierarchical fabrication techniques for three-dimensional metamaterial and plasmonic structures based on ultra-accurate and ultra-precise electron-beam lithography overlay will be discussed in this article.

We1.3 09:45 ***Invited: Optomechanical Torque Magnetometry 126***

Marcelo Wu, Nathanael L.-Y. Wu, Tayyaba Firdous, Fatemeh Fani Sani, Joseph E. Losby, Mark R. Freeman and Paul E. Barclay

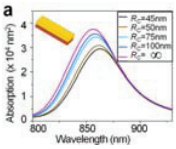


A thin film of magnetic permalloy is integrated into a photonic crystal split-beam cavity allowing for optomechanical detection of magnetic torques under applied fields. The magnetic response of the magnetometer is observed under ambient conditions.

We1. Parallel session 2: Biomedical application III
Time and Venue: 09.15 - 10.15, EA A
Chair: Prof. Eric Chiou, University of California at Los Angeles, USA

We1.4 09:15 ***Invited: Mechano-optical plasmonic nanoantenna 128***

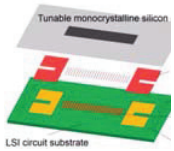
Somin Eunice Lee



We present a mechano-optical nano-antenna capable of nanometer spatial resolution and stability over a broad temperature range. We theoretically demonstrate a matching condition for mechanical properties that is essential for maximizing thermal expansion differences across a broad temperature range. Mechano-optical nano-antennas should allow for spatiotemporal temperature mapping in future applications where precise measurement of local temperature is needed.

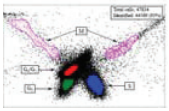
We1.5 09.45 ***Tunable Monocrystalline Silicon Grating on LSI Circuit Fabricated by Two-step Polymer Bonding 129***

T. Sasaki, T. Suzuki, H. Matsuura and K. Hane



This paper shows a fabrication process and device characteristics of the tunable monocrystalline silicon grating on LSI circuit. The thin monocrystalline silicon with thickness of 260 nm was transferred on the LSI circuit, by using the two-step polymer bonding process consisting of polymer patterning and bonding, and liquid-polymer filling. Furthermore, the grating was fabricated on the LSI circuit and the actuation of the grating by serial communication with the LSI circuit was demonstrated.

We1.6 10.00 ***High-throughput Volume Refractive Index Distribution Measurement Through Mechanical Deformation of Single Cells 131***



Antoine Leblanc-Hotte, Jean-Sébastien Delisle, Sylvie Lesage and Yves-Alain Peter

This paper reports a high-throughput microphotonic biosensor measuring volume refractive index distribution through mechanical deformation of single cells. This feature could readily add novel parameters for cell analysis without resorting to nucleic acid dies.

Coffee Break (10.15 – 10.45)

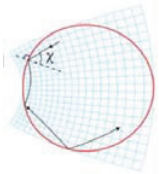
We2. Parallel session 1: Photonics VIII
Time and Venue: 10.45 - 12.30, LT 7A
Chair: Prof. Aaron Danner, National University of Singapore, Singapore

We2.1 10.45 ***Invited: Silicon photonic waveguide devices tunable by in-plane actuation 133***

K. Hane, H. M. Chu and T. Sasaki

Variable functional devices using MEMS/NEMS actuators are attractive to reconfigurable densely integrated optical circuits in silicon photonics, especially in optical telecommunication. Here, some silicon photonic waveguide devices, which are variable by integrated in-plane actuators, are presented. Coupler switches and wide-range tunable micro rings are discussed.

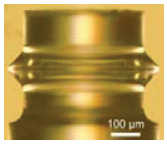
We2.2 11:15 ***Invited: Designing Whispering Gallery Modes via Transformation Optics 135***



Yushin Kimand and Bumki Min

Transformation optics provide a novel method of controlling the propagation of light. By applying it to a resonant optical cavity, whispering gallery modes can be restored in an optical cavity of deformed boundary.

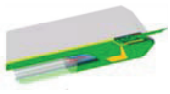
We2.3 11:45 ***Invited: Optical nonlinear control at a very low power in ultrahigh-Q microcavity systems 137***



Takasumi Tanabe, Tomohiro Tetsumoto, Hiroki Itobe, Ryo Suzuki and Takumi Kato

A small optical cavity with a high Q is attractive for optical nonlinear applications. We discuss various applications that utilize or are affected by cavity opto-mechanical coupling.

We2.4 12.15 ***Cantilever array with optomechanical read-out and integrated actuation for simultaneous high sensitivity force detection 139***



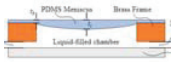
Thomas Michels, Ivo W. Rangelow and Vladimir Aksyuk

We present an on-chip cavity optomechanical cantilever array with integrated actuation, that combines high measurement bandwidth and very low displacement noise floor with compactness, robustness, small size, and potential for low cost batch fabrication inherent in micro- electro- mechanical- systems (MEMS).

We2. Parallel session 2: Optical MEMS IV
Time and Venue: 10.45 - 12.30, EA A
Chair: Prof. Deepak Uttamchandani, Strathclyde University, UK

We2.5 10.45 ***Design, Fabrication and Characterization of a Liquid-Tunable, Gravity-Immune Aspherical Lens 141***

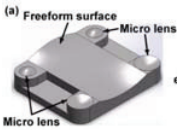
Pengpeng Zhao, Caglar Ataman and Hans Zappe



We designed, fabricated and characterized a 3mm liquid-tunable aspherical lens immune to gravity-induced membrane deformations. MTF measurements document that the lens has diffraction-limited performance regardless of its orientation, performing drastically better than conventional tunable lenses.

