

## Poster Session II (Exhibition Hall / Thursday, 27 August, 13:45~15:15)

### [27P-1] Terahertz Wave Modulators in Organic/Si Bilayers

Hyung Keun Yoo<sup>1</sup>, In-Wook Hwang<sup>1</sup>, Jung-Min Park<sup>2</sup>, and Joong Wook Lee<sup>2</sup>

<sup>1</sup>GIST, Korea, <sup>2</sup>Chonnam National University, Korea

We realized optically controllable active terahertz (THz) modulators with extremely high modulation efficiencies, using organic/silicon hybrid structures. The rapid photo-induced electron transfer in thermally annealed C<sub>60</sub>/silicon bilayers enables the realization of modulation efficiency up to 98%. Furthermore, we demonstrate the broadband modulation of THz waves due to the change cutoff condition caused by the formation of efficient charge separation by the photo-excitation in the structures. The realization of near-perfect modulation efficiency of THz waves opens up the possibilities of utilizing active modulators for THz spectroscopy and communications.

### [27P-2] Terahertz Multi-mode Resonances in T- and I<sup>-</sup>-shaped Resonators

Myeong-Seong Song<sup>1</sup>, In-Seong Lee<sup>1</sup>, Jin-Kyu Yang<sup>2</sup>, and Joong Wook Lee<sup>1</sup>

<sup>1</sup>Chonnam National University, Korea, <sup>2</sup>Kongju National University, Korea

We demonstrate the characteristics of multi-mode resonance in coupled resonators with multi-slots. Our results show that the multi-mode resonance is caused by the structural complicity of the multi-slot coupled resonators. Each resonance mode corresponds to each distribution of electric charges determined by the structural dimensions.

### [27P-3] Nondestructive and Remote Diagnosis on Coated Metal Surface by THz Imaging

Takashi Kimura, Seiya Takahashi, Kensaku Maeda, and Yutaka Oyama

Tohoku University, Japan

THz wave technique is available for nondestructive diagnosis on invisible metal surface covered with opaque coating and/or painting. The demonstrations are successfully conducted in which samples are insulated copper cable and hot-dip galvanized steel sheet.

### [27P-4] Non-destructive Measurement of Water Contents in Polyethylene Films by THz Time Domain Spectroscopy

Yasumasa Matsuoka, Kenji Sakai, Toshihiko Kiwa, and Keiji Tsukada

Okayama University, Japan

Transmittance change of low-density polyethylene films during drying process were measured by THz-TDS. The results suggest that the quantity of water molecules in films were estimated by evaluating the magnitude of absorption peaks.

### [27P-5] New Organic Electro-Optic Crystals for Highly Efficient Optical-to-THz Conversion

Seung-Heon Lee, Bong-Joo Kang, Ji-Soo Kim, Fabian Rotermund, and O-Pil Kwon

Ajou University, Korea

New organic electro-optic crystals based on acentric core OHQ exhibit excellent nonlinear optical properties and crystal characteristics, which show one order of magnitude higher THz generation efficiency than inorganic ZnTe.

### [27P-6] THz Near-field Spectral Encoding Imaging Using a Rainbow Metasurface

Kanghee Lee, Hyun Joo Choi, Jaehyeon Son, Hyun-Sung Park, Jaewook Ahn, and Bumki Min  
KAIST, Korea

We develop a spectral encoding image technique in the terahertz range using a space-frequency converting metasurface. From our developed technique, 2-dimensional images are successfully reconstructed using only 1-dimensional data acquisition processes.

### [27P-7] Adaptive Sampling, Terahertz Dual Comb Spectroscopy Using Unstabilized Dual Lasers

Tatsuya Mizuguchi<sup>1</sup>, Ryuichi Ichikawa<sup>1</sup>, Takuma Matsumoto<sup>1</sup>, Yi-Da Hsieh<sup>1,2</sup>, Kaoru Minoshima<sup>2,3</sup>, Hajime Inaba<sup>2,4</sup>, and Takeshi Yasui<sup>1,2</sup>

<sup>1</sup>Tokushima University, Japan, <sup>2</sup>JST, Japan, <sup>3</sup>The University of Electro-Communications, Japan, <sup>4</sup>National Institute of Advanced Industrial Science and Technology, Japan

Terahertz (THz) dual comb spectroscopy (DCS) is a promising method for high-accuracy, high-resolution, broadband THz spectroscopy. In this paper, we have demonstrated adaptive-sampling THz-DCS, allowing the use of unstabilized dual femtosecond lasers.

### [27P-8] Phase Modulation of Terahertz Waves in Arrayed Nanowire Heterojunction Diode

Jong-Hyuk Yim<sup>1</sup>, Sang Hyuk Park<sup>1</sup>, Jeong Woo Hwang<sup>2</sup>, Sang-Bae Choi<sup>1</sup>, Jung-Hong Min<sup>1</sup>, Dong-Seon Lee<sup>1</sup>, Jae Cheol Shiri<sup>2</sup>, and Young-Dahl Jho<sup>1</sup>

<sup>1</sup>GIST, Korea, <sup>2</sup>KOPTI, Korea, <sup>3</sup>Yeungnam University, Korea

We demonstrate how the phase of terahertz (THz) waves could be electrically manipulated in one-dimensional nanostructures such as InAs<sub>0.75</sub>P<sub>0.25</sub>-InP core-shell nanowires (NWS).

### [27P-9] Enhanced Terahertz Transmission through Graphene on Slit Antenna

Hyun-Deok Yoo, Jong-Hyuk Yim, Ik-Bu Sohn, Hun-Kook Choi, and Young-Dahl Jho

GIST, Korea

We observed enhanced terahertz (THz) transmission by implementing visible excitation in bilayer graphene transferred on a metal slit which was designed for funneling THz field.

### [27P-10] Various Photoconductive Antennas for Efficient Terahertz Detection

Won Tae Kim<sup>1</sup>, Bong Joo Kang<sup>1</sup>, Truong Khang Nguyen<sup>1</sup>, Hyeon Sang Park<sup>2</sup>, Kang Ho Kim<sup>1</sup>, Jae Jin Lee<sup>1</sup>, Ik Mo Park<sup>1</sup>, Tae In Jeon<sup>2</sup>, and Fabian Rotermund<sup>1</sup>

<sup>1</sup>Ajou University, Korea, <sup>2</sup>Korea Maritime University, Korea

We propose three different photoconductive antenna designs applicable as efficient THz receiver and investigate their detection properties. The experimental results showing different characteristics of spectral sensitivity and gain agree very well with the theoretical prediction.

### [27P-11] Terahertz Wavefront Characterization Using a Hartmann Sensor Combined with 2D Electro-Optic Imaging

Harsono Cahyadi<sup>1</sup>, Jérôme Deger<sup>2</sup>, Eric Freysz<sup>2</sup>, Takeshi Yasui<sup>1</sup>, and Emmanuel Abraham<sup>2</sup>

<sup>1</sup>The University of Tokushima, Japan, <sup>2</sup>Bordeaux University, France

Two-dimension electro-optic imaging combined with a Hartmann sensor enables THz wavefront characterization in time- and frequency-domain without cross-section scanning. Reconstruction with Zernike polynomials method allows qualitative and quantitative analysis as additional advantages.

### [27P-12] Gas-Phase Spectroscopy Using THz Frequency Synthesizer Based on Dual Optical Combs

Yi-Da Hsieh<sup>1,2</sup>, Kenta Hayashi<sup>1</sup>, Hajime Inaba<sup>2,3</sup>, Kaoru Minoshima<sup>2,4</sup>, and Takeshi Yasui<sup>1,2</sup>

<sup>1</sup>Tokushima University, Japan, <sup>2</sup>JST, Japan, <sup>3</sup>The University of Electro-Communications, Japan, <sup>4</sup>National Institute of Advanced Industrial Science and Technology, Japan

We constructed a THz frequency synthesizer based on photomixing of two continuous-wave lasers phase-locked to dual optical combs, and applied it for precision spectroscopy of molecular gas at low pressure.

