Welcome Message

Dear friends and colleagues,

We are very pleased to invite you to IONS-Asia 5 Hokkaido/ JSAP Student Meeting at Hokkaido/ Asia Core Student Meeting. This conference aims to build networks among students working on optics and photonics worldwide. Under the same aim, three student meetings, IONS-Asia 5 Hokkaido/ JSAP Student Meeting at Hokkaido/ Asia Core Student Meeting, are collocated, organized by Osaka University OSA Student Chapter and Hokkaido University OSA Student Chapter (IONS-Asia 5 Hokkaido), JSAP Student Chapter (JSAP Student Meeting) and Photonics Center Osaka University (Asia Core Student Meeting), respectively. With collocating these meetings, we expect to build huge networks across each student meeting community.

We are so thrilled to meet you at the conference. All programs are prepared for you to make a new networking easily. We believe that you all can enjoy everything of our conference programs such as invited talks, group work, conference banquet and excursion. We wish that a network built here gives benefit to you not only in scientific researches but also in many scenes of your life in the future.

IONS-Asia 5 Hokkaido, Co-Conference Coordinators
Takayuki Umakoshi, Ryo Niyuki

JSAP Student Meeting at Hokkaido, Conference Coordinator
Ryosuke Oketani

Asia Core Student Meeting, Conference Coordinator
Natsuo Taguchi

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Asia Core Student Meeting

Japan Society for the Promotion of Science

Conference Program

Day 0 - 14th Sep.

18:00-20:00	Welcome Reception

Day 1 - 15th Sep.

9:00-9:30	Registration
9:30-9:45	Opening Remark
9:45-10:35	Ice-break Session
10:35-10:55	Coffee-break
10:55-11:55	Invited Talk "Importance of networking for science and engineering based students: The perils of 'tunnel vision' " by Prof. Adarsh Sandhu
11:55-13:15	Lunch
13:15-14:45	Panel Discussion
14:45-15:10	Coffee-break
15:10-16:40	Students Oral Presentation
16:40-18:00	Poster Presentation + Coffee-break
18:00-20:00	Banquet

Day 2 - 16th Sep.

8:50-9:00	Opening
9:00-10:00	Invited Talk "Building A Career in Optics and Photonics" by OSA president Prof. Philip Howard Bucksbaum
10:00-10:10	Talk by JSAP president Prof. Satoshi Kawata
10:10-10:30	Coffee-break
10:30-12:00	Team Project Contest
12:00-12:15	Group Photo
12:15-12:30	Closing Remark
12:30-late	Excursion

Invited Talks

Building A Career in Optics and Photonics

Prof. Philip Howard Bucksbaum

OSA president

Departments of Physics, Applied Physics, and Photon Science, Stanford University, USA

Biography:

Philip Howard Bucksbaum received his A.B. degree in physics from Harvard University in 1975, and his Ph.D. in physics from the University of California, Berkeley in 1980. He was a postdoctoral research associate at Lawrence Berkeley Laboratory in 1980-1982. During that time, Bucksbaum also joined the staff of Bell Telephone Laboratories in New Jersey, first as a postdoc at Holmdel, and later as a member of the technical staff at Murray Hill in 1982-1990. Following Adjunct Associate Professor of Applied Physics at Columbia University in 1989-1990, he was appointed professor of physics at the University of Michigan in 1990, where he became the Otto Laporte Collegiate Professor in 1998 and the Peter Franken University Professor in 2005. In 2006, Bucksbaum moved to the SLAC National Accelerator Laboratory and Stanford University, and in 2009, he became the Marguerite Blake Wilbur Professor in Natural Science. He has joint appointments in the Physics Department, the Applied Physics Department, and the SLAC Photon Sciences Department, and he served as the department chair of Photon Science in 2007-2010. He is the director of the Stanford PULSE Institute for Ultrafast Science. He is a member of the U.S. National Academy of Sciences and a Fellow of the American Academy of Arts and Sciences, the American Physical Society, and the Optical Society. Bucksbaum's current research interests and contributions have covered several areas of atomic physics and ultrafast science: strong-field laser-atom interactions, Rydberg wave packets, ultrafast quantum control, and ultrafast X-ray physics.

Prof. Bucksbaum is the President of the Optical Society (OSA) for 2014. OSA is the leading professional association in optics and photonics, home to accomplished science, engineering, and business leaders from all over the world. Since 1916 OSA has worked to advance the common interests of the field, providing educational resources to the scientists, engineers and business leaders who work in the field by promoting the science of light and the advanced technologies made possible by optics and photonics. OSA units more than 130,000 professionals from 175 countries. This society also has been contributed to networking of students and young researchers.

Importance of networking for science and engineering based students: The perils of 'tunnel vision'

Prof. Adarsh Sandhu

Electronics-Inspired Interdisciplinary Research Institute, Toyohashi University of Technology, JAPAN

Biography:

Professor Adarsh Sandhu came to Japan in 1985 as a Monbusho Scholar to study at the Tokyo Institute of Technology and University of Tokyo. After completing his doctorate at the University of Manchester in 1986, he joined the exploratory devices group at Fujitsu Laboratories Ltd., Astugi, to develop molecular beam epitaxy for III-V quantum effect electron devices and heterojunction bipolar transistors. In 1992, he took a sabbatical as a visiting scholar at the Cavendish Laboratory, Cambridge University, and in 2002 accepted a tenured position at the Quantum Nanoelectronics Research Center, Tokyo Institute of Technology. Since 2010 he has been the deputy director of the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS) at Toyohashi University of Technology, and was presidential advisor and head of international public relations until April 2014.

Professor Sandhu has a visiting chair at Tsinghua University (Beijing) and collaborative projects with IIT Delhi, Indian Institute of Science, Bangalore, University College London, University of Paris, Daegu Gyeongbuk Institute of Science and Technology (DGIST), South Korea, and major Japanese corporations. His research includes fabrication of wet-capsules for in-situ TEM; bacteria-mediated graphene synthesis and related 2D materials; Hall effect magnetic field sensors for space applications; and point of care medical diagnostics based on functionalized superparamagnetic nanoparticles.

Professor Sandhu travels extensively in Asia Pacific and has written numerous articles for international journals and magazines about his observations on the development of science and technology in this part of the world. He has served as an editorial consultant for major scientific journals and played a central role in the launch of websites and newsletters focusing on science, medicine, and technology in Asia. Professor Sandhu was elected as a director of the Japan Society of Applied Physics in March 2014.

NOTE

NOTE

General Information

Conference Venue

Clark Memorial Student Center, Hokkaido University, Hokkaido, Japan

Access

- From New Chitose Airport

Train from New Chitose Airport

We strongly recommend catching the 40 minute JR Rapid Airport Line from the Airport to Sapporo Station which runs every 15 minutes.

Fare: Adult 1,040 yen / Child 520 yen

Bus from New Chitose Airport

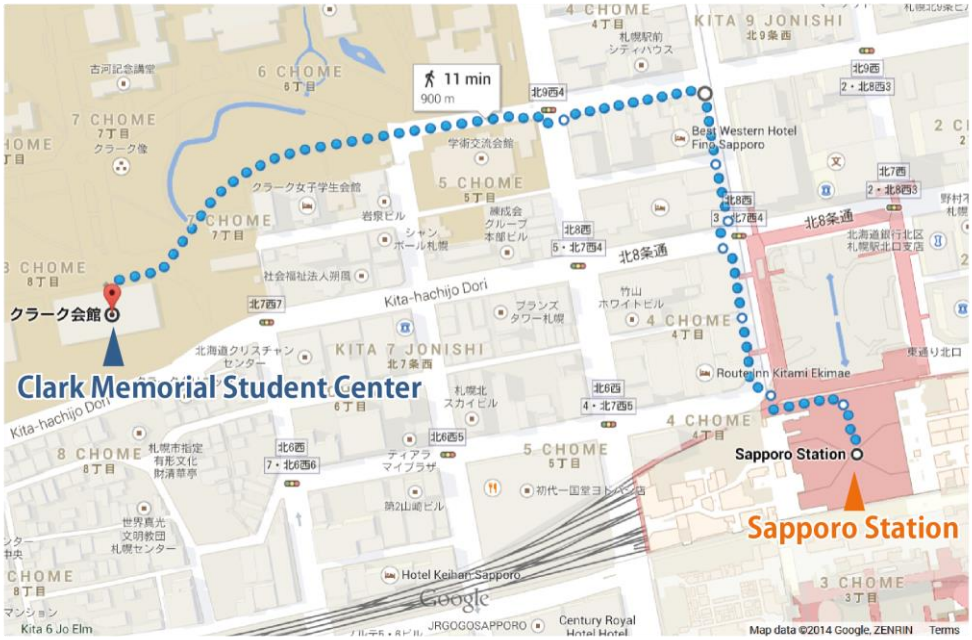
An express bus, known as the Chuo Bus / Hokuto Kotsu Bus also departs New Chitose Airport bound for Sapporo station and takes approximately 70 minutes.

Fare: Adult 1,000 yen / Child 500 yen

- From Sapporo Station

Walking from Sapporo Station (11 mins)

Upon disembarking the train, aim for the west ticket gates and then take the North exit out of the station. Walk for 11 minutes according to a route in a map shown below.



Taxi from Sapporo Station (5 mins)

If you have luggage or are due to arrive on a snowy or rainy day, we advise catching a taxi from the station to the University. A taxi fare usually starts at around 700 yen and due to the close proximity of the University, should be no more.

Registration

The registration desk is available at 3rd floor in Clark Memorial Student Center. The desk will be open from 9:00 on September 15th.

Your name badge is ready upon registration and it is required for all participants to wear during all the conference sessions, coffee breaks and banquet.

NOTE: Please bring a receipt of a hotel to the registration desk to receive the accommodation support (Reimbursement schedule: 15th 8:30-9:30, 16th 8:15-8:50).

Meal & Coffee Breaks

Coffee will be served during the breaks.

On September 15th, banquet and lunch will be served by the conference.

On September 16th, lunch will be served during Excursion.

Internet Access

Wireless Internet access is available in Clark Memorial Student Center.
SSID and Password will be announced on site.

Contacts

- Emergency Contact

Police: 110
Ambulance & Fire: 119

- Conference Contact

Tel: 090-6831-1330 (Umakoshi)
E-mail: student_chapter@parc.eng.osaka-u.ac.jp

Live Stream

We will stream live video of the invited talks. You can watch the videos in Ustream.

OsakaU OSA/SPIE SC TV: http://www.ustream.tv/channel/osakau-osa-spie-sc-tv

- JST 10:55-11:55, Sep 15th : Invited talk by Prof. Adarsh Sandhu
- JST 9:00-10:00, Sep 16th : Invited talk by Prof. Philip Howard Bucksbaum

You can enjoy the talks even after the conference.

Presentation Guideline

- Oral Presentation (Student)

Oral presentations will be given using a PC projector. We will prepare PCs including both of Microsoft Power Point and Keynote for your presentation. Presenters may bring your own PCs. Each presentation is scheduled 15 minutes for presentation (12 minutes for talk and 3 minutes for discussion). Please ensure your presentation does not exceed it, otherwise you will be stopped by the session chair in order to keep conference schedule.

- Poster Presentations

For poster presentations, display easels and pins for mounting are provided. The size of poster is ISO A0 (W: 841 mm, H: 1,189 mm). We do not provide printing service, so please bring your printed poster to the conference.
If your poster number is an odd number, you are required to attend your poster for 40 minutes of the session first half. If your poster number is an even number, you are required to attend your poster for 40 minutes following the presentation by the odd numbered poster.

Picture: Winter sky, Hokkaido

Student Presentation
Abstracts

Oral presentation List

O-1 "Assessment of Natural Enamel Lesions with Optical Coherence Tomography in Comparison to X-ray Tomography"
Jorge Espigares (Tokyo Medical and Dental University, Japan)

O-2 "A Hybrid Multiplexed Single Photon Source for Linear Optical Quantum Computing"
Elizabeth Hemsley (University of Bristol, United Kingdom)

O-3 "Nonlinear Scattering from Gold Nanoparticles And its Application to High Resolution Imaging"
Ryosuke Oketani (Osaka University, Japan)

O-4 "Direct laser writing of 3D microstructural carbon nanotube/polymer composites"
Shota Ushiba (Osaka University, Japan)

O-5 "All-optical tunable plasmon-induced transparency in metamaterials at optical communication range"
Yu Zhu (Peking University, China)

O-6 "Photothermoelectric Broadband Photodetector Based on Carbon Nanotube Fibers"
Ahmed Zubair (Rice University, USA)

Poster presentation List

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Achyut Adhikari (Nanyang Technological University, Singapore)

P-2 "Chemical synthesis of semiconductor nanocrystals for solar cell applications"
Tarik Ajjammouri (University Mohamed V-Agdal, Morocco)

P-3 "Surface enhanced Raman scattering from gold nanoparticles"
Kazuki Bando (Osaka University, Japan)

P-4 "Mid-IR Temperature Sensitivity of Chalcogenide-Based Photonic Band Gap Holey Fiber"
Ajanta Barh (Indian Institute of Technology Delhi, India)

P-5 "In vivo Eyes Development of Drosophila Embryo in Early Stage Studied by Three-dimensional Time-lapsed Imaging via Single Plane Illumination Microscopy"
Chin Hao Chang (National Yang-Ming University, Taiwan)

P-6 "Three dimensional light manipulation for full-color nano-projector"
Mu Ku Chen (National Taiwan University, Taiwan)

P-7 "Spectroscopic Study of Second Harmonic Generation Chiral Microscopy in Type I Collagen"
Mei-Yu Chen (National Taiwan University, Taiwan)

P-8 "Optical Stretch-Induced Calcium Influx vs. Dynamic Deformability of Human Red Blood Cells"
Hsin-Wei Chien (National Yang-Ming University, Taiwan)

P-9 "Local field enhancements for particle trapping"
Mark Daly (Okinawa Institute of Science and Technology Graduate University, Japan)

P-10 "Monte Carlo Light Propagation Modeling In Optically Thin Media"
Chen Yep Fam (Multimedia University, Malaysia)

P-11 "Continuous observation of osteoblastic mineralization by Raman imaging"
Aya Hashimoto (Osaka University, Japan)

P-12 "Plasmonic Photocatalyst for Photodegradation with Spinning Optical Disk Reactor"
Wen Ting Hsieh (National Taiwan University, Taiwan)

P-13 "Fabrication of plasmonic cavity and indefinite metamaterial by laser-induced forward transfer"
Yi-Teng Huang (National Taiwan University, Taiwan)

P-14 "Effect of free carriers on optical functions of erbium doped ZnO films"
Arsen Igityan (Institute for Physical Research, Ashtarak, Armenia)

P-15 "Design of Signal Pattern for Optical Correlator using Coaxial Holography"
Kanami Ikeda (University of Electro-Communications, Japan)

P-16 "LIF imaging of OH radicals and its collisional quenching effect in gas-liquid interface helium dc glow plasma"
Hiroaki Ishigame (Hokkaido University, Japan)

P-17 "Detection of low concentration of Pesticide on Orange by Particle-enhanced Raman Spectroscopy"
Ranjan Bikas (Osaka University, Japan)

P-18 "Intensity Modulated POF Multidimensional vibration sensor"
Putha Kishore (National Institute of Technology Warangal, India)

P-19 "Wearable Organic Optoelectronic Sensors for Prosthetic Actuation and Tissue Oxygenation"
Olena Kulyk (University of St Andrews, United Kingdom)

P-20 "Plasmon enhanced tunable MoS_2 FET based on polarization control"
Jiu Li (Peking University, China)

P-21 "Super-resolution Microscope Based on Laser Scanning and a Microsphere Lens"
Kuan-Yu Li (National Taiwan University, Taiwan)

P-22 "Enhanced luminescence efficiency by Ag nanoparticles dispersed on indium tin oxide for polymer light-emitting diode"
Yi-Ru Li (National Chiayi University, Taiwan)

P-23 "Isotropic perfect absorber in optical frequencies using vertical split-ring resonators"
Hao-Tsun Lin (National Taiwan University, Taiwan)

P-24 "The Stimulated Emission Depletion Properties of Spiro-BTA"
Wei-Kuan Lin (National Taiwan University, Taiwan)

P-25 "Reconfigurable Spatial Mode Conversion using a Spatial Light Modulator"
Tomohiro Maeda (Hokkaido University, Japan)

P-26 "Particle propulsion using higher order microfiber mode"
Aili Maimaiti (Okinawa Institute of Science and Technology Graduate University, Japan)

P-27 "Polarization analysis of near-field probe for tip-enhanced Raman imaging"
Toshihiro Mino (Osaka University, Japan)

P-28 "Multi-spectral plasmon induced transparency via dipole and dual-quadrupole coupling"
Masashi Miyata (Osaka University, Japan)

P-29 "A Theoretical Investigation of Super Continuum Generation in Exponential Saturable Nonlinear Response"
Kanagaraj Nithyanandan (Pondicherry University, Puducherry)

P-30 "Random lasing at a defect in a ZnO nanoparticle film"
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P-31 "Two-Channel Type Holographic Diversity Interferometry for High Accurate Wavefront Measurement"
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P-32 "Nanolens made of metallic rods array for magnified subwavelength images"
Yoshiro Ohashi (Osaka University, Japan)

P-33 "Metal-insulator-metal structures"
Siham Refki (University of Mohammed V-Agdal, Morocco)

P-34 "Optical ring-lattice generator using axially-symmetric polarization elements"
Moritsugu Sakamoto (Hokkaido University, Japan)

P-35 "Defect related photoluminescence study on Eu^{3+} activated Gd_2O_3 phosphors"
Thangaraj Selvalakshmi (National Institute of Technology, India)

P-36 "Dynamic Temperature Field Measurements Using a Polarization Phase Shifting Technique"
David Ignacio Serrano-García (Utsunomiya University, Japan)

P-37 "Development of Graphene-Based Infrared and Terahertz Devices"
Cody Sewell (Rice University, USA)

P-38 "Bandgap engineering in III-nitrides for solid-state lighting applications"
Chao Shen (King Abdullah University of Science and Technology, Saudi Arabia)

P-39 "Dynamic Imaging Stokes Polarimeter using Polarization Pixelated Camera"
Shuhei Shibata (Utsunomiya University, Japan)

P-40 "Computational imaging with single-pixel detection: applications in scattering media"
Fernando Soldevila Torres (GROC•UJI, Institut de Noves Tecnologies de la Imatge, Spain)

P-41 "Polarization-Dependent Infrared Spectroscopy of Macroscopic Films of Aligned Carbon Nanotubes"
S. Karuppasamy Pandian (SRM University, India)

P-42 "Solar powered memberane fillteration"
S. Sanjay Kumar (SRM University, India)

P-43 "Optical property of dye doped DNA-surfactant complex film made by immersion method"
Takemasa Suzuki (Hokkaido University, Japan)

P-44 "Molecular orientation in polymer wires with nanosized radii unveiled by polarized micro-Raman spectroscopy"
Natsuo Taguchi (Osaka University, Japan)

P-45 "Enhanced optical activity of chiral molecules in 2-D nanogap plasmonic fields"
Ryo Takei (Hokkaido University, Japan)

P-46 "Optical nano-imaging via plasmon focusing on metallic tip"
Takayuki Umakoshi (Osaka University, Japan)

P-47 "Spin Hall effect of light: in a view of cross-polarization"
Bo Wang (Peking University, China)

P-48 "Studies on the Application of Plasma Electron Density Measurement by Saturation Spectroscopy"
Huimin Wang (Hokkaido University, Japan)

P-49 "Performance Optimization of Organic Solar Cell"
Ying Qian Wong (Multimedia University, Malaysia)

P-50 "Imaging Carbon Dioxide Clusters using Laser-Driven Coulomb Explosion"
Xiguo Xie (Peking University, China)

P-51 "Spatiotemporal imaging of spin wave generated by light pulses"
Isao Yoshimine (the University of Tokyo, Japan)

P-52 "3D Luneburg Lens at Optical Frequencies"
Yuan-Yuan Zhao (Chinese Academy of Sciences, China)

P-53 "Vertical split-ring resonator based nanoplasmonic sensor"
Chun-Yen Liao (National Taiwan University, Taiwan)

O-1

Assessment of Natural Enamel Lesions with Optical Coherence Tomography in Comparison to X-ray Tomography

Jorge Espigares[1], Alireza Sadr[2]

[1]*Cariology and Operative Dentistry, Department of Restorative Sciences, Tokyo Medical and Dental University, 1-5-45 Yushima, Bunkyo-ku, Tokyo 113-8549, Japan*
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A technology to characterize early enamel lesions is needed in dentistry. Optical Coherence Tomography (OCT) is a non-invasive method that provides high-resolution cross-sectional images. **Objectives:** The aim of this study is to compare OCT with Microfocus X-ray Computed Tomography (µCT) for assessment of natural enamel lesions in vitro. **Methodology:** Ten human teeth with visible white spot-like changes on enamel smooth surface were selected. The cross-section of interest was marked using two guiding holes created by Er:YAG laser. The samples were then subjected to µCT (SMX-100CT, Shimadzu) [1] and 1300 nm swept-source OCT (Panasonic Health Care) imaging [2]. **Results:** In µCT, the lesions appeared as radiolucent dark areas, while in OCT, they appeared as areas of increased signal intensity beneath the surface (Fig. 1).

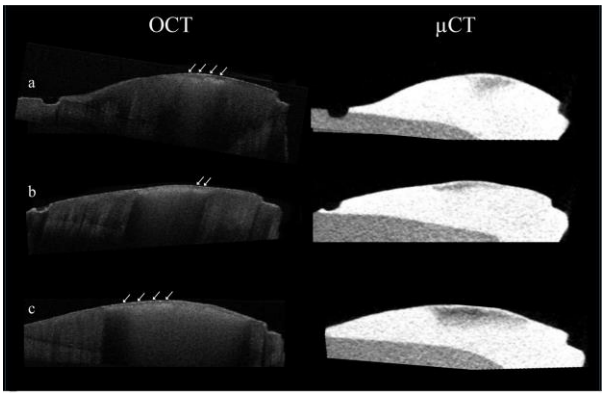

Fig. 1: (a), (b) and (c) show a comparison of 2D sections between OCT and µCT. The lesions appear as high scattering zones on OCT whereas on µCT the demineralized areas appear radiolucent. The arrows point to the visible surface layer overlying the subsurface lesion.

An automated OCT attenuation coefficient based on Beer-Lambert law could discriminate lesions from sound enamel. Lesion depth ranged from 175 to 606 µm in OCT. A correlation between µCT and OCT was found regarding lesion depth (R=0.81, p<0.001) and also surface layer thickness [3] (R=0.76, p<0.005) (Fig. 2).

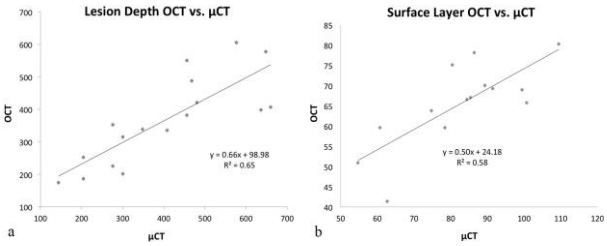

Fig. 2: (a) OCT and µCT lesion depth correlation (R=0.81, p<0.001), Best regression was established with a linear fit (R^2=0.65). (b) OCT and µCT surface layer correlation (R=0.76, p<0.005), Best regression was established with a linear fit (R^2=0.58).

Conclusions: OCT is suitable for clinical assessment of natural subsurface lesions and their surface layer, providing comparable images to a laboratory high-resolution µCT without the use of X-ray.

References:

[1] H. Hamba *et al.*, *JDR* **91**, 586-591 (2012)
[2] Y. Shimada *et al*, *Biophotonics* (2013)
[3] A. Groeneveld and J. Arends, *Caries research* **9**, 36-44 (1975).

O-2

A Hybrid Multiplexed Single Photon Source for Linear Optical Quantum Computing.

E. Hemsley, G. Mendoza, J. Munns, M. Piekarek, G. Marshall, J. O'Brien

Centre for Quantum Photonics, H. H. Wills Physics Laboratory, University of Bristol, Bristol, BS8 1TL, United Kingdom.

Small-scale quantum computing experiments typically use heralded photon sources based on spontaneous parametric down conversion (SPDC). In a heralded SPDC source, pairs of photons are probabilistically generated in a crystal via the χ^2 nonlinearity. The detection of one photon from the pair is used to 'herald' the presence of the other photon – which can then be used in the experiment. Such sources approximate a single photon source, but are probabilistic in nature. Higher order photon number contributions prevent the source being viable beyond 10% success probability. For a useful quantum computer using linear optics, this source is unsuitable and unscalable. A *near-deterministic* source of single photons is needed.

By combining several SPDC sources in a so-called *multiplexed source*, it is possible to increase photon production rate, without succumbing to higher order terms [1]. In a multiplexed source the heralding photon indicates which sub-source was successful in each instance. Fast optical switches then route the heralded photon to the output. The sources can be separated in time or space, but the generated photons are all switched into the same space time bin. Even taking into account switch loss, it is theoretically possible to achieve success probabilities sufficient for optical quantum computing [2, 3].

Previous multiplexing schemes using just 2 sources have achieved an increase in photon production probability of 63% compared to a single source [4].

Here we present a multiplexing scheme which combines 8 sources, actively routed by a series of 3 cascaded switches, shown in Figure 1. The source is realised in bulk optics, with 2 spatial sub-sources, and 4 temporal sub-sources. The switches have <2dB loss and maximum switching rate 200kHz. We expect to increase the single photon production probability by 280%, without increased higher order terms. Alternatively, for the same photon rate, we expect a signal to noise ratio that is increased 8-fold. We also hope to demonstrate quantum interference between the sub-sources, since purity and indistinguishability are necessary conditions for single photon sources. Early results from this system will be presented at the conference.

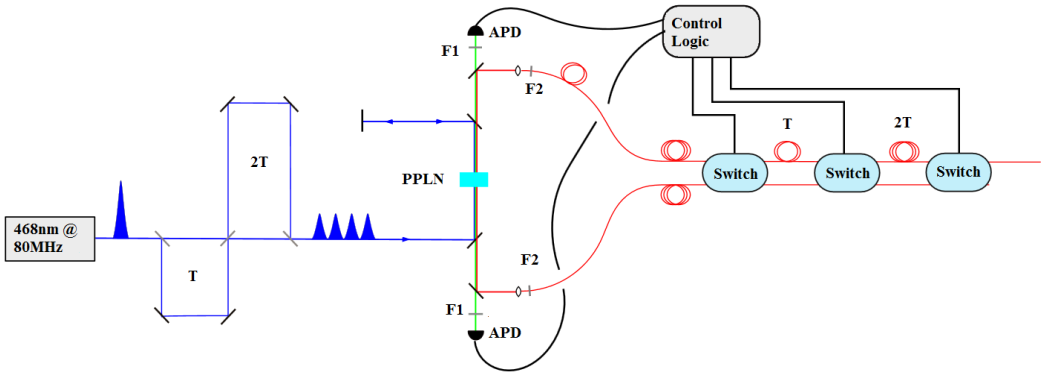

Figure 1 – Schematic of the hybrid multiplexed source. PPLN; periodically poled lithium niobate crystal, F1; narrowband filter centred on 671nm, F2; narrowband filter centred on 1547.5, T; 3.125ns delay, ΔT; fibre delay to match arm 1 and 2, APD; avalanche photodiode detector.

This multiplexed source will provide a benchmark for future photon sources in integrated or bulk optics, which are essential for any linear optical quantum computing architecture.

References

[1] A. L. Migdall, D. Branning, and S. Castelletto, *Phys. Rev. A* **66**, 053805 (2002).
[2] J. Mower and D. Englund *Phys. Rev. A* **84** 052326 (2011)
[3] T. Jennewein at al. *J. Mod. Opt.* **58** 276 (2011)
[4] M.J. Collins et al. *Nat. Commun.* **4** 2582 (2013)

O-3

Nonlinear Scattering from Gold Nanoparticles And its Application to High Resolution Imaging

Ryosuke Oketani[1] Tung-Yu-Su,[2] Hsueh-Yu Wu,[2] Hsuan Lee,[2] Yen-Ta Huang,[2]
Yasuo Yonemaru,[1] Satoshi Kawata,[1] Shi-Wei Chu,[2] and Katsumasa Fujita[1]
[1] *Department of Applied Physics, Osaka University, Osaka, 565-0871, Japan*
[2] *Department of Physics, National Taiwan University, Taipei, Taiwan, 10617, Republic of China*

Nonlinear optical effects have been used to improve the spatial resolution of optical microscopy and lithography [1-2]. Since the nonlinear optical effect appears prominently under the strong laser irradiation, the optical effect can be localized in a laser focus generated by an objective lens. In our research, we found that scattering from metallic nanoparticle can show a nonlinear response with being irradiated by strong laser light and utilized this phenomenon to improve the spatial resolution of confocal microscopy.

Fig.1 shows the relation between the excitation and scattering intensities measured with a single gold nanoparticle. For the measurement, we observed gold nanoparticle on a cover slip by confocal reflection microscopy with various excitation intensities. After the image acquisition, we plotted the scattering intensity at the center of an image of a single particle as shown in Fig.1. We used a CW laser with the wavelength of 532 nm as the light source and gold nanoparticles with 80 nm diameter as the sample.

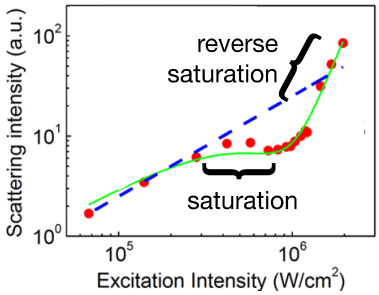

Fig. 1: The nonlinear scattering response from a single gold nanoparticle with 80 nm diameter [3]. Green line shows the polynomial fitting.

As shown in Fig.1, the nonlinear relation between the excitation and scattering intensities is clearly observed [1]. With increasing the excitation intensity, the scattering intensity was saturated. With the further increase of the excitation intensity, the scattering intensity rose up again. A similar phenomenon was observed in light absorption and called "reverse saturation." We performed the same experiment with different excitation wavelengths and found that the strong nonlinearity in scattering appeared when the wavelength of incident light matched to the localized surface plasmon resonance (LSPR) wavelength. This result suggests that excitation of LSPR contributes to the nonlinearity in the light scattering at gold nanoparticles.