We2.6 11.00 ***Alignment-mechanism design for solid tunable lenses based on Alvarez principle 143***

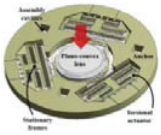
Yongchao Zou, Wei Zhang, Tong Lin, Fook Siong Chau and Guangya Zhou



The performance of Alvarez lenses is sensitive to the misalignment of lens elements. To improve the alignment accuracy and hence the lens performance, a feasible active alignment mechanism is proposed in this paper. Four micro lenses are created on the corners of the lens elements, forming two afocal lens pairs when the two lens elements are stacked. By monitoring the position of the laser spot coming from the afocal lens pair, the relative position of the two lens elements can be controlled precisely. The results show that an alignment accuracy less than 10 µm is achievable. Such an alignment mechanism would be useful in future solid tunable lens designs.

We2.7 11.15 ***A microactuator for autofocus and optical image stabilization in mobile phone cameras using unleveled comb electrodes 145***

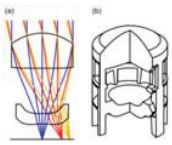
Seunghwan Moon, Geon-Ha Lee, Yangkyu Park, Minyoung Yun and Jong-Hyun Lee



Out-of-plane translatory and tilting motions were demonstrated using electrostatic microactuators for autofocus and optical image stabilization. The vertical displacement of the device was 90.5 µm at 40 V with a response time of 10 ms.

We2.8 11.30 ***Design, Simulation and 3D Printing of Complex Micro-optics for Imaging 147***

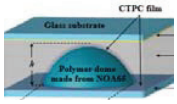
Simon Thiele, Kathrin Arzenbacher, Timo Gissibl, Sören Schmidt, Herbert Gross, Harald Giessen and Alois Herkommer



In this work we use a hybrid geometrical and wave optical approach to design and simulate stacked microlenses with varying fields of view. After 3D printing, an excellent agreement of simulated and measured imaging performance is found.

We2.9 11.45 ***Non-Mechanical Solid Tunable Diaphragm With a Large Optical Aperture 149***

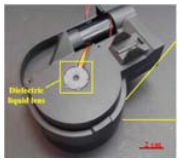
Wen-Cheng Shih, Cheng-Huan Lyu, Bo-Jiun Chen, Shun-Hao Yu and Jui-che Tsai



In this paper, we demonstrate a non-mechanical solid diaphragm with a large optical aperture and continuous-tuning ability. The diameter of the aperture can be tuned from 0 to 3.3 mm.

We2.10 12.00 ***Portable Dielectric Tunable Forensic Lens Design for Jadeite Analysis 151***

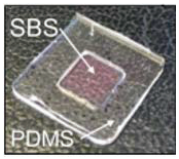
Kaiwei Liao, Kuanjung Lu, Ruchian Luo and J. Andrew Yeh



This paper presents a dielectric tunable forensic lens design for jadeite analysis. The gemstone tunable forensic lens with three-step (5, 7 and 10 X) magnification is based on the research of dielectric liquid lens, which is able to capture internal and surface characteristics such as color distribution, bubble trapping and cracks by bright field and dark field illumination.

We2.11 12.15 ***Fabrication and evaluation of freestanding stretchable nanosheet for optical MEMS application 153***

Hayato Kumagai, Nobutaka Sato, Shinji Takeoka, Kazuaki Sawada, Toshinori Fujie and Kazuhiro Takahashi



We developed a stretchable freestanding ultra-thin sheet composed by styrene-butadiene-styrene (SBS) and evaluated its optomechanical properties. The freestanding SBS sheet with a thickness of 675 nm was formed above a through hole of a PDMS sheet. Deflection of the freestanding sheet with a size of 10.4 mm x 10.4 mm was found to be 50 nm by optical surface profiler. In evaluation of the sheet stretch measured by reflection spectra of a thin-film interference peak, SBS nanosheet revealed about 38% of elastic strain. This result demonstrated that the SBS nanosheet is stretchable even though its thickness is one order magnitude of thinner than PDMS.

Lunch Break (12.30 – 13.30)

We3.Parallel session 1: Photonics IX
Time and Venue: 13.30 - 15.00, LT 7A
Chair: Prof. Ki-Hun Jeong, Korea Advanced Institute of Science and Technology, Korea

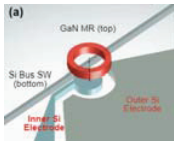
We3.1 13.30 ***Invited: Piezo-optomechanical circuits 155***

Krishna C. Balram, Marcelo Davanco,B. Robert Ilic,Jin Dong Song and Kartik Srinivasan

We demonstrate an optomechanical circuit platform in GaAs in which optomechanical cavities are interfaced with interdigitated-transducers using phononic crystal waveguides. We use this platform to demonstrate phonon routing, acousto-optic and opto-acoustic modulation, and sensitive motion detection.

We3.2 14.00 ***Si/GaN Microring Resonator Integrated with Si Electrodes for Electro-optic Tuning 157***

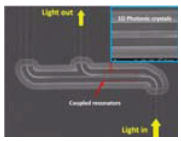
Borriboon Thubthimthong, Takashi Sasaki and Kazuhiro Hane



We report here the hybrid Si/GaN microring resonator structure integrated with Si electrodes. Preliminary results on electro-optic tuning of the guided-mode resonance was in the range of 140 pm for the entire applied voltage range of -60 V to 80 V. Up to 9 dB change in the transmission was observed at the maximum applied voltage. The device might be useful for static wavelength-selectable notch filtering of on-chip guided optical signal.