### [27P-13] Analysis of Fano Coupling in Terahertz Sub-wavelength Hole Arrays with Coupled Oscillator Model

Shan Yin<sup>1</sup>, Xinchao Lu<sup>2</sup>, Ningning Xu<sup>2</sup>, Yiwen E<sup>1</sup>, Weili Zhang<sup>3</sup>, and Li Wang<sup>1</sup>

<sup>1</sup>Chinese Academy of Sciences, China, <sup>2</sup>Institute of Microelectronics of Chinese Academy of Sciences, China, <sup>3</sup>Oklahoma State University, USA

Firstly employing coupled oscillator model to quantitatively analyze the Terahertz enhanced transmission through sub-wavelength hole arrays, we clarify the surface plasmons resonance is excited by the localized resonance via coupling instead of the external E-field.

### [27P-14] Measuring the Both Surfaces Profiles of Optical Element Using Transmission Deflectometry with Liquids

Sanghoon Shin and Younghun Yu

<sup>1</sup>KEPCO KPS, Korea, <sup>2</sup>Jeju National University, Korea

We propose a method for simultaneously measuring the front and back surface profiles of transparent optical components. The proposed method combines dual wavelength transmission deflectometry with liquids to record distorted phases at different wavelengths, and then numerically reconstructs the three-dimensional phase information to image the front and back surfaces of the bifocal lens.

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**[27P-15] Enhanced Optical Absorption in VO<sub>2</sub> Film Using Photonic Crystal**

Zhe Wang, Wei Hong, Qian Chen, Guohua Gu, and Jun Lu  
Nanjing University of Science and Technology, China

A VO<sub>2</sub> film with photonic crystal (PC) pattern is investigated and the optical absorption enhancement is significantly enhanced in near IR band. The structural parameters for PC are optimized to get a better performance.

**[27P-16] Spectral Dependence of Photovoltaic Cell Conversion Efficiency for Monochromatic Radiation**

Minato Takesawa and Terubumi Saito  
Tohoku Institute of Technology, Japan

Photovoltaic cell conversion efficiencies for quasi-monochromatic radiation have been measured as a function of the wavelength. It has been proven that the conversion efficiency is nearly proportional to the wavelength of the input radiation as the theory predicts. Also, it has been shown that the efficiency increases as a logarithmic function of the input irradiance. In conclusion, highest conversion efficiency is realized by illuminating a photovoltaic cell by intense radiation of low energy photons close to the bandgap energy while satisfying sufficient absorption.

**[27P-17] Stress-induced Optical Rotation in CVD-grown Diamond**

Hadiya Jasbeer, Robert Williams, Ondrej Kitzler, Jipeng Lin, Aaron McKay, and Richard Mildren  
Macquarie University, Australia

Defect induced stress birefringence in CVD grown diamond has been investigated using Metripol and Mueller polarimetry. Optical rotation was observed, up to a maximum of 28° through an 8 mm long diamond sample, in addition to linear birefringence.

**[27P-18] Broadband Soft Glass Photonic Crystal Fiber Polarization Splitter**

Zhenkai Fan and Shuguang Li  
Yanshan University, China

We report on a novel soft glass dual-core photonic crystal fiber (DC-PCF) with a chalcogenide glass core, whose polarization dependent coupling can be enhanced by the high refractive index As<sub>2</sub>S<sub>3</sub> core. Numerical results demonstrate the designed soft glass DC-PCF application as a broadband polarization splitter.

**[27P-19] Broadband, Ultrahigh-Sensitivity Plasmonic Antennas Prepared from Nanoparticles on Imprinted Mirrors**

Yi-Chuan Tseng, Chen-Chieh Yu, Pao-Yun Su, Keng-Te Lin, Chang-Ching Shao, Sin-Yi Chou, Yu-Ting Yen, and Hsuen-Li Chen  
National Taiwan University, Taiwan

We developed a low-cost and direct imprint-in-metal method to prepare incident angle-tuned, broadband, ultrahigh-sensitivity plasmonic antennas from nanoparticles (NPs) and imprinted-metal mirrors that can detect analytes at concentrations as low as 10<sup>-15</sup> M.

**[27P-20] Spatial Mode Projection Technique in Extracting Nanofeatures**

Nestor Jr. Bareza and Nathaniel Hermosa  
University of the Philippines, Philippines

We propose a technique based on spatial mode projection that can access dimensional information of nanofeatures. We demonstrate this by calculating the power of a mode-projected Gaussian beam that has been reflected by a nanocylinder.

**[27P-21] Analytical Modeling of a Linear Variable Filter for Hyperspectral Sensing**

Cheng-Hao Ko<sup>1</sup>, Kuei-Ying Chang<sup>1</sup>, You-Min Huang<sup>1</sup>, Jih-Run Tsai<sup>2</sup>, and Bang-Ji Wang<sup>2</sup>  
<sup>1</sup>National Taiwan University of Science and Technology, Taiwan, <sup>2</sup>National Space Organization, Taiwan

An analytical thin film thickness model calculates the profiles of linear variable filters, which perform spectral filtering. Coupled with an image sensor and using a computational algorithm, this device becomes a LVF-hyperspectral imager.

**[27P-22] Development of a Transmissometer for Meteorological Visibility Measurement**

Seongchong Park, Dong-Hoon Lee, and Yong-Gyoo Kim  
KRISS, Korea

We developed a 62 m-baseline transmissometer to establish the national standard on visibility observation. A 75 W, white LED with 3000 K CCT1 is used for transmitter, and two photometers for receiver and monitor.

**[27P-23] Phase Relations between the Reflected and Transmitted Light Waves at Beam Splitters**

Jueun Park, Byung Woo Son, Hee Joo Choi, and Myoungsik Cha  
Pusan National University, Korea

We investigated the phase relations between the reflected and the transmitted light waves at beam splitters made of lossless dielectric stacks. Definite phase relations exist dictated by the generalized Stokes relations irrespective of the detailed layer structure of the beam splitter. We verified it numerically for two representative beam splitters with symmetric and asymmetric layer structures, respectively.

**[27P-24] Dual Optical Comb Spectroscopy Using Modified Adaptive Sampling Method**

Shuji Miyamoto<sup>1</sup>, Yi-Da Hsieh<sup>1,2</sup>, Kohei Kotani<sup>1</sup>, Sho Okubo<sup>2,3</sup>, Hajime Inaba<sup>2,3</sup>, and Takeshi Yasui<sup>1,2</sup>  
<sup>1</sup>Tokushima University, Japan, <sup>2</sup>Japan Science and Technology Agency, Japan, <sup>3</sup>National Institute of Advanced Industrial Science and Technology, Japan

We apply a modified adaptive sampling method for dual optical comb spectroscopy in order to make signal integration of interferogram in time domain for improvement of signal-to-noise ratio.

**[27P-25] 30 GHz Spaced Astro-comb for Low Resolution Astronomical Spectrographs**

Yuxuan Ma<sup>1</sup>, Yizhou Liu<sup>1</sup>, Ziyun Kong<sup>1</sup>, Fei Zhao<sup>2</sup>, Chen Li<sup>1</sup>, Tongxiao Jiang<sup>1</sup>, Aimin Wang<sup>1</sup>, Gang Zhao<sup>2</sup>, and Zhigang Zhang<sup>1</sup>  
<sup>1</sup>Peking University, China, <sup>2</sup>Chinese Academy of Sciences, China

We demonstrate an astro-comb for relatively low resolution astronomical spectrographs. The space of comb lines is filtered to 30 GHz by a Fabry-Perot cavity spaced by an ULE glass. The radial velocity precision is <40 cm/s.

**[27P-26] Highly Stabilized Fiber-based Optical Frequency Comb Interferometer with Meters-wide Scanning Range by Frequency Tuning**

Yoshiaki Nakajima<sup>1,2</sup> and Kaoru Minoshima<sup>1,2</sup>

<sup>1</sup>The University of Electro-Communications, Japan, <sup>2</sup>Japan Science and Technology Agency, Japan

We developed a fiber-based optical frequency comb interferometer with fiber noise cancellation technique. Long reference path was stabilized to nm-level, and extremely wide length scanning range of 2.8-m was demonstrated only by repetition frequency tuning.

**[27P-27] Application of Raman Spectroscopy in Detection of Aflatoxin B1 in Maize Kernels**

Mary S. Taabu, Zephania Birech, and Kenneth Kaduki  
University of Nairobi, Kenya

Use of Raman spectroscopy in detecting aflatoxin B1 (AFB1) in maize kernels is reported. Distinct difference between AFB1 contaminated and uncontaminated kernels were observed from Raman spectral profiles obtained after 532 nm excitation.