We used the saturation effect to improve the spatial resolution of confocal microscopy. Since the saturation appeared at the center of the focal spot, we use saturated excitation (SAX) microscopy [2] to extract the scattering from the saturation region. The incident laser light was temporally modulated the intensity like a sinusoidal wave. The saturation appears on each peak of the wave, which is highest intensity. The saturation gets the wave distorted and causes the harmonics of the modulated frequency. By extracting the harmonics, which is only from the saturation area, we can improve the spatial resolution.

Super resolution imaging of gold nanoparticles was achieved as shown in fig. 1 [3]. The adjacent particles indicated by white arrows looks like a rod shape in a conventional confocal image (a). With saturation, the adjacent particles are clearly divided into two (b), which corresponds to the SEM image (c). Attached particles are, on the other hand, not resolved. It suggests that the resonance wavelength of LSPR is red shifted by the attachment. The result also showed the contribution of LSPR for the saturation.

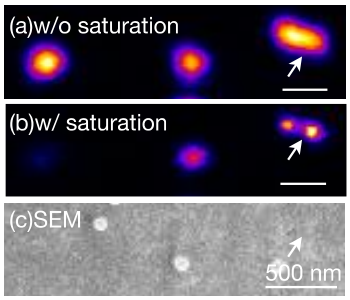

Fig. 2: The comparison of scattering images of gold nanoparticles [3]. The diameter of particles is 100 nm. (a) Conventional confocal image without saturation. (b) The image with saturation method. (c) Scanning electron microscope (SEM) image.

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O-4

Direct laser writing of 3D microstructural carbon nanotube/polymer composites

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Single wall carbon nanotubes (SWCNTs) are quasi-one dimensional carbon nanomaterials that consist of a rolled-up single layer graphene forming into hollow cylinder shape, of which the typical diameter and the length are ~1 nm and ~1000 nm, respectively. SWCNTs exhibit remarkable mechanical, electrical, and thermal properties. The intrinsic characteristics make them ideal candidates as advanced filler materials in composites, and hence a great deal of efforts has been made for SWNT/polymer composites. Here, we present a method to develop single-wall carbon nanotube (SWCNT)/polymer composites into arbitrary three-dimensional micro/nano structures [1,2]. Our approach, based on two-photon polymerization lithography [3,4], allows one to fabricate three-dimensional SWCNT/polymer composites with a minimum spatial resolution of a few hundreds nm. A Ti:sapphire femtosecond pulsed laser emitting at 780 nm was focused onto a SWCNT-dispersed photo resin by an objective lens with NA of 1.4. The laser light solidified a nanometric volume of the resin in the focus spot through two photon polymerization. The focus spot was three-dimensionally scanned, resulting in the fabrication of arbitrary shapes of SWCNT/polymer composites. After scanning, unsolidified resin was rinsed away with acetone. We demonstrated 3D micro/nano structural SWNT/polymer composites, such as a 8 μm long micro bull, tea-pod, lizard, and 300 nm wide nanowire (Fig.1). SWCNTs were uniformly distributed throughout the whole structures, even in a few hundreds nm thick nanowires (Fig. 2). Furthermore, we also found an intriguing phenomenon that SWCNTs were self-aligned in polymer nanostructures, promising improvements in mechanical and electrical properties. Our method has great potential to open up a wide range of applications such as micro- and nano- electromechanical systems, micro/nano actuators, sensors, and photonics devices based on CNTs.

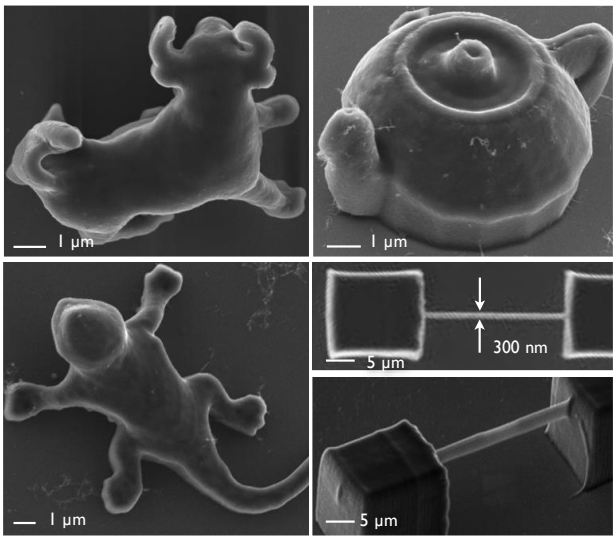

Fig. 1: SEM images of 3D micro structural SWCNT/polymer composites

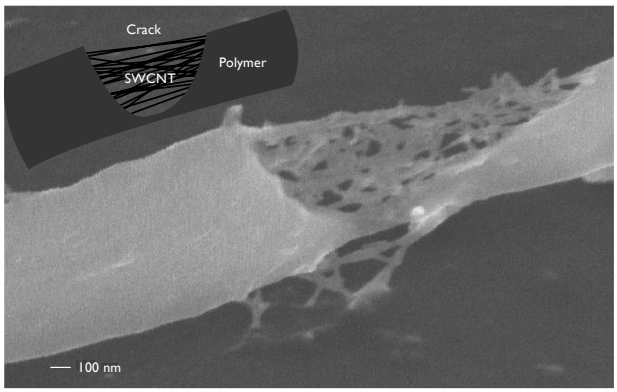

Fig.2: SEM image at a crack on a nanowire produced by laser ablation. SWCNTs are bridged between the crack.

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O-5

All-optical tunable plasmon-induced transparency in metamaterials at optical communication range

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Actively all-optical tunable plasmon-induced transparency in metamaterials paves the way for achieving ultrahigh speed quantum information processing chips[1]. Here, we report an ultralow-power and ultrafast all-optical tunable plasmon-induced transparency in metamaterials coated on polycrystalline indium-tin oxide layer at the optical communication range. We fabricated the metamaterial as showed in Fig.1(a), which consisted of periodic arrays of square lattice of gold meta-molecules, coated on a 180-nm-thick ITO layer with the EBL and PLD system. For the transverse-magnetic (TM) polarization incidence case, a sharp and deep reflectance dip appeared near the center of the broad and strong reflectance band as showed in Fig. 1(b), which indicates the formation of plasmon-induced transparency[2]. The destructive interference of the direct diploe excitation of the super-radiant meta-atom by the incident TM-polarized light, and the excitation of the sub-radiant meta-atom by the super-radiant meta-atom and coupling back to the super-radiant meta-atom result in the formation of plasmon-induced transparency as showed in the Fig. 1(c,d) the electric-field distribution of the meta-molecule.

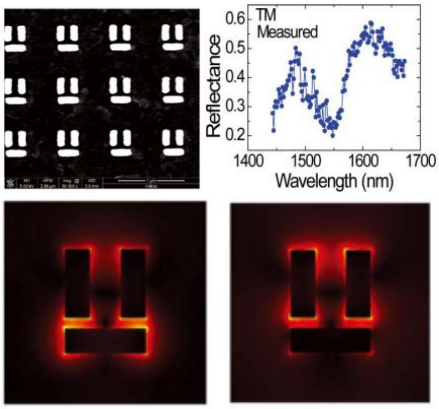

Fig. 1: (a). SEM image of the metamaterial. (b) Measured linear reflectance spectrum of the metamaterial for TM polarization incidence case. Calculated electric-field distribution of the meta-molecule for the TM-polarized incident light with a wavelength of 1460 nm (c), and 1550 nm(d).

The all-optical tunability of the plasmon-induced transparency is confirmed by measuring the reflectance changes of a 1550nm probe laser as a function of delay time between pump and probe pulses by using the femtosecond pump and probe method, and the measured results are shown in Fig.2(a). We attribute the all-optical tunablity of the metamaterial to the large nonlinear refractive index of polycrystalline ITO layer, which was measured by using the close-aperture Z-scan method as showed in Fig.2(b), due to strong nonlinearity enhancement associated with strong quantum confinement effect associated with the nanoscale crystal grains of polycrystalline ITO, hot-electron injection from gold nano-structures into ITO film[3], and field reinforcement near the end facets of meta-molecules.

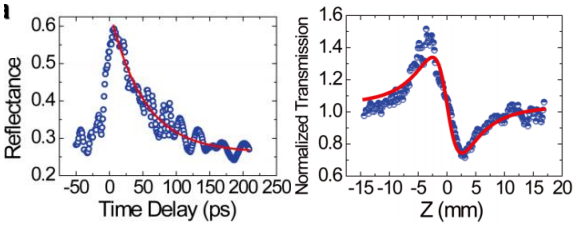

Fig. 2: (a) Measured reflectance changes of a 1550 nm probe laser as a function of delay time between pump and probe pulses (b) Measured closed-aperture Z-scan curve of a 180-nm-thick ITO film.

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O-6

Photothermoelectric Broadband Photodetector Based on Carbon Nanotube Fibers

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Carbon nanotubes (CNTs) have some extraordinary properties such as ultrahigh electrical and thermal conductivities, ultralight weights, and ultrahigh mechanical strengths, which have attracted the interest of researchers in diverse fields. In particular, recently the photonic and optoelectronic properties of carbon nanotubes have received enormous attention. The ability of films of aligned CNTs to absorb broadband polarized light from the ultraviolet to the far-infrared wavelengths makes CNTs promising for applications in solar cells and photodetectors. Recently, realization of a photothermoelectric (PTE) effect based photodetector made of a macroscopic CNT film was reported [1,2]. Furthermore, high-performance multifunctional fibers of CNT that combine the specific strength, stiffness, and thermal conductivity of carbon fibers with the specific electrical conductivity of metals were recently reported [3]. Here, we explore the optoelectronic properties of these fibers of CNTs towards the development of broadband and flexible photodetectors. Specifically, we present a PTE effect based flexible CNT-fiber photodetector fabricated using a novel technique.

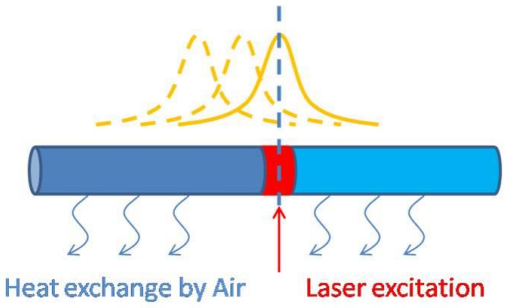

Fig. 1: Photodetection with a CNT fiber. The fiber is illuminated at the junction (red), and heat is produced, generating a voltage via the Seebeck coefficient gradient. Solid and dashed brown lines are temperature profiles due to illumination at different positions.

Figure 1 shows a schematic diagram of a CNT fiber with two regions with different doping densities illuminated at junction between the two regions. The spatial variation of doping creates a Seebeck coefficient gradient, leading to a photothermoelectric signal. This fiber photodetector shows promising performance in the visible and near infrared regime. Figure 2 shows the effect of red light (660 nm) illumination on the I-V characteristic of the fiber, producing finite short-circuit current (I_{SC}) and open-circuit voltage (V_{OC}). The device showed responsivities up to 0.2 V/W.

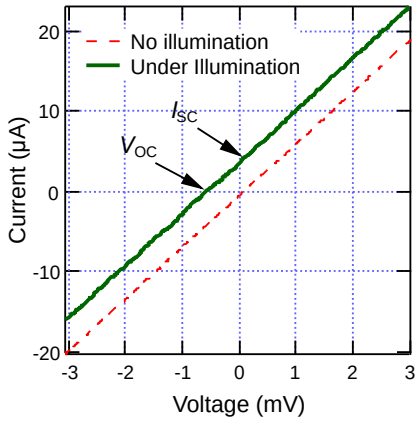

Fig. 2: I-V characteristics of the CNT fiber photodetector with (green line) and without (red dashed line) illumination at 660 nm.

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P-1

Birefringence Testing of Injection Molded Microplates

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Birefringence testing of Injection molded micro-plates is one of the reliable methods to assess the quality of the specimen plates. Depending upon their manufacturing / production processes, different plates exhibit varying birefringence, which is undesirable when used as micro-plates. A phase shift polariscope is used to determine residual stresses and other related parameters, vital for the evaluation and selection of suitable plates. Broad chemical resistance and high mechanical stability of the plates are the desirable properties that can be characterized by birefringence measurement. Birefringence, expressed in nm/cm is light retardance (nanometer) after passing through a sample with certain thickness (centimeter). Low or uniform birefringence plates provide high-resolution demonstrating higher performance, hence suitable for bio-chemical analysis.

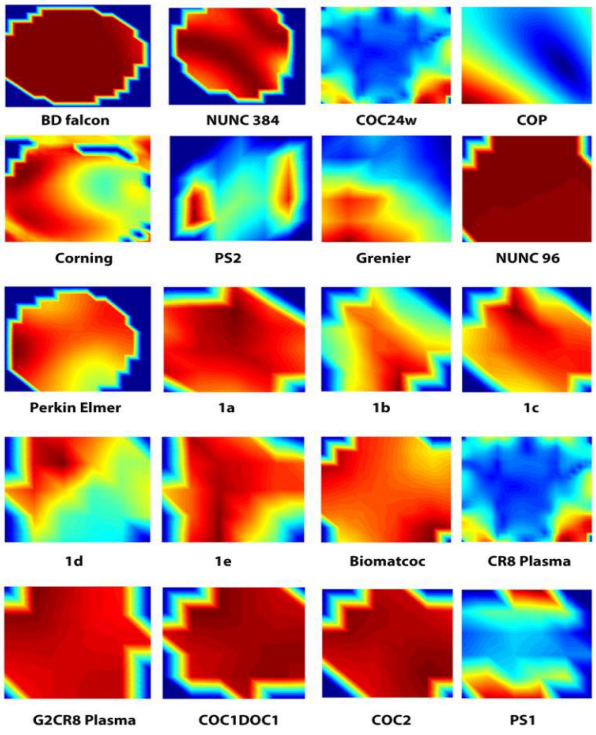

Figure 1: Birefringence of different micro plates

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P-2

Chemical synthesis of semiconductor nanocrystals for solar cell applications

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[3] *Kobe University,*

1. Introduction

A great variety of semiconductor materials, such as CIGS[1] ,CdTe[2] and Cu_2ZnSnS_4 (CZTS) have been intensively investigated in order to fabricate highly efficient solar cells [3]. However the wet-chemical synthesis of semiconductor nanocrystals and their use for the large-scale fabrication of films for solar energy conversion is an emerging area of research compared with physical deposition techniques, because it can produce solar cells with potentially lower fabrication cost.

Herein we report a method of the synthesis of CZTS nanocrystals by chemical way for solar cell application.

2. Experimental

The synthesis of CZTS nanocrystals was made by a hot-injection technique using $CuCl_2$, $ZnCl_2$, ($SnCl_2.2H_2O$) and dodecanethiol or oleylamine as both solvent and capping agent. The nanocrystals were isolated by precipitation with ethanol followed by centrifugation. The precipitation and centrifugation process was repeated several times and the final product was dispersed in toluene for further characterizations.

The morphology and the crystalline structure of the CZTS nanocrystals were determinedd by TEM, XRD and Raman spectroscopy. The optical properties were also characterized by ultraviolet–visible (UV-VIS) spectroscopy.

3. Results and discussion

The vibrational spectra of the CZTS nanocrystals obtained from Raman analysis (fig 1) exhibits a strong peak at 330 cm^{-1}which coincides with the characteristic vibrational mode assigned to CZTS in literature [4-5].
The insert spectrum in (fig 1) shows the absorbance of CZTS nanocrystals. We observe that the absorbance around the UV-Vis region of CZTS nanocrystals is very high which is very important for the solar cell application.

Furthermore, the X-ray diffraction (XRD) measurement exhibits strong signals at diffraction angles allocated to CZTS in literature (2θ = 28.53°, 47.33°, 56.16°) [6] which confirms the purity of CZTS nanocrystals.

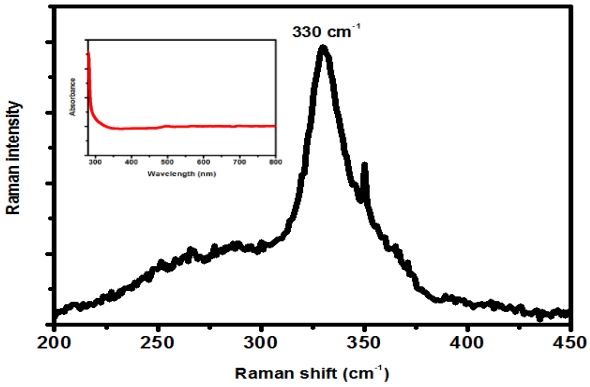

Fig.1: Raman spectrum of CZTS nanocrystals. Insert shows the absorbance of CZTS nanocrystals.

To study the morphology and further confirm the structure of the synthesized CZTS nanocrystals, TEM analysis was carried out and we obtained polydispersed CZTS nanocrystals with a spherical shape. The size of the nanocrystals varies from 8 nm to 20 nm.

According to all of the previous results it can be seen that a simple synthetic route for producing CZTS nanocrystals by chemical way was successfully done and we believe that the crystal structure of this semiconducting materials can be controlled by tuning the reaction conditions, such as metal salt reactants, reaction temperature and solvents.

4. Conclusion

CZTS nanocrystals have been successfully produced directly by the reaction between metal salts and elemental sulfur in either dodecanethiol or oleylamine.

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P-3

Surface enhanced Raman scattering from gold nanoparticles *with cell nuclear entry*

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Surface enhanced Raman scattering (SERS) has been used to measure molecular vibrations near a metal nanostructure with high sensitivity. Especially for detecting biological molecules in a living cell, gold nanoparticles (GNPs) have been utilized as SERS agents since GNPs can penetrate into cytosol of living cells without causing significant damage into the cells. We have proposed a technique to measure SERS spectra and the motion of GNPs introduced in a living cell and observed behaviors of SERS spectra corresponding to the dynamics of the GNPs [1,2].

Here we report SERS observation from GNPs undergoing cell nuclear transportation. The nuclear transportation is an important cellular process that related to a virus infection and DNA/RNA traffic. In order to induce nuclear transportation of GNPs, we conjugated GNPs with nuclear localized signal (NLS) peptides through some chemical cross-linkers [3]. 40nm-diameter GNPs were chosen for the experiment so that GNPs can enter a cell nucleus through a nuclear pore. HeLa cells were incubated with NLS-peptide-conjugated GNPs for 24 hours and imaged by a slit-scanning Raman microscopy with 676nm excitation. Raman imaging was performed every 3min (30 sec/image) with simultaneous observation of GNP dynamics by a dark field microscopy.

Figure (a) and (b) show the time-lapse averaged SERS images (intensity averaged from 600 to 1500cm^{-1}) and the corresponding SERS spectra measured at the bright spot indicated by the arrows, respectively. From time-lapse measurement, we found that the GNP entered a cell nucleus with time and some SERS signal attribute to DNA base appeared. Guanine and Cytosine (1530cm^{-1}) was confirmed when the GNP passed over nuclear pore. This result indicates that the environmental change near the GNP during the nuclear entry caused the drastic change in the SERS spectrum.

In a finite-difference time-domain (FDTD) calculation, we found some peaks of surface plasmon resonance in visible range, and the strongest peak appeared at a wavelength of 727 nm (Fig. 2). These results show that the combination of lithography and self-assembly has the potential to realize plasmonic nanolens made of Au nanorods.

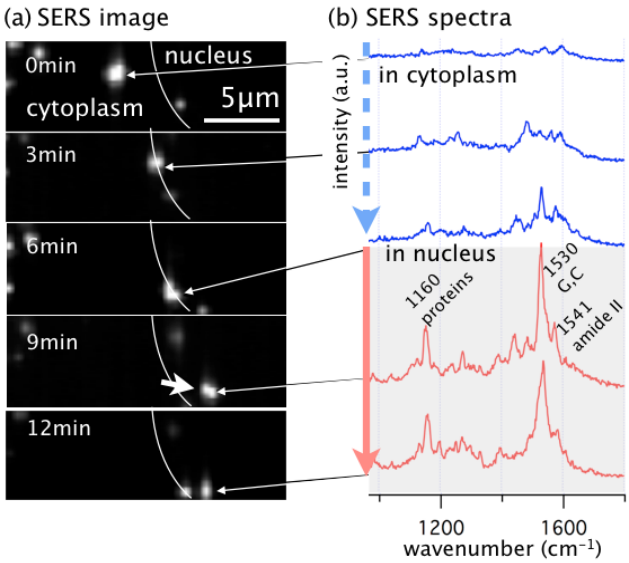

Fig. 1. (a) time-lapse intensity averaged Raman images (600 to 1500cm^{-1})
(b) SERS spectra around a NLS-conjugated GNP which entered cell nucleus

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P-4

Mid-IR Temperature Sensitivity of Chalcogenide-Based Photonic Band Gap Holey Fiber

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ajanta.barh@gmail.com

Introduction:
Light guidance via *photonic band-gap fiber* (PBGF) was first demonstrated by E. Yablonovitch and S. John, separately in 1987 and from then the PBGF technology has grown rapidly till now owing to its various potential applications in broad-band communication, high power guidance, sensing, filtering, THz applications and many more [1]. Recently *eye safe* mid-IR spectral range (2 ~ 10 μm), attracted numerous potential applications in defence, atmospheric monitoring, medical diagnostics, molecular spectroscopy etc. [2]. For sensing, filtering or medical applications, tuning of operating wavelength (λ) is quite common. One way to achieve that is via tuning the PBG in a holey fiber [3]. Few proposals have been made in this direction, however, they are quite complex in structural geometry and most of these were targeted for today's telecom wavelength (1.55 μm). In this paper, we report a simple PBG holey fiber structure made of mid-IR suitable chalcogenide (Ch) glass [2], where its band-gap (BG) is tuned at mid-IR regime via controlling the external temperature (T). Our proposed PBGF is an *all-solid* fiber made of two fabrication compatible, low index contrast (Δ) Ch-glasses [4] because, *all-solid* fibers are most fabrication friendly and scattering loss can be minimized in low Δ structure.

Designs, results and discussions:
Proposed structure is composed of an uniform background of refractive index (RI) n_b with hexagonally arranged circular rods (RI of rod is n_r) embedded on it. We have used *plane wave expansion* method for the simulations and BG is found for the low Δ system for *out of plane propagation*, which of course is the actual situation for fiber optics. In first case, we choose $n_b > n_r$ and optimized the radius of rod (r) ~ 0.675 μm and separation (Λ) ~ 1.5 μm such that BG can found at mid-IR λ ~ 2.5 μm. We have deliberately chosen an appropriate larger diameter for the central rod (as defect core) so that *surface modes* can be eliminated and found only lower order BG (cf. Fig. 1). In second case we exchanged the materials of rod and matrix, thus now $n_r > n_b$ and core is created by omitting a rod. For the same values of r and Λ, two PBGs are found (cf. Fig. 2). For both the cases we have examined the variation in BG positions (mid-gap λ) by tuning the T and found that sensitivity (S_T) is better for the latter case which shown in Fig. 3. Maximum achievable S_T is ~ 140 pm/°C for lowest order BG. This continuous variation of BG properties with T would be very attractive for use as all fiber mid-IR filters, sensors or dispersion compensators.

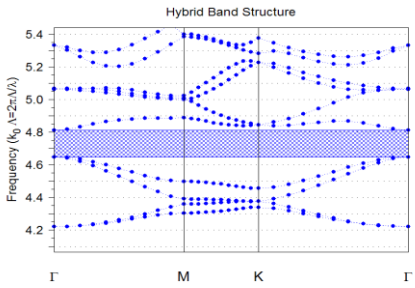

Fig. 1: Band structure of proposed PBGF for $n_b > n_r$.

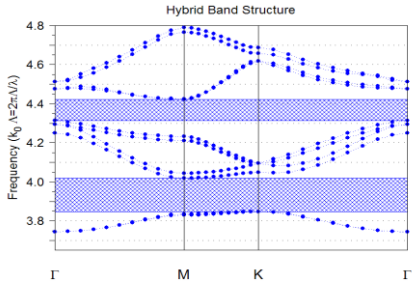

Fig. 2: Band structure of proposed PBGF for $n_r > n_b$.

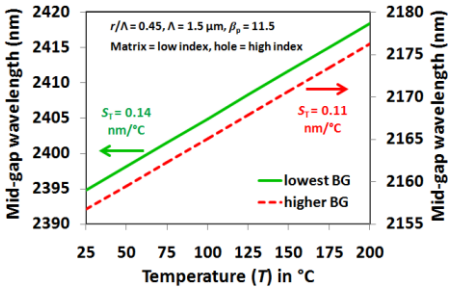

Fig. 3: T dependent of mid-gap λ. Green solid is for lowest BG and red dashed is for higher BG.

This work is partially supported by ONRG project. A.B. acknowledges CSIR (India) for PhD fellowship.

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P-5

In vivo Eyes Development of *Drosophila* Embryo in Early Stage Studied by Three-dimensional Time-lapsed Imaging via Single Plane Illumination Microscopy

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Introduction

Although fluorescent staining and imaging have been used to study the eyes development at each developmental stage of *Drosophila* from larva to adult [1-2], the dynamic behaviour of the precursor cell during the formation of Eye-Antenna Disc Primordium (EADP) in embryonic stage still remains unclear.

To clarify the developmental process of EADP in early stage, we recorded, via single plane illumination microscopy (SPIM), time-lapsed 3-d images of the *Drosophila* embryos with GFP-labeling on CD enhancer, which can represent the *eyegone* (*eyg*) gene as the earliest uniformly-expressed marker of EADP from stage 15 [3]. Furthermore, we compared the fluorescence expression patterns of *engrailed* (*en*) gene, which was regarded as an earliest regulator to the eyes development of *Drosophila* [4], and CD enhancer to clarify their correlation and the spatio-temporal contribution of *en* gene to EADP.

Result

The dynamics of CD enhancer expression during the course of *Drosophila* eyes development from stage 14 (~ 11 hours after fertilization) to stage 17 (~ 15 hours after fertilization) was recorded via time-lapse imaging of the embryogenesis for 4 hours. Figure 1 shows the formation of EADP (i.e., the bright V-shape structure in the images) from the CD-GFP cells at stage 15. It reveals that the *eyg* gene was upregulated in the head region from stage 15, and coordinated the precursor cells to migrate and proliferate to form the eye-antennal imaginal disc (EAD) in later first instar larval (L1) stage.

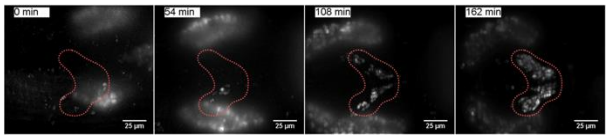

Fig. 1: Four out of 80 time points of the time-lapse images of *CD-GFP(II)/S-T Drosophila* embryo which show the formation of eye-antenna disc primordium (EAPD) from stage 14 through stage 17. Each image is projected over 113 2-d optical sectioning slices. The red dotted V-shape highlights the area where EAPD appears. Objective: 40X/0.75; time interval: 54 min.

To further study the contribution of *en* gene to eyes development, we merged the dual fluorescence 3-d images of a *Drosophila* embryo (CD-GFP/*en*-Gal4;UAS-H2B-RFP/+) at stage 16, as shown in Fig. 2, with the CD-enhancer and *en* gene labeled by GFP and RFP, respectively. To inspect the co-localization of these two genes, we examined the 2-d optical sectioned images at different depths as well as the reconstructed 3-d image.

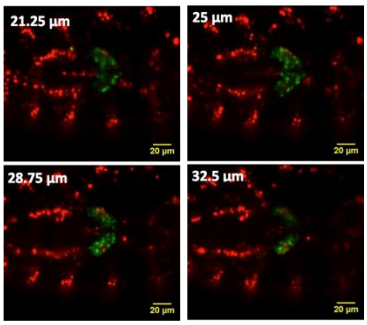

Fig. 2: Four out of 102 slices of the single stack images of a *Drosophila* embryo (CD-GFP/*en*-Gal4; UAS-H2B-RFP/+) which show the merged result of dual fluorescence images. CD enhancer and *en* gene are expressed with GFP and RFP, respectively.

Conclusion

The long-term 3-d images of CD-enhancer have provided the detail information of the cell dynamics during the EADP development process from stage 15. A comparison of the fluorescence gene expression patterns of CD enhancer and *en* gene has indicated that they only co-expressed in a few cells in EADP.

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P-6

Three dimensional light manipulation for full-color nano-projector

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Using plasmonic nanostructures to manipulate the scattered light from the SPP waves will be experimental demonstrated. The surface plasmon waves can be scattered and modified by various plasmonic structures composed of gold nanobumps. The height and intensity profile of the focusing patterns are precisely controlled in three-dimensional space by the curved arrangement of nanobumps. The modulation of the projecting height of the focusing pattern is reached as high as 10 micron-meters. The intensity profile of focusing pattern can be approached to a diffraction-limited spot. The projecting image constructed by focusing spot from designing nanobumps arrangement is achieved in three-dimensional space.

The Au nanobumps confer additional three-dimensional propagating wave vectors on SPP wave for departing from surface. It is possible to manipulate the three-dimensional plasmonic scattering by arranging the Au nanobumps. In this work, we manipulate the scattering of SPP waves by various plasmonic structures composed of arranged nanobumps on a gold thin film. Upon controlling the geometry of the plasmonic structures, the height, position, and pattern of scattered light can be modified as desired. It provides a simple and efficient way to project a specific light pattern into free space, and demonstrate the capability of three-dimensional light manipulation. By precisely designing a particular curved structure with appropriate radius of curvature and adjacent interspacing of nanobumps, we can construct a clear single focusing spot at a specific altitude. The irregular light patterns of the scattering of designed structures are observed at any observation plane, except for the scattering-light-focal plane where observing the focusing spot of curved structure. When the focal plane is shifted to this scattering-light-focal plane, the “NTU” light patterns are clearly observed. Under the different color laser which are green, blue and red illuminating, the “NTU” pattern are observed with different color respectively. Figure 1 shows the ”NTU” pattern is illuminated by green laser. These results confirm the controllability of the focused spot in three-dimensional space by settling curved structures.

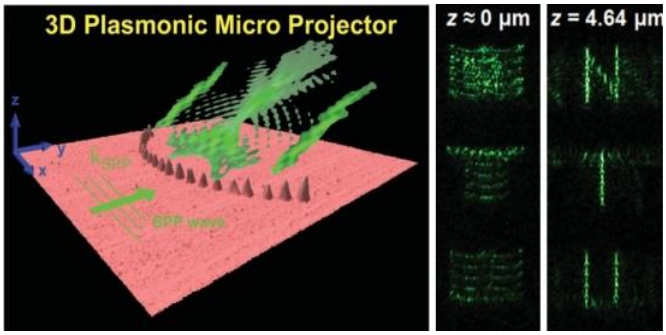

Fig. 1: Iimagine of the NTU pattern whch is illuminated by green laser.