We3.3 14.15 ***Quasi-coherent mixing of mechanical excitations in vacuum 159***

Tong Lin, Xingwang Zhang, Yongchao Zou, Fook Siong Chau and Guangya Zhou



We have experimentally demonstrated the quasi-coherent mixing of mechanical excitations in vacuum based on the coupled-resonator platform. The opposite damping behavior is due to the optical gradient force and enhancing the photothermal effect.

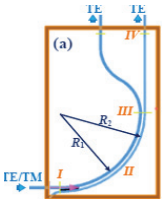
We3.4 14.30 ***LIDAR system using indirect time of flight method and MEMS scanner for distance measurement 161***

Sung-Woo Lee, Haesoo Jeong, Seoung-Ki Lee, Young-Kweon Kim and Jae-Hyoung Park

In this paper, we present a LIDAR (Light Detection And Ranging) system as an application of the MEMS (Micro Electro Mechanical System) scanner that was developed in our previous research. The electromagnetically actuated 2-axis driving MEMS scanner operated about the X axis at 1.4 kHz and about the Y axis at 10 Hz is applied for LIDAR system that provides measurement of the distance to an object. We adopt the indirect time of flight method for distance measurement. We measured the distance through the single laser spot and scanning laser beam using MEMS scanner. The measured distance at 1, 2 and 3 m through single laser spot were 118±15 cm, 207.8±23.4 cm and 310±48.3 cm, respectively. The measured distance at 1, 2 and 3 m through scanning laser beam using MEMS scanner were 118±15 cm, 207.8±23.4 cm and 310±48.3 cm, respectively.

We3.5 14.45 ***Compact CMOS-compatible polarization splitter and rotator based on 90° bend 163***

Kang Tan, Changyuan Yu and Chengkuo Lee

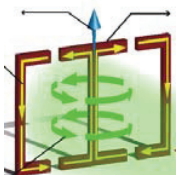


We propose and experimentally demonstrate a compact highly-efficient CMOS-compatible polarization splitter and rotator (PSR) with a wide bandwidth covering the whole O-band. It benefits from the different confinement capability of TE and TM modes in bend structure. The fabricated PSR achieves a high TM-TE conversion efficiency of -0.4 dB and high TE-TE conversion efficiency of -0.2 dB at 1310 nm, while the extinction ratio is better than 18 dB.

We3. Parallel session 2: Metamaterial II
Time and Venue: 13.30 - 15.00, EA A
Chair: Prof. Benjamin S. Williams, University of California Los Angeles, USA

We3.6 13.30 ***Planar toroidal metamaterials 165***

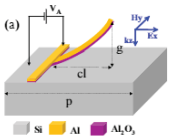
Manoj Gupta, Vassili Savinov, Ningning Xu, Longqing Cong, Govind Dayal, Shuang Wang, Weili Zhang, Nikolay I. Zheludev and Ranjan Singh



Toroidal multipoles, which along with the familiar electric and magnetic multipoles is necessary for the complete multipole representation of an arbitrary radiating source. We have designed a planar metasurface with resonant response in the terahertz range, which is easy to fabricate and exhibits the signature of a toroidal excitation.

We3.7 13.45 ***Versatility of microcantilever metamaterials for advanced polarization control in terahertz region 167***

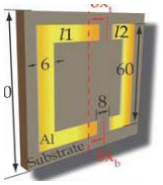
Prakash Pitchappa, Chong Pei Ho and Chengkuo Lee



Out-of-plane reconfigurable microcantilevers integrated into metamaterial unit cells is explored as a technological platform for the realization of advanced polarization control of THz waves. By varying the positioning of the microcantilever structures and isolating the control signals to these cantilevers, various designs are reported for active polarization-dependent resonance switching, polarization-independent resonance switching and polarization response switching characteristics. These metamaterials will greatly aid in the development of numerous polarimetric devices operating in terahertz spectral region.

We3.8 14.00 ***Tailoring the Fano resonances in terahertz metamaterials 169***

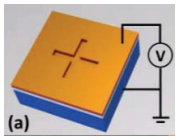
Manukumara Manjappa, Yogesh Kumar Srivastava, Longqing Cong, Ibraheem Al-Naib and Ranjan Singh



We report the passive as well as active modulation of the sensitive Fano resonances in terahertz asymmetric metamaterial structures. The strength of the Fano resonances can be completely switched off passively by changing the asymmetry of the structures and also actively by shininh the sample with very low pump powers. These devices can be used as ultrasensitive sensors, low threshold modulators and ultrafast switches in real world device based applications.

We3.9 14.15 ***Graphene Based Tunable Plasmonic Resonator at Mid-Infrared 171***

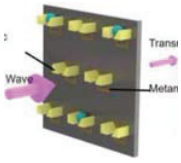
Nan Chen, Dihan Hasan, Chong Pei Ho, Prakash Pitchappa, Piotr Kropelnicki and Chengkuo Lee



This work presents a graphene plasmonic resonator whose electrically tunable capability at mid-infrared spectral range is experimentally demonstrated and characterized. We believe this device can pave a way for a variety of sensing applications.