**[27P-28] Seeking Null Frequencies by Autocorrelation of Spectrum of Interference Signal**

Nian Fang, Lutang Wang, and Zhaoming Huang  
Shanghai University, China

In order to locate accurately external disturbances in a Sagnac interferometer fiber sensing system, a seeking null frequencies method of calculating autocorrelation of frequency spectrum of interference signal is proposed and demonstrated by software simulation.

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### [27P-29] Stress Induced Bend Compensation in a Large Mode Area Fiber

Xuan Wu, Huizi Li, and Seongwoo Yoo  
Nanyang Technological University, Singapore

Large mode area fiber with pre-compensated index profile by asymmetric stress applying part is proposed to effectively cancel out the bending effects. Mode area scalability up to  $\sim 2500 \mu\text{m}^2$  is presented.

### [27P-30] Fibre Fabrications for High Power Laser Fibres and High Nonlinearity Fibres

Seongwoo Yoo, Sidharthan Raghuraman, Daryl Ho, Men Seng Yee, Xuan Wu, and Liling Zhang  
Nanyang Technological University, Singapore

This paper presents fibre fabrications to achieve asymmetric core fibre for high power laser applications and high-nonlinearity fibres for Raman scattering. Fabrication results and challenges are discussed.

### [27P-31] Theoretical Study of Deep Laser Cooling of Magnesium Atoms

Oleg Prudnikov<sup>1</sup>, Denis Brazhnikov<sup>1,2</sup>, Anatoly Bonert<sup>2</sup>, Andrei Goncharov<sup>2,3</sup>, Roman Il'enkov<sup>2</sup>, Alexey Taichenachev<sup>1,2</sup>, and Valery Yudin<sup>1,2,3,4</sup>

<sup>1</sup>Novosibirsk State University, Russia, <sup>2</sup>Institute of Laser Physics SB RAS, Russia, <sup>3</sup>Novosibirsk State Technical University, Russia, <sup>4</sup>Russian Quantum Center, Russia

The two-stage laser cooling strategy for <sup>24</sup>Mg is proposed. The calculations based on quantum treatment with full account for the recoil effect. The results can assist overcoming current difficulties in deep laser cooling of magnesium.

### [27P-32] Discrete Rogue Waves in an Array of Waveguides

Cem Yuce and S. Efe  
Anadolu University, Turkey

We study discrete rogue waves in an array of nonlinear waveguides. We show that very small degree of disorder due to experimental imperfection has a deep effect on the formation of discrete rogue waves. We predict long-living discrete rogue wave solution of the discrete nonlinear Schrödinger equation.

### [27P-33] Sub-Doppler DAVLL for D Lines of Rb Atoms

Gyeong-Won Choi and Heung-Ryoul Noh  
Chonnam National University, Korea

A theoretical and experimental study of lineshapes in sub-Doppler DAVLL (dichroic atomic vapor laser lock) spectroscopy for the D lines of Rb atoms was presented. From the calculation of sub-Doppler DAVLL spectra using both density matrix equations and rate equations we found that the coherence effect depended significantly on the branching ratios of the transition lines. We also investigated the dependence of the amplitude and the slope of the spectra on the magnetic field and the pump beam intensity, and found good agreement with the results calculated from the rate equation.

### [27P-34] Propagation of the Light Phase Pulses in Atomic $\Lambda$ -type Medium Under EIT Conditions

Maksim Basalae<sup>1,3</sup>, Oleg Prudnikov<sup>1</sup>, Alexey Taichenachev<sup>1,2</sup>, and Valery Yudin<sup>1,3</sup>

<sup>1</sup>Novosibirsk State University, Russia, <sup>2</sup>Institute of Laser Physics SB RAS, Russia, <sup>3</sup>Novosibirsk State Technical University, Russia

We study the dynamics of the phase pulses of laser radiation with two resonant frequency components propagating in an atomic three-level medium. We show that the effect of great slowing-down occurs also for phase pulses.

### [27P-35] Protecting Quantum Discord Using Weak Measurement and Quantum Measurement Reversal

Jiwon Yune<sup>1</sup>, Kang-Hee Hong<sup>2</sup>, Hyang-Tag Lim<sup>2</sup>, Jong-Chan Lee<sup>2</sup>, Osung Kwon<sup>1</sup>, Sang-Wook Han<sup>1</sup>, Sung Moon<sup>1</sup>, Yong-Su Kim<sup>1</sup>, and Yoon-Ho Kim<sup>2</sup>

<sup>1</sup>KIST, Korea, <sup>2</sup>POSTECH, Korea

We report that quantum discord can be protected from decoherence by making use of weak and reversing quantum measurements, making it possible to distribute quantum correlation between two remote parties in noisy environment.

### [27P-36] Generation of Time-Bin Entangled Photon Pairs Utilizing Coherence Revival Property of a CW Multi-mode Laser

Osung Kwon<sup>1</sup>, Kwang-Kyoon Park<sup>2</sup>, Young-Sik Ra<sup>2</sup>, Yong-Su Kim<sup>1</sup>, and Yoon-Ho Kim<sup>2</sup>  
<sup>1</sup>KIST, Korea, <sup>2</sup>POSTECH, Korea

We report another regime for generation of time-bin entangled photon pairs and demonstrate the scheme experimentally. In our scheme, the photon pairs are pumped by a cw multi-mode laser having coherence revival property.

### [27P-37] The Quantum Problem of Laser Cooling of Two-level Atoms: Statistical Approach

Roman Il'enkov<sup>1,2</sup>, Oleg Prudnikov<sup>1</sup>, Alexey Taichenachev<sup>1,2</sup>, and Valery Yudin<sup>1,3</sup>

<sup>1</sup>Novosibirsk State University, Russia, <sup>2</sup>Institute of Laser Physics SB RAS, Russia, <sup>3</sup>Novosibirsk State Technical University, Russia

Developed a statistical approach, which provides information about the cooling time of an atomic ensemble without directly solving a dynamic problem. The effect of velocity saturation of laser cooling with increasing Rabi frequency was found.

### [27P-38] Avoiding Entanglement Sudden Death on Two-qubit Systems Using Single-qubit Quantum Measurement Reversal

Hyang-Tag Lim, Jong-Chan Lee, Kang-Hee Hong, and Yoon-Ho Kim  
POSTECH, Korea

Decoherence on two-qubit systems degrades entanglement, and sometimes even causes entanglement sudden death (ESD). We show that quantum measurement reversal on only one subsystem can avoid ESD, providing methods for practical entanglement distribution under decoherence.

### [27P-39] Apparatus for Generating Quantum Degenerate Gases of Ytterbium Atoms

Min-Seok Kim, Moosong Lee, Jeong Ho Han, and Yong-Il Shin  
Seoul National University, Korea

We present an experimental apparatus where we can generate a Bose-Einstein condensate of  $6.2 \times 10^4$  174Yb atoms or a degenerate Fermi gas of  $7.8 \times 10^4$  173Yb atoms at  $T/T_F=0.31$ .

### [27P-40] Cotrollable Asymmetric Matter-wave Beam Splitter and Ring Potential on an Atom Chip

Seung Jin Kim<sup>1</sup>, Seok Tae Gang<sup>1</sup>, Hoon Yul<sup>2</sup>, and Jung Bog Kim<sup>1</sup>

<sup>1</sup>Korea National University of Education, Korea, <sup>2</sup>University of Colorado, USA

We have constructed an asymmetric matter-wave beam splitter and a ring potential on an atom chip by applying rf-field parallel to the quantization axis added to perpendicular rf-fields. Versatile controllability on the potentials can be obtained.

### [27P-41] Quantum Key Distribution with Mode-locked Two-photon States

Tomoyuki Horikiri  
Yokohama National University, Japan

Quantum key distribution (QKD) with mode-locked two-photon states is discussed. The photon source with a combined second-order correlation function is shown to be useful for implementing long distance time-energy entanglement QKD.

### [27P-42] Two-photon Interference between Distinguishable Pathways Utilizing SPDC Pumped by a Multimode Diode Laser

Osung Kwon, Yujun Choi, Young-Su Kim, Sang Wook Han, and Sung Moon  
KIST, Korea

We report the two-photon interference between distinguishable pathways before arriving at two detectors utilizing SPDC pumped by a multimode diode laser with the distinctive coherence property.