The out-of-plane plasmonic light manipulation by converting the SPP wave into radiaotpn using various fs-laser fabricated nanobumps on Au thin film. Not only the altitude of the focused light pattern is modulated by adjusting the RCs of curved structures ,but also the interspacing of adjacent nanobumps in curved structures determine the intensity distribution of the focused pattern. The curvature condition the optical path length and the interspacing of adjacent nanobumps govents the kx propagating wave vector. The three dimensional light projection is achieved as long as the arrangement of nanobumps are precisely designed. The full color nano projector

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P-7

Spectroscopic Study of Second Harmonic Generation Chiral Microscopy in Type I Collagen

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Chiral molecules have different efficiencies in generating second-harmonic generation signal for left- and right-circular-polarized light. This effect is called second-harmonic generation circular dichroism (SHG-CD). It has been shown that SHG-CD exhibits much better chiral contrast than traditional chiroptical spectroscopies [1]. Furthermore, combined with a laser scanning microscope, SHG-CD provides optical sectioning capability that is suitable for examining thick tissue samples. We have shown that type I collagen gives rise to strong second-harmonic generation circular dichroism (SHG-CD) responses [2]. However, to resolve the molecular structures and chiral properties of biological tissues, it is not enough to study SHG-CD for only one specific wavelength.

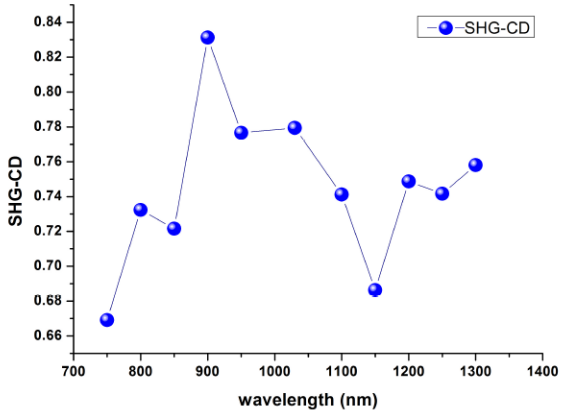

Fig. 1. SHG-CD value varies with the excitation wavelength from 750 to 1300nm.

Here, we measured SHG chiral microspectroscopy of type-I collagen in the excitation spectral range of 750 – 1300 nm, for the first time. The result is shown in Figure 1. It is interesting to note that maximum SHG-CD value corresponds to the wavelength of 900nm.
This wavelength dependency not only reflects the resonance frequency of the molecular structure, but also the micro-chiral property of type I collagen. Our investigation constitutes an important landmark towards a realistic SHG-CD chiral spectroscopic technique and will make great impact for protein chirality study in three-dimensional tissue samples.

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P-8

Optical Stretch-Induced Calcium Influx vs. Dynamic Deformability of Human Red Blood Cells

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The physiological functions of human red blood cells (RBCs) are critical for oxygen and carbon dioxide transport. The unique biconcave shape and superb deformability of RBCs enable them to pass through small capillaries, with diameter on the order of a few microns, during circulation [1]. In physiological environment and/or pathological conditions, the morphology and the deformability of RBCs are related to calcium ion (Ca^{2+}) concentration [2]. Ca^{2+} is also a ubiquitous mechanosensor that links external mechanical stimuli to cellular response. A change in Ca^{2+} concentration is an important signal that regulates the cellular function and mechanics [3][4]. Thus, the possibility to simultaneously image intracellular Ca^{2+} distribution and measure the intracellular Ca^{2+} concentration along with deformability of individual RBCs will allow us to better understand the interplay between the biochemistry of Ca^{2+} and the mechanobiology of RBCs.

In this study we focus on calcium dynamics through stretch-activated calcium influx of individual RBCs, trapped and stretched by the dual-trap optical tweezers, and the possible correlation between Ca^{2+} concentration and RBC's mechanics. Specifically, we have integrated dual-trap optical tweezers system with fluorescence microscopy (Fig. 1) for simultaneous real-time imaging of intracellular fluorescence-labeled calcium (Ca^{2+}) and RBC deformation under optical stretch [5]. Our experimental results indicate that the stretch force induced calcium influx into the red blood cell (Fig. 2), which in turn led to a reduction in the deformability of red blood cell.

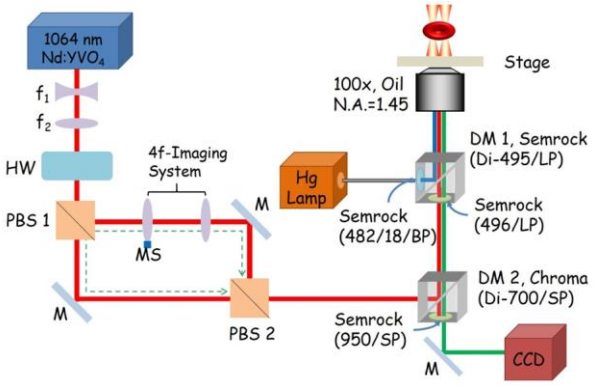

Fig.1: A schematic diagram illustrating the integration of a dual-trap optical tweezers with a fluorescence microscope.

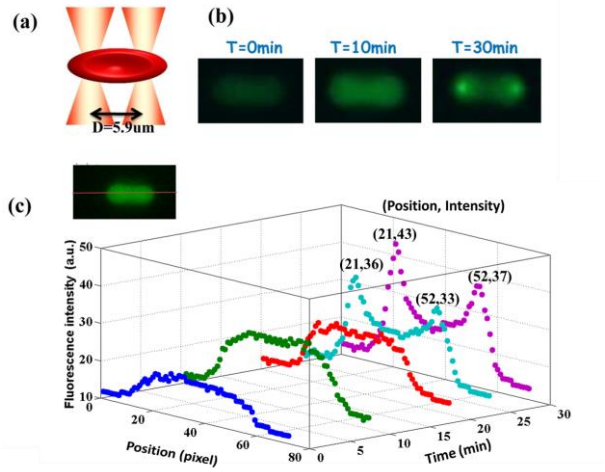

Fig. 2: (a) A schematic illustration of a human RBC trapped and stretched at D = 5.9 μm by a set of dual-trap optical tweezers; (b) Fluorescence image of a trapped and stretched human RBC at different time; the increase in fluorescence intensity of Fluo-4 indicates the increasing accumulation of Ca^{2+} in the RBC with time; (c) Quantitative measurement of the distribution of Ca^{2+} concentration (indicated by the fluorescence intensity) along the RBC axis as a function of time.

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P-9

Local field enhancements for particle trapping

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Trapping and manipulating particles on the micron and sub-micron scale has been of interest to the science community for the past few decades [1]. Limits imposed by conventional Gaussian optical tweezers restrict the size range over which particles can be adequately trapped. To overcome such limitations, focus has shifted from free-space optical beam-based optical tweezers to those based on optical near-fields [2], which offer highly confined optical fields with large local field enhancements. The creation of intense near-fields can be achieved using numerous methods; here we focus on those created via sub-wavelength features at dielectric boundaries and the inclusion of metallic nanoparticles which provide large plasmonic field enhancements [3,4]. Optical micro/nanofibres (MNFs) are used as a platform for particle trapping due to their versatility and excellent light confinement properties [5].

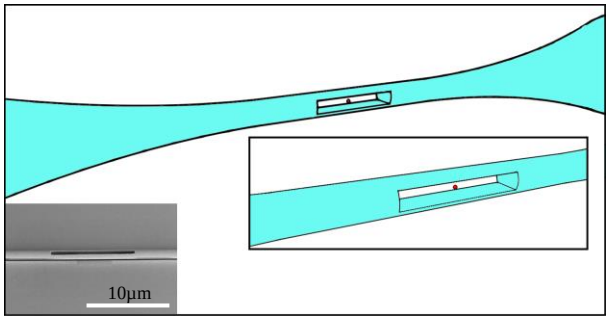

Fig. 1: Diagram of a nano-structured micro/nanofibre SEM image inset.

MNFs consist of optical light guiding fibres with diameters comparable too, or smaller than, the wavelength of the guided light. Typically, such fibres are produced using a heat-and-pull rig and standard, telecommunications grade fibre is pulled over a heat source to reduce its diameter. MNFs produce large evanescent fields when the diameter approaches the wavelength of guided light. This field is capable of interacting with objects within the evanescent decay length of the system. It has been shown that MNFs are capable of trapping and propelling dielectric particles as small as 600 nm [6]. We propose two methods of enhancing fields near, or in MNFs. As a first method, we use lithographic techniques to etch nano-scale cavities into the waist region of an MNF (Fig. 1). For the fundamental mode of an MNF, a large portion of the power is confined to the central region. When this field encounters a cavity in this area, optical near-fields are produced. The near field exhibits both an enhanced optical field, as well as large field gradients, both of which are desirable for trapping particles. An alternative to this nanostructured device involves the combination of plasmonic nanoparticles with MNFs. Due to the interaction of light fields with bound electrons on a metallic surface, many metallic particles exhibit localised surface plasmon resonance (LSPR) phenomena when their diameters become comparable to the wavelength of light, thereby producing extremely large local field enhancements (Fig. 2). By embedding gold nanorods into polymer MNFs, the fields around the nanorods are vastly increased. This allows for enhanced propulsion of nearby dielectric particles. The fabrication and testing of both of these devices will be discussed.

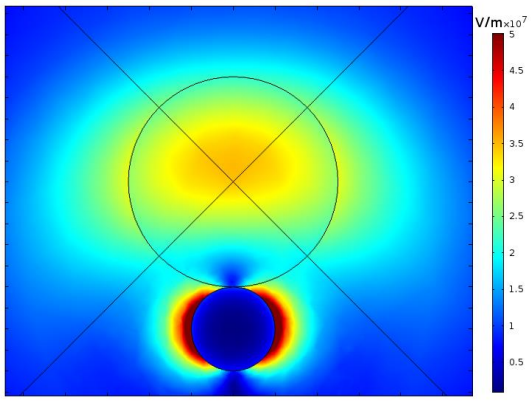

Fig. 2: LSPR of a 200 nm gold particle (lower circle) excited with light of wavelength 808 nm near a 500 nm MNF (upper circle).

References:

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P-10

Monte Carlo Light Propagation Modeling In Optically Thin Media

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Monte Carlo is a stochastic method which rely on repeated random sampling to calculate results. In light propagation application, light beam is contributed by millions of photon. Each photon undergoes random walk in the media based on step size and direction random sampled from particular probability density function. The net distribution of photon paths yield an accurate approximation to reality [1]. Conventional Monte Carlo method uses discrete absorption weighting that is not reliable in optically thin media because most photon pass through the media without any interaction. A novel proposed absorption weighting approach uses continuous absorption weighting concept to reduce the variance of results and number of photon required [2]. Continuous absorption weighting approach measures the weight absorption based on the distance traveled regardless any interaction take place. The result of proposed approach is compared with the conventional discrete absorption weighting approach and shows that the proposed approach can provide same statistical estimate of result with smaller variance and less number of photon.

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P-11

Continuous observation of osteoblastic mineralization by Raman imaging

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Introduction

Bone formation is initiated during mineralization process undergone by osteoblasts. In the mineralization process, osteoblasts produce hydroxyapatite (HA), which is major component of bone. Previous researches have shown that various biomolecules are involved in the process of osteoblastic mineralization by invasive biochemical diagnosis. Although traditional bio logical assays greatly contribute to understanding bone formation, they are unable to follow up the osteoblastic mineralization process. Raman imaging is a nondestructive and label-free technique that provides contrast images based on vibrational frequencies that are derived to target molecules including their locations with time domains. Thus, Raman imaging enables time-lapse observation of the dynamics of the biomolecules in a living specimen without any preliminary preparations. In this study, we observed the osteoblastic mineralization process in the culture of mouse osteoblasts by continuous Raman imaging.

Experimental method

We induced differentiation of KUSA-A1, a mouse mesenchymal stem cell line, into osteoblasts and monitored the differentiation and mineralization process by Raman imaging. The Raman measurements were performed every 4 hours. HA Raman band was used as a marker for the osteoblastic mineralization since HA Raman signal was gradually strong by progression of the processes [1].

Results and discussion

As the result in Figure, we revealed that HA was produced around the spots where β-carotene was localized in osteoblastic mineralization process. From the time-lapse Raman images, we observed first, Raman signal of β-carotene was detected from minute spots in the tissue and then, HA Raman signal appeared around the minute spots after disappearance of the β-carotene signal. Previous researches have reported that β-carotene has a direct stimulatory effect on the differentiation of osteoblasts. From both our result and the previous study, it was suggested that β-carotene was an important biomarker of initial site of the mineralization.

Conclusion

The monitoring of mineralization-related molecules in the same osteogenic lineage cells by time-lapse Raman imaging as successfully accomplished. It was revealed that HA was produced in where β-carotene was localized. In addition, the decrease of cytochrome c and protein Raman signals, which was associated with apoptosis, was observed after the mineralization process Time-lapse Raman imaging serves as a powerful tool to reveal the mechanism of osteoblastic mineralization in an in-vitro culture of osteogenic lineage cells.

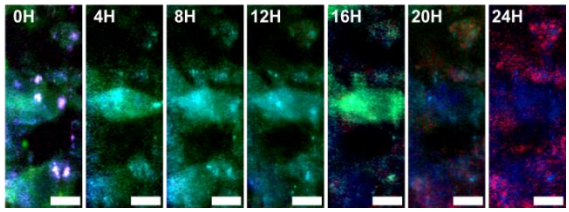

Figure. Raman images of mouse osteoblasts.
The Raman images were reconstructed from the distribution of the Raman signal at 750, 9 56, 1526 and 2940 cm^{-1} assigned to cytochrome c, HA, β-carotene and protein, respectively. In the image , cytochrome c, HA, β-carotene and protein are shown in green, red , magenta and blue, respectively. Scale bar: 10 μm.

Acknowledgements

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P-12

Plasmonic Photocatalyst for Photodegradation with Spinning Optical Disk Reactor

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1. Introduction

Since concern has been raised over the environmental contamination issue, environmental remediation and green energy has become one of the most high-profile topics in recent years. In this work, we developed an environmental benign process of growing large-area ZnO nanorods on optical disk substrate, which can easily accompany with the spinning optical disk driver to significantly accelerate the surface photocatalytic degradation reaction[1].

2. General Instructions

method of approach

In order to promote photocatalytic efficiency and make use of visible light, we deposit silver nanoparticles on the ZnO nanorods surface, see Fig. 1. (a, b). Noble metal nanoparticles dispersed into semiconductor photocatalysts was considered as plasmonic photocatalysis that possesses two prominent features—a Schottky junction and localized surface plasmonic resonance (LSPR), provided better charge separation and strong absorption of visible light, respectively[2]. UV and visible light source were fixed in-side the reactor and employed during the reaction process for excitation of ZnO and plasmon, respectively. The photocatalytic activity was evaluated by the degradation of methyl orange dye (MO for short) as a model compound in aqueous solution. The degradation of MO molecules can be monitored by the optical spectroscopy measurements, thus the decomposition rate could be calculated accordingly[3].

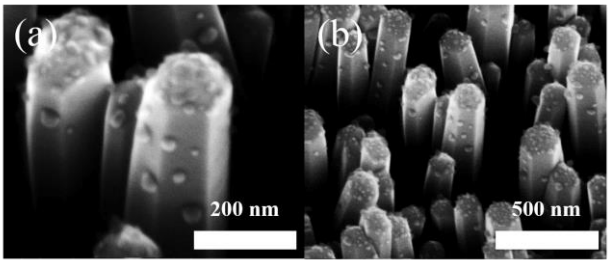

Fig. 1: (a, b) The SEM images of silver-sputtered ZnO nanorods. The sizes of the silver nanoparticles range from 10 to 45 nm.

Results

In the MO decomposition experiment, the variation of MO concentration directly displayed the photocatalytic ability of the ZnO nanorods. More than 13.9% MO was decomposed after a 20-minute treatment with visible light turned on, and the calculated chemical reaction rate constant was almost 50% larger than the one from experiment without any plasmonic effect, see Fig. 2. These results indicated that the plasmonic effect is well demonstrated through the apparent enhancement of photocatalytic reaction rate.

3. Conclusions

In this work we had combined the intelligent spinning optical disk reactor with the plasmonic photocatalysis nanostructure, both promote the reaction efficiency and the latter also accomplish to make further use of visible light region, which composed a major part of sunlight. As the optical disk is widely used and quite available material in our daily life, this work is very prospective for the environmental treatment.

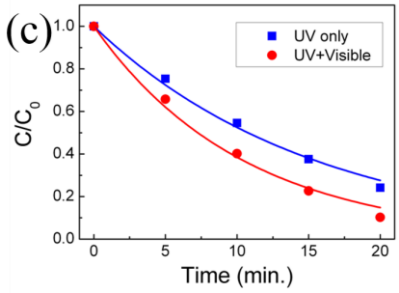

Fig. 2: The relative concentration at different time of reaction with and without visible light source. C is the concentration of MO molecules at time t, and C0 is the original concentration.

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P-13

Fabrication of plasmonic cavity and indefinite metamaterial by laser-induced forward transfer

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1. Introduction

Optical cavity has found many applications in integrated photonics [1], micro/nano-laser [2], luminescence enhancement [3], and nonlinear optics [4]. To achieve high performances on the applications, an optical cavity with a high Purcell factor Q/Vm is desired, where Q and Vm denotes the quality factor and mode volume. Unfortunately, mode volumes are limited by diffraction limit. Plasmonic cavities can squeeze light in volumes significantly smaller than the diffraction limit and have drawn lots of attention recently. To fabricate multilayer and three-dimensional plasmonic nanostructures, laser-induced forward transfer (LIFT) is a simple and low -cost writing technique to choose. LIFT technique is very fascinating for the throughput and fast prototyping of various nanophotonic devices. In our research, we implement the femtosecond LIFT (fs-LIFT) technique to fabricate square-shaped multilayer plasmonic resonant cavities, and study their optical properties by both experiments and numerical simulations.

2. Results and Discussion

Figure 1 shows the schematic illustration of the experimental process. By using a magnetron sputtering system (Shibaura Mechatronics Corp.), multilayer thin films composed of Au(20 nm) / ZnS-SiO2(30 nm) / Au(20 nm) / ZnS-SiO2(30 nm) / Au(20 nm) are sputtered on a cleaned BK7 glass substrate. Under focused laser illumination, the local material on the precoated substrate (so called donor) can be transferred to the opposite substrate (so called receiver). Multilayer films of fabricated patterns can be observed in SEM images, indicating that the multilayer structures of laser-fabricated pattern are not damaged by the lateral heat dissipation during laser illumination. We also compare the experimental with simulated transmittance spectra of the plasmonic cavity illuminated by a y–polarized light at normalincidence. We found that two transmittance dips appear around 1280 nm and 1800 nm in both spectra. To understand the origin of these dips, we also analyze the plasmonic resonance modes of the structures by simulation.

3. Conclusions

We successfully demonstrated a low-cost, efficient and simple fabrication technique for manufacturing multilayered plasmonic resonance cavity by femtosecond laser-induced forward transfer technique. We have found the optimized laser fluence and laser raster speed on the multilayer films for making the fabricated multilayer structure uniform and smooth. Two resonance modes are alsofound in near infrared region, showing electromagnetic energy mainly stored in the sandwiched dielectric layer with subwavelength property. The optical properties of laser-fabricated plasmonic cavity quantitatively agree with simulations results. We can expect that People may readily find the optimization of processing parameters for the desired layered structures, and fabricate the designed photonic devices on the arbitrary substrates.

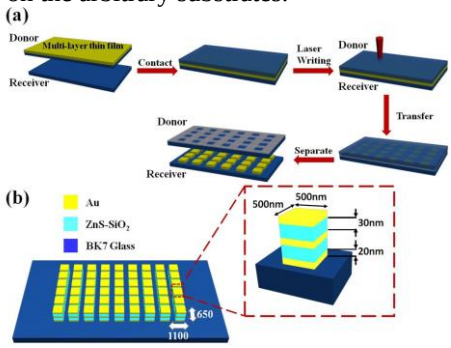

Fig. 1: (a) Schematic illustration of fs-LIFT process. (b) The feature size of a multilayered plasmonic cavity in nanometer scale. The period along x-direction P_x and y-direction P_y are 1100 nm and 650 nm.

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P-14

Effect of free carriers on optical functions of erbium doped ZnO films

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Impurity (Al, Er or Ga) doped zinc oxide (ZnO) films have been attracting considerable attention as an alternative material to tin doped indium oxide [1,2]. Doped ZnO thin films have several advantages such as good electrical conductivity, high transmittance in the visible range, high infrared reflectance, hardness, chemical inertness, and stability under exposure to hydrogen plasma [3]. Doped ZnO films incorporated into optoelectronic devices generally have high carrier concentrations of 10^{19}-10^{21} cm^{-3} [1-4]. At these carrier concentrations light absorption by free carriers alters the optical parameters (dielectric permittivity ε, optical conductivity σ, effective mass m^*/m, mobility μ, and scattering rate τ of the free carriers) significantly in a range extending from the near-infrared to visible region [4]. Although there have been reports about of the optical properties of doped polycrystalline ZnO films [5, 6], all of these reports are not associated with the frequency dependent optical parameters of doped ZnO films. The present report is focused on the frequency dependent optical properties of the conducting erbium (Er) doped ZnO films prepared on sapphire and glass substrates by e-beam evaporation technique. Frequency dependences of the optical conductivity $\sigma(\omega)$, effective mass (m^*/m), dielectric permittivity (ε) and electron loss energy Im($1/\varepsilon$) of Er-doped ZnO films have been calculated via Kramers-Kronig transformation of the reflectivity spectra and analyzed by the generalized Drude (one-component) and Drude-Lorentz (two-component) models (Fig. 1, 2).

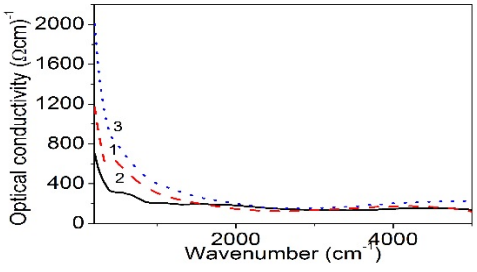

Fig. 1: Optical conductivity Er-doped ZnO films (1- 0.64% Er, 2-0.9% Er, 3-1.2% Er).

Lorentz oscillator is necessary to simulate the spectroscopic data, revealing the presence of bound optically active electrons, whereas one-component Drude model leads to a frequency dependent scattering rate τ and enhanced low-frequency effective mass m^*/m. Carrier transport properties determined from Drude analysis have been compared with data obtained by Hall measurements.

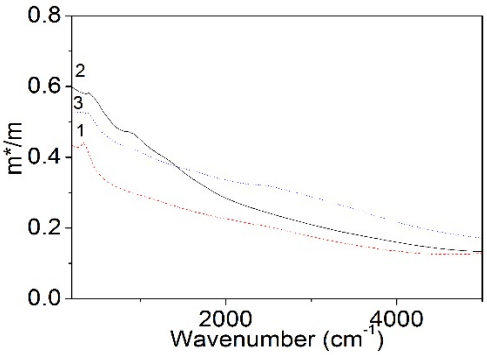

Fig. 2: Frequency dependences of effective mass m^*/m of ZnO films for different Er-content (1- 0.64% Er, 2- 0.9% Er, 3-1.2% Er).

The electron concentration (N/m) and electron mobility in Er-doped ZnO films are achieved up to 10^{21} cm^{-3} and ~ 10^{-3} $m^2/V{\cdot}s$, respectively. The optical and carrier transport properties including doping mechanism and carriers' origin are discussed.

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P-15

Design of Signal Pattern for Optical Correlator using Coaxial Holography

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Services for sharing video have recently become popular, with widespread Internet use. Therefore, high-speed non-textual search, such as image search or video search, is becoming more important. Moreover, we have been developing a high-speed optical correlator that uses coaxial holography and a holographic optical disc. The process of optical correlation consists of the hologram recording and correlation processes. To improve the correlation speed, it is necessary to optimize each process. A large intensity deviation in a recording medium generally reduces the dynamic range of the medium. Therefore, several approaches to homogenize the intensity distribution in the recording plane have been reported [1–4].

In this study, we verify our signal pattern by simulating hologram recording using scalar analysis. Figure 1(a) shows the simulation model of the hologram recording process. The holographic medium is divided into M layers. We simulated the diffraction spectrum at the medium plane using the fast Fourier transform (FFT) method with defocusing amount of the ith layer (z_i in Fig. 1(a)) [5]. The simulation parameters are summarized in Table 1.

Table 1: Simulation parameters.

Calculation area (pixels)	2048 × 2048
Pixel size (μm)	2.675
Resolution of focal plane (nm)	194
Wavelength λ (nm)	532
Focal length f (mm)	4.00
Number of layers N	100
Medium thickness (μm)	500

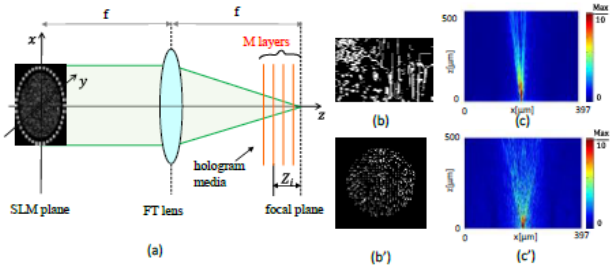

Figure 1: (a) Simulation model of hologram recording process, (b) image with conventional preprocessing, (b′) random arrangement of (b), (c) and (c′) cross sections of intensity distribution in holographic media where (b) and (b′), respectively, were the inputs. SLM: spatial light modulator.

Now we propose the randomly arranged signal input pattern shown in the Fig.1(b′). Figure 1(c) and (c′) show the calculated cross section of the intensity distribution in the holographic medium obtained by simulations using the image with conventional preprocessing [Fig.1(b)] and the randomly arranged image [Fig.1(b′)]. We calculate the standard deviation using the following equations and compare the results for the conventional and random arrangement methods. The intensity deviation in the medium for the images is given by

$$\mu(x,y) = \frac{1}{N}\sum_{i=1}^{N} \mathrm{I}_i(x,y),$$

$$\sigma^2(x,y) = \frac{1}{N}\sum_{i=1}^{N} \{\mathrm{I}_i(x,y) - \mu(x,y)\}^2,$$

where $\mathrm{I}_i(x,y)$ is the cross section of the intensity in the medium. The calculated value of $\overline{\sigma_r^2}/\overline{\sigma_n^2}$ was 0.417. Therefore, the intensity deviation of the different images was reduced by using the random rearrangement method. Here, $\overline{\sigma_n^2}$ and $\overline{\sigma_r^2}$ denote the average of σ when images with conventional preprocessing and preprocessing with random arrangement, respectively, were used.

We define the evaluation function SR (the similarity rate) as follows:

$$SR = 10\log(S_{ac} / S_{cc}) \text{ [db]},$$

where S_{ac} and S_{cc} denote an auto-correlation and a cross-correlation, respectively. These values are detected as the optical intensity in the optical correlation experiment. In an experiment, the SR for the randomly arranged image was 2.3 times that for the conventionally preprocessed image. Consequently, we decided to introduce the random rearrangement method in the preprocessing of the signal pattern design.

In summary, we obtained a lower intensity deviation when a randomly arranged image was used and decided to introduce random arrangement in the preprocessing of the signal pattern design.

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P-16

LIF imaging of OH radicals and its collisional quenching effect in gas-liquid interface helium dc glow plasma

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1. Introduction

Atmospheric-pressure non-equilibrium plasmas attract much attention in recent years for its newer fields of plasma applications. Especially, the plasma in contact with liquid phase is interested as the radical species generator and carrier to the liquid phase. Many kinds of radicals are generated by discharge in air; and, hydroxyl (OH) radical is one of the most important radicals by its high reactivity. The existence of OH radicals in gas phase is able to be detected by laser induced fluorescence (LIF) technique. However, the quenching process should be considered for quantitative evaluation of OH radical density by LIF technique because of the high reactivity of OH radicals.

In this study, we have investigated the spatial distribution of OH radicals in the gas phase of dc glow plasma between stainless-steel nozzle as an anode and electrolyte of NaCl solution as a cathode by LIF imaging technique to understand the basic phenomena of gas-liquid plasma.

2. Experiment

The electrolyte cathode was 1% NaCl solution which was filled in a square acryl vessel with quarts windows. The stainless-steel nozzle anode was placed above the electrolyte surface. The gap length between the nozzle and the surface of electrolyte was 4 mm and the outer and inner diameter of the nozzle were 0.7 mm and 0.48 mm, respectively. Helium as working gas was fed into the electrolyte surface and the gas flow rate was controlled by a mass flow controller. A DC power supply was connected between the nozzle anode and a platinum wire immersed in the electrolyte cathode.

The light source of the LIF measurement was an optical parametric oscillator (Spectra-Physics MOPO-HF) which generated a tunable intense pulsed laser beam. The laser wavelength was tuned around 283.037 nm to excite OH radicals from the ground state ($X^2\Pi(v''=0)$) to an excited state ($A^2\Sigma^+(v'=1)$). Fluorescence images were recorded using a gated ICCD camera (Roper PI-MAX) with an interference filter centered at 307.1 nm (FWHM 10 nm). Fluorescence of the OH radicals at $A^2\Sigma^+(v'=1) \rightarrow X^2\Pi(v''=1)$ transition and $A^2\Sigma^+(v'=0) \rightarrow X^2\Pi(v''=0)$ transition passed the filter. The gate of ICCD camera synchronized to the excitation laser pulse and adjusted with a delay controller of the ICCD camera. Quenching effect was thought in various position and correct LIF images was made by considering quenching effect and the kind of quencher was decided.

3. Results and discussion

Figs. 1(a), (b), and (c) show the obtained LIF images at 40 mA discharge current, 210 sccm gas flow rate and various gate delay time of the ICCD camera. The label 't=0ns' means that the end of the excitation laser and the opening the gate of ICCD camera was simultaneous. The label 't=10ns' and 't=20ns' mean the delay of opening the ICCD gate to the end of the excitation laser pulse were 10 ns and 20 ns, respectively. In these images, self-emission of the plasma and stray light of the excitation beam are eliminated. These figures show that the LIF signal decreased rapidly, especially near the electrolyte surface. It is clear that collisional quenching caused the rapid decay of LIF signal because the estimated lifetime of the obtained LIF signal is quite shorter than the radiation lifetime of $OH(A^2\Sigma^+)$, 6 μs.