We3.10 14.30 ***Particle-trap Array on Metamaterial for Selective Detection in Terahertz Region 173***

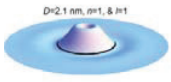
Kailing Shih, Prakash Pitchappa, Manukumara Manjappa, Chong Pei Ho, Ranjan Singh and Chengkuo Lee



Metamaterials operating in terahertz (THz) region is an attractive platform for the detection of micro-sized particles. However, only certain location in the metamaterial pattern offers maximum sensitivity. In this work, microfluidic structure was integrated with THz metamaterial in order to precisely handle the position of particles. This enables sensitive and effective detection of microorganism detection in the THz spectral range.

We3.11 14.45 ***Quantum Plasmon Resonance in Small Metallic Nanoparticles 175***

Modjtaba Moaied, Mário G. Silveirinha, Stefano Palomba and Kostya Ostrikov



The theory of non-local quantum permittivity in metals is introduced and the application of this theory in the propagation of light and its interaction with small metallic nanoparticles (i.e., less than 10 nm in diameter) is investigated.

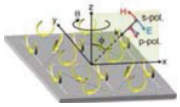
End of Day's Program

Thursday, August 4th, 2016

Th1. Keynote Session
Time and Venue: 08.30 – 09.15, LT 7A
Chair: Prof. Chengkuo Lee, National University of Singapore, Singapore

Th1.1 08.30 ***Keynote: Plasmonic Metadevices by Vertical Split Ring Resonator*** ***177***

Din Ping Tsai

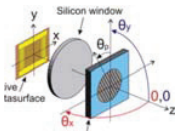


Split-ring resonator (SRR), one kind of building block of metamaterials, has attracted wide attentions due to the resonance excitation of electric and magnetic dipolar response. Fundamental plasmon properties and potential applications in novel three dimensional vertical split-ring resonators (VSRRs) are designed and investigated. The resonant properties arose from the electric and magnetic interactions between the VSRR and light are theoretically and experimentally studied. Tuning the configuration of VSRR unit cells is able to generate various novel coupling phenomena in VSRRs, such as plasmon hybridization and Fano resonance. The magnetic resonance plays a key role in plasmon coupling in VSRRs. The VSRR-based refractive-index sensor will be demonstrated, as shown in Figs. 1. Due to the unique structural configuration, the enhanced plasmon fields localized in VSRR gaps can be lifted off from the dielectric substrate, allowing for the increase of sensing volume and enhancing the sensitivity. We perform a VSRR based metasurface for light manipulation in optical communication frequency, as shown in Fig. 1 as well. By varying the prong heights, the 2π phase modulation can be achieved in VSRR for the design of metasurface. Because the phase shift is changed via the upright configuration rather than the one parallel to the substrate, it can be used for high areal density integration of metal nanostructures and opto-electronic devices. Fabrication of three dimensional VSRR by stress-driven assembly method for uniaxial-isotropic metamaterials is demonstrated as well.

Th1. Parallel session 1: Metamaterial I
Time and Venue: 09.15 – 10.15, LT 7A
Chair: Prof. Guangya Zhou, National University of Singapore, Singapore

Th1.2 09.15 ***Invited: Terahertz Metasurface Quantum Cascade Lasers*** ***178***

Luyao Xu, Christopher Curwen, John Reno, Tatsuo Itoh and Benjamin S. Williams



We report THz quantum-cascade vertical-external-cavity surface-emitting-lasers (VECSELs) with up to 60 mW of power at 3.3 THz at 77 K. High quality, directive, near-diffraction limited, Gaussian beams are observed.

Th1.3 09.45 ***Invited: Resonance Modulations in Electromagnetically Coupled Terahertz Metamaterials*** ***180***

Dibakar Roy Chowdhury

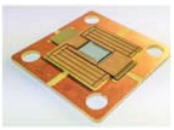
Reconfigurable resonance modes in metamaterials were demonstrated through switching from split-ring resonators to closed-ring resonators configurations via selective optical excitation of the split gap of ring resonator constituting the metamaterial unit cell. We observed that both the fundamental and the third-order resonance modes experienced monotonic damping and the evolution of the second-order resonance mode by increasing the optical pump at very high value. In another experiment we have shown ultrafast modulation of near field coupling

between bright and dark resonance modes in metamaterials. These experimental realizations offer additional degrees of freedom in tuning the electromagnetic response of metamaterials.

Th1. Parallel session 2: Optical MEMS V
Time and Venue: 09.15 – 10.15, EA A
Chair: Prof. David Dickensheets, Montana State University, USA

Th1.4 09.15 ***Optical Amplitude Gratings with Tunable Diffraction Efficiency 181***

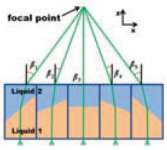
Moritz Stürmer, Matthias C. Wapler and Ulrike Wallrabe



We present a new kind of electro-mechanical optical grating with highly tunable diffraction efficiency. An efficient overlapping effect allows us to use an integrated direct piezo actuation. We demonstrate the principle with a simulation and a prototype with which we achieve tuning capabilities of 97% in the 1st diffraction order.

Th1.5 09.30 ***Focal point control using an EWOD-based tuneable Fresnel lens 183***

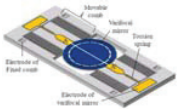
Carlos Enrico Clement, Si Kuan Thio and Sung-Yong Park



This work presents focal tuning of Fresnel lens using arrayed liquid prisms via electrowetting-driven beam steering. Liquid prism arrays are individually controlled to mimic small subsections of a Fresnel lens. Arrayed subsections in the proposed device are symmetrically tuned to achieve focal length control, while conventional solid-type Fresnel lenses provide a fixed focal length. Consequently, incoming light beams can be effectively converged at a single point in space without any bulky mechanical moving parts.