### [27P-43] Polymer Planar Optical Waveguides for Optical Interconnections

Vaclav Prajzler<sup>1</sup>, Pavla Nekvindová<sup>2</sup>, Petr Hyps<sup>1</sup>, Jan Brychta<sup>1</sup>, and Vitezslav Jerabek<sup>1</sup>

<sup>1</sup>Czech Technical University, Czech, <sup>2</sup>Institute of Chemical Technology, Czech

The paper reports on technology for realization of an optical planar waveguides for optical interconnections. The waveguiding properties were measured by dark mode spectroscopy and optical loss were measured by the fiber probe technique.

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**[27P-44] Circular Polarization Filters Using Perturbed Chiral Sculptured Thin Films**

Zahir Muhammad  
Quaid-i-Azam University, Pakistan

A structurally chiral layer defect or central 90° twist-defect in chiral sculptured thin film (STF) transmits light of one circular polarization state and reflect other in a spectral Bragg regime. The perturbed chiral STF reflects light of both circular polarization states in the Bragg regime if the amplitude of modulation of vapor incident angle is increases. A structurally chiral layer defect in a perturbed chiral STF results as a narrow bandpass or ultranarrow bandstop filter depending upon different thickness of the STF. However, both the bandpass or narrow bandpass and ultranarrow bandstop filters are made polarization-insensitive by the appropriate modulation of the tilt nanohelices of perturb chiral STF. Moreover, it is also observed that the polarization-insensitive Bragg mirrors, laser mirror and Bragg reflector fabricated using chiral STFs, which are very tolerant of structurally chiral layer defect if the amplitude of modulation vapor incident angle of the structural nano-materials is sufficiently large.

**[27P-45] Transmission of Laser Light Through Tapered Glass Capillaries for Microbeams**

Wei-Guo Jin<sup>1</sup>, Sou Kawamura<sup>1</sup>, Yuya Ito<sup>1</sup>, Tatsuya Minowa<sup>1</sup>, and Tokihiro Ikeda<sup>2</sup>  
<sup>1</sup>Toho University, Japan, <sup>2</sup>RIKEN, Japan

Propagation and transmission of laser beam through tapered glass capillary were investigated for light microbeams. Transmittances of laser light at 488 nm and 633 nm through capillaries were measured to be up to 15 %, depending on outlet diameters. By modeling the real capillary, transmittances were calculated using taper angles obtained from shape analysis and agree well with experimental ones.

**[27P-46] Tunable Chirality Indouble-layer Metamaterials**

Yu Zhu  
Peking University, China

An all-optical tunable chirality is realized in a doublelayer photonic metamaterial. The maximum circular dichroism reached 30%. Under excitation of a 40 kW/cm<sup>2</sup> weak pump light, the peak in the circular dichroism shifts 45 nm in the short-wavelength direction and an ultrafast response time of 35 ps is maintained.

**[27P-47] Nanolithography Using Micro-scale Mask Enabled by Hyperbolic Metamaterial**

Donghwan Kim, Yong Rae Cho, and Bumki Min  
KAIST, Korea

We newly developed a nano-scale patterning method overcoming the diffraction limit of conventional photolithography technique by utilizing micro-scale aluminum mask-hyperbolic metamaterials hybrid structures, which is supported by our numerical simulation and experimental results.

**[27P-48] PL Emission of InP/GaNAs/InP Core-multishell NWs Grown by Self-catalytic VLS Mode**

Takehiro Ogino, Keita Asakura, Takao Waho, and Kazuhiko Shimomura  
Sophia University, Japan

Photoluminescence emission of InP/GaNAs/InP core-multishell nanowires was obtained at room temperature. InP nanowires were grown on InP(111)B substrate by selfcatalytic VLS mode of MOVPE using an indium catalyst. InP-core and GaNAs-shell structure was grown by changing the growth temperature. We have successfully obtained the PL emission from these core-shell nanowires at room temperature, and measured the PL spectrum dependent on the thickness of GaNAs-shell.

**[27P-49] Terahertz Wire-grid Polarizer with Al Grating**

Rei Yoshida<sup>1</sup>, Itsunari Yamada<sup>1</sup>, Junichi Yanagisawa<sup>1</sup>, Keisuke Takano<sup>2</sup>, Masanori Hangyo<sup>3</sup>, Mitsunori Saito<sup>3</sup>, and Wataru Watanabe<sup>4</sup>

<sup>1</sup>University of Shiga Prefecture, Japan, <sup>2</sup>Osaka University, Japan, <sup>3</sup>Ryukoku University, Japan, <sup>4</sup>Ritsumeikan University, Japan

A terahertz (THz) wire-grid polarizer consisting of a micrometer-pitch Al grating on a Si substrate was fabricated by photolithography and wet etching. Extinction ratio (the ratio of TM and TE transmittances) was over 35 dB at 0.5 THz, and over 23 dB in the 0.5–3 THz range. At the Brewster's angle of Si (74°), TM transmission exceeded 90% in the 0.5–3 THz range. The fabricated polarizer had a higher extinction ratio than conventional free-standing terahertz wiregrid polarizers.

**[27P-50] Lasing Characteristics of Cardioid-Shaped 2-D Microcavity Laser**

In-Goo Lee<sup>1</sup>, Sung Min Go<sup>1</sup>, Changhwan Yf<sup>2</sup>, Ji-Won Lee<sup>2</sup>, Ji-Hwan Kim<sup>1</sup>, Jin-Hyeok Ryu<sup>1</sup>, Kwang-Ryung Oh<sup>2</sup>, Sung-Bock Kim<sup>2</sup>, and Chil-Min Kim<sup>2</sup>

<sup>1</sup>Sogang University, Korea, <sup>2</sup>DGIST, Korea, <sup>3</sup>ETRI, Korea

Directional emission in a cardioid-shaped microcavity is investigated. When a microcavity laser deformed from a circular shape in polar coordinate is excited by current injection, it emits unidirectionally at a certain deformation parameter. We confirm the emission characteristics in an InGaAsP semiconductor laser.

**[27P-51] Dynamical Properties in Asymmetric Reuleaux Triangle 2-D Microcavity**

Jinhyeok Ryu<sup>1</sup>, Ji-Won Lee<sup>2</sup>, Changhwan Yf<sup>2</sup>, Ji-Hwan Kim<sup>1</sup>, In-Goo Lee<sup>1</sup>, Sung-Min Go<sup>1</sup>, and Chil-Min Kim<sup>2</sup>

<sup>1</sup>Sogang University, Korea, <sup>2</sup>DGIST, Korea

A Reuleaux triangle microcavity is one of the curves having a constant width. We deform it asymmetrically and compute its ray and wave properties. As a result, we find a unidirectionally emitting mode at a single window. Here, we investigate the emission mechanism and characteristics depending on the deformation.

**[27P-52] Mid-Infrared Optical Waveguide Modulator Based on the Epsilon-near-Zero Effect of ITO**

Jeonghun Lee and Min-Suk Kwon  
UNIST, Korea

Electroabsorption modulators based on the epsilon-nearzero (ENZ) effect of ITO are theoretically investigated. They are designed to work in the mid-infrared. We demonstrate that the modulator length is made smaller than 1.16  $\mu$ m.

**[27P-53] Optical Mode Converter Using Ring Resonator Structure**

Intekhab Alam, M. Raquib Ehsan, Saika Muntaha Bari, Mainul Haque, and Nur-E Mohammad Rifat

United International University, Bangladesh

We present a novel ring resonator structure for optical mode conversion for mode division multiplexing. The proposed micro structure (<15x15  $\mu$ m<sup>2</sup>) converts 0th mode to 1st mode with just 1.08 dB conversion loss ( $\lambda$  = 1.55  $\mu$ m, TE mode).

**[27P-54] Ultra-flat and Broad Optical Frequency Combs Generation Based on Novel Dispersion-flattened Double-slot Microring Resonator**

Yuanwu Wang, Minming Zhang, Lulu Lu, Meifeng Li, Jinghao Wang, and Deming Liu  
Huazhong University of Science and Technology, China

An ultra-flat and broad optical frequency comb with 7 dB bandwidth of 1155 nm wavelength is obtained, based on a novel double-slot microring resonator in simulation, which produces flattened dispersion of 0 ~ 3.8 ps/(nm-km) over a 1150 nm wavelength range.