4. Conclusions

The LIF measurement of OH radicals around the atmospheric helium dc glow plasma near an electrolyte surface was carried out with consideration of the quenching effect. The spatial distribution of LIF signal and its decay frequency showed that the quencher was mainly distributed the adjacent of the electrolyte surface, while the OH radical was concentrated at the separated region from the electrolyte surface.

However, the electron temperature should be considered to discuss the spatial density distribution of OH radicals more accurately.

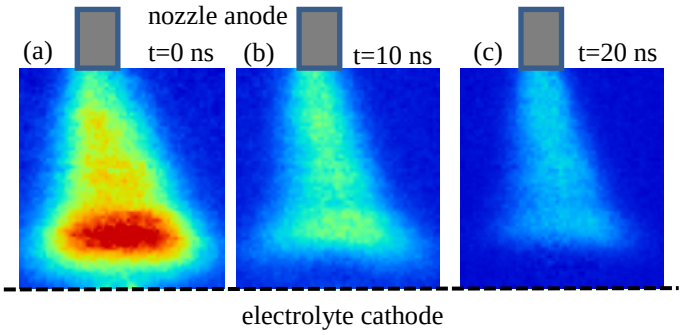

Figure 1: Temporal variations of LIF images of OH radicals: (a) delay= 0 ns, (b) 10ns, (c) 20 ns

P-17

Detection of low concentration of Pesticide on Orange by Particle-enhanced Raman Spectroscopy

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Widespread use of pesticides in modern agriculture has resulted in high yield and quality of the food crops, however, with harmful effects on human and other living creatures, this has caused a great concern, and the researchers are looking for a suitable technique to detect pesticides on food, even when they are in low concentration. Raman spectroscopy is a powerful, sensitive and nondestructive way to detection pesticides, but it is difficult to detect Raman signal when concentration of pesticides is ultra low. To overcome this problem, plasmonic technique can be used to enhance the weak Raman signal to detect ultralow level of pesticides [1].

Here, we report an approach based on plasmonic enhancement, which is rapid, nondestructive and sensitive for pesticides detection, named particle enhanced Raman spectroscopy (PERS). In this technique, Raman signal is enhanced via the resonant excitation of localized plasmons in metallic nanoparticles. As the plasmonic reso- nance wavelength highly depends on the shape, size and material of nanostructures, it is possible to grow a particular type of nanoparticles that would match the plasmon resonance frequency for any desired excitation wavelength with very good accuracy [2].

Gold is a promising material that has plasmon resonance in visible to near-IR, which depends on shape and size of nanostructures. In our work, we synthesized gold nanospheres and gold nanorods (GNRs) with various sizes by us- ing seed mediated growth method [3]. Gold nano-spheres with average diameter 20 nm showed plasmon resonance at 530 nm. Subsequently, GNRs showed plasmon resonance that could be tuned from 600 nm to 100 nm by changing the length of GNRs, as shown in Fig. 1.

For our experiment, we used gold nanospheres that has plasmon resonance at 530 nm, close to the excitation wavelength of 532 nm used for Raman measurements of Polycarbamate
pesticide.

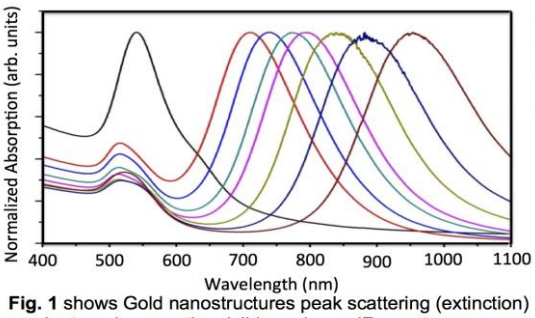

Fig. 1 shows Gold nanostructures peak scattering (extinction) can be tuned across the visible and near IR spectra.

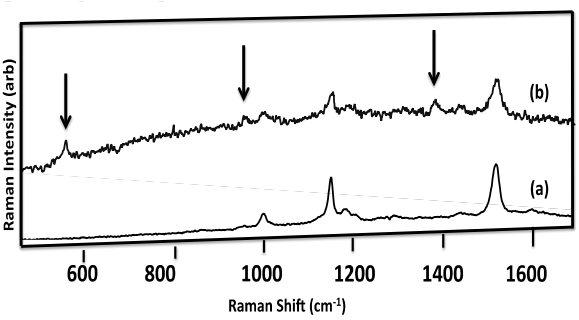

Fig. 2 The Raman spectra of (a) orange and pesticides, (b) Orange Pesticides and gold nanospheres

We sprayed the pesticide solution on the orange and flushed it several times by DI water and measured Raman spectrum. Fig 2(a) shows no peaks related to the pesticide, which is because of the ultralow concentration after the wash. We then dropped gold nano-spheres solution and detect the Raman spectra again (Fig2 (b)). As indicated by the arrows, here we can clearly see the excitation of a few Raman peaks corresponding to the pesticides.

Conclusions

Here, we successfully detected ultra low concentration pesticide residues on fruits using our PERS technique, which was not detected by normal Raman technique.

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P-18

Intensity Modulated POF Multidimensional vibration sensor

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This paper demonstrates the design and development of a non-contact fiber optic three dimensional vibration sensor using the principle of reflected intensity modulation. Ratiometric output is adopted to extract independent signals and a simple program proposed to compile the analysis.

Vibration measurement is one of the parameter to study the health condition of engineering machine tools. A few techniques are proposed in the literature to characterize the three dimensional vibration [1-3]. These sensors are widely used in security applications, spacecraft, navy and military applications. In this paper a simple and compact three dimensional vibration measurement system is presented based on fiber optic reflected light intensity modulated sensors [4, 5].

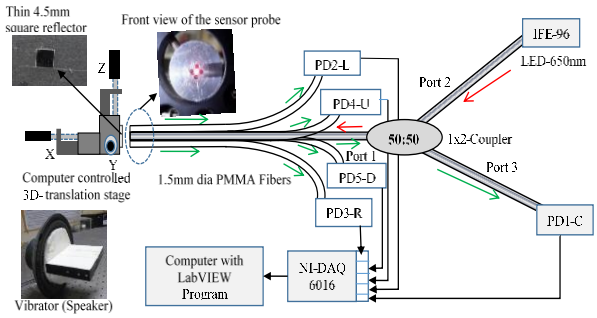

Fig. 1. Schematic experimental setup of the seismic vibration sensor.

Schematic experimental setup for three dimensional vibration measurement is shown in fig. 1. It consists bundle of five fibers measures diameter 1.5mm and length 50cm are arranged in the form of plus symbol; the center fiber shown in fig. 1 is used for axial vibration, and the other two fibers positioned left and right to the center fiber are used for the horizontal vibration measurement, remaining two fibers positioned up and down to the center fiber are used for the vertical vibration measurement as shown in fig. 1. A rational output (RO) method is proposed to simplify the analysis process and measured the RO of left (PD2-L) and right (PD3-R) named as HRO, similarly measured the RO of the up (PD4-U) and down (PD5-D) named as VRO. The sensor probe is calibrated for the vibration measurement using a computer controlled XYZ-translation stage. A thin reflector of 4.5mm square is attached to the translation stage and characterized the displacement response of the sensor. The translation stage is replaced with vibrator (speaker) which is designed to apply the vibrations in three dimensions to the sensor probe as shown in fig. 1.

Fig. 2(a) shows the response of the sensor for axial vibration at the frequency of 10Hz. It is observed that only central fiber shows vibration response whereas HRO and VRO provide constant signal. Further, applied vibration of frequency 24Hz in horizontal direction and recorded the sensor response as shown in fig. 2(b). It shows that the HRO shows the vibration response whereas central and VRO give the constant signal indicates it is insensitive to horizontal direction. Similarly applied the vibration of frequency 16Hz in vertical direction and the sensor response is represented in fig. 2(c), which illustrates that only VRO is sensitive to vertical vibration whereas other signals are constant. The results revealed that the proposed sensor configuration is simple, cost effective, easy to install and simple analysis.

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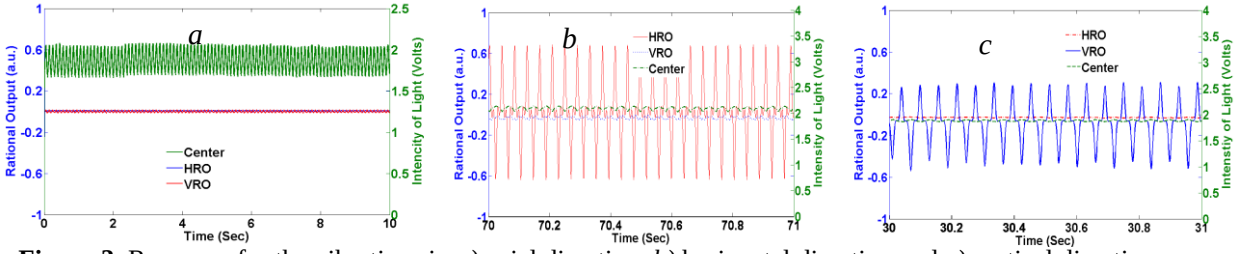

Figure 3. Response for the vibrations in *a)* axial direction, *b)* horizontal direction and *c)* vertical direction.

P-19

Wearable Organic Optoelectronic Sensors for Prosthetic Actuation and Tissue Oxygenation

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Abstract: Organic semiconductors are important optoelectronic materials that are now of growing interest for sensing applications. They offer the potential for compact, light and flexible sensors that are simple to fabricate. Here we will present recent progress using organic light-emitting diodes and organic photodiodes for biophotonic applications with two examples. In the first example we will discuss a haemodynamic sensor using organic LEDs and photodiodes to measure changes in tissue oxygenation for a forearm ischemia. In order to induce ischemia a tourniquet was used to restrict blood flow, and the resulting changes in oxygenation of forearm muscles were measured. In the second example we have made a flexible organic optoelectronic muscle contraction sensor that can distinguish between isotonic and isometric types of muscle contraction. We will also show the feasibility of this sensor for prosthetic actuation by actuating a robotic arm using the signal detected from a volunteer's real arm. These results provide another interesting direction for organic optoelectronics, and the possibility of measuring a range of important biomedical processes.

P-20

Plasmon enhanced tunable MoS_2 FET based on polarization control

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Layer MoS2 can convert photons into electrons with high efficiency, making it an ideal material for use in light detectors and photosensors. Therefore, as a basic electric component, MoS2 FET is widely investigated in order to extend its function. Here, based on Surface Plasmon Resonance (SPR), we report a multilayer MoS2 FET with plasmonic nanostructures which could be manipulated by a linear polarized incident laser. We designed the FET as Fig.1 (a, b, c) shows, on which a uniform oriented nanobar array was coated. In the case of SPR longitudinal mode, the absorption spectrum of gold nanobars was simulated by Comsol Multiphysics software shown in Fig.1 (d) .

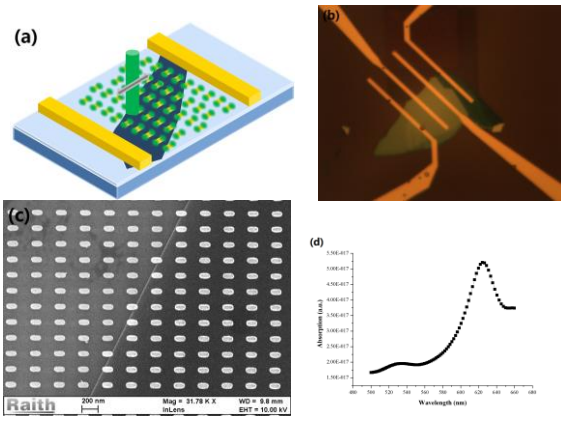
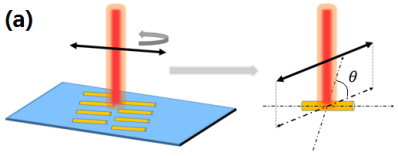


Fig. 1: (a) Configuration of nanobar coated MoS2 FET.(b) Optical image of multilayer MoS2 FET. (c) SEM image of nanobar array (single nanobar size: 50nm:50m:100nm). (d) Simulated absorption spectrum of Au nanobars by Comsol Multiphysics software.

The polarization control on MoS2 FET by plasmon enhancement was verified by measuring the I_{ds} changes when the angle between incident laser polarization direction and nanobar longitudinal axis ranged from 0° to 180° , as shown in Fig. 2 (a).



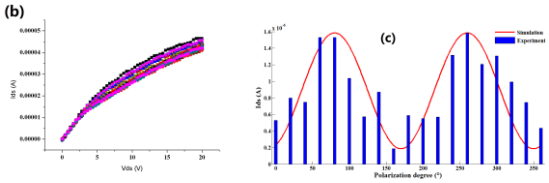


Fig. 2: (a) Mechanism of measurements. (b) the I-V curves of MoS2 FET with different incident polarization angle from 0° to 180° . (c) The Drain-Source current (V_{ds}=5V, V_g=-30V) was manipulated by a polarized incident laser.

We attribute the polarized modulation effect, as shown in Fig.2 (b, c), to the nature of plasmonic nanostructures of which the plasmon enhancement occurs only when the polarization of incident laser parallels to the longitudinal axis of nanobars and when the incident wavelength matches the absorption of nanobars and MoS2, simultaneously.

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P-21

Super-resolution Microscope Based on Laser Scanning and a Microsphere Lens

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Optical microscope has played an important role in the many fields, such as biology and material study. Because of the wave nature of light, the resolution of optical microscope is limited by diffraction limit, about $\lambda/2$ in practice, and that prohibits one from observing more detailed structure of the sample. In the last decade,, some techniques have been developed to overcome the limit, including stimulated emission depletion microscopy (STED), near-field scanning optical microscopy (NSOM), superlens, etc.

However, these methods require high-intensity laser luminescence, sample stability, and specific operating condition, respectively. As a consequence, they suffer from phototoxicity, slow acquisition, and sample applicability.. Recently, a new method was proposed [1], which combined a dielectric microsphere with a white light source to achieve far-field super-resolution microscopy. Since confocal microscopy is able to give better contrast than bright-field microscopy, here we experimentally demonstrate the combination of dielectric microsphere and confocal laser scanning microscopy to provide super-resolution capability. The field of view and magnification of microsphere are determined. Comparing to other super-resolution techniques, this method can work without fluorescence, high-intensity laser, or specialized sample preparation. Moreover, the transferability of microsphere is also demonstrated in this study. This technique can be easily implemented with a confocal microscope and shows the potential of high-resolution biological cell observation.

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P-22

Enhanced luminescence efficiency by Ag nanoparticles dispersed on indium tin oxide for polymer light-emitting diode

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1. Introduction

Polymer light-emitting diodes (PLEDs) that are based on conjugated polymers have attracted a lot of attention in recent years because of their extreme thinness, high peak brightness, high dark room contrast, lower power consumption, super viewing ability, and fast response time for use in low-cost optoelectronic devices. The typical structure of a PLED is metal (cathode) / polymer film / hole transport layer (HTL) / transparent conducting oxide (TCO) film (anode) / glass substrate; its quantum efficiency depends on efficient dual carrier injection and transportation to balance electrons and holes. TCO films are typically manufactured from indium tin oxide (ITO). ITO has been extensively used as an anode in PLEDs because it has a high visible transmittance, a low electrical resistivity and a relatively high work function (WF). To improve further the luminescence efficiency of PLEDs, several studies [1-5] have sought to increase the conductivity and the WF of the ITO anode by coating an additional hole transport layer. However, Ag nanoparticles, which are introduced between the HTL layer and the ITO layer, have not been investigated in detail for their effects on the performance of PLEDs.

In this work, we report on the characteristics of an Ag nanoparticles-dispersed ITO anode for enhancing hole injection in phosphorescent PLEDs. The Ag nanoparticles were fabricated using low-power sputtering method at room temperatures. Atomic force microscopy (AFM), conducting atomic force microscopy (CAFM), and scanning surface potential microscopy (SSPM) were then employed to elucidate the impact of Ag nanoparticles on the surface microstructure and electrical properties of the ITO film. Finally, a polymer material was spin-coated onto the Ag nanoparticles-dispersed ITO substrate, and then deposited onto the metal electrodes to form the proposed PLED structure . A spectral measurement system was used to observe any enhancement of the optical gain during electroluminescence. The experimental results proved that the novel PLED device is highly practical, and the simple and low-cost fabrication makes it commercially feasible.

2. Results and Discussion

To investigate variations in the composition of Ag/ITO substrate prepared at different Ag deposition process times, we perform elemental analyses of Ag/ITO surfaces using XPS. The Ag concentration (shown in Table 1) is determined by calculating the peak areas of the binding energy at 364 eV. The calculated concentrations (in atomic percentages) for the Ag/ITO samples deposited at Ag deposition process times of 10, 20, 30, 40, and 50 s are 15.1%, 31.4%, 47.8%, 54.3%, and 61.9%, respectively.

Tab. 1. Ag concentration, RMS roughness values, coverage percentages of conducting regions, and mean WFs of bare ITO and Ag/ITO surfaces using various Ag deposition process times.

		Deposition process times of Ag (s)				
	ITO	10	20	30	40	50
Ag concentration (%)	0	15.1	31.4	47.8	54.3	61.9
RMS roughness value (nm)	5.68	6.52	6.91	6.32	6.24	6.23
Coverage percentages of conducting regions (%)	78.3	84.2	86.4	89.8	93.2	96.8
Mean work functions (eV)	4.82	4.92	4.83	4.66	4.35	4.30

3. Conclusions

This paper proposes a PLED structure, ITO/Ag nanoparticles/PEDOT:PSS/F8BT/LiF/Al. CAFM measurement showed that the Ag deposited on ITO at approximately 10 s can increase the oxygen vacancies, causing the coverage of the conducting regions to increase by 4.9 %. Furthermore, due to the product of Ag_2O nanoparticles on the Ag/ITO surface, the mean WF measured using SSPM increases from 4.82 eV to 4.92 eV, which can effectively improve hole injection efficiency for PLEDs. When the optimal Ag-deposited ITO substrate is used as the anode material of a green PLED, the EL intensity increases by 330% compared to a standard green PLED with bare ITO substrate. The prepared device offers a new design scheme for optimizing the carrier injection and recombination, which is potentially advantageous for various organic-semiconductor-based devices.

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P-23

Isotropic perfect absorber in optical frequencies using vertical split-ring resonators

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1. Introduction

Plasmonic metamaterials are composed of artificial metamolecules exhibiting unusual optical properties such as negative refraction index, and toroidal dipolar response that can lead to applications that are otherwise unattainable in nature, such as sub-diffraction imaging, and optical and spectrum manipulation.

Split ring resonators (SRRs), commonly constructed building blocks of plasmonic metamaterials, have been proposed to produce electric as well as magnetic dipolar response. The dipolar response of such SRR structures can be excited by an incident wave with either electric field perpendicular to two prongs or the magnetic field passing through the gap of SRR. The benefits of making perfect absorber by SRRs are that this structure can confine both the electric field part and the magnetic field part of the energy of the incident light at the same time.

2. Results

Our structure consists of a gold mirror at the bottom, a dielectric layer in the middle and four vertical split-ring resonators (VSRR) on the top (Fig. 1). Then, by tuning the thickness of dielectric layer, we can get different strength of absorbance as the colormap shows in Fig. 2. According to the simulation result, a ultrahigh absorption intensity about 99.9 % can be approached by appropriate design.

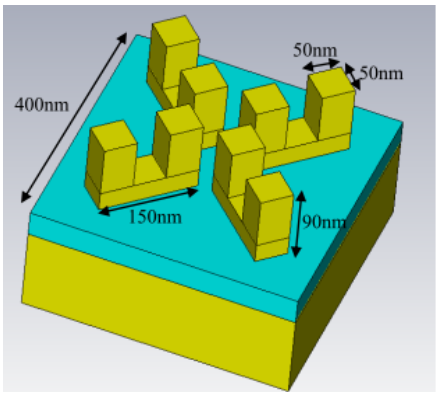

Fig. 1: Schematic diagram for VSRR-based super absorber device. A unit cell composed of four VSRR structures with identical dimensions.

3. Conclusions

We demonstrate numerically a perfect absorber at optical region by VSRRs. An isotropic characteristic is observed by using symmetric arrangement of VSRR structures. Owning to the available to the confinement of electric as well as magnetic fields, the absorption can be approached to higher than 99% at normal incidence according simulation results. This work paves a way for a couple of potential applications, such as super absorber and plasmonic sensor with ultrahigh figure of merit (FOM).

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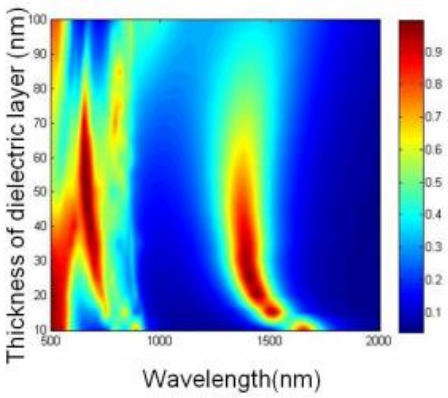

Fig. 2: Absorption spectra for VSRR-based super absorber as a function of thickness of dielectric layer. A pronounced resonance peak associated magnetic dipolar response around 1.5 μm is recorded which can be employed for super absorber application in optical region.

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P-24

The Stimulated Emission Depletion Properties of Spiro-BTA

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In the field of optical imaging, diffraction limit is one of the most serious barriers that limit the spatial resolution to roughly half of wavelength. It was not until last decade had the diffraction limit been broken and from then on, super-resolution microscopy has generated strong impact to biological and material researches. Among these techniques, stimulated emission depletion (STED) microscopy is arguably the most successful one, which reaches super-resolution by turning fluorophores on and off with stimulated emission process. This technique needs two beams: a short-wavelength beam with solid shape to excite the fluorophore and a long-wavelength beam with doughnut shape to suppress spontaneous fluorescence via STED. As a result, spontaneous fluorescence is only allowed in the central region of the doughnut-shaped beam, and therefore resolution can be effectively improved. The higher the STED beam intensity, the better the resolution can be enhanced. However, the fluorophores need extraordinary photostability to sustain strong depletion beam as well as repeated excitation and depletion.

In this work, we demonstrated STED property from Spiro BTA, which is an ultra-stable organic fluorophore designed for organic light emitting diode applications.. Due to its exceptionally large cross section, we expect it to have good stimulated emission depletion property. Moreover, it is known that Spiro BTA has high photoluminescence and high bio-compatibility, which are both main considerations in biological application. We studied the suppression efficiency of fluorescence emitted from Spiro-BTA with different depletion intensity and obtained the effective saturation intensity of Spiro-BTA from the analysis of depletion curve. Moreover, in order to demonstrate our sample, Spiro-BTA's capability of reaching super-resolution, we wrap the dye in silica balls with diameter of 50nm. By measuring the point spread function of the silica balls, we confirm that the silica balls' point spread function is effectively narrowed, with FWHM only 100nm.

As a result, we confirmed that Spiro-BTA has great potential in application in super resolution imaging via STED microscopy.

P-25

Reconfigurable Spatial Mode Conversion using a Spatial Light Modulator

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1. Introduction

Studies have already been conducted on mode conversion technology for optical transmission via spatial modes [1, 2]. We have developed a technology for dynamic extraction and conversion of spatial modes by combining a spatial light modulator (SLM) and a spatial phase detector [3]. In this paper, we propose a method for the reconfigurable conversion of the spatial mode using a phase-modulation-type SLM, and describe the experimental results of interconversion among LP01, LP11, and higher-order spatial modes.

2. Phase modulation method

The conceptual design of the proposed phase modulation method using a phase-modulation-type SLM is shown in Fig. 1. The original spatial mode beam exiting the optical fiber is incident on the SLM. Next, spatial phase modulation is added. The optical beam output from the SLM has a spatial distribution corresponding to the phase difference between the original spatial mode and the displayed phase modulation pattern. The output beam is converted into the desired LP mode via light propagation using an optical lens.

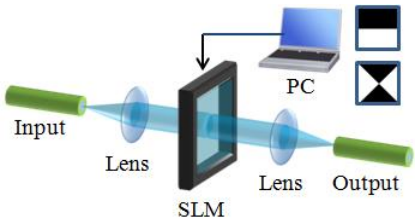

Fig. 1: Conceptual design of the phase modulation method.

3. Experimental

Our experimental setup consists of three main parts—a "mode generation" part, a "mode conversion" part, and a "mode detection" part. First, in the mode generation part, the original spatial mode is generated by extraction of the first-order diffraction beam from SLM1 in which a computer-generated hologram is displayed [4]. Next, spatial mode conversion is achieved by displaying the phase difference pattern between the original input mode and the desired output mode on SLM2. The phase and amplitude distributions of the converted spatial mode are detected using holographic diversity interferometry in the mode detection part [5]. Reconfigurable mode conversion among LP01, LP11, and LP21 are successfully performed, as shown in Fig. 3.

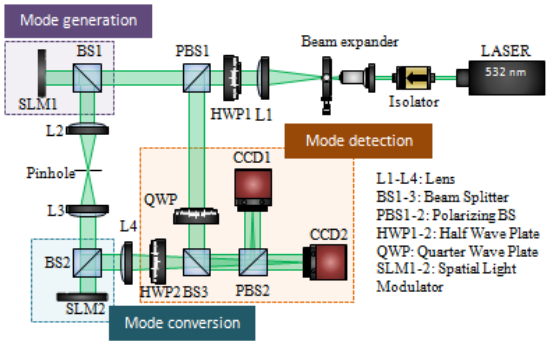

Fig. 2: Experimental setup.

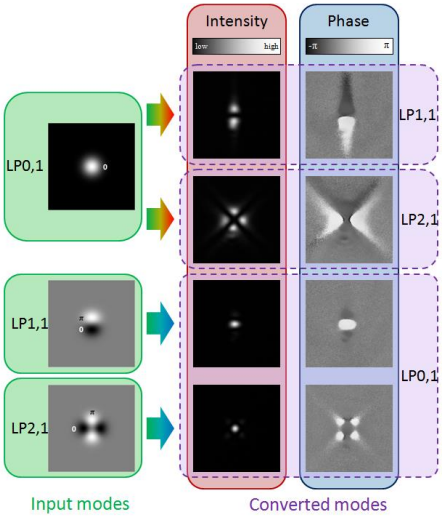

Fig. 3: Experimental results.

4. Conclusion

We believe that this spatial mode control technology facilitates signal routing in a spatial mode region similar to current photonic switching in the wavelength region.

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Acknowledgements

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P-26

Particle propulsion using higher order microfiber mode

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We studied propulsion properties of single 1 μm, 2 μm, 3 μm, and 5 μm polystyrene particles induced by the evanescent field of both the fundamental mode (FM) and first family of higher order modes (HOM) propagating in a microfibre (diameter ~2 μm) for a range of input powers. The HOMs are generated in an 80 μm diameter cladding fibre, which is adiabatically tapered to a diameter of 2 μm [1], i.e. near the single mode cut-off diameter (1.60 μm) in water for 1064 nm light. Incorporating the microfibre into an optical tweezers [2] allows us to control the number of particles trapped at the microfibre surface and study the dynamics of a single or a specific number of particles with the evanescent field fibre.

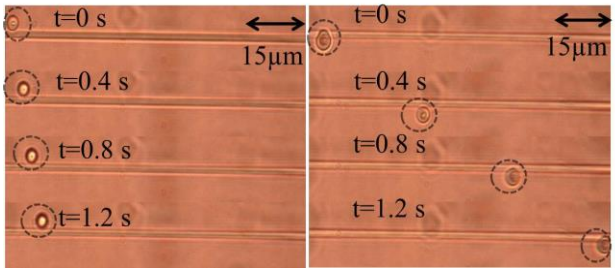

Fig.1. Micrograph for the speed of a 3 μm diameter polystyrene particle (marked with dotted circle) under FM (left) and HOM (right) propagation. In both cases the waist power was 25 mW.

Figure 1 indicates a large increase in the propulsion speed of the particle when exposed to the HOM compared to the FM. It testifies that the HOM has stronger evanescent field intensity than the FM at this fibre diameter.
Figure 2 shows the speed dependence on the particle size using either the HOM or FM. It is evident that, in the HOM case, an increase in particle size is consistently matched with an increase in speed. However, this was not obvious for the fundamental mode with same size fibre. Since the evanescent field for the FM is optimized at a smaller fibre diameter, for 2 μm fibre as the evanescent field intensity is minimal.

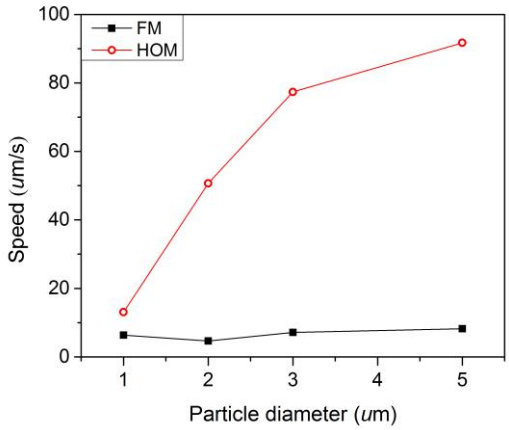

Fig.2. Speed dependence on particle size under both HOM (red circles) and FM (black squares) propagation. In both cases the waist power was 25 mW.

As is well-known, larger particles have larger scattering cross-sections compared to smaller particles, consequently they have a stronger interaction with a given evanescent field, causing the larger particles to move faster than the smaller particles [3].
The larger evanescent field extension and the field distribution of the HOM mode may make it a useful tool for refractive index sensing and particle sensing where high sensitivity is required [4]. In future work, we will focus on controlling the individual mode in the HOM set using counter propagating beams and integrating the HOM tapered fibre into a cold atom system [5, 6] for fibre-based trapping.

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P-27

Polarization analysis of near-field probe for tip-enhanced Raman imaging

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1. Introduction

Polarization controlled illumination in Raman spectroscopy is of tremendous advantage as it allows one to study highly directional intrinsic properties of a sample [1]. Tip-enhanced Raman scattering (TERS) microscopy, which realizes Raman imaging at super spatial resolution beyond the diffraction limit owing to the resonant excitation of localized surface plasmon polaritons at the tip apex [2,3], has the potential to achieve such polarization imaging at nanoscale. However, neither evaluation nor control of the polarization properties of near-field light in TERS is as straightforward as in usual far-field illumination, because the polarization of near-field light is influenced by the random shape, size and orientation of the metallic nanostructure attached to the apex of the tip used in TERS.