Th1.6 09.45 ***Varifocal Mirror Integrated with Scanner Using Wafer Bonding Technology 185***

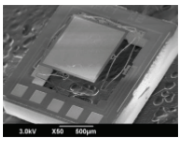
Kenta Nakazawa, Takashi Sasaki, Hiromasa Furuta, Jiro Kamiya, Hideki Sasaki, Toshikazu Kamiya and Kazuhiro Hane



The integration of a varifocal mirror with a scanner using wafer bonding technology is presented. The technology enables to enlarge the mirror diameter of the varifocal mirror while maintaining the driving frequency band width.

Th1.7 10.00 ***A Wide-angle Immersed MEMS Mirror and Its Application in Optical Coherence Tomography 187***

Xiaoyang Zhang, Liang Zhou, Can Duan, Dong Zheng, Sanjeev Koppal and Huikai Xie



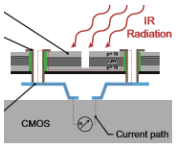
We report a wide-angle immersed two-axis electrothermal MEMS mirror and its utilization in 3D-OCT. The MEMS mirror immersed in mineral oil has a FOV of 75°, more than twice as much as 32° in air.

Coffee Break (10.15 – 10.45)

Th2. Parallel session 1: Optical MEMS VI
Time and Venue: 09.15 – 10.15, LT 7A
Chair: Prof. Minoru Sasaki, Toyota Technological Institute, Japan

Th2.1 10.45 ***Invited: Heterogeneous 3D Integration of MOEMS and ICs 189***

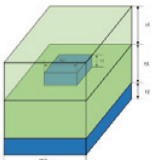
Frank Niklaus and Andreas C. Fischer



Heterogeneous integration of micro-opto-electromechanical systems (MOEMS) and integrated circuits (ICs) allows the combination of high-quality optical and photonic MOEMS materials such as monocrystalline silicon (Si) with standard CMOS-based electronic circuits in order to realize complex optical systems. In this paper, we will present examples of such heterogeneous optical systems, including CMOS-integrated SiGe bolometer arrays and CMOS-integrated Simicro-mirror arrays.

Th2.2 11.15 ***A Design for CMOS Infrared Metamaterial Absorbers for near Unity Absorpitivity 191***

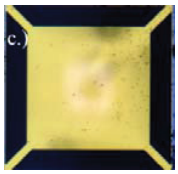
Zhengxi Cheng and Hiroshi Toshiyoshi



We design infrared metamaterial absorbers by using CSMC 0.5-μm and 0.18-μm CMOS technology. Absorption peaks appear in 2-5 μm waveband which is absent in SiO_2 absorption spectra, and absorption in 8-14 μm waveband is enhanced.

Th2.3 11.30 ***Power limits for non-destructive laser ablation of contaminants on micromachined structures 193***

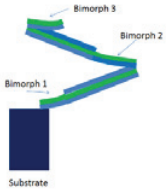
Andrew Brown, Merlin Mah and Joseph Talghader



The minimum and maximum laser irradiances that are effective in cleaning etch-released membranes and microstructure was measured for carbon microparticles on LPCVD silicon nitride thin films and suspended platforms. A 1064nm Nd:Yag laser was scanned across the samples to ablate the contaminants. Microscope images of the membranes showed mass removal for an irradiance as low as 600W cm^{-2}. More thorough cleaning was achieved by increasing the irradiance. For 2.5x2.5mm, 205nm thin silicon nitride membranes, 79% of the contaminated area was removed with an exposure of 3.7kW cm^{-2}. Catastrophic damage was seen at a power level of 8.4kW cm^{-2}. Ablation effects were also measured as a change in optical absorption using a photo thermal common-path interferometer. Peak absorption values were decreased from over 100,000 ppm to less than 20,000 ppm. Silicon nitride platforms were also tested. Despite significant substrate heating, the platforms survived intact up to power levels of 8.4kW cm^{-2} with near perfect cleaning of carbon particles from their surfaces.

Th2.4 11.45 ***A High Fill Factor 1×20 MEMS Mirror Array Based on Electrothermal Bimorph Actuators 195***

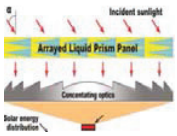
Qiao Chen, Jinling Ding and Huikai Xie



An electrothermally actuated 1×20 MEMS mirror array with the fill factor of 96% is proposed. Each electrothermally actuated micromirror can perform 2D scan. The thermal cross coupling is reduced by proper design.

Th2.5 12.00 ***Invited: Optofluidic Tunable Liquid Prisms 197***

Sung-Yong Park, Carlos Enrico Clement and Vinayak Narasimhan



A liquid prism is a popularly studied optofluidic device driven by electrowetting-on-dielectric (EWOD). Such a microfluidic technology allows a high degree of the tunability for optical control without any mechanical input. In this paper, we present liquid prisms fabricated with a high-capacitance ion gel dielectric and their potential applications of a tunable Fresnel lens and solar energy collection.