**[27P-55] InGaAsP Nanobeam Light Emitter Integrated with Si Waveguide via Transfer Printing**

Jaehyeon Son<sup>1</sup>, Indra Karnadi<sup>1</sup>, Ju-Young Kim<sup>2</sup>, Hoon Jang<sup>1</sup>, Seungwoo Lee<sup>3</sup>, Ki Soo Kim<sup>4</sup>, Yong Hee Lee<sup>3</sup>, and Bumki Min<sup>1</sup>

<sup>1</sup>KAIST, Korea, <sup>2</sup>Stanford University, USA, <sup>3</sup>Sungkyunkwan University, Korea, <sup>4</sup>ETRI, Korea

A nanobeam photonic crystal cavity made with InGaAsP quantum well and Si waveguide is integrated on SiO<sub>2</sub>/Si substrate via transfer printing. The light emitted from the nanobeam showed coupling to waveguide. We demonstrated novel way to integrate III-V devices on Si based photonic integrated circuits.

**[27P-56] Ultralow-energy InGaAsP Modulators Based on a Photonic Crystal Waveguide/Nanocavity Involving the Franz-Keldysh Effect**

Kengo Nozaki, Shinji Matsuo, Abdul Shakoor, Silviu Dinulescu, Koji Takeda, Takuro Fujii, Eiichi Kuramochi, and Masaya Notomi

NTT Corporation, Japan

Ultrasml InGaAsP optical modulators were realized using a photonic crystal waveguide/nanocavity with a small capacitance p-i-n junction and the Franz-Keldysh effect. Eye patterns reaching 56 Gb/s and a record-low charging energy of <100 aJ/bit were evaluated.

## Poster Session II (Exhibition Hall / Thursday, 27 August, 13:45~15:15)

### [27P-57] Microwave Signal Generation Using Sideband Injection Locking in an Fabry-Perot Laser Diode

Liqing Gan<sup>1</sup>, Feng Li<sup>1</sup>, Jie Liu<sup>2</sup>, and P. K. A. Wai<sup>1</sup>

<sup>1</sup>The Hong Kong Polytechnic University, Hong Kong, China, <sup>2</sup>Sun Yat-sen University, China

Microwave signal generation using sideband injection locking in a Fabry-Pérot laser diode is studied numerically. The frequency tuning range in frequency doubling and maximum RF output power in frequency doubling, tripling, and quadrupling is compared.

### [27P-58] Spectral Tuning of an Add-drop Filter by Using Double Dielectric Microdisks

Da Eun Lee, Tae-Woo Lee, and Soon-Hong Kwon

Chung-Ang University, Korea

A spectrally tunable add-drop filter based on a whispering gallery mode in a double dielectric microdisk pair with an air gap is proposed, and its operation process and performance are demonstrated by finite-difference time-domain simulation.

### [27P-59] Optical Bistable Temperature Switch Properties Using 1DPC with a Kerr Defect

Juan Zhang and Rongjun Zhang

Shanghai University, China

Optical bistable temperature switching is investigated for one-dimensional Kerr defective photonic crystal. Steep transition and high optical contrast can be achieved and switching temperature and the hysteresis width can be precisely tuned.

### [27P-60] Emission Characteristics of a Microcavity Laser Comprised of Half Circle and Half Ellipse

Ji-Won Lee<sup>1</sup>, Changhwan Yi<sup>1</sup>, Ji-Hwan Kim<sup>2</sup>, Kwang Ryong Oh<sup>2</sup>, Sung-Bock Kim<sup>3</sup>, and Chil-Min Kim<sup>1</sup>

<sup>1</sup>DGIST, Korea, <sup>2</sup>Sogang University, Korea, <sup>3</sup>ETRI, Korea

We experimentally investigate emission characteristics of a microcavity laser, which is comprised of a half ellipse and a half circle. The emission direction of the fabricated InGaAsP semiconductor laser is unidirectional. At high injection current, the laser emits a single mode.

### [27P-61] Interaction between Slots as Oscillator Model

Suyeon Lee and Q-Han Park

Korea University, Korea

We present oscillator model for coupled plasmonic resonators. Narrow slot on metal film can be modeled as a bound charge oscillator. The oscillator model offers quantitative description about fundamental modes and electromagnetic induced transparency spectrum.

### [27P-62] Design of Epsilon-Near-Zero Coherent Perfect Absorption with Indium Tin Oxide Thin Films Using Admittance Matching Method

Tae Young Kim<sup>1</sup>, Md. Alamgir Badsha<sup>1</sup>, Junho Yoon<sup>1</sup>, Young Chul Jurl<sup>2</sup>, and Chang Kwon Hwangbo<sup>1</sup>

<sup>1</sup>Inha University, Korea, <sup>2</sup>UNIST, Korea

In this study, we report ITO thin film designs for epsilon-near-zero coherent perfect absorption in near infrared wavelength regime using an admittance matching method and investigate their optical properties.

### [27P-63] Numerical Simulation of an Ultra-Wide Tunability and Enhanced Spontaneous Emission of a Nanofiber Bragg Cavity

Hideaki Takashima<sup>1,2,3</sup>, Andreas W. Schell<sup>1,2,3</sup>, Shinjiro Fujita<sup>1</sup>, Yasuko Oe<sup>1,2,3</sup>, Syunya Kamioka<sup>2,3</sup>, Masazumi Fujiwara<sup>2,3</sup>, and Shigeki Takeuchi<sup>1,2,3</sup>

<sup>1</sup>Kyoto University, Japan, <sup>2</sup>Hokkaido University, Japan, <sup>3</sup>Osaka University, Japan

A detailed numerical study using 3D FDTD simulation on the fiber Bragg grating cavity is reported in order to further improve the ultra-wide tunability over 20 nm and the enhanced spontaneous emission we recently reported.

### [27P-64] Design of High-Efficiency Nanorod Emitters Using Optical Cavity Effects

Da-Som Kim, Jin-Young Na, Yoon-Jong Moon, and Sun-Kyung Kim

Kyung Hee University, Korea

We studied the extraction efficiency of nanorod emitters by performing full-vectorial electromagnetic simulations. The result indicated that the extraction efficiency was dramatically changed by the radial position of a light generation layer.

### [27P-65] Polarization-dependent Properties of Human Scleral Tissues at Terahertz Frequencies

Dae-Cheol Shin<sup>1</sup>, Jung-Min Park<sup>1</sup>, Gyeong Bok Jung<sup>2</sup>, Jae-Ho Shin<sup>2</sup>, Chul-Sik Kee<sup>3</sup>, Chul Kang<sup>3</sup>, and Joong Wook Lee<sup>3</sup>

<sup>1</sup>Chonnam National University, Korea, <sup>2</sup>Kyung Hee University, Korea, <sup>3</sup>GIST, Korea

We used terahertz time-domain spectroscopy to distinguish between normal and cross-linked human scleral tissues. Normal tissue is sensitive to the polarization of terahertz waves, whereas cross-linked tissue is polarization insensitive. Our results demonstrate terahertz spectroscopy can be a powerful tool for investigating human scleral tissues.

### [27P-66] A Self-calibrating Fluorescent Sensor for Mitochondrial Micro-viscosity Imaging and Measurement

Zhigang Yang, Danying Lin, Xiao Peng, and Junle Qu

Shenzhen University, China

A fluorescent rotor was developed for mitochondrial microviscosity imaging, by which the mitochondrial average viscosity was determined to be ca. 62 cp in normal HeLa cells and was increased to ca. 110 cp after treated by nystatin.

### [27P-67] Fluorescence Lifetime Determination of Photo-bleaching Correlation

Won Sang Hwang, Youngsik Song, and Dugyoung Kim

Yonsei University, Korea

FLIM is relatively stable about photo-bleaching effect. In case of dye has multi-exponential decay property, fluorescence lifetime can be affected by photo-bleaching. Such lifetime variation can cause critical error in many FLIM applications. If lifetime is changed by photobleaching, we cannot measure accurately donor lifetime with acceptor. It is difficult to separate lifetime variation by photo-bleaching and FRET. For this reason, we carry out the experiment to know influence of such fluorescence intensity loss on fluorescence lifetime.