2. Experimental

Near-Field Polarization Analysis by Defocused Imaging

In this work, we demonstrate our idea to investigate the ambiguous polarization of the near-field probe from the scattering pattern produced by a metallic tip. Under dipole approximation, we measured the scattering pattern by de- focused imaging, where, in order to keep the information about the direction of the dipole oscillation intact, the image of the dipole was formed at a plane away from the focal plane. Figure.1 indicates the experimental setup for defocused imaging and defocused patterns depending on the direction of the dipole oscillation. The direction of the dipole oscillation was determined from the asymmetry in the defocused pattern, and then the polarization of near-field light was evaluated from the oscillation direction by calculating the intensity distribution of near-field light through Green's function.

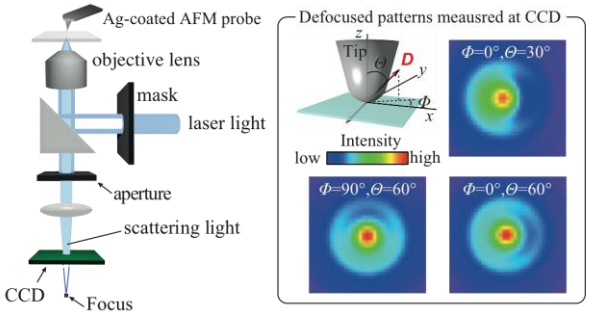

Fig. 1: Overview of defocused imaging to investigate the dipole induced at the apex of a TERS tip.

TERS Imaging by Using Tips after Polarization Evaluation

The effectiveness of our method was verified by obtaining TERS images of single-walled carbon nanotubses (SWNTs), where intensity contrast and orientations of SWNTs tell us the state of the excitation polarization. After evaluating the dipole oscillation and hence the polarization of fabricated tips, we used those tips to measure TERS images from SWNTs. Figure.2 shows an example of the TERS images. SWNTs oriented in the direction of the dipole oscillation were strongly excited, and the contrast of the TERS image indeed depended on the oscillation direction of the dipole. Moreover we found the TERS image was in excellent agreement with the calculated TERS image, verifying that the polarization of near-field light was quantitatively estimated by our technique.

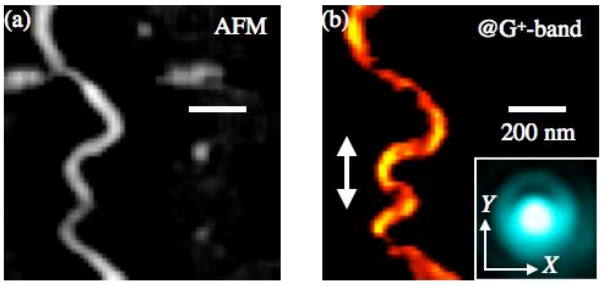

Fig. 2: (a) AFM and (b) TERS images of SWNTs. The white arrow in (a) means the in-plane component of the dipole oscillation induced in the tip used in the measurement. Inset shows the defocused image of the dipole indicating the oscillation direction.

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P-28

Multi-spectral plasmon induced transparency via dipole and dual-quadrupole coupling

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Plasmon induced transparency (PIT) is an optical interference effect via strongly coupled plasmonic resonators, allowing for a spectrally narrow optical transmission window [1]. This enhanced transmission accompanied with extreme dispersion is highly desirable for sensing and slow light applications. Most studies on this topic mainly focused on dipole-quadrupole resonance coupling on plasmonic metamaterials that shows PIT effect at a single resonance. On the other hand, metamaterial systems supporting multiple coupled dipole-quadrupole can offer PIT responses at multi-spectral windows, which will open a new route toward metamaterial applications operating at multiple frequency domains.

Here, we experimentally demonstrate an approach based on dipole and dual-quadrupole coupling to construct a planar metamaterial supporting multi-spectral PIT [2]. The proposed structure consists of two short silver wires (dipole antennas) and two long silver wires (dual-quadrupole antennas) (Fig. 1). Due to close proximity, the dipole and the dual-quadrupole antennas are strongly coupled, resulting in two transmission windows even in the absorbance linewidth of the dipole.

Figure 2 shows the experimental transmittance spectra in dependence on the antenna length l_1. In the case of l_1 = 14 μm, that is the symmetric metamaterials (l_1 = l_2), the single transmission window can clearly be observed. On the other hand, in the case of l_1 = 13 μm, the transmission window splits into two peaks and the multi-spectral PIT effect arises. This is due to the resonance shift of one of the quadrupole antennas, as the shorter wire length makes the resonance frequency higher. This phenomenon can also be derived by classical model calculations. We note that these multi-spectral resonances can be achieved only in a three or more oscillators system with radiative and sub-radiative modes, highlighting our metamaterials ideal for the realization of multi-spectral PIT in a planer system. By further shortening l_1, however, the multi-spectral transmission window disappears and the single transmission window appears. This can be understood by the decrease of the coupling strength. The shorter quadrupole antenna leads the weak coupling with the dipoles due to the wide gap, so the upper quadrupole antenna does not contribute in this case.

The calculated spectra are also plotted as red dashed curves in Fig. 2. The results show qualitative agreement with the experiment, it further supports the measured multi-spectral PIT behaviour.

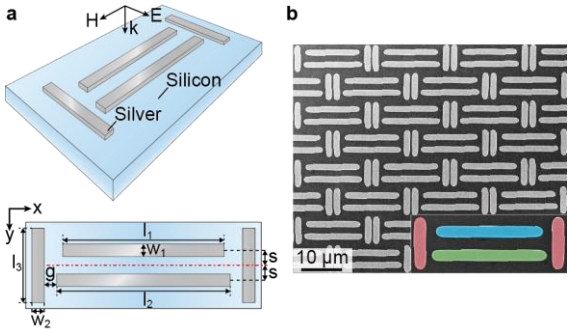

Fig. 1: Structural geometry of PIT metamaterials (a) Schematic diagram of the metamaterial. (b) Normal view of the structure. Inset: Enlarged view. The dipole antennas are indicated in red and quadrupole antennas are indicated in blue and green, respectively.

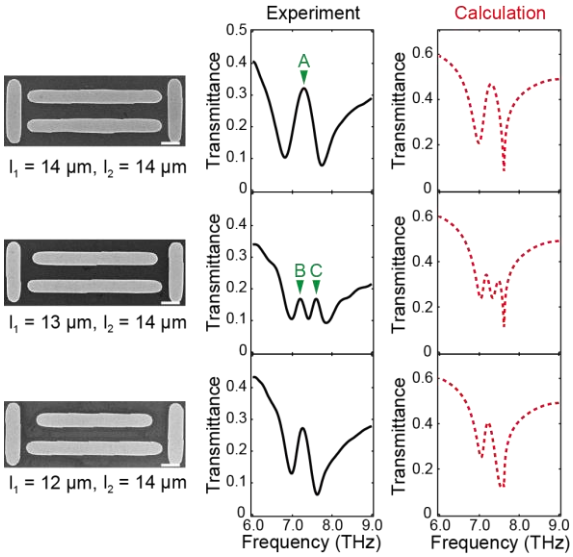

Fig. 2: Transmittance spectra in dependence on the wire length l_1. Left column shows SEM images of the corresponding structures. Black and red curves represent the experimental and calculated transmittance spectra, respectively.

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P-29

A Theoretical Investigation of Super Continuum Generation in Exponential Saturable Nonlinear Response

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1. Introduction

The Supercontinuum generation (SCG) using photonic crystal fiber (PCF) is the technology of choice for the future generation of ultrabroadband sources of coherent light. SCG is a process which dramatically broadens the spectral shape from the narrow initial spectrum, mainly induced by soliton fission and pulse breaking arising due to higher order effects of soliton related dynamics such as higher order linear dispersion terms, Raman soliton self-frequency shift, and spectral recoil. At higher peak power, Kerr nonlinear response is insufficient to predict the nonlinear response of the medium rather require saturable nonlinear response to figure out the overall nonlinear response of the medium [1,2,3].

We have analyzed the impact of MI-SCG under the so called conventional saturable nonlinearity (CSN) [3]. However, our intensive literature survey brings us the evidence of the existence of other type of saturable nonlinearities called as exponential saturable nonlinear response (ESN).

2. Theoretical Model

The propagation of ultrashort pulse in the presence of exponential saturable nonlinear response in LCPCF is given by the modified nonlinear Schrodinger equation (MNLSE)

$$\frac{\partial U}{\partial z}+\sum_{n=2}^{3}\beta_n\frac{i^{n-1}}{n!}\frac{\partial^n U}{\partial t^n}=i\gamma\frac{(1-\exp-\Gamma|U|^2)}{\Gamma} \quad (1)$$

Where β_n is the nth order dispersion coefficient, γ and Γ are Kerr and saturable nonlinearity.

2.1 Numerical analysis

To investigate SCG in LCPCF, we numerically solved Eq. (1) using split step Fourier method with initial envelope of the soliton at z=0 given by U (0, T) =$\sqrt{P_0}$ sech (T). The fiber parameters are calculated using scalar effective index method. From the numerical simulation it is observed that the exponential saturable nonlinear response suppress the SCG like the case of conventional saturable nonlinear response. But the inclusion of ESN enables to achieve the broadband spectrum at relatively short distance of propagation owing to the ability to achieve the required phase matching for the nonlinear effects. **Fig.1** describes the spectral broadening in LCPCF with the influence of exponential saturable nonlinearity of CS_2 liquid.

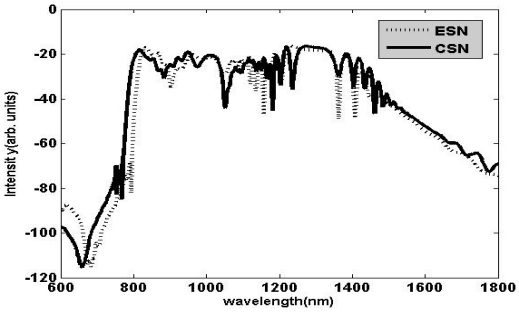

Fig.1 Supercontinuum spectrum of CSN and ESN

From the **Fig.1**, it is evident that the broadband spectrum obtained through ESN and CSN are approximately the same for the given length. But the coherence obtained through the shot to shot noise analysis gives us the incorporation of ESN instead of CSN increases the coherence of the spectrum slightly.

3. Conclusion

We conclude that the use of exponential nonlinearity like the most cases of saturable nonlinearity suppress the supercontinuum spectrum, however the coherence of the achieved SCG is better in the case of exponential type nonlinearity in comparison to the conventional saturable nonlinear response.

Acknowledgement

KP thanks CSIR, IFCPAR, NBHM and DST, for the financial support through major projects. K. Nithyanandan thanks SPIE for awarding Laser Technology, Engineering and Application Scholarship.

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P-30

Random lasing at a defect in a ZnO nanoparticle film

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Random laser have attracted much attention over the past decade because of their unique phenomena without a clear cavity structure[1, 2]. These laser are typically composed of randomly distributed scatterers and gain materials, and the interference effect of recurrent multiple scattered light provide optical feedback in the structure, which can be expected to be utilized for easily fabricated and low- cost applications such as surface-emitting devices. However, considering the potential applications, these properties should raise issues of lasing mode controllability such as wavelength, location, and number of lasing modes, due to the randomness.

For this issue, we have proposed a simple structure for manipulating resonant conditions in the random structure, in which a "defect" region is deliberately made (Fig.1). Because the average transmittance of the ensemble of size-monodispersed scatterers exhibits sharp dips in the transmitted intensity spectra due to the modal coupling of Mie resonances, it can be work as mirrors or filters and, therefore, intended long-lived modes in the defect surrounded by the random structure can be expected[3, 4].

In this study, towards the experimental realization of our proposed method, we examined random lasing properties of ZnO nanoparticle film including defect particles.As a first step toward experimental verification of this method, we examined the characteristics of random lasers by introducing polymer nanoparticles as point defects in a homogenized submicrometer-sized ZnO nanoparticle film.

From the results of the non-treated ZnO NP film(Fig.2(a,b)), multiple sharp peaks superposed on a collapsed broad emission spectrum were observed at the wavelengths nearby the maximum of the emission spectrum around 387 nm. In addition, the intensity distribution of the non-treated ZnO film shows almost uniform distribution, although the defect particle existed at the center of the structure (black arrow). These behaviors were similar to the characteristics of typical random lasers. However, at the defect within the laser-treated ZnO NP film(Fig.2(c,d)), the observed behaviors were clearly different from the non-treated ZnO NP film (typical random lasers), in which single sharp peak, about 10-times lower threshold, and an intense bright spot at the defect were observed. Thus our proposed structure can possibly provide the controllability of lasing properties even in random structures.

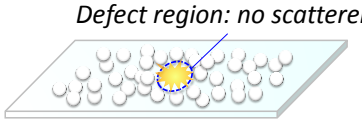

Fig. 1: Proposal random structure which composed of size-monodispersed scatterers and defect region.

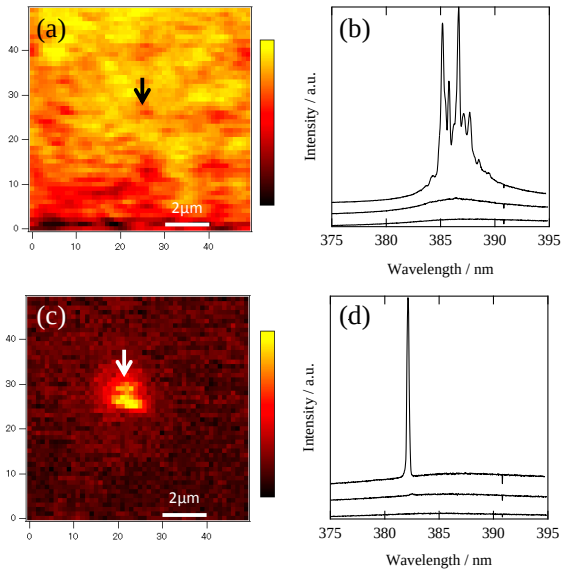

Fig. 2: Emission distribution and emission spectra at the defects within (a,b) non-treated and (c,d) laser-treated ZnO NP films. In (b) and (d), The excitation intensities were 0.5, 1.0, and 2.0 times of each threshold, and appropriate offsets were added for the sake of clarity. Arrows represent the positions of a point defect.

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P-31

Two-Channel Type Holographic Diversity Interferometry for High Accurate Wavefront Measurement

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1. Introduction

To achieve both high speed and high accurate wavefront measurement, holographic diversity interferometry (HDI) [1] has been proposed. Unlike conventional phase-shifting digital holography [2,3], this technique utilizes polarization elements and four image sensors to generate four phase-shifted interference patterns in one shot. However, the optical setup is complicated and the alignment is difficult due to four image sensors. In this paper, we propose a new algorithm for composing HDI using two image sensors referred to as two-channel type HDI (2ch-HDI). 2ch-HDI can achieve high speed and high accurate measurement with simple setup. The proposed algorithm can compensate for the differences of intensity distributions on two image sensors which is the matter of calculation error. We performed an experiment to verify the basic operation of 2ch-HDI and the results showed that 2ch-HDI can measure the wavefront of object with great accuracy.

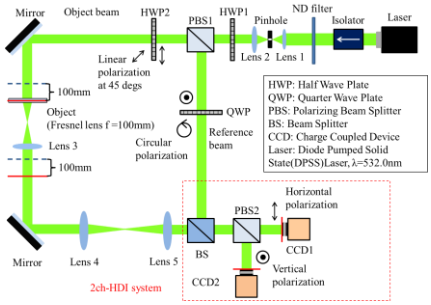

Fig. 1 Experimental setup

2. Two-channel type holographic diversity interferometry (2ch-HDI)

Figure 1 shows an experimental setup using 2ch-HDI. In this experiment, a Fresnel lens (Edmond Optics 32592-L) structured concentric rings was used as a measuring object. In 2ch-HDI, the signal beam is linearly polarized at 45 degrees by HWP2, and the reference beam is circularly polarized by QWP. Since the circularly polarized beam composed of orthogonal polarization components with phase difference of π/2, transmitted components and reflected components after the PBS2 have the phase difference of π/2. Thus, 2ch-HDI system can obtain two phase-shifted interferograms on the two imagers at the same time.

3. Wavefront detection using 2ch-HDI

The proposed algorithm introduces new parameters for the intensity ratio of signal beam α and intensity ratio of reference beam β to compensate for the differences of intensity distributions on two image sensors. In this algorithm, complex amplitude is estimated as follows;

$$A_o \exp(i\phi) = A_o \cos\phi + iA_o \sin\phi = \frac{H_1 - I_1}{2A_r} + i\frac{H_2 - I_2}{2\sqrt{\alpha\beta}A_r} \quad (1)$$

$$x = \alpha^2 + \alpha\beta$$
$$y = \{\alpha\beta(\alpha+\beta)A_r^2 + \alpha^2\beta H_1 + \alpha^2 H_2\} \quad (2)$$
$$z = \alpha^3\beta H_1^2 - 2\alpha^2\beta(\alpha-\beta)H_1A_r^2 + \alpha\beta(\alpha+\beta)^2A_r^4 + \alpha^2H_2^2$$

$$I_1 = \frac{\alpha-\beta}{\alpha}A_r^2 + \frac{1}{\alpha}I_2$$
$$I_2 = \frac{y \pm \sqrt{y^2 - xz}}{x} \quad (3)$$

where A_r is the reference beam intensities, H_1 and H_2 are the interference patterns, and I_1 and I_2 are the dc components of H_1 and H_2, respectively. The proposed algorithm provides more accurate measurement using 2ch-HDI. To verify the effectiveness of the proposed method, the object profiles with and without compensation are compared, as shown in Fig. 2. From these results, the reconstructed image using the proposed algorithm showed the structure of the Fresnel lens more clearly than the conventional one.

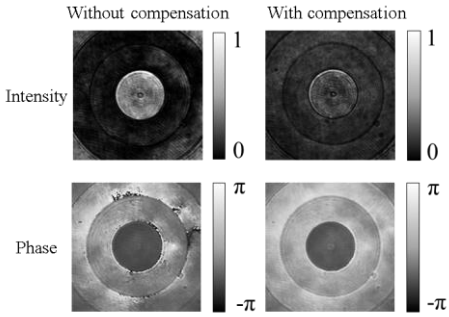

Fig. 2 Reconstructed images

4. Conclusions

This paper proposed 2ch-HDI including a new algorithm. The performance of 2ch-HDI was greatly enhanced by developing the algorithm assuming simultaneous measurements using two CCD imagers.

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P-32

Nanolens made of metallic rods array for magnified subwavelength images

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Metallic nanostructured materials exhibit interesting optical applications such as imaging, field enhancement, optoelectronic devices, and biosensors. In particular, the early research by other scientists was aimed to achieve super-resolution imaging by using metallic subwavelength structures with distinct shapes and arrangement. Although such structures act as a lens with super-resolution, they still have two major restrictions. The first restriction is that they can only work at one particular resonant wavelength. The second is that the image can only be transferred for a short distance within the limits of the near field and is therefore undetectable in the far field. Recently, our group has proposed a lens made of stacked metallic nanorods array tapered at a certain angle for magnification [1]. This nanolens realizes the subwavelength super-resolution color imaging in visible range. The image is magnified and plasmonically transferred through metallic nanorods arrays, until it is detectable in far field.

These properties of nanolens to transfer and magnify images require proper stacking of nanorods, such as long chains placed at tapered angles in a fan-like shape. Hence, we first fabricate the arranged nanorods chain, and we will make tapered configuration of those nanorods chain for magnification of subwavelength images. Such metallic nanorods chains are fabricated with combination of lithography and self-assembly method, known as the template-assisted self-assembly (TASA) method [2].

We assembled chemically synthesized gold (Au) nanorods in trench templates, which was patterned by focused-ion beam (FIB) lithography on a poly-methyl methacrylate (PMMA) coated glass substrate. The diameter and length of nanorods were ~15 nm and ~50 nm, respectively, and the trench width was ~25 nm for precise alignment of Au nanorods. After arranging the nanorods into the trenches, we removed the PMMA layer with acetone to clean the surface outside the trenches (Fig. 1). A bilayer of CTAB surfactant, which is used in chemical synthesizing process of Au nanorods, was coated on the surface of Au nanorods to create a 10 nm gap between the rods. The hydrophilic CTAB bilayer and hydrophobic PMMA layer helped to control capillary force and to efficiently align Au nanorods into hydrophilic trenches.

In a finite-difference time-domain (FDTD) calculation we found some peaks of surface plasmon resonance in visible range, and the strongest peak appeared at a wavelength of 727 nm (Fig. 2). These results show that the combination of lithography and self-assembly has the potential to realize plasmonic nanolens made of Au nanorods.

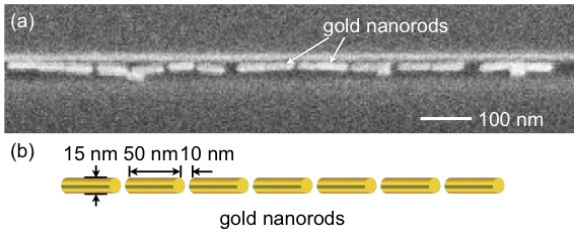

Fig. 1. (a) SEM image of self-assembled Au nanorods in a thin trench (b) Aligned Au nanorods of 50 nm heights, 15 nm diameters and 10 nm gaps.

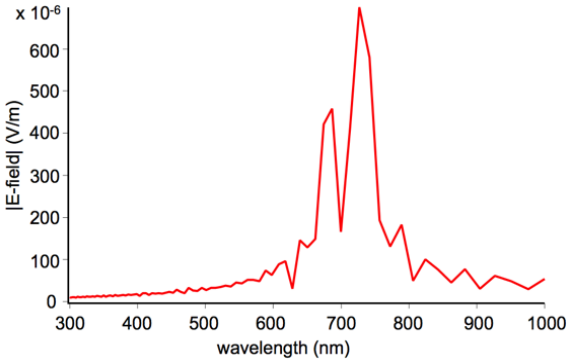

Fig. 2. FDTD calculation of E-field at the output side of 11 aligned Au nanorods chain in air. The strongest peak appeared at 727 nm.

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P-33

Metal-insulator-metal structures

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1. Introduction

In the present work, we propose a metal-insulator-metal (MIM) structure consisting of a thick insulator layer sandwiched with metal layers. This structures allows to couple two surface-plasmon polaritons (SPPs). The coupling between two SPPs achieved when the thicknesses of each layer are properly chosen.

The structures which we suggested in this paper can easily be prepared compared to those prepared by Korean group [1] to improve the resolution using MIM structures. However, ours results of reflectivity measurements show a sharp resonance compared to conventional SPR with single layer.

2. Experimental results

MIM structure used for the present work is schematically shown in Fig.1. It was prepared by vacuum evaporation technique. First, a 40-nm Ag film is deposited on a BK7 substrate. An insulator PMMA layer of a 216-nm thickness was coated by spin-coating on top of the Ag film. A 40-nm thick Ag film was deposited thereon to complete the MIM structures.

To measure reflectivity spectra, the sample was mounted on a rotating table and excited by a p-polarized laser beam with a wavelength of 633 nm. The reflectivity was measured as a function of the incident angle.

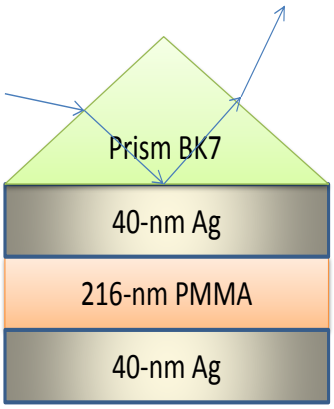

Fig. 2: MIM structures.

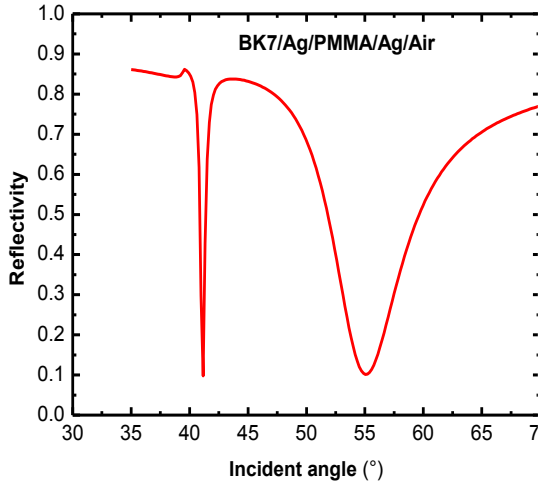

Fig. 2: Experimental results for the present MIM structures.

Figure 2 shows two resonances located at 41.05°and 55.20°, respectively. The first one is a narrow resonance which corresponds to SPP at the Ag/Air interface modified by the MIM structures. The second one is a broad resonance which corresponds to a symmetric SPP arising from SPP coupling. The full width at half maximum of the sharp resonance is 38% narrower than that of conventional SPR.

3. Conclusion

In this paper, we described experimental results for a simple MIM structure prepared with a PMMA insulator layer. Sharp and broad resonances observed. The width of the sharp resonance was found to be smaller than that of conventional SPR. The MIM structures may find potential applications in various sensing problems.

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P-34

Optical ring-lattice generator using axially-symmetric polarization elements

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When two optical vortices with different topological charges (TCs) are interfered with each other, a ring-shaped optical lattice is generated [1]. This kind of ring-lattice has a feature that it can be rotated by changing the relative phase-difference between the two vortices, and hence it has been applied to the optical manipulation for the micro-particles and the ultracold atoms.

For generating the ring lattice, several methods using spatial-light modulators (SLMs) have been developed so far [1, 2]. However, these previous methods have trade-off issue between the stability and the flexibility of the generated ring lattices because of the difficulty in modulating the relative phase-difference between co-propagating two optical vortices from a single SLM by using external phase modulators.

In this presentation, we describe a novel method using the axially-symmetric polarization elements, overcoming the above drawback. Figure 1 illustrates one of the typical configurations based on our method [3, 4]. The laser light is first transmitted by a polarization modulator (PM) so that the phase difference between the left- and right-circularly polarized (LCP and RCP) components of laser beam can be controlled by an electro-optic modulator (EOM). Then this light successively passes through an axially-symmetric half-wave plate (AHP), a normal half wave plate (HWP), an axially-symmetric polarizer (ASP), and a right-circular analyzer (RCA). The light output from the RCA is the superposition of two optical vortices with the TCs of l=4 and -2, which are respectively converted from the LCP and RCP components incident to the AHP. Finally, a 6-petaled ring-lattice is generated as a Fraunhofer diffraction pattern of the two optical vortices at the back focal plane of the convex lens.

This method has a feature that the generated lattice pattern is immune to the external fluctuation because the interfering two vortices are generated by the common-path optical system. In addition, the lattice pattern can be rotated at high frequency because of the rapid response of the EOM. We note that the ring lattices with different numbers of the petals can be generated by changing the arrangements of the AHP and ASP [3, 4].

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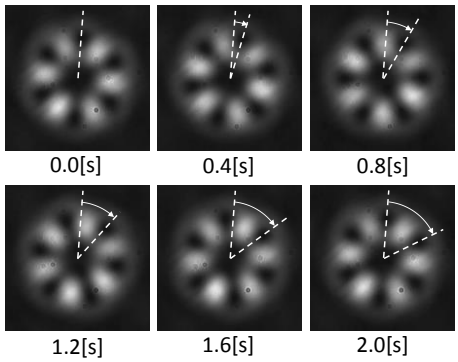

Fig. 2 Rotating ring lattice.

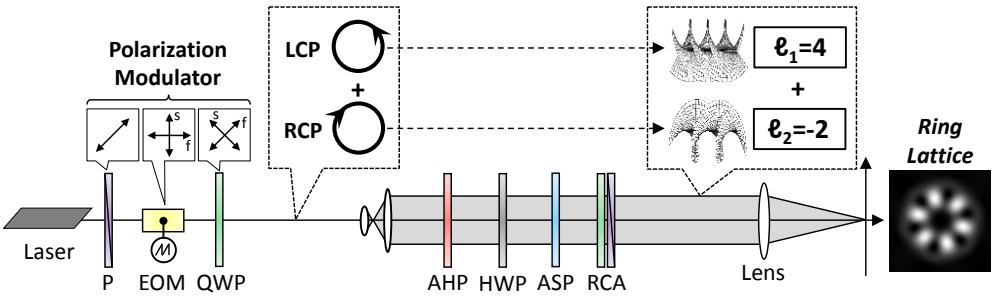

Fig. 1 Schematic of the ring-lattice generator.

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Defect related photoluminescence study on Eu^{3+} activated Gd_2O_3 phosphors

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Background

Gd_2O_3 is one of the host matrix for luminescent applications due to its low phonon energy, high thermal and chemical stability [1]. Crystallographically Gd^{3+} in Gd_2O_3 has two different symmetric site namely C_2 (non-inversion symmetry) and S_6 (inversion symmetry) and its spectroscopic properties are site dependent. The activator cation Eu^{3+} can also occupy either C_2 or S_6 site where as in Gd_2O_3 site preference for Eu^{3+} is random. Lattice defect is one of the parameter to govern the site occupancy of Eu^{3+} in C_2 or S_6 site which indeed affect the photoluminescence properties [2]. With the aid of positron annihilation lifetime spectroscopy (PALS), the defects like dislocations, monovacancies, micro-voids, pores etc., can be detected [3]. The lifetime of positrons trapped by vacancy-type defects increases because of the reduced electron density in such defects. Depending on the annihilation time, the type of defect can be evaluated. The presence of vacancy defects plays an important role in modifying the properties of materials at nanoscale, efforts to identify the evolution with change of experimental parameters are highly appropriated. In the present work, we have reported the optical properties and lattice defects of Gd_2O_3:Eu^{3+}.

Results and discussion

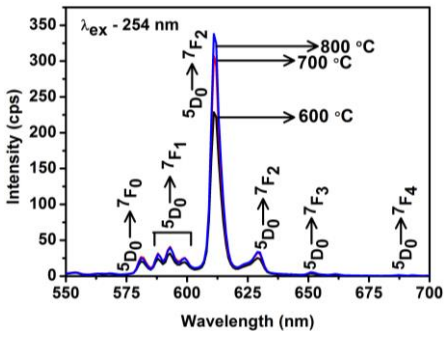

Figure 1 Emission spectra of Gd_2O_3:Eu^{3+}

In emission spectra (Figure 1), Eu^{3+} is characterized by a narrow emission peak at 611 nm and weak emission peaks at 553, 580, 587, 592, 599, 626 and 652 nm. All these emission peaks confirm the presence of Eu^{3+} in Gd_2O_3 matrix. In the emission spectra, $^5D_0 \rightarrow {}^7F_1$ transition is an insensitive to the crystal field environment and it is an allowed magnetic dipole transition. The high intense peak transition $^5D_0 \rightarrow {}^7F_2$ is a hypersensitive forced electric-dipole transition which is strongly affected by the surrounding environment. Crystallographically Eu^{3+} can occupy C_2 or S_6 site in the matrix, the former site is responsible for $^5D_0 \rightarrow {}^7F_2$ and the latter for $^5D_0 \rightarrow {}^7F_1$ transition. In the present work, majority of Eu^{3+} ions are located in C_2 site The PL emission intensity increases with the crystalline nature of the phosphor.