Th2.Parallel session 2: Optical MEMS VII
Time and Venue: 09.15 – 10.15, EA A
Chair: Prof. Hiroshi Toshiyoshi, University of Tokyo, Japan

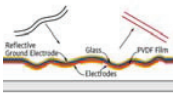
Th2.6 10.45 ***A Large-Piston Scanning Electrothermal Micromirror with a Temperature Control Frame 199***

Jiawen Luo, Zhiming Chen, Yingtao Ding, Qiao Chen, Jinling Ding, Jin Cheng and Huikai Xie

An electrothermal bimorph micromirror with integrated temperature control is presented. The central mirror plate position is controlled against the ambient temperature variation through a thermally-isolated frame with embedded Pt heaters and temperature sensors.

Th2.7 11.00 ***Piezoelectric PVDF Actuated, Lightweight Deformable Thin Mirror for Adaptive Optics 201***

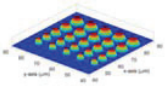
Kaustubh Banerjee, Pouya Rajaeipour, Çağlar Ataman and Hans Zappe



We present a light-weight deformable concept based on film-form glass and piezoelectric PVDF films compatible with a roll-to-roll compatible fabrication process. The feasibility of the approach is demonstrated through FEA simulations.

Th2.8 11.15 ***Unconventional Optical Responses of Wavelength-scale Microlenses: beyond Refraction Limit 203***

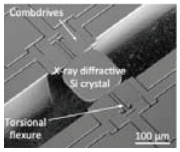
Myun-Sik Kim, Toralf Scharf, Hans Peter Harzig and Reinhard Voelkel



Miniaturized optical systems show often unconventional responses compare to larger systems of the same design. We investigate such new phenomena using microlenses, and demonstrate characteristics beyond the refraction limit of the micro-optical systems.

Th2.9 11.30 ***High Repetition-Rate X-Ray Pulse Selection at Synchrotron Sources 205***

Il Woong Jung, Zhilong Li, Ya Gao, Donald Walko, Jin Wang, Gopal Shenoy and Daniel Lopez

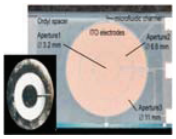


Hard x-ray research taking advantage of both the coherence and timing properties of next generation low- emittance storage rings will thrive in exploring the spatial and temporal correlations at the nanometer and nanosecond scales. Current gating technology with fast detectors and mechanical choppers will not be able to handle the high repetition-rates of these sources and requires the development of a fast gating device that can fill the needs of the timing community. Here, we introduce a MEMS device that has the potential to meet the current and future requirements of x-ray timing science. We demonstrate a device that is frequency matched to the operating sub-frequency of a high rep-rate bunch mode at the APS

(Advanced Photon Source) to select single pulses from the pulse train with separations of ~153 ns.

Th2.10 11.45 ***Depth-controlled Bessel Beams 207***

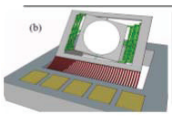
Angelina Müller, Matthias Christian Wapler and Ulrike Wallrabe



We present a ring aperture with independently switchable segments for the three-dimensional control of quasi propagation invariant beams. We demonstrate that our liquid crystal design concept preserves coherence and generates the Bessel beam structure.

Th2.11 12.00 ***A 2-Axis Electrothermal MEMS Micro-Scanner with Torsional Beam 209***

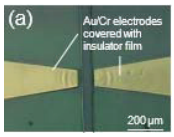
Quentin A.Tanguy, Can Duan, Wei Wang, Huikai Xie, Sylwester Bargiel, Przemyslaw Struk, Philippe Lutz and Christophe Gorecki



In this paper we introduce a 2-axis MEMS micro-scanner using a compact and optimized electrothermal bimorph actuator and a torsional beam to tip and tilt a dual-reflective mirror plate.

Th2.12 12.15 ***A micro plasma chip using dielectric barrier discharge 211***

Tomohiro Okada, Minoru Sasaki and Shinya Kumagai

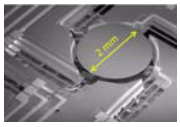


A micro plasma chip which used dielectric barrier discharge was developed. The micro plasma source achieved stable operation for 5 min under ambient conditions. Adjusting plasma generation conditions, reactive species can be changed

End of Day's Program

Po. Poster session 1
Time & Venue - 15.30 - 16.00 at EA A Lobby

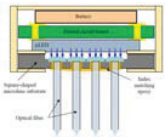
Po1.1 ***Wavelength Tuning of a Solid-State Laser with a Tilting MEMS Micromirror 213***



Alan Paterson, Ralf Bauer, Ran Li, Walter Lubeigt and Deepak Uttamchandani

Wavelength tuning of a Yb:KGW solid-state laser is presented using an electrothermally-actuated micromirror and a diffraction grating or dispersing prism. 27 nm and 7.5 nm tuning ranges are achieved using extracavity and intracavity configurations respectively.

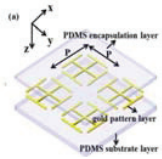
Po1.3 ***Square-shaped Glass Microlens Array for Fiber-optic Neurostimulation 215***



Sunghyun Yoo, Dae-Gon Kim, Hongkyun Lee, Sang Beom Jun, Yong-Kweon Kim and Chang-Hyeon Ji

We present a square glass microlens array for the improvement of light transfer efficiency of the fiber-optic neural probe. Optimal design has been derived using finite element analysis and fabricated microlens array has been analyzed.