### [27P-68] Imaging through Turbidity by Using Speckle Illumination

Joo Eon Oh<sup>1</sup>, Giuliano Scarcelli<sup>2</sup>, and Yoon-Ho Kim<sup>1</sup>

<sup>1</sup>POSTECH, Korea, <sup>2</sup>University of Maryland, USA

We demonstrate that a clear image of an object hidden behind a turbid medium may be obtained by using speckle illumination and correlation measurement whereas coherent illumination only results distorted and blurred images.

### [27P-69] Digital Holographic Microscopy for Phase Images of Cervical Cells 3D Structure

Mona Mihailescu<sup>1</sup>, Irina Alexandra Paun<sup>1</sup>, Eugen Scarlat<sup>1</sup>, Irina Grigorescu<sup>1</sup>, Oana Tatiana Nedelcu<sup>2</sup>, and Roxana Radu<sup>3</sup>

<sup>1</sup>Politehnica University from Bucharest, Rumania, <sup>2</sup>National Institute for Microtechnology, Rumania, <sup>3</sup>Lotus Hospital, Rumania

The phase images of cervical cells were obtained in digital holographic microscopy to establish the cells 3D characteristics as criteria for information quantification and cells classification. We introduced a simple approach for the cells overlapping regions based on the focalization criteria.

### [27P-70] Supercontinuum as a Light Source for Miniature CMOS Sensors in Endoscopic Imaging

Ming-kuan Lu<sup>1,2</sup>, Hsin-Yu Lin<sup>1</sup>, Chih-Cheng Hsieh<sup>3</sup>, and Fu-Jen Kao<sup>1</sup>

<sup>1</sup>National Yang-Ming University, Taiwan, <sup>2</sup>Chung-Hua Telecom Research Institute, Taiwan, <sup>3</sup>Taipei Veteran General Hospital, Taiwan

We have successfully implemented supercontinuum through fiber coupling as a light source for miniature CMOS sensors (~0.8 mm) in endoscopic imaging. Comparison with LED and other light sources are also made to show the advantages and characteristics of supercontinuum.

Poster Session II (Exhibition Hall / Thursday, 27 August, 13:45~15:15)

**[27P-71] Multiple Labeling Fluorescence Lifetime Analysis in a Single Shot Imaging**

Young Sik Song<sup>1</sup>, Young Jae Won<sup>2</sup>, Chang Jun Lee<sup>1</sup>, and Dug Young Kim<sup>1</sup>  
<sup>1</sup>Yonsei University, Korea, <sup>2</sup>Osong Medical Innovation Foundation, Korea

We propose new approaches analysis for fluorescence lifetime imaging measurement of multiple labeling at single shot process. This paper suggests analysis concept of which can extract small scale signal ratio simply in the complex environment.

**[27P-72] Detection of Blood Flow Using Laser Speckle Contrast Imaging with Dual Wavelengths**

Youngmo Jeong, Jiwoon Yeom, and Byoungho Lee  
Seoul National University, Korea

A detection system for blood flow using laser speckle contrast with dual wavelengths is proposed. A 780 nm near-infrared laser and a 450 nm blue laser are simultaneously utilized to eliminate the effect of scattering at skin.

**[27P-73] Mapping the Progression of Malaria Infected Erythrocytes with Holographic Microscopy**

Xuefei He, Alexander Maier, and Steve Lee  
The Australian National University, Australia

We demonstrate an off-axis digital holographic microscopy system for imaging infected red blood cell and propose to combine that with flow channels to study adhesion bonds of infected blood cells at the cellular and molecular level.

**[27P-74] Compact Probe Head of Second-Harmonic-Generation Microscopy for Dermatological Applications**

Kosuke Atsuta, Eiji Hase, and Takeshi Yasui  
The Tokushima University, Japan

We construct a compact probe head of the fiber-based SHG microscopy for the dermatological applications, and successfully demonstrated SHG imaging of the tendon sample using it.

**[27P-75] Lithium-Niobate-Silica Hybrid Whispering-Gallery-Mode Resonators**

Fang Bo<sup>1,2</sup>, Jie Wang<sup>1</sup>, Jiao Cui<sup>1</sup>, Sahin Ozdemir<sup>2</sup>, Yongfa Kong<sup>1</sup>, Guoquan Zhang<sup>1</sup>, Jingjun Xu<sup>1</sup>, and Lan Yang<sup>2</sup>  
<sup>1</sup>Nankai University, China, <sup>2</sup>Washington University, USA

Hybrid whispering-gallery-mode resonators were made by depositing a polycrystalline lithium niobate film onto silica resonators. Efficient coupling with tapered fiber and all-optical modulation were realized in these resonators.

**[27P-76] Optical Feedback Effects on the Dynamics of Semiconductor Nano-lasers**

Alan Shore and Zubaida Sattar  
Bangor University, UK

Enhanced spontaneous emission effects are shown to increase the sensitivity of semiconductor nano-lasers to optical feedback. These results have significance for the use of nano-lasers in photonic integrated circuits.

**[27P-77] Lasing on Surface States at the Edge of a Defect-free Photonic Crystal**

Yonan Su<sup>1</sup>, Chun-Yan Lin<sup>1</sup>, Ray-Ching Hong<sup>1</sup>, Wen-Xing Yang<sup>1,2</sup>, Chien-Chung Jeng<sup>2</sup>, Tien-Chang Lu<sup>4</sup>, and Ray-Kuang Lee<sup>1</sup>  
<sup>1</sup>National Tsing-Hua University, Taiwan, <sup>2</sup>Southeast University, China, <sup>3</sup>National Chung-Hsing University, Taiwan, <sup>4</sup>National Chiao Tung University, Taiwan

We report experimental observation of lasing on surface states, in the form of standing waves at the termination of a defect-free photonic crystal on top of vertical cavity surface emission lasers. Direct images of lasing modes at the truncated periodic potential, along one side of a square lattice, are demonstrated by collecting near-field radiation patterns, as well as in numerical simulations.

**[27P-78] Realization of Bragg Grating Based Integrated Fractional Photonic Hilbert Transformer**

Bolan Liu<sup>1</sup>, Chaotan Sima<sup>1</sup>, Wei Yang<sup>1</sup>, Deming Liu<sup>1</sup>, Yu Yu<sup>1</sup>, James Gates<sup>2</sup>, Michalis Zervas<sup>2</sup>, and Peter Smith<sup>2</sup>

<sup>1</sup>Huazhong University of Science and Technology, China, <sup>2</sup>University of Southampton, UK

Wideband integrated fractional order photonic Hilbert transformer (FrPHT) is proposed and demonstrated, by using single apodized Bragg gratings with phase shifts in a silica-on-silicon planar platform. Effects of apodization profiles and operation bandwidths are analyzed.

**[27P-79] Lasing Characteristics of Resonance Modes in a Racetrack Cavity with Hexagonal Corners**

Jae-Dong Kim, Kyung-Sook Hyun, and Hee-Jong Moon  
Sejong University, Korea

We propose resonance mode in a racetrack cavity with hexagonal corners, in which the modes are guided by both boundaries of the corner. The modes were demonstrated by investigating the laser oscillations in semiconductor cavities.

**[27P-80] Optical Heterodyne Detection of a Surface Plasmon Signal in an Electronic Circuit**

Shinya Okahisa<sup>1</sup>, Hiroki Sakai<sup>1</sup>, Takuma Aihara<sup>1,2</sup>, Masashi Fukuhara<sup>1,2</sup>, Yuya Ishii<sup>1</sup>, and Mitsuo Fukuda<sup>1</sup>

<sup>1</sup>Toyoashi University of Technology, Japan, <sup>2</sup>Japan Society for the Promotion of Science, Japan

We demonstrate the dynamic operation of monolithically integrated plasmonic detector and MOSFETs on silicon. The integrated device operates at the beat signal of surface plasmons converted from two light beams in 1.31- $\mu$ m wavelength band.

**[27P-81] In-Situ Monolithic Integration of Nanobeam Laser with Passive Waveguide on SOI**

Jungmin Lee, Hoon Jang, Indra Kamadi, Putu E. Pramudita, Hwi-Min Kim, and Yong Hee Lee  
KAIST, Korea

We demonstrate in-situ monolithic integration of an InP-based nanobeam laser and a passive waveguide on SOI using selective quantum well etching technique. The device on SOI platform is realized by employing transfer printing process.