PALS yields three lifetime component with relative intensities. The lifetime τ_1 may represent a mixed lifetime comprising of both annihilation at grain boundary and monovacany in the crystallite as well. The second lifetime component τ_2 varied between 543 and 497 ps corresponds to the positron trapping at nano voids (cluster vacancies) in the crystalline during the annihilation processs. The highest lifetime τ_3 points the formation of positronium in large voids.

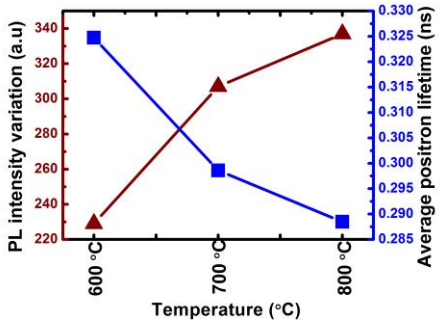

Figure 2 Comparison of analysed positron data and Luminescence data of all samples

During synthesis, Eu^{3+} ions might be kinetically trapped at some location in the form of clusters (kind of defects) but during annealing process, the ions migrate in the Gd_2O_3 lattice and occupy C_2 or S_6 sites of Gd^{3+}. As a result the defect caused due to the clustering of Eu^{3+} decreases and results in the enhancement of emission intensity (Figure 2). In PALS, the decrease in average lifetime (τ_1 and τ_2) indicates the reduction of defects in phosphors.

In conclusion, the emission spectra show a sharp red emission peaks corresponding to $^5D_0 \rightarrow {}^7F_2$ transition in $Eu^{3+}$and its intensity increases with the crystalline nature of the phosphor. The positron lifetime spectroscopy reveals the presence of cluster vacancy in the host matrix and is occupied by Eu^{3+} ions at 700 ˚C and 800 ˚C and also proves that the structural defect is directly related to the site occupancy of Eu^{3+} in Gd^{3+}.

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P-36

Dynamic Temperature Field Measurements Using a Polarization Phase Shifting Technique

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An optical system capable of simultaneously grabbing three phase-shifted interferometric images was developed for dynamic temperature field measurements outside of a thin flame. The polarization phase shifting technique and a Michelson interferometer that is coupled to a 4-f system with a Ronchi grating placed at the frequency plane are used. This configuration permits the phase-shifted interferograms to be grabbed simultaneously by one CCD. The temperature field measurement is based on measuring the refraction index difference by solving the inverse Abel transform, which requires information obtained by the fringe order localization. Experimental results of a dynamic event are presented varying in time.

The optical setup presented for the optical phase calculation is composed of a Polarization Michelson Interferometer (PMI) that is coupled to a 4-f system with an amplitude grating placed on the Fourier plane, figure 1. As a result, the interferogram first obtained by the PMI is replicated on the image plane of the 4-f system. The major drawback of this system is the amplitude interferogram modulation generated by the use of phase/amplitude gratings[1,2]. This information can be avoided through the implementation of fringe pattern normalization algorithms already encountered in the literature [3-4]. This system is able to obtain three phase shifted interferograms in only one shot. Therefore, it is suitable to carry out temporal measurements of temperatures changes occurred outside of a thin-flame.

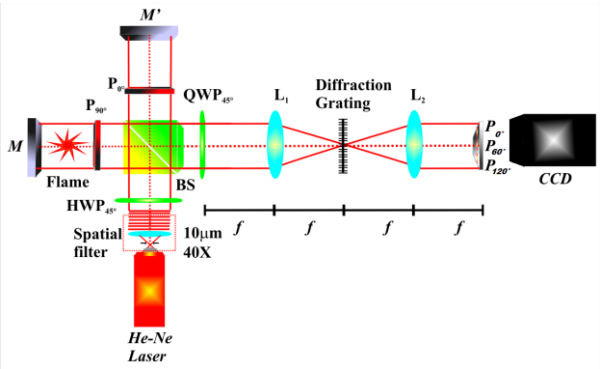

Figure 1 Setup of the instantaneous polarized phase-shifting interferometer

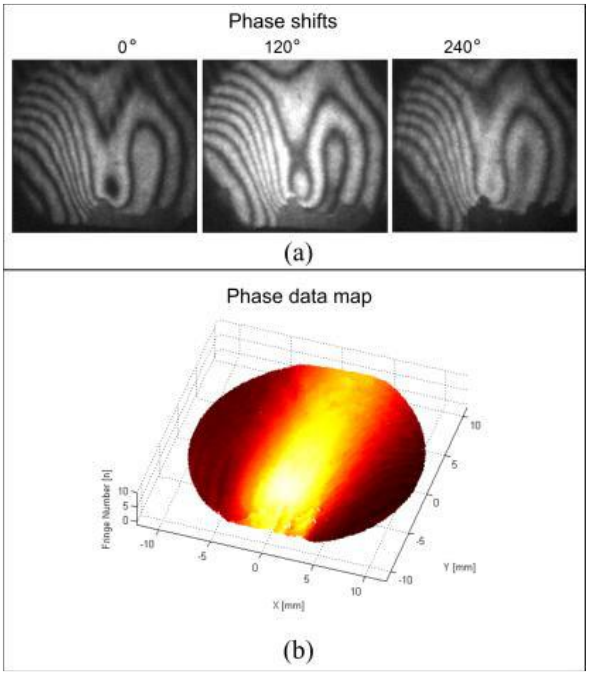

Figure 2 a) Three phase shifted interferograms obtained in a single capture and b) Unwrapped Phase map.

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P-37

Development of Graphene-Based Infrared and Terahertz Devices

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The overall goal of this work is to develop graphene-based optoelectronic devices that work in the technologically important mid-infrared (MIR) and terahertz (THz) ranges. Specifically, in this project, we prepare large-area graphene samples on various substrates and assess their MIR and THz properties in terms of sources and modulators. These properties will be investigated using pump-probe spectroscopy. Graphene is a promising candidate for THz generation because it has been predicted that THz amplification will occur in graphene if population inversion is created under sufficiently strong optical pumping [1]. This is illustrated below.

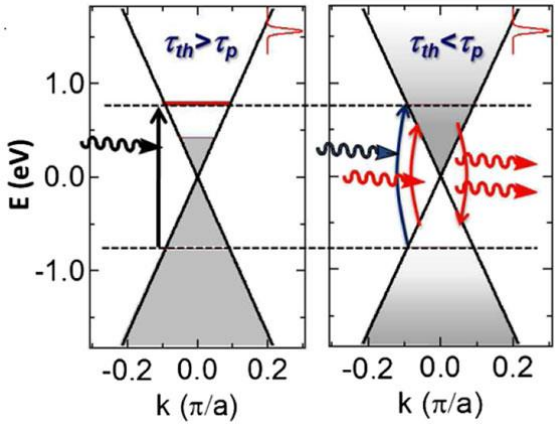

Fig. 1: Dispersion of electron-doped graphene monolayer illustrating state filling (left) and band filling (right) that leads to stimulated emission from a broadband, inverted population (red arrow).

The gapless band structure causes the gain (or negative conductivity) to take place in the THz frequency regime. Therefore, we are investigating the conditions when THz and MIR stimulated emission occurs in graphene under optical pumping. We excite graphene through ultrafast interband optical pumping and probe subsequent carrier dynamics with a delayed MIR or THz pulse. Graphene is also ideal for the modulation of THz radiation due to its high electron mobility and nonlinear response to electromagnetic waves. Since graphene is highly absorptive in the THz range, it is a promising material for controlling THz waves by manipulating the free-carrier density through gating. A pertinent, exciting prediction is that an energy gap will appear at the Dirac point (illustrated below) when graphene is irradiated by a circularly-polarized, intense laser field [2].

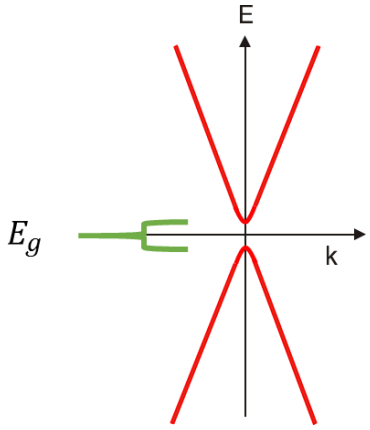

Fig. 2: Band gap appearance when graphene is shone with circularly polarized laser field. The band gap is proportional to the intensity of the field and inversely proportional to the frequency.

This provides a coherent and ultrafast means for tuning the band gap, which will be used to modulate the transmission of THz radiation. To experimentally realize this, an optical parametric amplifier (OPA) will be used to produce MIR radiation that will open up the band gap. The graphene will then be transparent to THz radiation. The polarization of the light will be controlled using a wave plate. We can then compare the results to the current theory [3]. Later, we will replace the OPA with a MIR quantum cascade laser (QCL). The QCL will be modulated at speeds up to 10 GHz, which will produce ultrafast THz modulations.

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P-38

Bandgap engineering in III-nitrides for solid-state lighting applications

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In photonics industry, III-nitride based white light solid state lighting (SSL) technology is currently a viable contender for general illumination. While the bandgap engineering in most III/V materials systems, GaAs and InP as examples, has been studied and applied in red and IR emitters, it has not yet been detailed investigated in III-nitrides for blue, green and white emitters. Our work demonstrates that by engineering the transition metals doped dielectric capping structure, the trimming of bandgap and tuning of band profile is achieved via quantum well interdiffusion. Our findings also reveal an increasing of emission bandwidth and a reduction of efficiency droop in processed devices.

In this presentation, the difficulties in achieving bandgap engineering in nitride based quantum well structure are discussed, followed by the explanation of our patent-pending quantum well intermixing (QWI) approach. The observation of bandgap trimming and band profile softening are analyzed in detail. The theoretical and experimental studies of mechanisms, including thermal interdiffusion, metal induced vacancy and Auger recombination are presented. The emitting wavelength of bandgap tuned LED structures we demonstrated show a blue-shift of 80 meV in green color regime. In band profile softened LEDs, the efficiency droops at 150 A/cm2 are found to be reduced from 26.2% to 21.4% (for a 60 μm circular LED mesa) and from 24.9% to 18.6% (for a 50 μm circular LED mesa), compared with as-grown chips. The integration process flow, such as graded band structure design, sidewall enhanced intermixing and self-isolation formation, and prospects of future developments towards high efficient, multi-color emitter will be discussed by the end of the presentation.

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Dynamic Imaging Stokes Polarimeter using Polarization Pixelated Camera

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Polarization state can be described as a Jones or Stokes vectors. The Jones vector is possible to describe only perfect polarization state, but the Stokes parameters can be represent partially polarized and unpolarized state. - To measure the Stokes parameters, many methods have been proposed before. Recently one of these methods is polarization pixelated camera whose a pixel polarizer is attached on each CCD pixel to measure it dynamically [1, 2]. However this camera cannot measure right circular or left circular component s_3 of the Stokes parameters because it consists only a system of polarizer without a retarder. A different type polarization pixelated camera has been proposed. It consists that an array of elliptical polarizer is attached on CCD [3, 4]. It can measure full Stokes parameters, however a calibration of linear retardance of each pixelated retarder is difficult. Our group proposes Stokes polarimeter using a rotating retarder and the polarization pixelated camera. This paper reports calibration method of the rotating retarder during the Stokes parameters measurement. Figure 1 shows an optical setup of the Stokes polarimeter. Intensity is captured by CCD after unknown Stokes parameters (s_0, s_1, s_2, s_3) of incident light passing the rotating retarder of retadance δ and azimuthal direction ξ and the polarizer array of azimuthal direction φ which are set 0°, 45°, 90° and 135°.

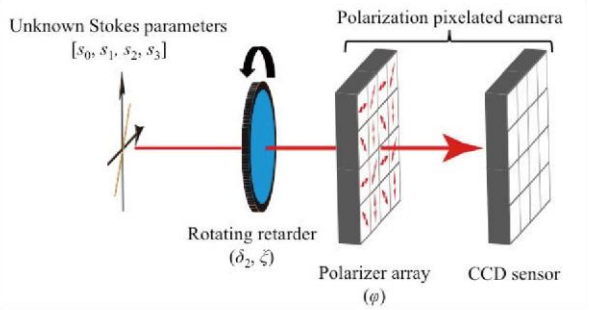

Fig. 1: Optical setup of Stokes polaimeter using the rotating retarder and polarization pixelated camera.

Intensity I Detected by CCD sensor,

$$I=\frac{1}{2}\Big[s_0+\Big[s_1\{1-(1-\cos\delta)\sin^2 2\xi\}+s_2(1-\cos\delta)\sin 2\xi\cos 2\xi -s_3\sin\delta\sin 2\xi\Big]\cos 2\varphi+\Big[s_1(1-\cos\delta)\sin 2\xi\cos 2\xi +s_2\{1-(1-\cos\delta)\cos^2 2\xi\}+s_3\sin\delta\cos 2\xi\Big]\sin 2\varphi\Big] \quad (1)$$

When intensities are detected by azimuthal direction ξ which are 0°, 45° and 90° of the rotating retarder, 12 kind of intensities are gotten. Because if intensities are captured by polarization pixelated camera with 1-shot, intensities I_0, I_1, I_2 and I_3 of 0°, 45°, 90° and 135° of the polarizer array can be detected. The unknown Stokes parameters can be given from the 12 intensities I_0~ I_{11},

$$\begin{bmatrix} s_0 \\ s_1 \\ s_2 \\ s_3 \end{bmatrix}=\begin{bmatrix} 1 \\ \dfrac{I_0-I_2}{I_0+I_2} \\ \dfrac{I_5-I_7}{I_0+I_2} \\ \dfrac{I_1-I_3-I_9+I_{11}}{2(I_0+I_2)\sin\delta} \end{bmatrix}. \quad (2)$$

The retardance δ of rotating retarder can be calculated from same the intensity simultaneously,

$$\delta=\cos^{-1}\left\{\frac{I_1-I_3+I_9-I_{11}}{2(I_5-I_7)}\right\}. \quad (3)$$

A retarder placed on a rotating motor synchronized with an encoder value of the pixelated camera allows almost real time temporal measurement of a sample. Figure 2 shows a dynamic measurement of ellipticity and azimuthal angle of polarization calculated from Stokes parameters using U-shape film as sample compressed.

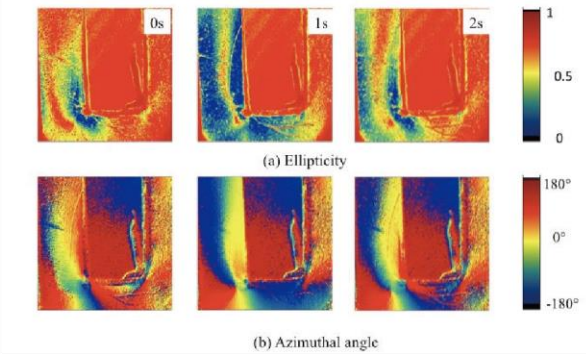

Fig. 2: Dynamic measurement of ellipticity and azimuthal angle of polarization of U-shape film.

As a conclusions an imaging stokes polarimeter was builded. A calibration procedure was made taking into account the retardance variation of the retarder in order to increase the accuracy of the system.

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P-40

Computational imaging with single-pixel detection: applications in scattering media

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Computational imaging with single-pixel detection is an imaging technique very well adapted to provide multidimensional optical information of an input scene. The key process of the method is to sample the input scene with a set of microstructured light patterns by using a spatial light modulator. In this way, with the appropriate single-pixel detector, the technique has been applied to measure the spatial distribution of polarimetric [1], spectral [2] and phase [3] information of a scene. Advantages of these architectures include high signal-to-noise ratios in low illumination regimes. Single-pixel cameras also benefit from the fact that compressive sensing (CS) enables the retrieval of an image with a number of measurements lower than the established by the Shannon-Nyquist theorem [4]. In this contribution we describe a new application of computational imaging with single-pixel detection, the transmission of images through scattering media.

In a conventional imaging experiment, a lens maps every input pixel of an object to its conjugated output pixel at the sensor. However, when a scattering medium is located between the input object and the sensor, the relationship between input and output pixels suffers the effects of light propagation by multiple scatters. As a result, the spatial information of an input mode is scrambled and coupled through all output modes [5]. Different methods for image transmission, focusing, and imaging through scattering media based on wavefront control have been proposed over the past few years [6]. However, in general, they are based on feed-back algorithms or need a-priori calibration processes.

In this work we describe a single-pixel system, based on compressive detection, that overcomes the fundamental limitation imposed by multiple scattering even in the dynamically varying case [7]. We use computational imaging by projecting binary patterns with measurements being captured sequentially by a single-pixel sensor. The programmed patterns are used as generalized measurement modes where the object information is expressed. Consequently, the presence of a scattering medium between the object and the light detector does not invalidate the operation principle. In contrast with other schemes based on the transmission matrix technique, our approach does not require any a-priori calibration process. Furthermore, the method is accurate even if the medium is dynamic as shown experimentally.

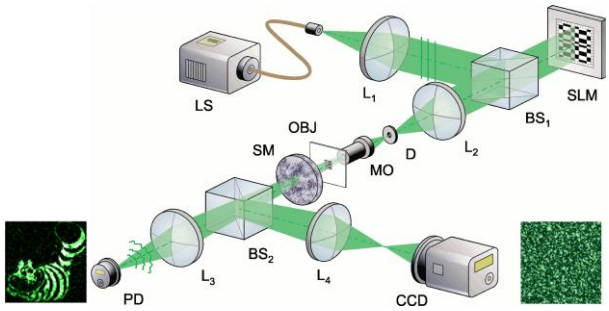

Fig. 1: Disorder-assisted compressive microscopy. Schematic diagram of the optical setup. The object is the *Cheshire Cat* from *Alice's Adventures in Wonderland.*

We have described a computational technique combined with single-pixel sensing that enables image reconstruction behind arbitrary scattering media, in contrast to charge-coupled device cameras, where the pixelated structure of the sensor returns a noise-like speckle pattern. Our approach does not require a previous calibration of the disordered media and permits to retrieve images when we deal with dynamic scatterers Our technique does not need to characterize the scattering medium, but operates on an intensity basis, thereby computing intensity distributions instead of complex fields. Moreover, the use of compressive sensing is limited to scenes that are sparse on the chosen basis. Our implementation is a first step to tackle the general problem of imaging objects completely embedded in a scattering medium.

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P-41

Polarization-Dependent Infrared Spectroscopy of Macroscopic Films of Aligned Carbon Nanotubes

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Carbon nanotubes (CNTs) have laid a novel one-dimensional platform on which to develop novel applications in the areas of super-capacitors, hydrogen storage, solar cells, THz polarizers, transistors, and optical modulators. CNT have the unique property of being optically anisotropic at any wavelengths. Here we have characterized macroscopically aligned CNT films using polarization-dependent Fourier transform infrared (FTIR) spectroscopy. By passing polarized light at different orientations over a frequency range of 2000 to 8000 cm^{-1}, we determined the angular dependent absorbance as well as the linear dichroism of such films. The transmittance in the perpendicular case is very high while that in the parallel orientation is low, leading to a high value of linear dichroism; we found that the average value of the reduced linear dichroism was 2.26. These results show that CNTs can be assertively used as a polarizer to polarize light, especially in the infrared and terahertz range.

P-42

Solar powered memberane fillteration

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In the world of increasing industrial developments and population the demand for energy and water is increasing day by day. The estimated increase of demand in energy is modeled to be around 420 exojoules/year in the future. In contrast the energy now produced is from non-renewable resources by converting water in to steam. Thus the future depends on implementation of renewable sources to produce energy. In this work, the use of solar energy for the production of energy as well as purification of wastewater and seawater for domestic purposes is carried out. The purification of water is carried out by means of a hybrid desalination technology called the membrane distillation which uses both the thermal as well as the membrane process in order to get product water. Membrane distillation is a thermally driven separation process in which separation is enabled due to phase change. A hydrophobic membrane displays a barrier for liquid phase, letting water vapor pass through the membrane pores. The driving force of the process is given by a partial vapor pressure difference commonly triggered by a temperature difference.

In membrane distillation process the main source of energy requirement is to produce thermal energy in order to heat the water to form water vapors. Thus a comprehensive use of solar energy to power the thermal operation in the Membrane distillation process is very essential.

P-43

Optical property of dye doped DNA-surfactant complex film made by immersion method

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Dye laser is especially useful for tunable laser by grace of an organic dye's wide fluorescence spectrum. However, dye molecules are broken high intensity pumping light. So, dye laser needs a large circulation system to protect them. Many ideas were suggested for break out this problem - one of it is using DNA-surfactant complex. This complex is composed by deoxyribonucleic acid sodium (DNA) as anionic polymer, and cationic surfactant [1]. It is very available for dye laser because it interacts with dye molecule and enhance fluorescence and durability of an organic fluorescence dye [2]. On decade, DNA-surfactant complex have been studied for dye laser material, especially, solid state dye laser has been studied to achieve non-circulation system dye laser by using DNA-surfactant complex as polymer matrix. Generally, dye doped DNA-surfactant complex film is made by mixing dye and DNA-surfactant complex. But this manufacture method limits a kind of dye because common solvent between dye and DNA-surfactant complex need for this method. In this situation, H. You *et al*., reported that when DNA-surfactant complex powder immersed in dye solutions, these powders are stained [3]. We attended this phenomenon and we developed new manufacture method. Here we show that optical property of dye doped DNA-surfactant complex film made by immersion method. We employed 4-[4-(dimethylamino) stylyl]-1-dococylpyridinium bromide (DMASDPB, Aldrich) for a fluorescence organic dye and cethyltrimethyl ammonium chloride (CTMA-Cl, Aldrich) as cationic surfactant.

At first, we describe manufacture of DNA-CTMA complexes. We made 6.5g/L DNA (Ogata material laboratory) aqueous solution and 6.8g/L CTMA-Cl aqueous solution. After 1 day, mixing them, DNA-CTMA complex precipitated. Secondary, few days later, filtration under reduced pressure and cleaning them by pure water and acetone, drying at low vapor at 60℃ in 12 hour, we obtained DNA-CTMA powder. Then, we dissolved DNA-CTMA powder in ethanol at concentration of 60g/L, and spin-coated it on the glass substrate at 2000rpm in 15sec, we fabricated pure DNA-CTMA film (thickness: 1.1μm). Finally, we immersed film into acetone solution of DMASPDB (3.3×10^{-5} M). After 1 day, we obtained the dye doped DNA-CTMA film.

We excited this film with a ns frequency doubled Nd^{3+}: YAG laser (7ns, 10Hz, Surelite II, Continuum) and measured the emission from film by using the spectra meter (USB4000, Ocean Optics). Using the same laser source, we made distributed feedback cavity on the surface of film by dynamic grating [4].

Results of measurements are shown in Figure 1. Absorption spectra of the film showing that concentration of dye was estimated to be 10 wt%, therefore the ratio of the dye to complex base pair must be 1:5. Then, we confirmed amplified spontaneous emission (ASE) and lasing from immersed film. Threshold value of ASE is 0.3mJ/cm^2; this value is lower than our former work [5]. Moreover, we succeeded lasing and wavelength conversion from immersion film.

In summary, we created new manufacture method of dye doped DNA-CTMA film. Threshold value of ASE from this film was lower than our former work. In addition, we succeeded lasing and wavelength conversion by dynamic grating. The details of optical characteristics will be shown at the poster session.

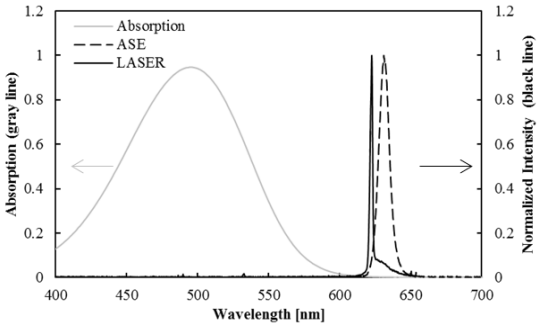

Fig.1 Spectrums from immersed film.

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P-44

Molecular orientation in polymer wires with nanosized radii unveiled by polarized micro-Raman spectroscopy

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Molecular orientation of polymer wires whose radii were in nanoscales was uncovered by polarized micro-Raman spectroscopy to clarify physical properties of nanosized polymer. When the size of materials is confined to nanoscales, the materials can show characteristics which are different from bulk system. Regarding polymer wires whose radii are confined to nanoscales, elastic modulus increases nonlinearly as decreasing radii behind a threshold. Although increase of molecular orientation degree in the wires is considered to have crucial roles for the peculiar increase of elastic modulus, origins have not been clarified yet. [1] In this study, we achieved evaluating molecular orientation of individual polymer wires with radii reaching 120 nm by utilizing polarization micro-Raman spectroscopy which is one of ideal tools to evaluate molecular structure without destruction. This research result gives a clue to unveil origins of unique physical properties of nanosized polymer represented by size-dependent elastic modulus of polymer wires, which is expected to develop fields of polymer micromachining and its applications.

Polymer wires with various radii between 120-500 nm were fabricated by two-photon polymerization as shown in Fig. 1 (a). The wires mainly consist of cross-linked poly(methyl methacrylate) (PMMA). Regarding polarized micro-Raman spectroscopy, linearly polarized incident light (wavelength 532 nm) was focused on the wires via an objective lens (x100, NA=0.9) and Raman spectra were obtained. On the Raman spectra, a peak assigned to one of C-C-C skeletal chain oscillation modes from PMMA locates at 540 cm^{-1} as shown in Fig. 1 (b). To evaluate molecular orientation of the wires, we compared the intensity of the peak along polarization angles of the incident light about each wire radius. Half wavelength plate was used changing polarization angle. Background signals on obtained Raman spectra were subtracted by a polynomial function that is widely used for background subtraction of Raman spectrum. The Raman spectra after background subtraction were normalized by a peak assigned to one of oscillation modes of benzene circle whose intensity is independent on polarization angle.

As a result, a polarization angular dependence on the peak intensity was observed in the case of each wire radius. Moreover, the polarization angular dependence became to be strong as decreasing wire radius. As increasing wire radius, on the other hand, the polarization angular dependence approached a bulk system which does not have the polarization angular dependence. The polarization angular dependence also fitted a curve of a theoretical function that can be applied when polymer chain has uniaxial orientation. [2] This agreement between experimental results and theoretical function plots indicates that polymer chain in the wires tends to have orientation to uniaxial (longitudinal) direction of the wires as decreasing wire radius.

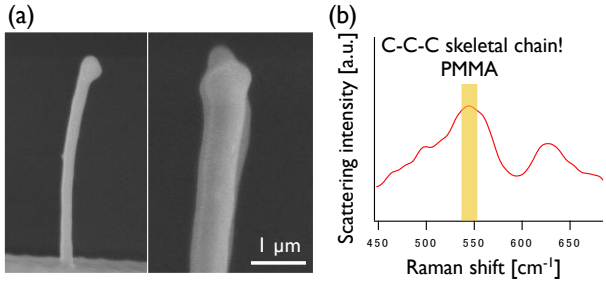

Fig. 1: (a) A set of polymer wires with different nanosized wire radii. (b) A Raman spectrum obtained from a polymer wire.

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P-45

Enhanced optical activity of chiral molecules in 2-D nanogap plasmonic fields

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Recently, the research on plasmonics has revealed several new interactions between materials and light. To use metal plasmonic nanostructures, the light was localized in nanoscale space and the interaction was enhanced. Such as, optical trapping [1], surface enhanced raman scattering (SERS) and surface plasmon amplification by stimulated emission of radiation (SPASER) [2]. One of the most significant applications is high sensitivity biosensor which utilizes the large change of optical properties on materials.

Our study is the plasmonic nanostructure which measure stereoisomer of chiral molecules with high sensitivity. Here we developed a method of numerical analysis which calculate electric field vector on the local field and extinction spectrum on the far field with high accuracy. To use this method, we calculate the localization property of circular polarized field on 2-D nanogap plasmonic structure. This field has a component of angular momentum. We show that arrangement of a pseudo-chiral molecules which consist of metal asymmetry nanostructures in the nanogap elucidate plasmonic enhancement effect of circular dichroic (CD) spectrum.

The model of numerical analysis show below that the chiral nanostructure in Fig.1 (a) set into the center of the 2-D nanogap gold structure in Fig.1 (b). Circular polarized light irradiate the structure to vertically upward.

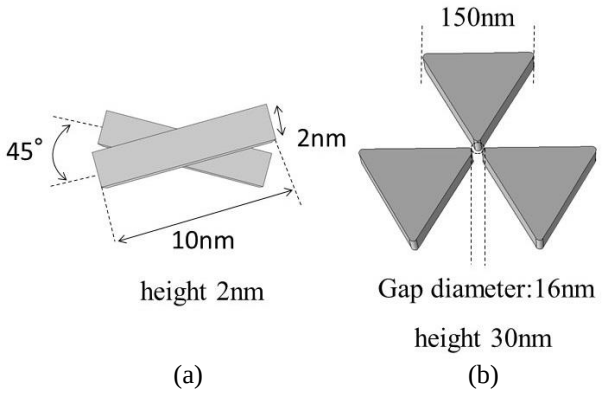

Fig. 1: (a) chiral gold nanostructure
(b) 2-D nanogap gold structure

Figure 2(a) displays the extinction spectra which is from only 2-D nanogap structure and is the case of intercalating the chiral nanostructure. Because of the interaction with chiral nanostructure, the split is generated in the spectrum. Figure 2(b) shows the circular dichroic (CD) spectra which is from only chiral nanostructure and is the case of intercalated in the 2-D nanogap structure. To compare the spectrum of the only chiral nanostructure, the intensity of circular dichroism enhance three hundred times owing to the existence of the 2-D nanogap structure.

At poster presentation, we show about local field distributions in nanogap and enhanced properties of circular dichroic spectra.