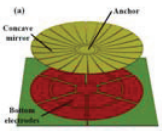
Po1.5 ***Ultrathin Flexible Sensor in Curving Terahertz Metamaterial 217***



Xiaoqing Zhao, Bin Yang, Jingquan Liu, Prakash Pitchappa, Dihan Hasan, Chong Pei Ho, Chunsheng Yang and Chengkuo Lee

In this work, we present a multiband flexible metamaterial with one of the resonance acting as a strain sensor, while the other resonances remain unchanged with bending strain, that might occur due to wrapping around irregular curved surface. And the first resonance frequency 0.51THz of the horizontal dipole blue shifts by 6.4GHz, or about 1.29%, and the relative intensity change in transmission of 31.95% was achieved when the strain was 2.79‰. This study promises applications in curvature sensing and other controllable metamaterial-based devices.

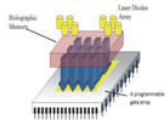
Po1.6 ***Radially-Segmented Micromirror With Surface Shaping Ability 219***



Cheng-You Yao, Chao-Ching Ku and Jui-Che Tsai

We propose a radially-segmented micromirror with surface shaping ability. It is designed to combine the scanning and variable focusing functions, which is useful for applications such as optical imaging.

Po1.7 ***Radiation tolerance of a MEMS mirror device 221***

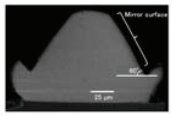


Takumi Fujimori and Minoru Watanabe

This paper presents experimentally obtained results demonstrating the radiation tolerance of a MEMS mirror device. The radiation tolerance was confirmed as 170 Mrad or higher total-ionizing dose tolerance.

Po1.8 ***Simultaneous Molding and Low-Temperature Bonding of Au Microstructures for Fabrication of Micromirrors on Non-Silicon Substrates 223***

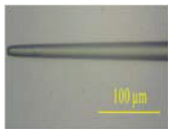
Seiya Matsuoka, Eiji Higurashi, Tadatomo Suga and Renshi Sawada



In order to realize micromirrors on non-silicon substrates, simultaneous molding and low-temperature bonding (150 °C) of Au microstructures was demonstrated using a glass mold as a bonding tool.

Po1.9 ***The Making of a Fiber Tip Vibration Sensing Device 225***

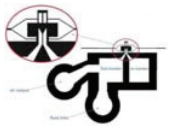
Fang-Wen Sheu and Cheng-Wei Lin



We sealed a flat-end fiber docking with a fiber tip in a capillary tube to form a vibration sensing device. It can detect the frequency of the driving sound wave from the received light intensity.

Po1.10 ***Design and feasibility of a new optofluidic intereferometer 227***

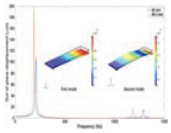
Mohsen Ataei, Peyman Mobini, Ali Sabaghifar and Hadi Veladi



A novel interferometer is proposed based on optofluidics technology on polymer substrates. The device is a modified Mach-Zehnder interferometer with liquid-core waveguides and provide Sync-shape interferogram in 1-2 μm range of wavelengths.

Po1.11 ***Vibration-excitation Method for Measuring the Mass Sensitivity of a Macro-scale PZT Bimorph Cantilever 229***

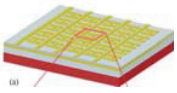
Faezeh Arab Hassani and Chengkuo Lee



The micro g/Hz mass sensitivity of a macro-scale PZT bimorph cantilever has been measured by using a vibration-excitation method in its second mode of resonance by using experimental and numerical methods.

Po1.12 ***Hybrid Metamaterial Absorber with Broadband Visiable Light Harvesting 231***

Guoqiang Chen, Guangya Zhou and Fook Siong Chau

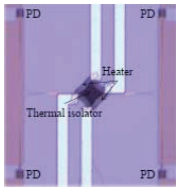


We report a hybrid MPA with broadband response in visible rang. It shows normalized absorption of 0.88 in the range of 330–650 nm. This metamaterial offers potential for development of photon harvesting and photovoltaics.

Po. Poster session 2
Time & Venue - 15.30 - 16.00 at EA A Lobby

Po2.1 ***Coherent receiver for DP-QPSK on the SOI platform 233***

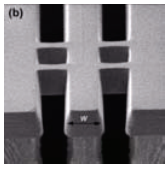
Lianxi Jia, Tsung-Yang Liow, Xianshu Luo, Xiaoguang Tu, Chao Li, Mingbin Yu and Guoqiang Lo



A coherent receiver for DP-QPSK signal is fabricated on SOI. The 90 degree hybrid shows loss smaller than 4dB, CMRR lower than -25dB and phase deviation lower than 5 degree from 1525 to 1605nm. The PR converts the TM to TE with insertion loss lower than 0.8dB.

Po2.2 ***Low loss suspended coupler for coupling to laser diode 235***

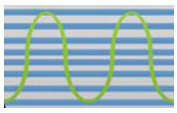
Chao Li, Xiaoguang Tu, Koh Sing Chee and Guo-Qiang Lo



We demonstrated a low loss silicon suspended coupler for coupling to DFB laser diode with wide tolerance. The measured insertion loss is ~3.5 dB. The alignment tolerance is >±0.7 μm for 1 dB excess loss.

Po2.3 ***Tunable Optical Delay Line Using Quadratic-Coupled Waveguide Lattices 237***

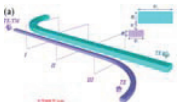
Tenghao Li, Qingming Chen and Xuming Zhang



A broadband variable optical delay line is proposed based on the discrete harmonic oscillation in waveguide lattices with a quadratic distribution of coupling coefficients. Theoretical analysis and numerical simulations are performed with the sample design.