**[27P-82] Cavity Length Dependence on Lasing Characteristics of Double-capped QDs Laser**

Toshiki Sukigara, Yuta Yamamoto, Tetsuo Nishiyama, and Kazuhiko Shimomura  
Sophia University, Japan

Cavity length dependence on lasing characteristics was obtained in the p-modulation doped double-capped InAs QDs laser on the InP substrate at 1.65  $\mu$ m wavelength. Stranski-Krastanov InAs QDs was grown low-pressure MOVPE, and employed the p-modulation doping in the capping layer during the double-capped process. Lasing characteristics was obtained under pulsed injection current at room temperature. We have shown the lasing wavelength and threshold current dependent on the cavity length of the laser.

**[27P-83] Monolithic Integration of Microlaser with Passive Waveguide via Selective Quantum well Etching**

Hwi-Min Kim, Hoon Jang, Sejeong Kim, and Yong Hee Lee  
KAIST, Korea

Monolithic integration of a photonic crystal laser and a passive waveguides via selective quantum well etching are demonstrated. Coupling efficiency between photonic crystal cavity and waveguide is investigated numerically.

**[27P-84] Integrated Polarization Rotator on Silicon Waveguides with an Asymmetric Trench**

Yudeuk Kim<sup>1</sup>, Dong Wook Kim<sup>1</sup>, Moon Hyeok Lee<sup>1</sup>, Min Hee Lee<sup>1</sup>, Dong Eun Yoo<sup>2</sup>, Ki Nam Kim<sup>2</sup>, Sang Chul Jeon<sup>2</sup>, and Kyong Hon Kim<sup>1</sup>

<sup>1</sup>Inha University, Korea, <sup>2</sup>National Nanofab Center, Korea, <sup>3</sup>Korea Polytechnics, Korea

We demonstrate an integrated polarization rotator with a single trench on a silicon waveguide fabricated using a single etch-step complementary metal-oxide-semiconductor (CMOS)-compatible process. The measured polarization rotation efficiency is 95 % with 0.76 dB insertion loss for a total 67- $\mu$ m long and 100-nm wide asymmetric trench.

## Poster Session II (Exhibition Hall / Thursday, 27 August, 13:45~15:15)

### [27P-85] Measuring Equi-frequency Contours of Spoof Surface Plasmon Polaritons

Kap-Joong Kim<sup>1</sup>, Seong-Han Kim<sup>2</sup>, Chul-Sik Kee<sup>2</sup>, and Yong Hee Lee<sup>3</sup>  
<sup>1</sup>ETRI, Korea, <sup>2</sup>GIST, Korea, <sup>3</sup>KAIST, Korea

By directly measuring electric fields, we obtain equifrequency contours of surface waves. In the metallic square lattice, the presence of the anisotropy from the equifrequency contours is experimentally confirmed.

### [27P-86] Thermo-optic Tunable Silicon Grating Coupler

Linghai Liu, Bingqing Zhu, and Hon Ki Tsang  
The Chinese University of Hong Kong, Hong Kong, China

We demonstrate a thermally tunable silicon grating coupler. The experimental result of ~10nm shift in center wavelength at about 410mW electrical power was in reasonable agreement with the expected ~16nm tuning range.

### [27P-87] Selection of the Lasing Direction using S-bend in the Semiconductor Cavities

Kyung-Sook Hyun, Sang-Hyuk Jeong, Young Hoon Kim, Dae-Jin Kim, and Jinwoong Lee  
Sejong University, Korea

The selection of lasing direction in micro cavity is demonstrated by using s-bend in the rectangular cavity. The parameter of S-bend section is calculated to minimize the propagation loss and optimized to serve good selectivity.

### [27P-88] Proposal of a PLC-based 3-mode (2 LP modes) Demultiplexer

Keito Kataoka, Hirokazu Kubota, Yuji Miyoshi, and Masaharu Ohashi  
Osaka Prefecture University, Japan

We propose a PLC-based 3-mode demultiplexer and numerically investigate three mode separation of the demultiplexer. Insertion loss is calculated by the numerical simulation.

### [27P-89] Plasma Assisted Tunable Exciton States in Monolayer MoS<sub>2</sub>

Younghee Kim, Young In Jhon, June Park, Jae Hun Kim, and Young Min Jhon  
KIST, Korea

We performed photoluminescence (PL) and Raman spectroscopy for Cl<sub>2</sub> and H<sub>2</sub> plasma modified monolayer MoS<sub>2</sub> (1L-MoS<sub>2</sub>) crystals. We demonstrated that PL intensities in 1L-MoS<sub>2</sub> can be tuned by treating Cl<sub>2</sub> and H<sub>2</sub> plasma.

### [27P-90] Electrically Driven Quasicrystal Microcavity Laser Based on Organic Semiconductor

Xiao Chen, Yuanyuan Cai, Ning Li, Changwei Li, and Yiquan Wang  
Minzu University of China, China

We design and fabricate an electrical pumping laser with a quasicrystal microcavity based on MEH-PPV layer sandwiched between two electrodes. The lasing performance is observed at 606 nm. The threshold current is around 0.8 mA.

### [27P-91] Polarization Dependence and Optical Aharonov-Bohm Oscillations in a Single Local QR in a Large Droplet QD

Seongho Park<sup>1</sup>, Takayuki Kiba<sup>2</sup>, Akihiro Murayama<sup>2</sup>, Jindong Song<sup>3</sup>, and Kwangseuk Kyhm<sup>1</sup>  
<sup>1</sup>Pusan National University, Korea, <sup>2</sup>Hokkaido University, Japan, <sup>3</sup>KIST, Korea

We analyzed time-resolved and magneto-micro-PL of a single droplet quantum dot in terms of polarization anisotropy, decay time, and diamagnetic coefficient in order to support the presence of localized state in a large droplet quantum dot.

### [27P-92] Scale-Adaptive Compressive Tracking

Zhengping Wu, Yang Jie, and Haibo Liu  
Wuhan University of Technology, China

Real-time Compressive Tracking(CT tracker) may drift away or fail especially when the object is under the complex environment, including cluttered background, similar color distribution, drastic illumination change and occlusion, etc. Built upon the same framework of the CT tracker, this paper proposes a new scale-adaptive tracker. Two main components improve the robustness of our approach: 1) a novel object information measure method based on CT algorithm, and 2) a simple and feasible algorithm for adjusting the scale of the tracked bounding window according to the amount of the object information. Numerous experiments with three state-of-the-art compressive trackers on challenging sequences demonstrate that the proposed algorithm performs well in terms of accuracy, robustness and speed under the complex environment.

### [27P-93] Chaos Synchronization of a Star Network Based on Delayed Electro-Optical Systems

Hu Han Ping and Chen Xiaofeng  
Huazhong University of Science and Technology, China

Chaos synchronization of a star network based on delayed electro-optical systems is discussed in this paper. The outer nodes of the star network are connected to a center node through a unidirectional optical injection signal from the center node to each outer node. We design a special network coupling function through the Lyapunov stability theory, and set up the mathematical model of the proposed star network. We prove stable zero-lag chaos synchronization can be realized among all the nodes of our proposed star network mathematically. At last, chaos synchronization of the star network is numerically investigated. The simulation results are consistent with the results of theoretical analysis.

### [27P-94] Optical Compensation for Elimination of Off-Axis Light Leakage in a Liquid Crystal Display

Seung-Won Oh and Tae-Hoon Yoon  
Pusan National University, Korea

Optical compensation for wide viewing angle characteristics in a liquid crystal display (LCD) is essential for high-quality dark images, especially from the bisector direction of the crossed polarizers. We introduce achromatic compensation configurations for a perfect dark state in LCDs. To cancel out the effect of wavelength dispersion, we replaced each A plate in the conventional uniaxial configurations by a pair of orthogonal A plates.