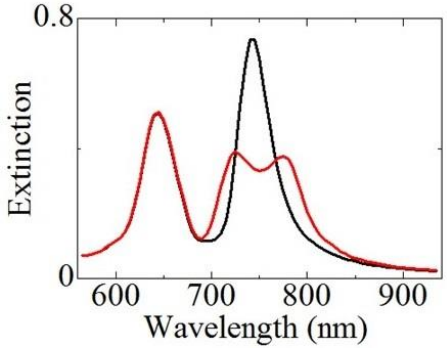

Fig. 2: Extinction spectra
Black line: only Fig.1 (a)
Red line: Fig.1 (a) + (b) intercalate

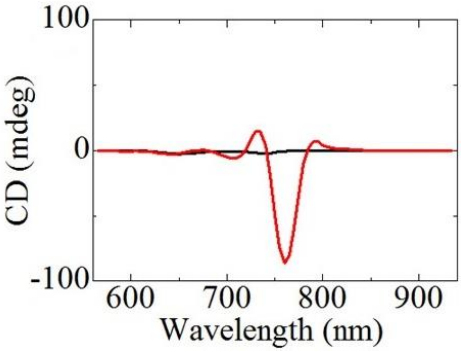

Fig. 3: Circular dichroic spectra
Black line: only Fig.1 (b)
Red line: Fig.1 (a) + (b) intercalate

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P-46

Optical nano-imaging via plasmon focusing on metallic tip

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Tip-enhanced near-field microscopy is a powerful technique to observe and analyze various materials with rich optical information at nanoscale spatial resolution [1]. In a common tip-enhanced near-field microscopy, we excite near-field light at an apex of a metallic tip through plasmon resonance by illuminating the apex with laser. Therefore, not only the near-field light but also the laser illumination to the apex itself creates some scattering, which can be huge background. To remove this background, Raschke et al. presented a method based on plasmon nanofocusing phenomenon [2]. In this method, they illuminated a grating fabricated on a tip shaft with far-field laser to couple plasmon and launch plasmon propagation to the apex in order to create near-field light at the tip apex. Since one does not need to illuminate the apex with laser, the background signal can be largely reduced. In spite of this great advantage, there are only a few reports on this technique. To make this technique more practical, it is important to optimize tip structures for high efficiency in all processes of plasmon coupling, propagation and focusing.

In this paper, we report that we optimized tip structure through finite-differential time-domain (FDTD) method and fabricated metallic tips that have an optimized structure. We also applied the fabricated tips for optical nano-imaging.

To make a metallic tip, we applied a commercially-available silicon tip well-used for atomic force microscope, which was coated with silver by vacuum vapor deposition as a plasmonic material. Through the FDTD simulation, we found out that 630 nm grating period and 40 nm silver coating thickness were the best in the case of 642 nm excitation. We fabricated metallic tips which have the optimized structure by means of vacuum vapor deposition and focused ion beam lithography as shown in Fig. 1. We then demonstrated that light spot showed up at the tip apex due to the plasmon propagation to the apex when we illuminated the grating with laser (Fig. 2-a). We confirmed that the light spot was created through the plasmon propagation to the apex by investigating dependence of near-field intensity on incident polarization, which is indicated in Fig. 2-b. The intensity followed tendency of $\cos^2\theta$, where θ is incident polarization direction and $\theta = 0$ means that polarization is parallel to grating grooves. This proves that plasmon nanofocusing was involved to create the near-filed light. We have then demonstrated optical nano-imaging of carbon nanotubes with high-enough image contrast. The details of optical-nano-imaging will be discussed in the presentation.

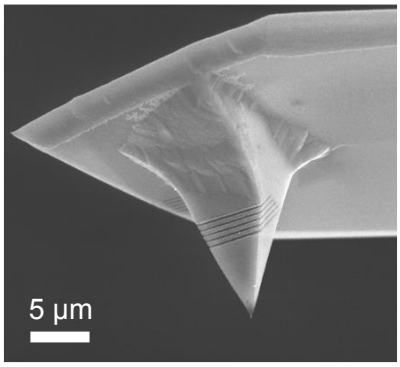

Fig. 1: SEM image of a silver-coated tip with a grating structure.

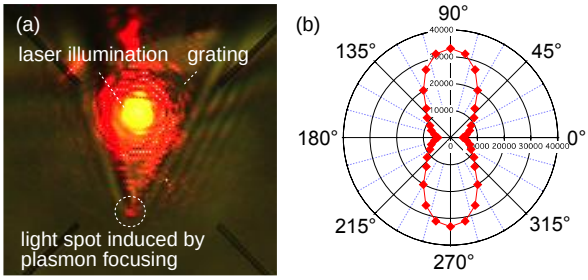

Fig. 2: (a) Optical image of a light spot induced at the apex through plasmon focusing. (b) Intensity of near-field light with respect to incident polarization.

References:

[1] S. Kawata, Y. Inouye, and P. Verma, *Nat. Photonics*, **3**, 338, (2009).
[2] M. Raschke *et al.*, *Nano Lett.*, **10**, 592, (2010).

P-47

Spin Hall effect of light: in a view of cross-polarization

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Spin Hall effect of light (SHEL) has intrigued the interests of researchers in recent years. It describes an opposite out-of-plane shift of the two spin components of light when a polarized beam impinges upon and reflects from a planar interface. The SHEL originates from spin-orbital angular moment interaction, and can be explained by total angular moment conservation at an interface [1].

We consider a linear polarized incidence Gaussian beam, which reflects from an air-glass interface. For plane waves, the *S* (electric field perpendicular to the plane-of incidence) and *P* (electric field parallel to the plane-of-incidence) polarizations are the eigenstates of the interface. For a spatially confined wave package, however, they are no longer eigenstates. Take *S* for example, the polarization of the reflected beam is not exactly *S* anymore, but *S* with a small amount of *P* that spatially varies in the wave front. Here the light of *P* polarization is called the cross-polarization component that is induced by reflection, while *S* is the dominant one [2]. We find that the tiny electric field ratio of the cross polarization component and the dominant one equals the ratio of SHEL displacement and the beam waist, as shown in Fig.1. Therefore, the SHEL can be derived by just measuring the intensities of crossed polarizations, rather than detecting the gravity center of beams by using CCD or quadrant detectors.

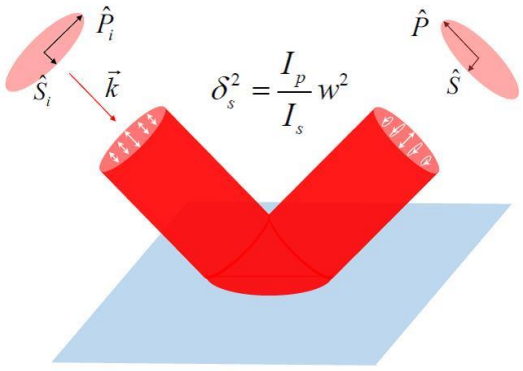

Fig.1: The relationship between SHEL and cross polarizations. An *S* polarized Gaussian beam impinges upon an interface and is reflected. The polarization of reflected beam is spatially variant in the wave front. The total intensities of reflected beam that along *P* polarization and *S* polarization are related to the SHEL and the beam waist in a simple way represented by the formula in the sketch.

In the experiment, we measure *P* state and a close linear polarization that along $\cos\alpha P + \sin\alpha S$, with $\alpha << 1$, rather than measuring the beam intensities of *P* and *S* states. This approach not only solve the problem that the intensity difference between *P* and *S* is so large that it exceeds the dynamic range of the detector, but also effectively enhances the signal. The measured SHEL agrees well with the prediction as presented in Fig.2.

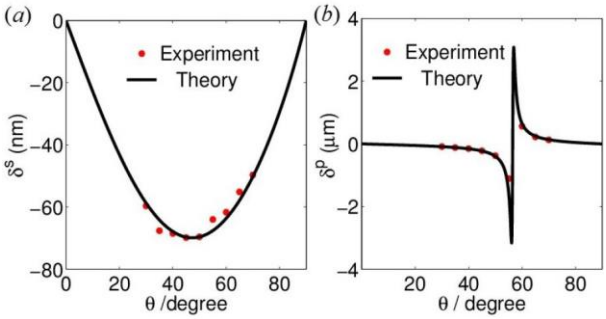

Fig.2: SHEL displacements of left-handed component, as a function of the incident angle θ , in the case of (a) *S* polarization and (b) *P* polarization. The dots are experimental results, and solid curves are theoretical prediction.

References:

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P-48

Studies on the Application of Plasma Electron Density Measurement by Saturation Spectroscopy

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1. Introduction

Saturation spectroscopy is widely used in the field of fundamental spectroscopy to identify the wavelengths of transition lines buried under the Doppler broadening. However, the application of saturation spectroscopy to plasma diagnostics is rather rare. We investigate the application of saturation spectroscopy to the measurement of electron density in argon-containing low-temperature plasmas. In this work, we propose a method for evaluating the saturation parameter from the spectrum of saturation spectroscopy in the presence of velocity changing collisions. We examined the relationship between the electron density and the saturation parameter.

2. Experiment

We used an inductively-coupled plasma source with an internal antenna in this experiment. The antenna was connected to an RF power supply at 13.56 MHz via a matching network. The light source of absorption spectroscopy was a diode laser. The diode laser beam was divided into two beams, and the diode laser beams with higher and lower intensities were used as the pump and probe beams, respectively. The pump and probe laser beams were injected into the plasma from the contour directions. The intensity of the probe laser beam passing through the plasma was detected using a photodiode. The electron density was measured using a Langmuir probe.

3. Results, discussion, and conclusions

According to the theory of saturation spectroscopy, saturation parameter is given by $S_0 = B_{12} I_\nu / cR^*$, where S_0 is the saturation parameter at the line center, B_{12} is the Einstein's B coefficient, I_ν is the spectral intensity of the pump laser beam, R^* is the effective relaxation frequency of relevant energy system. In this work, we proposed a new method to evaluate saturation parameter from the measured saturated absorption spectra with considering velocity changing collisions, given by $S_0 = [(\sqrt{\pi/\ln 2})(\Delta\nu_D)(1/\pi\gamma)][(\alpha_0 - \alpha_D)/\alpha_S]$, where α_0 and α_S are the absorption coefficients at the line center observed with and without the presence of pump laser beam, respectively, α_D is the estimated value of the line-center absorption coefficient in an imaginary situation that the population difference between the upper and lower levels in the presence of the pump beam makes a Doppler broadened absorption spectrum without the Lamb-dip, and as a coefficient of the second equation, γ and $\Delta\nu_D$ are FWHM of homogeneous broadened Lamb-dip and Doppler broadened spectrum, respectively. We employ the $4s[3/2]_2^0 - 4p[3/2]_2$ absorption line of argon. The lower energy state is metastable, and the effective relaxation frequency is determined by the relaxation frequency of the metastable state. In this case, the relaxation frequency of the metastable state is dominantly determined by electron impact quenching and the transit time of metastable argon through the diameter of the pump laser beam such that $R^* = k_q^e n_e + \bar{v}/a$, where k_q^e is the rate coefficient of electron impact quenching, n_e is the electron density, a is the diameter of the pump beam, and $\bar{v}$ is the mean velocity of metastable argon. Therefore, by evaluating α_0, α_S, and α_D on the basis of experimental spectra, we can evaluate the electron density n_e.

The relationship between $1/S_0$ and n_e is shown in Fig 1. We found linear relationships between $1/S_0$ and n_e, which are reasonable according to the aforementioned relationships among S_0, R^*, and n_e. It is confirmed that the slopes of the linear curves in Fig.1 are proportional to the inverse of the pump intensity which is consistent with proposed theory. Therefore, in conclusion, the experimental results indicate that the proposed method can work as a method for the electron density measurement in argon-containing plasmas.

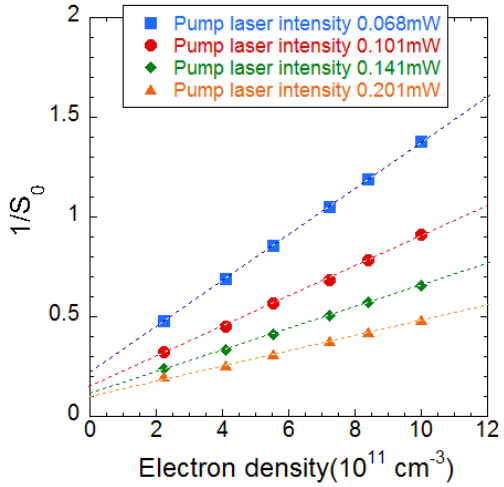

Fig. 1: Relationship between the reciprocal of the saturation parameter and the electron density. (Argon gas pressure is 100mTorr)

P-49

Performance Optimization of Organic Solar Cell

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Organic solar cells (OSCs) have been gaining great popularity in recent years due to their potentials to be low-cost, lightweight and flexible [1]. The performance of OSCs is growing steadily and they have achieved power conversion efficiency (PCE) close to 10% (for single-junction polymer-fullerene OSC). The enhancements are contributed by structural improvement as well as the material research breakthrough [2]. This research project studies the efficiency enhancement of organic solar cell via photovoltaic design parameter optimization and the incorporation of advanced structures e.g. nanoparticles for enhanced light-scattering and light-absorption. Both experimental and numerical analysis means will be employed in the study. The initial research involving theoretical studies and numerical finite-difference time-domain (FDTD) simulation to investigate the proposed design showed positive results. A 13% light absorption enhancement was obtained using the optimized proposed device structure. With the incorporation of Au nanoparticles, a 14.1% light absorption enhancement was obtained. Experimental results will be obtained to further confirm the simulation results. Based on the simulation results, we conclude that the photovoltaic design parameter optimization and the incorporation of advanced structures enhanced the performance of the OSC.

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P-50

Imaging Carbon Dioxide Clusters using Laser-Driven Coulomb Explosion

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Atoms, molecules can be bound together by van der Waals force to form clusters. Due to the weak interaction, this kind of clusters might become floppy and different isomers arise when the temperature rises. Usually, one structure distinct isomer corresponds to a local minimum on the potential energy surface. In the experiment, infrared spectrum is often used to identify the lowest energy isomer. Due to the important role of carbon dioxide cluster in the field of atmospheric science and supercritical solvation, the study of the aggregation of carbon dioxide has attracted much attention. In the early experiments, the structures of small CO_2 clusters are obtained based on the assignment of high resolution IR spectrum. These works can be found in a review article [1]. Laser-induced Coulomb explosion, a novel method to determine the structure of clusters, is intuitional and simple. Irradiated by femtosecond laser pulses, many electrons are immediately ionized and the clusters are left in high charge states. Then the multiply charged cluster ions are quickly fragmented, undergoing the process of so-called Coulomb explosion. The structure of the cluster ions are then deduced from the momentum vectors of the correlated fragmental ions in the Coulomb explosion process. When the duration of the laser pulse used in the experiment is short enough, the cluster components are confined in their original position. Thus the reconstructed structural parameters for ions can represent the structure of the neutral clusters before the laser irradiation [2].

Recently, we carry out a joint experimental and theoretical study of the structures of carbon dioxide clusters. In the experiment, the carbon dioxide clusters were generated by supersonic expansion. Then these carbon dioxide clusters were exploded through laser-driven multiple ionization. Precise momentum vectors of explosion fragments were obtained for each explosion channel. In the theory, we calculated the low-energy structures of carbon dioxide clusters using basin-hopping (BH) global minimum search program combined with density functional theory (DFT) geometric optimization. Based on the Coulomb potential approximation, we simulated the explosion dynamics of these carbon dioxide clusters. In comparison with the momentum vectors of explosion fragments, we identified the lowest energy isomer of carbon dioxide cluster and determined their structures, which are shown in figure 1. Carbon dioxide dimer has a planar slipped parallel structure. Carbon dioxide trimer has the planar cyclic structure with C3h symmetry. Carbon dioxide tetramer exhibits a triangular pyramid structure.

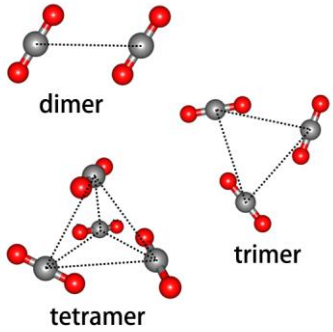

Fig. 1: Lowest energy structures of CO_2 dimers, trimers and tetrames.

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P-51

Spatiotemporal imaging of spin wave generated by light pulses

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Spin wave is propagating disturbance in magnetically ordered materials without Joule heating because net electron charges do not flow. It is expected that spin wave can be applied to information processing devices with low energy consumption.

Using polarized light pulses, local spin precession can be excited via the inverse Faraday effect, the inverse Cotton-Mouton effect, or photoinduced magnetic anisotropy [1]. This spin precession can be propagated as spin wave. The method of spin wave generation by polarized light pulses does not need attaching electrodes for the excitation of the spin wave. Two techniques have been proposed to achieve direction control of the spin wave propagation; spatially-shaped light spot [2] and phased array [1].

We excited and measured the spin wave by pump-probe method. To obtain spatial map of the propagated spin wave, we scanned the light pulses and measured magnetization at each spot via the Faraday rotation of the probe pulses. This method took too much time to measure the 3D-spatio-temporal (2D-spatial and 1D-temporal) waveform of the spin wave.

In this study, we report the 3D-spatio-temporal waveform measurements of spin wave generated by light pulses with a pump-probe geometry using CCD camera.

Circularly polarized pump pulses with 1300 nm wavelength and 150 fs time duration were focused on a $Gd_{3/4}Yb_{2/3}BiFe_5O_{12}$ single crystal to a spot diameter of 70 μm. In-plane external magnetic field H = 1 kOe was applied to make the sample monodomain. Large area of the sample (about 5 mm in radius) was illuminated with linearly polarized probe pulses with 800 nm wavelength and 150 fs time duration. The probe pulses transmitted the sample and an analyzer were detected by CCD camera. The Faraday rotation of the probe pulse was calculated from multiple (about 20) images taken with changing the azimuth angle of the analyzer in the range of 2 deg.

Measured map of the Faraday rotation of probe pulses at 1 ns after the generation of the spin wave is shown in Fig. 1(a). Good agreement between the experimental result and the calculated waveform of the spin wave assuming backward volume magnetostatic wave is shown (Fig. 1(b)).

By use of imaging, we measured a spatial map of the spin wave 50 times faster than scanning. Then, we measured 3D-spatio-temporal waveform of the spin wave (will be shown in the talk).

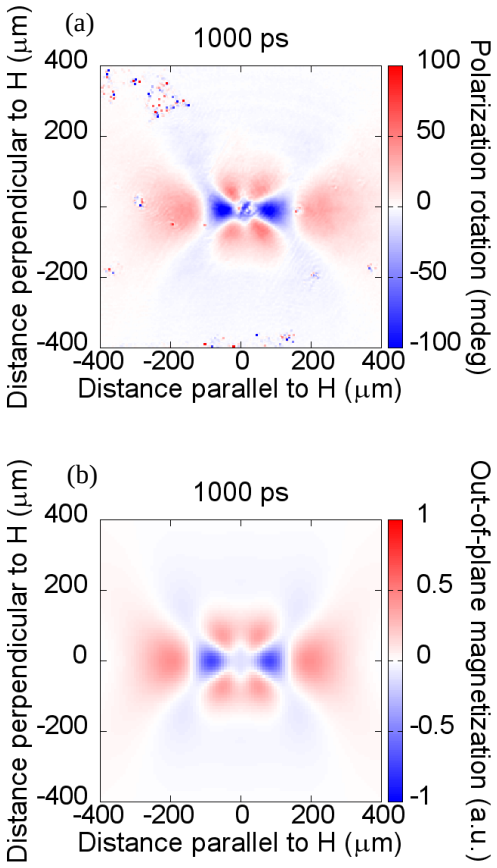

Fig. 1: (a) Measured map of the Faraday rotation of probe pulses.
(b) Calculated waveform of the spin wave.

References:

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[2] I. Yoshimine, T. Satoh, R. Iida, A. Stupakiewicz, A. Maziewski, T. Shimura, *J. of Appl. Phys.* (in print).

P-52

3D Luneburg Lens at Optical Frequencies

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The Luneburg lens[1] is an aberration-free gradient index (GRIN) spherical lens whose focal point lies on its surface. Reported experimental realizations of Luneburg lens are mainly based on two dimensional (2D) micro- and nanostructure GRIN optics with deep subwavelength lattice period[3,4,5]. In order to achieve the real ideal imaging and take advantage of the wide field-of-view of Luneburg lens, it is necessary to fabricate 3D Luneburg lens at the optical frequencies. Here, the 3D Luneburg lens is designed with ten layers of GRIN 3D simple cubic photonic crystals (PCs) structure in metamaterial regime, based on the effective medium theory[2]. A complete 3D spherical Luneburg lens is fabricated with multilayered dielectric plates by multiphoton laser direct writing method in the commercial photoresist IP-L. Simulation and experimental results demonstrate excellent performance of the 3D Luneburg lens for different polarizations over a broad frequency band. These progresses provide theoretical and experimental basis for further study the wide field-of-view and perfect imaging of 3D Luneburg lens with potential applications in further integrated photonic devices.

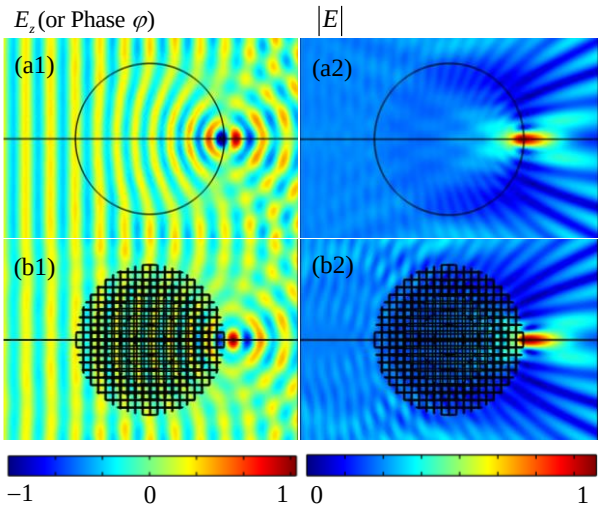

Fig. 1: FEM simulation results of electric field distribution for (a) the original ideal lens and (b) the GRIN PCs based on Luneburg lens, The incident wavelength is 6 μm. (a1) and (b1) show the z-component of electric field. (a2) and (b2) are the electric field intensity.

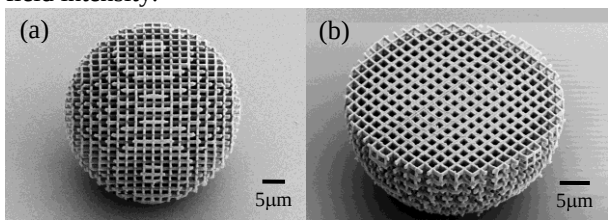

Fig. 2: SEM image of the fabricated Luneburg lens. The radius of 3D Luneburg lens is 20 μm. The distance from the top of the lens to substrate is 40 μm. (a) Overall drawing, (b) Internal sectional drawing.

References:

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P-53

Vertical split-ring resonator based nanoplasmonic sensor

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1. Introduction

The optical properties of the plasmonic metamaterials are often times intrinsically connected to the localized surface plasmon (SP) resonances (LSPR) arising from the collective oscillations of free electrons which induce strong electromagnetic fields adjacent to the artificial sub-wavelength metallic elements in the metamaterials. The resonance wavelengths are determined by feature geometries of metamaterial elements and their surrounding environment, and thus can be tuned by either changing the element dimensions or the surrounding dielectric. Such a property can be explored for a variety of applications, one of which is sensing based on the following general design principle. The motivation of exploring metamaterials for the sensing application is the potential for achieving high sensitivity. To this end, metamaterials require to possess strong plasmon resonance features that are sensitive to environment change. The split-ring resonator (SRR) is such a metal structure that is typically used as a building block for metamaterials because of its strong magnetic resonance accompanied with strong field enhancement within the SRR gap [1]. One important measure of a metamaterial sensor is its sensitivity characterized as the ratio of LSPR shift to the change in refractive index of its nearby sensing medium ($\delta\lambda/\delta n$). Unfortunately, a majority of the metamaterials reported so far have planar SRRs that lay flat on substrates, resulting in a rather appreciable fraction of the plasmon energy distributed in the dielectric substrate below which limits the effective sensing volume as well as the sensing performance [2]. In this work, we report the fabrication of vertical SRRs (VSRRs) capable of lifting essentially all of the localized fields above the supporting substrate they stand on as illustrated in Fig. 1(a). Using Fourier transform infrared spectroscopy measurement and numerical simulation software, we demonstrate that plasmonic refractive index sensors constructed of VSRRs deliver significantly improved sensitivity over their planar counterparts reported in the literature.

2. Results and Discussion

Figure 1(a) shows the schematic concept of our designed VSRR structure standing up vertically on a fused silica substrate under normal illumination. This upright configuration strongly confines an electromagnetic field within the gap as the magnetic plasmon is excited, suspending the enhanced field entirely in the free space away from the dielectric substrate and thus increasing the sensing volume. To demonstrate and examine the sensing performance of the VSRR structure, we have performed the sensitivity analysis by experiment and simulation. According to the linear fitting, the simulation has predicted a sensitivity of about $\delta\lambda/\delta n$ = 797 nm/RIU, while our measurement has produced a less value of 603 nm/RIU, as shown in Fig. 1(b). It is interesting to point out that our transmittance measurement has yielded spectral resonance shift between the two different liquids greater than what was predicted by the simulation.

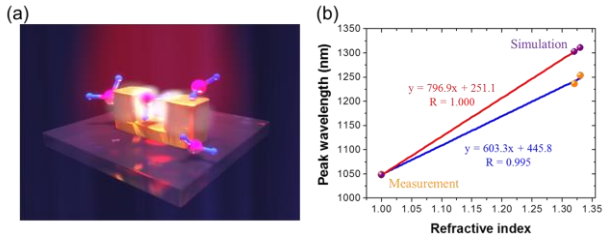

Figure 1. (a) Illustration of the field distribution in the VSRR gap and its advantage for increasing sensing volume. The resonance wavelength associated with magnetic resonance of experimental (orange dots) and simulation (purple dots) results as a function of the surrounding refractive index.

3. Conclusions

Our recently developed alignment technique has allowed us to fabricate VSRR structures capable of lifting localized plasmon fields off of the substrates. Such a feature is desirable for developing refractive index sensors based on plasmonic structures that respond to environment change with LSPR shift. By reducing the fraction of the plasmon field diffused into substrates, we effectively increase the sensing volume and therefore the sensitivity. We have experimentally demonstrated the sensitivity of 603.3 nm/RIU while our simulation predicts about 800 nm/RIU from this simple VSRR based sensor.

References

[1] P. C. Wu, et al., Nanophotonics **1** (2012), 131-138.
[2] A. Dmitriev et al., Nano Letters **8** (2008), 3893-3898.

NOTE

NOTE

Picture: Otaru, Hokkaido

Participants' CVs

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My research:

"Birefringence effects on Imaging"

Research interests: Photo mechanics, Non-Destructive Testing, Optical Design, Injection Molded Optics, Optical Sensors

Educational Background:

2012 Ph. D (Doctor in Philosophy) Mechanical and Aerospace Engineering (MAE), Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798
2008 B.E. (Bachelors in Mechanical Engineering) Institute of Engineering (IOE), Pulchowk Campus, Tribhuvan university(TU) Patandhoka Rd, Patan 44700, Nepal

About me:

I like to explore the things, travel the world from sand deserts to ice covered regions. I play guitar as well as lawn tennis for refreshment. My dream is to be proficient in optical design and sensors materials. I know English, Nepali, and little bit Chinese language as well.For the upcoming days or future, I wish I could do new findings on optical design, imaging and sensors that will enrich my career towards better achievement.

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My research:

"Materials science and thin films for solar energy conversion"

Research interests: (Materials for energy and environment , Thin film chalcogenide photovoltaic materials, Synthesis of metallic and semi-conducting nanoparticles).

Educational Background:

Since 2012 Ph.D. student in materials science and thin films for solar energy conversion (Photovoltaic), MAScIR, morrocan foundation for advanced science, innovation and research and University Mohammed V , Rabat, Morocco.

2011 Engineering diploma (engineer) and Master, Material science and engineering, Polytechnic, Lorraine, Nancy, France.

2008 Bachelor of Science, chemistry and physics: condensed matter, University Cadi Ayyad, Marrakech, Morocco.

About me:

I would like to continue my career on photonic center like researcher in the future. To achieve my dream i work to improve my skills on photovoltaic and materials science.

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My research:

"Surface enhanced Raman spectroscopy and imaging for bio application"

Research interests: SERS,Plasmonics, Photonics, Microscopy.

Educational Background:

2013 M.S. Applied Physics, Osaka University
2011 B.S. Applied Physics, Osaka University

About me:

I was born in Osaka and I've been Osaka until now. I wonder I will go out and work in abroad in the future.
Hobby: Climbing mountain, Cycling, Playing baseball.
Language: Japanese and English.

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My research:

"Mid-IR Temperature Sensitivity of Chalcogenide-Based Photonic Band Gap Holey Fiber"

Research interests: (ex. Microstructured optical fiber, Fiber nonlinearity, Photonic band gap fiber, Silicon photonics)

Educational Background:

(ex.)2010 - 2014 Joined Ph.D. at IIT Delhi in 2010 and till continuing. (Visited City U, London for two months (Jun-Aug, 2011) for research work)

2010 M.Sc. Physics, Indian Institute of Technology Delhi, India
2008 B.Sc. Physics (with honors), Calcutta University, Kolkata, India

About me: I am in the finishing stage of my Ph.D. Wish to get Postdoc in optics.

Chin Hao Jimmy Chang

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My research:

In vivo Three-dimensional Time-lapsed Studies of Drosophila Embryogenesis by Single Plane Illumination Microscopy (SPIM).

Educational Background:

2014	M.S.	Institute of Biophotonics, National Yang Ming University, Taipei, Taiwan
2012	B.S.	Department of Medica Imaging and Radiological Science, Chung Shin Medical University, Taichung, Taiwan

About me:

I'm interested in 3D imaging and microscopy technique.