Po2.4 ***Three-Dimensional Polarization Splitter and Rotator Based on Multi-layer Si3N4-on-SOI Platform 239***

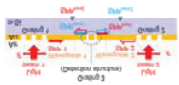
Kang Tan, Ying Huang, Guo-Qiang Lo, Chengkuo Lee and Changyuan Yu



We propose a three-dimensional polarization splitter and rotator with high fabrication tolerance and CMOS BEOL compatibility, achieving a high TE-TE transmission and TM-TE conversion efficiency of -0.21dB and -0.63dB at 1310nm, respectively.

Po2.5 ***Behavior of surface plasmon polaritons on multi-plasmonic waveguides 241***

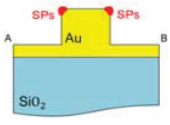
Yutaro Nakayama, Shinya Okahisa, Yuya Ishii and Mitsuo Fukuda



We investigate the detection efficiency of a metallic-grating-based plasmonic detector composed of a Schottky diode and multiple plasmonic waveguides. We then demonstrate a metal-oxide-semiconductor field-effect transistor that includes the plasmonic detector and two plasmonic waveguides.

Po2.6 ***Plasmonic intensity modulator using superfocusing modes in tapered metallic waveguide 243***

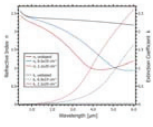
Takahiro Furuki, Masashi Ota, Ryo Watanabe, Yuya Ishii and Mitsuo Fukuda



We demonstrate a plasmonic intensity modulator using plasmonic superfocusing. The device comprises a metallic taper and a nanoscale waveguide. Its 10.8 dB extinction ratio is confirmed by controlling the phase difference between two input plasmons.

Po2.7 ***Characterization of Highly-Doped GaN as a New Material for Plasmonic Applications 245***

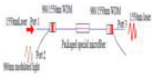
Lukas Wetterau, Lingaparthi Ravikiran, Nethaji Dharmarasu, K Radhakrishnan, Manvi Agrawal and Thomas Kusserow



Optical properties of highly doped GaN layers are presented. Samples with different carrier concentrations were grown by PA-MBE and characterized by VASE. The resulting isotropic and anisotropic complex refractive indices are discussed for plasmonic applications.

Po2.8 ***Optical Fiber Acoustic Sensor with an All-optical Phase Modulator based on Special Optical Microfiber 247***

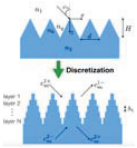
Xueliang Zhang, Zhangqi Song, Yuzhong Chen and Zhou Meng



An optical fiber acoustic sensor with improved all-optical phase modulator based on special optical microfiber is introduced, which can realize all-fiber structure through remotely intensity-modulating the modulator with a semiconductor laser with 980nm wavelength.

Po2.9 ***Numerically Stable and Physically Intuitive Analysis of Diffracting and Subwavelength Non-rectangular Shape Gratings 249***

Shuai Li, Changhe Zhou and George Barbastathis



We propose and demonstrate a physically intuitive formulation of Simplified Modal Method (SMM) that can be applied for the analysis of diffracting and subwavelength gratings of non-rectangular shapes at arbitrary angles of incidence.

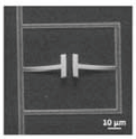
Po2.10 ***Improvement in Environmental Reliability of Amorphous Indium-Gallium-Zinc-Oxide Thin-Film Transistors by CF4 Plasma Treatment 251***

Fan-Ping Tseng and Ching-Lin Fan

In this work, the environmental reliability of the a-IGZO TFTs was improved by CF4 plasma treatment. The TFTs were fabricated without passivation layer to exam the reliability in air ambience. For the untreated a-IGZO TFTs stressed under the negative bias stress (NBS) voltage VNBS = -10 V, the transfer characteristics show significantly increased subthreshold swing (S.S) and off current with increasing of time, which indicated that the TFT was heavily affected by H2O molecules from air ambience. Compared to the untreated a-IGZO TFTs, the smaller increased values of S.S and off current in the TFTs with CF4 plasma treatment was observed. The smaller S.S indicated that there are fewer interface traps between IGZO/SiO2 interface. In addition, the smaller increased off current indicated that the resistivity degradation by H2O molecules was smaller than untreated a-IGZO TFTs. As a result, the CF4 plasma treatment can effectively improve the a-IGZO TFTs environmental reliability under gate voltage stress.

Po2.11 ***Digitally reconfigurable binary coded terahertz metamaterial with output analogous to NOR and AND 253***

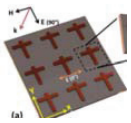
Chong Pei Ho, Prakash Pitchappa and Chengkuo Lee



We demonstrate a digitally reconfigurable binary coded terahertz metamaterial with isolated control in adjacent meta-bits. The transmission output is analogous to NOR and AND logic and will aid in the development towards dynamically programmable metamaterial.

Po2.12 ***Polarization Controllable Multispectral Symmetry-Breaking Absorber in Mid-infrared 255***

Nan Chen, Prakash Pitchappa, Chong Pei Ho, Dihan Hasan, Piotr Kropelnicki, Massimo Alioto and Chengkuo Lee



This work presents the polarization control of interchangeable multispectral absorption based on the dual-band metamaterial absorber in split mode. Large modulation depth of absorption is obtained during multi-band transition through polarization control.