### [27P-95] A Study of Lens Array Compensation for Excimer Laser Beam Homogenizing

A. Hyeonjun Song<sup>1</sup>, Hakjun Lee<sup>2</sup>, Kwangwoo Cho<sup>1</sup>, Daegab Gweon<sup>2</sup>, and Hongjin Park<sup>1</sup>  
<sup>1</sup>Laser Total Solution, Korea, <sup>2</sup>KAIST, Korea

In recent display industry, an interest of laser manufacturing process is increasing. It is important homogeneity of line beam because of manufacture. In this study, we propose a new lens array compensation system for beam homogenizing. To verify the performance of system, experiment are carried out.

### [27P-96] Formation of Holographic Memory by Angle-multiplexing Recording in Liquid Crystal Composites

Akifumi Ogiwara<sup>1</sup> and Minoru Watanabe<sup>2</sup>  
<sup>1</sup>Kobe City College of Technology, Japan, <sup>2</sup>Shizuoka University, Japan

Formation of holographic polymer-dispersed liquid crystal (HPDLC) memory for an optically reconfigurable gate array based on the angle-multiplexing recording is discussed by controlling the laser interference exposure in liquid crystal (LC) composites. The successive laser illumination system to record the various configuration contexts at the different region and angle in HPDLC memory is constructed by using the half mirror and photomask placed on the motorized stages under the control of a personal computer (PC). The effect of laser exposure energy on the formation of holographic memory is investigated by the measurement of diffraction intensity during the grating formation process. The reconstruction of configuration contexts for the various logical circuits is demonstrated by the laser illumination at different incident angle in the HPDLC memory.

### [27P-97] Reference Functions in Grayscale and Noised Multiview Images

Vladimir Saveljev<sup>1</sup> and Sung-Kyu Kim<sup>2</sup>  
<sup>1</sup>Hanyang University, Korea, <sup>2</sup>KIST, Korea

The previously proposed reference functions for synthesis and analysis of multiview images in autostereoscopic 3D displays are applied to the analysis of grayscale and noised images of a wireframe object.

### [27P-98] Effect of the Coherence Length of Sunlight on the Absorption of V-shaped Organic Solar Cells

Kyungnam Kang<sup>1</sup>, Changjoo Lee<sup>2</sup>, Sungchul Kim<sup>2</sup>, and Jungho Kim<sup>1</sup>  
<sup>1</sup>Kyung Hee University, Korea, <sup>2</sup>Myongji University, Korea

We numerically investigate the effect of the coherence length of sunlight on the absorption of V-shaped organic solar cells. The absorbance and the spatial distribution of power dissipation are calculated with respect to partially coherent light.

Poster Session II (Exhibition Hall / Thursday, 27 August, 13:45~15:15)

**[27P-99] Off-Axis Terahertz Digital Holography Using Continuous-Wave Terahertz Radiation**

Takayuki Ogawa<sup>1</sup>, Dahi Ibrahim<sup>1,2</sup>, Takashi Masuoka<sup>1</sup>, Takeshi Yasui<sup>1,2</sup>, and Hirotsugu Yamamoto<sup>2,3</sup>

<sup>1</sup>The Tokushima University, Japan, <sup>2</sup>JST, Japan, <sup>3</sup>Utsunomiya University, Japan

We constructed an off-axis THz digital holography system equipped with a 0.1-THz CW-THz source and a mechanically-scanning THz pyroelectric detector, and then acquired THz digital hologram by it.

**[27P-100] The Authenticity of Art: Analysis of the Optical Characteristics of Paintings**

Seonhee Hwang, Kyujung Kim, and Eunhee Kim  
Pusan National University, Korea

In this study, we designed a setup using two different light sources to prove the authenticity of paintings through analysis of optical characteristics.

**[27P-101] Computer-generated Holograms Using Stereo Disparity with a Multi-matching Algorithm**

Yan-Ling Piao<sup>1</sup>, Ki-Chul Kwon<sup>1</sup>, Jeong-Hyeon Lee<sup>1</sup>, Sang-Keun Gil<sup>2</sup>, and Nam Kim<sup>1</sup>  
<sup>1</sup>Chungbuk National University, Korea, <sup>2</sup>Suwon University, Korea

Extracting depth information from stereoscope image is an important field in 3D imaging. In this paper, we proposed a method to record the computer-generated holograms based on high quality point cloud models which are generated by the disparity map from the stereoscopic image by use of a multi-matching algorithm.

**[27P-102] Temperature-dependent Transport Properties in Vanadium Dioxide Thin Films**

Jeongyong Choi<sup>1</sup>, Bong-Jun Kim<sup>2</sup>, Giwan Seo<sup>3</sup>, and Yong Wook Lee<sup>1</sup>  
<sup>1</sup>Pukyong National University, Korea, <sup>2</sup>Mobirik Co. Ltd., Korea, <sup>3</sup>KAIST, Korea

In VO<sub>2</sub>, which is a promising strongly correlated material of electro-optics, temperature-dependent electrical transport properties were investigated by using ordinary Hall effect measurement. The interesting variation on the near boundary of insulator-to-metal transition was observed.

**[27P-103] Organic Thin Film Photomemory with Isolated Photo-charge Storage**

Mincheol Kim, Hyejeong Seong, Seungwon Lee, Hyukyun Kwon, Sung Gap Im, and Seunghyup Yoo  
KAIST, Korea

Organic photomemory devices are demonstrated in a geometry similar to that of floating gate memory. Simultaneous application of gate bias and light triggers a threshold-voltage shift. The proposed devices show fast light programming with gate pulse as short as 50 msec.

**[27P-104] Trans-scale Optical Simulation for OLEDs Involving Scattering Substrates**

Eunhye Kim, Hyunsu Cho, Jin Chung, Jinouk Song, and Seunghyup Yoo  
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Scatter-embedded substrate is a powerful platform for improving light extraction efficiency in OLED lighting. In this work, we propose trans-scale optical simulation for OLEDs involving scattering substrates. This simulation combines rigorous dipole model analyzing thin-film stacks with Monte-Carlo simulation based on Henyey-Greenstein phase function for tracing rays encountered with specific size of scatter. The simulation provides a useful tool to analyze and design OLEDs with bulk scatter.

**[27P-105] Design of Holographic Head Mounted Display Using Holographic Optical Element**

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Recently, head mounted displays based on holographic optical elements have been reported. These head mounted displays can be implemented in a compact form factor but the image presented to each eye is still two-dimensional, which causes fatigue in stereoscopic three-dimensional image viewing condition. In this paper, we propose a holographic three-dimensional head mounted display which displays holographic three-dimensional images. We experimentally confirmed that holographic three-dimensional images are presented to each eye through a holographic optical element. In order to reduce the volume and weight of the system, we use one more holographic optical element and perform a simulation based on ray tracing through the two holographic optical elements.

**[27P-106] Light-Field Camera Using Fast Switchable Micro-lens Array for Simultaneous 2D/3D Image Acquisition**

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<sup>1</sup>Kyungpook National University, Korea, <sup>2</sup>ETRI, Korea

To make switchable light field camera, we developed fast switchable micro lens array which allows to capture both 3D image and 2D image by high frame rate.

**[27P-107] Feasibility of 'Radiative Transfer Theory' for Simulation of Organic Light-Emitting Diodes with Scattering Media**

Jinouk Song, Seunghyup Yoo, and Eunhye Kim  
KAIST, Korea

We explore the feasibility of 'radiative transfer theory' for simulation of scattering media by comparing accuracy and simulation time with Monte-Carlo simulation. Simulation based on 'radiative transfer theory' agrees very well with Monte-Carlo simulation with about 1/20 simulation time. Hence, 'radiative transfer theory' is effective basis for trans-scale simulation and fast optimization of OLEDs with scattering media.

**[27P-108] Study of Reflection-beam Shape Using Beam Splitter and CCD Camera**

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We report a new method for measuring a beam's shape at the focus point on a surface using an optical system and a CCD camera. An analytical model based on z-axis movement testing has been proposed, and experimental setups have been developed. Analysis of the obtained results allowed us precisely position the specimen for the focus point identification.

**[27P-109] Probabilistically Coupled Multi-Population Rate Equations Model of 1.55  $\mu\text{m}$  InAs/InP Quantum Dot Lasers**

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A multi-mode model of 1.55  $\mu\text{m}$  coupled quantum dot lasers (QDLs) is developed and simulated by fourth order Runge-Kutta method. Calculated results show that the coupled QDLs have significant advantages over the uncoupled ones.