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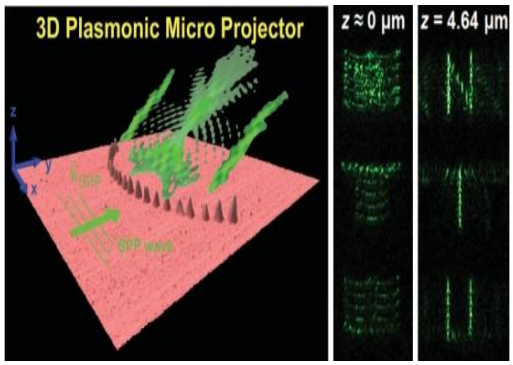

My research:

"Three dimensional light manipulation for full-color nano-projector"

Research interests: Plasmonics, Laser fabrication

Educational Background:

(ex.)2013 M.S. Department of Physics, National Taiwan Normal University
2010 B.S. Department of Electronic Engineering, Chang Gung University

About me:

In my M.S. life, my research is graphene synthesize and its application. And now in my PhD life, I am learning optical field and laser fabrication. Welcome to guide and discuss with me. Thank you very much.

Name: Mei-Yu Chen

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My research:

"Presentation title"

Research interests: Nonlinear optics, Biophysics, Quantum Information Science

Educational Background:

- **07/2010-09/2014** Department of Physics, National Taiwan University, Taipei, Taiwan
  Currently pursuing PhD degree (4th year of PhD program)
- **07/2009-06/2010** Institute of Biophotonics Engineering, National Yang Ming University, Taipei, Taiwan **/**Research Assistant
- **07/2006 -06/2008** Institute of Physics, National Cheng Kung University, Tainan, Taiwan
  Master of Physics
- **07/2001-06/2006** Department of Physics, Soochow University, Taipei, Taiwan
  Bachelor degree of Physics

About me:

In my career planning, I enthusiastically look forward to putting my knowledge and experience into practice in the developing of new products and solve the technology challenges.

Hsin-Wei, Chien

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My research:

Optical Stretch-Induced Ca^{2+} Influx v.s. Dynamic Deformability of Human Red Blood Cells

Educational Background:

2012~2014 M.S. Institute of Biophotonics, National Yang Ming University, Taipei, Taiwan

2012 B.S. Department of Mechanical Engineering, Yuan Ze University, Chung-Li, Taiwan

About me:

I'm glad to attend the IONS-Asia and happy to make friends in JAPAN.

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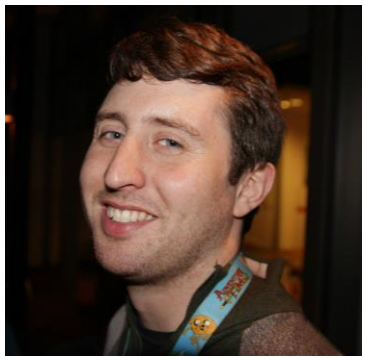

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My research:

"Local field enhancements for particle trapping"

Research interests: Near-field interactions, particle trapping and manipulation, plasmonics

Educational Background:

2012 – Now	Ph.D. candidate at the Okinawan Institute of Science and Technology
2010 – 2012	M.Sc. Student at the University College of Cork
2005 – 2009	B.Sc. Physics, University College of Cork

About me:

I enjoy studying physics, but my other interests include music, gaming (of all types!), and films. In OIST I enjoy participating in many different extracurricular clubs. I enjoy socialising with people and if you happen to find yourself in Okinawa, please don't hesitate to contact me.

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My research:

"Assessment of Natural Enamel Lesions with Optical Coherence Tomography in Comparison to X-ray Tomography"

Research interests: Optical Coherence Tomography

Educational Background:

2005 Dentistry in Odontología Faculty at Granada's University (Spain)

About me:

I love travelling, learning new languages, new challenges and very interested in photonics.

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My research:

"Monte Carlo Light Propagation Modeling In Optically Thin Media"

Research interests: Biomedical Imaging, Fiber Optics.

Educational Background:

2012 October-December Visiting internship in A*STAR, Singapore
2012 July-August Visiting internship in Academia Sinica, Taiwan
2010 B.E. Mechanical Engineering, University Tunku Abdul Rahman

About me:

Interest: Travel and explore foreign country's lifestyle and culture.
Professional skill: Engineering drawing, programming, piping and ducting design, air flow system design.
Languages: Chinese, Malay, English

Name: Bikas Ranjan

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My research:

"Nanoplasmonics and Raman spectroscopy"

Research interests: Plasmonics, Photonics, Microscopy.

Educational Background:

2012-Till now PhD Applied Physics, Osaka University
2010 M.S. Cochin University of Science and Technology

About me:

Personal motto: For me, things will be just fine.
Research motto: follow the rules and break the bounderies.

Hobby: Extramural activities
Language: Hindi, English and Japanese (sukoshi)

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My research:

"Continuous observation of osteoblastic mineralization by Raman imaging"

Research interests: Raman spectroscopy, Stem cell, osteoblast, mineralization, bone formation

Educational Background:

2014 M.S. Applied Physics, Osaka University
2012 B.S. Material Science, University of Hyogo

About me:

Hobby: Painting, Playing with my house dog, Live-kun

Favorite animal: Dog (pug in particular), Raptores (owl, falcon, eagle, etc.), whale shark, ray

Favorite artist painter: Vermeer (I like "The Love Letter" and "Girl with a Pearl Earring" in particular.)

I would like to talk with everyone, but I'm not good at English. (;△;)
So please help me out!!

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My research:

"A Hybrid Multiplexed Single Photon Source for Linear Optical Quantum Computing."

Research interests: Single photon sources, ring resonators, spontaneous parametric down conversion.

Educational Background:

2012 M.Sci, Physics, University of Bristol
2010-2011 Student Placement at Rutherford Appleton Laboratory.

About me:

I like cycling, cats, good food and being outdoors. I am learning Japanese in my free time.

Name: Jumpei Hirohara

Master course (Grade 2)
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My research:

Research interests: Plasmonics, Metamaterial

Educational Background:

2013-2015 M.S. Applied Physics, Osaka University
2009-2013 B.S. Applied Physics, Osaka University

About me:

Hi, friend!! Today is a nice day!!
My hobby is watching baseball game and playing baseball.
I like eating and drinking. So, Hokkaido is very great place for me. If you have seen the man eating a lot, it is maybe me.
I want to talk to you!! So please contact me!!

Name: Wen Ting Hsieh

Master course (2nd)
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My research:

"Plasmonic Photocatalyst for Photodegradation with Spinning Optical Disk Reactor"

Research interests: Plasmonics, Photocatalyst

Educational Background:

2013 M.S. student Physics, National Taiwan University
2013 B.S. Chemical Engineering, National Taiwan University

About me:

I would like to find a job after attaining master degree. After studying in chemical engineering during university, I turn to study physic because it is very interesting. My hobby is listening to music, post rock and Britpop are both my favorite.
I am so happy to attend this conference, I do hope we would be having a pretty good time and joyful cooperation!

Yu Shan Cherry Huang

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My research:

In vivo Three-dimensional Time-lapsed Studies of Zebrafish and Drosophila Embryogenesis by Single Plane Illumination Microscopy (SPIM).

Educational Background:

2006~ MS and PhD program,
Institute of Biophotonics, National Yang Ming University, Taipei, Taiwan

2006 B.S. Department of Physics, National Cheng Kung University, Tainan, Taiwan

About me:

I have great enthusiasm about my research and would like to be a good scientist to better the world.

Name: Yi-Teng Huang

Master student of Din Ping Tsai's lab,
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(If you have, ex. skype, facebook, twitter, and etc…)

My research:

"Fabrication of plasmonic cavity and indefinite metamaterial by laser-induced forward transfer"
Research interests: Plasmonic photocatalyst

Educational Background:

2014 M.S. student Physics, National Taiwan University

2013 B.S. Physics, National Tsing Hua University

About me:

I am very interested in applications about energy and environment. I hope that one day I could make some contribution through the power of physics to the earth we live!

Name: Arsen Igityan

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Russian-Armenian University,
Senior Lab
Assistant, Material Science Laboratory
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My research:

"Effect of free carriers on optical functions of erbium doped ZnO films"

Research interests: Material Science, Semiconductors, Thin film heterostructures

Educational Background:

2011- (currently) Ph.D. Student, Semiconductor Physics, Russian-Armenia University
2011 M.Tech. Quantum and Optical Electronics, Russian-Armenia University
2009 B.Tech. Electronics and Microelectronics, Russian-Armenian University

About me:

I am currently studying for Ph.D. Degree and working in science research center. I research electrical and optical characteristics of thin films, their application in microelectronics and trying to find a way to use them in new types of non-volatile memory modules.

Kanami Ikeda

Master course (Second year)
Infomation Photonics Laboratory,
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My research:

"Design of Signal Pattern for Optical Correlator Using Coaxial Holography"

Research interests: information photonics and pattern recognition

Educational Background:

2013 B.S. Science, Japan Women's University

About me:

I was received the B. E degrees in science from Japan Women's University, Tokyo Japan, in 2013. I am now a master course student of University of Electro-Communications, Tokyo Japan. My research interest includes information photonics and pattern recognition. Besides my research, I very much also enjoy taking pictures, playing basketball, watching sports, good food and wine.

Name: Hiroaki Ishigame

Master course (2)
Plasma applied engineering lab. , Division of Quantum Science and Engineering , Hokkaido Univ.
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My research:

"Presentation title" 「LIF imaging of OH radicals and its collisional quenching effect in gas-liquid interface helium dc glow plasma」

Research interests: LIF , OH radical

Educational Background:

(ex.)2013 M.S. Division of Quantum Science and Engineering, Hokkaido University
2009 B.S. Engineering, Hokkaido University

About me:

I like soccer. I love sports.
I research movement of radicals in gas-liquid interface helium dc glow plasma by LIF so I would like to study optics more particularly.

Name: Chun Yen Liao

Ph. D. student of Din Ping Tsai's lab,
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My research:

"Vertical split-ring resonator based nanoplasmonic sensor"
Research interests: Plasmonics metamaterials

Educational Background:

2014 Ph. D. student Appied Physics, National Taiwan University

2013 M.S. Physics, National Taiwan University

2010 B.S. Physics, National University of Kaohsiung

About me:

My hobby is playing basketball. It let me relax my tight life. **#Basketball never stop**

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My research: Photonics

"Intensity Modulated POF multidimensional vibration sensor"

Research interests: Nano-Photonics, Bio-Photonics, Surface Plasmon's, Beam Optics

Educational Background:

2009 Ph.D.(Pursuing) Physics (Photonics), National Institute of Technology Warangal India

2008 M.S. Physics (Electronics), Sri Venkateswara University, Tirupati, India
2006 B.Sc M. P. Computer Science, Sri Venkateswara University, Tirupati, India

About me:

I am bounded by family relations. So I always think about family then others.
My hobbies are playing cricket, reading books, Observation and work with hardware and software.
My dream is establishment of the educational, handloom businesses and also to help poor people by putting the finance to establish their own business.

Name: Olena Kulyk

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School of Physics and Astronomy, the University of St Andrews, Scotland, UK
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My research:

"Wearable Organic Optoelectronic Sensors for Prosthetic Actuation and Tissue Oxygenation"

Research interests: Light –tissue interactions, optical design for biomedical applications.

Educational Background:

2011 MSc Physical and Biomedical Electronics, National Technical University of Ukraine, Kiev
2010 BEST Summer Exchange Student, Wrocław University of Technology, Poland
2011 Engineer, Kiev Design Bureau LUCH, Ukraine
2010 IAESTE Intern, ECIT, Queen's University of Belfast, UK
2009 BSc, Electronics, National Technical University of Ukraine, Kiev

About me:

I am enthusiastic about technology and innovation. During my work and study I have developed strong communication and managerial skills and looking for a stimulating progressive environment to develop my career in product development in engineering sector.

Name: Jiu Li

Ph. D candidate
Institute of Modern Optics, Department of Physics, Peking University
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My research:

- MoS_2 FET manipulated by Surface plasmon resonance
- SHG imaging of 2D materials like MoS_2

Research interests: optoelectronic device, nonlinear optical imaging, near-field optics

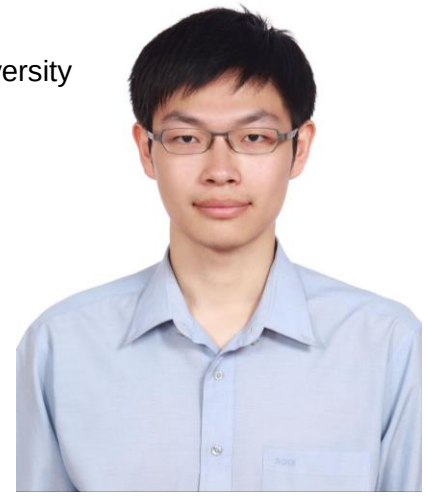
Educational Background:

- 2011-now Ph.D. Candidate, Optics, Department of Physics, Peking University
- 2013-now B.S. Candidate, Economics, national school of development, Peking University
- 2007-2011 B.S. Information display and Optoelectronic, University of electronic science and technology of China

About me:

Deeply touched by entrepreneurship and innovation, I'm inclined to convert basic physics into use in a way akin to the relationship of bricks and skyscraper.

Name: Kuan-Yu Li



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My research:

Research interests: Nonlinear Optics, Plasmonics

Educational Background:

- 2014 B.S. Physics, National Taiwan University

About me:

Recently, I like to watch movies, especially those in IMDB top 100. I also play Rubik's cubes during my spare time. If you want to share your ideas about Rubik's cube, I would be glad to join with you. One of my dreams is to make friends with people working in different fields of science, so that I can find someone to explain any amazing breakthrough to me. It is very interesting and important for me to have friends to gratify my curiosity. Likewise, I still try to become one who can introduce something fascinating about my research to others.

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My research:

"**Enhanced luminescence efficiency by Ag nanoparticles dispersed on indium tin oxide for polymer light-emitting diode**"
Research interests: PLED、AFM .

Educational Background:

2013.12 National Chiayi University Department of Electrophysics

About me:

I would like to found my own company on manufacture in the future.

Name: Lin, Hao-Tsun

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My research:

"Isotropic perfect absorber in optical frequencies using vertical split-ring resonator"

Plasmonics, Metamaterials

Educational Background:

2013 B.S. Physics, National Taiwan University

About me:

I am interested in plasmonic effects and the application of metamaterials.

Name: Wei-Kuan Lin

Master (1)
Biomedical optics laboratory, Department of physics , National Taiwan
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My research:

"Presentation title"

Research interests: Bio-optics

Educational Background:

2014 M.S. Physics, National Taiwan University

About me:

Hello, I am Wei-kuan Lin, coming from Taiwan. I am an outgoing person. In my free time, I like to go swimming, go surfing, go scuba diving and do other outdoor activities. For me, I think go venturing and do something special can help me relax.
I am now a master student and I plan to have further studying in the future. Perhaps, I will study for a doctoral degree in physics or for another master in management or engineer.
My long term goal is to have a company on photonics so that I try to learn as much knowledge in photonics as possible. But some challenge I encountered now is that I do not know how to establish a company, and I am lacking of ideas. If anyone has ideas or even has same plan, please let me know. I think we can have some interesting encounter.

Name: Tomohiro Maeda

Master course (2nd grade)
Laboratory of Optical Processing and Networking, Graduate School of Information Science and Technology, Hokkaido University
Address: Graduate School of Information Scinece and Technology 5-22, Kita 14 Nishi 9, Kita-ku, Sapporo, 060-0814, Japan,
Phone number: +81-11-706-6522
E-mail: maeda@optnet.ist.hokudai.ac.jp
beloved0827@gmail.com (private)
accounts of social networking service: facebook

My research:

"Reconfigurable Spatial Mode Conversion using a Spatial Light Modulator"

Research interests: mode-division multiplexing, optical communication, spatial mode, spatial light modulator, mode conversion

Educational Background:

2013 B.Information Science Hokkadio University

About me:

I love to travel in foreign countries with results of my reserch.
I love baseball!

Name: Aili Maimaiti

Ph. D student
Light matter interaction Unit, OIST Graduate university
Address: Light-matter interaction unit, OIST graduate university, 19-19-1,Tancha, Onna Son, Okinawa, Japan, 940-495
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alijanuyghur@gmail.com (private)

My research:

"Particle propulsion using higher order microfiber mode"
Research interests: particle manipulation

Educational Background:

2012- present special research student, OIST Graduate University
2011 – present PHD student University College Cork, Ireland
2008-2010 M.S Physics, Camerino University, Italy

About me:

I am a Working on Particle manipulation using evanescent field of micro-nanofiber and higher order fiber modes. I would like to discuss more and more about research and any other topics. I am very friendly, social. I like sports, singing, dancing.

Name: Toshihiro Mino

Ph. D. course (3rd grade)
Verma lab, Applied Physics, Osaka University
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E-mail: mino@ap.eng.osaka-u.ac.jp
toshihiro.mino@gmail.com (private)
accounts of social networking service:
Facebook: Toshihiro Mino

My research:

"Polarization Analysis of near-field probe for tip-enhanced Raman imaging"

Research interests:
Raman spectroscopy and microscopy, Polarization, Near-field Optics, Plasmonics, and so on.

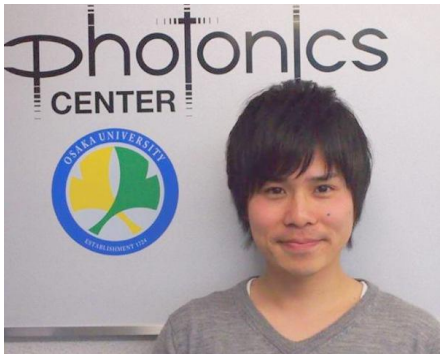
Educational Background:

2012 M.S. Applied Physics, Osaka University
2010 B.S. Applied Physics, Osaka University

About me:

I like to chat, to play sport, to travel abroad, to watch movies and to learn about optics. I'm looking forward to seeing many friends in this IONS. Hokkaido is famous for fresh sea foods. Lets' go out to eat together!

Name: Masashi Miyata



Ph. D student (2nd Grade)
Takahara Lab., Dept. of Applied Physics, Osaka University
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Phone number: +81-6-6879-8504
E-mail: miyata@ap.eng.osaka-u.ac.jp;
facebook: (Masashi Miyata)

My research:

"Multi-spectral plasmon induced transparency via dipole and dual-quadrupole coupling"

Research interests: Plasmonics, Metamaterial, Silicon Photonics, Quantum Dots

Educational Background:

2013–Present: Ph.D student, Dept. of Applied Physics, Osaka Univ., Japan
2013–2014: Visiting Student Researcher, Dept. of Materials Sci. and Eng., Stanford Univ., USA
2012–2013: Master student, Dept. of Applied Physics, Osaka Univ., Japan
2011–2012: Master student, Div. of Advanced Electronics & Optical Science, Osaka Univ., Japan
2009–2011: Bachelor student, Dept. of Electronics & Materials Physics, Osaka Univ., Japan

About me:

I am interested in working for the development of forefront science and technology which is related to the improvement of human life. I have studied plasmonics until now and I strongly believe that plasmonics has the potential to play a unique and important role in the further advances in many areas of modern and future science and technology. So, it is very fortunate for me to be able to research plasmonics and it will be exciting to see what plasmonics will bring for the next decade

Name: Yusuke Nagasaki

Master course
Takahara Lab.
Dept. of Applied Physics, Osaka-Univirsity

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Osaka 565-0871, Japan
Phone number: 81-6-6879-8504
E-mail: nagasaki@ap.eng.osaka-u.ac.jp

My research:

Research interests: Plasmonics, Metamaterial

Educational Background:

2014 B.S. Applied Physics, Osaka University

About me:

I take a coase in intaractive materials science cadet program. The program is a collaborative program designed to drive innovation in materials science research and business by preparing outstanding PhD students to assume leadership roles in industry, government, and academia. If you are interested, please contact me.

Name: K.NITHYANANDAN

Ph. D.
Department of Physics,
Pondicherry University, Department, University
Puducherry – 605 014,
India.
Mob. No. : +91 9994041255
E-mail nithi.physics@gmail.com
Facebook: nithisachin

My research:

"A theoretical Investigation of Supercontinuum Generation in Exponential Saturable Nonlinear Response"

Research interests: Nonlinear Optics and Photonics.

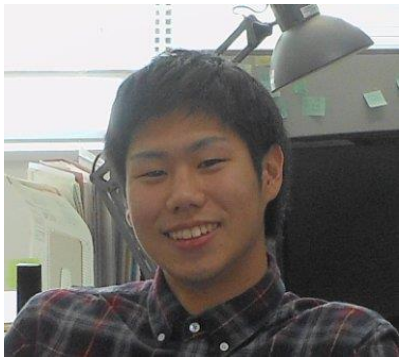
Educational Background:

2013 Senior Research Fellow. Physics, Pondicherry University, Puducherry, India
2008 M.Sc. Physics, Pondicherry University, Puducherry, India
2006 B.Sc. Tagore Arts College, Puducherry, India.

About me:

After completing my Ph.D, I have wish to do Post doc for couple of years in abroad. Then I wish to come back to my country and want to serve the society, in all the possible means. I wish to become a scientist want to invest my time and energy for science. Not interested in money at all, but wants to be rich in knowledge and service,

Name: RYO NIYUKI



Ph. D. course (second grade)
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accounts of social networking service: Ryo Niyuki (Facebook)

My research:

"Random lasing at a defect in a ZnO nanoparticle film"

Research interests: random laser, Zinc Oxide, micro cavity, non-linear optics

Educational Background:

2014- Ph. D course, Electronics for Informatics, Hokkaido University
2012-2014 M.I. Electronics for Informatics, Hokkaido University
2008-2012 B.E. Electronics for Informatics, Hokkaido University

About me:

I am currently studying nonlinear optics and working on diamond random laser. Soccer is my favorite sport. I am related to soccer in various ways. (player, referee, coach)

Name: Jin Nozawa

A doctoral course
Optoelectronics Laboratory,
Guraduate School of Information Science and Technology, Hokkaido University
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HP URL: https://www.facebook.com/j.noppo.san

My research:

"Two-Channel Type Holographic Diversity Interferometry for High Accurate Wavefront Measurement"

Research interests: (Digital Holography, Image reconstruction technique, Holographic Interferometry, phase conjugation technique,)

Educational Background:

2012 Master of Information Science, Hokkaido University
2010 Bachelor of Information Science, Hokkaido University

About me:

I propose the digital holographic system for high speed and high resolution measurement of three-dimensional object. Now, I am trying to apply this system to damage measurement with a cooperation of Japanese company. Moreover, I am planning to construct another operation mode for optical communication system.

Name: Yoshiro Ohashi

Ph. D. course
Verma Laboratory, Department of Applied Physics, Osaka University
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sunny.smilers@gmail.com (private)
HP URL: https://sites.google.com/site/yoshiroohashihp/
Accounts of social networking service:
- facebook: Yoshiro Ohashi (https://www.facebook.com/yoshiro.ohashi?fref=ts)

My research:

"Nanolens made of metallic rods array for magnified subwavelength images"

Research interests: plasmonics, nanophotonics, optical antenna, metamaterial

Educational Background:

B.S. (2011), M.S. (2013), Ph.D. (2013 - Present) Applied Physics, Osaka University

About me:

- Hobby: DIY, Dance (Break, Tap), Swimming, Designing, Illustration, Books (SF, Art & Design, Novel)

- Dream: To make a nanomachine, To become a tap dancer, To manage a bar

- Other interests: Web programming and designing, Business etc.

Name: Ryosuke OKETANI

Ph. D. student
Kawata lab., Depertment of Applied Physics,
Osaka University.

E-mail: oketani@ap.eng.osaka-u.ac.jp
Accounts of social networking service:
Search my name on facebook!

My research:

"Nonlinear Scattering from Gold Nanoparticles
And its Application to High Resolution Imaging"

Research interests: Plasmonics, Photonics, Microscopy.

Educational Background:

2014 M.S. Applied Physics, Osaka University
2013 Oct.-2014 Jan. Exchange student in National Taiwan University
2012 B.S. Applied Physics, Osaka University

About me:

Personal motto: For me, things will be just fine.
Research motto: Keep rules, break theories.

Hobby: Watching F1 race.
Language: Japanese and English.

Name: Siham REFKI

Ph. D. Student
Optics, Photonics, Physics, University Mohamed-V
Rabat, Morocco
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Rabat 10100 Morocco,
Phone number: +212628237085, E-mail: s.refki@mascir.com
accounts of social networking service: facebook: siham refki

My research:

"**Metal-insulator-metal structures"**
Research interests: Plasmonics structures for biosensing and photovoltaic

Educational Background:

Since 2013 Ph.D. student : Photonics, Plasmonics and Materials Sciences, study of plasmonics structures for solar energy conversion (Photovoltaic) and biosensor by thins films technology. MAScIR, morrocan foundation for advanced science innovation and research and University Mohammed V , Rabat, Morocco.

2012-2010 Master, Computer physics and Materials Sciences. University Mohammed V , Rabat, Morocco.

2010-2006 Bachelor of Science, physics: Materials sciences. University Chouaib Doukkali, EL Jadida, Morocco

About me:

I would like to continue my career on photonic center like researcher in the future. To achieve my dream i work to improve my skills on photonics and materials sciences.

Name: MORITSUGU SAKAMOTO

Ph. D. course student
Laboratory of Photonics Engineering,
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Phone number: +81-11-706-6720
E-mail: m.sakamoto@eng.hokudai.ac.jp
accounts of social networking service: Moritsugu Sakamoto (Facebook)

My research:

"Optical ring-lattice generator using axially-symmetric polarization elements"

Research interests: (Optical vortex, Singular optics, Polarization, Diffraction, Astronomy)

Educational Background:

2012.4- Ph. D course in Applied Physics, Hokkaido University
2010.4-2012.3 Master of Eng., Applied Physics, Hokkaido University
2008.4-2010.3 Bachelor of Eng., Applied Physics, Hokkaido University

About me:

I am a PH. D. course student of Hokkaido University. My research topic is optical instrumentation for generating the optical vortex and the optical ring-lattice.

Name: T Selvalakshmi

Research Scholar
Address: Department of Physics
National Institute of Technology, Trichy
Tamil Nadu, India.
Phone number: +91 9965421511
E-mail: tselvalakshmi@gmail.com
HP URL:

My research:

"Photoluminescence study on Rare Earth ions"

Research interests: Luminescence, Material Science, Nanoscience

Educational Background:

2010 M.Sc Applied Physics, National Institute of Technology
2009 STIP 2009 (May-June), Indira Gandhi Centre for Atomic Research
2008 B.Sc Physics, Lady Doak College

About me:

My wish is to become teacher.
I am happy to do Knitting, Embroidery, Origami, Sewing.
I love to play with my dog.

Name: David Serrano
ダビッド　セラノ

Postdoc
Center for Optical Research and Education
Utsunomiya University
7-1-2, Yoto, Utsunomiya-city, Tochigi, 321-8585, Japan
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E-mail: serrano_d@opt.utsunomiya-u.ac.jp

My research:

"Dynamic Temperature Field Measurements Using a Polarization Phase Shifting Technique"
Research interests: Interferometry, Polarization Phase Shifting Technique, Optical Metrology, Polarimetry

Educational Background:

2011-2014 Phd. Degree in Optical Sciences. Centro de Investigaciones en Óptica A.C. Mexico
2013 Graduate research internship. CORE, Utsunomiya University, Japan
2009-2010. Master of Science in Optics at Centro de Investigaciones en Óptica A.C. Mexico
2002-2008. Physical Engineering at Tec de Monterrey, Campus Monterrey. México.

About me:

I am currently studying relations between interferometry and polarization in order to extend the usage of common interferometry techniques for biomedical applications.

Cody Sewell

Junichiro Kono Laboratory, Department of Electrical and Computer Engineering, Rice University
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Phone number: +1 9188086518
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My research:

"Development of Graphene-Based Infrared and Terahertz Devices"

Research interests: (Graphene, 2D Materials, Pump-Probe Spectroscopy, Devices)

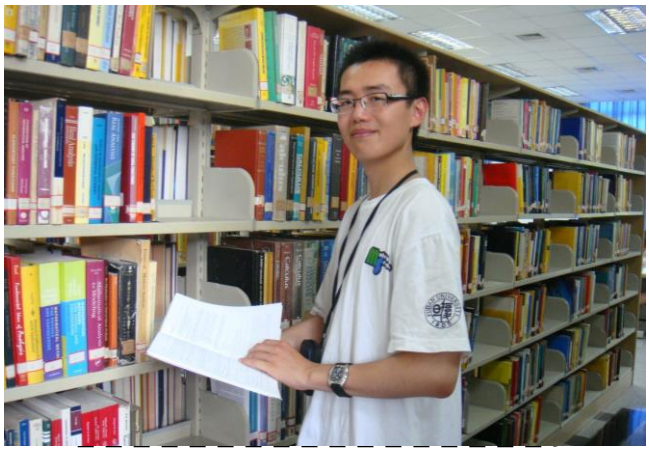
Educational Background:

2012 August-January Visiting student in Hong Kong Polytechnic University
2013 B.S. Engineering Physics, Tulsa University

About me:

Some of my hobbies include biking, electric bass, and programing microcontrollers for home automation.
I want to work an industrial lab to or in a hardware startup company. I want to contribute to the state of the art of technology by developing next generation or novel devices.

Name: Shen Chao



Ph. D. Candidate
KAUST Photonics Laboratory
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Thuwal, Kingdom of Saudi Arabia
Phone number: +966-544701679
E-mail: chao.shen@ieee.org
Wechat/QQ: 444039185

My research:

"Bandgap engineering in III-nitrides"

Research interests: GaN based LEDs and laser diodes, laser display, III-nitride photonics integration circuits.

Educational Background:

2016 Ph.D. Electrical Engineering, King Abdullah University of Science and Technology, KSA
2013 M.S. Materials Science, King Abdullah University of Science and Technology, KSA
2011 B.S. Materials Physics, Fudan University, PRC

About me:

As the co-founder of the first OSA student chapter in GCC countries, I am eager to share ideas with friends and learn from others' experiences to promote the vision of OSA.
I am excited to explore new fields and challenge problems. The topic I am working on aims at achieving on-chip integration of light sources, modulators and sensors for smart display and visible light communication systems.
Fan of badminton, table tennis, bowling and orienteering.

Name: Shuhei Shibata

Ph. D.
Otani Laboratory, Center for Otical Research and Education, Utusnomiya University
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HP URL: http://www.opt.utsunomiya-u.ac.jp/~otani/
accounts of social networking service:
https://www.facebook.com/spie.utsunomiya.univ

My research:

"Dynamic Imaging Stokes Polarimeter using Polarization Pixelated Camera"

Research interests:Polarimeter, Ellipsometry, 3D profilometry)

Educational Background:

2012 M.S. Department of Advanced Interdisciplinary Sciences, Utsunomiya University
2010 B.S. Mechanical engineering , Utsunomiya University

About me:

I am studying polarization.

Name: Fernando Soldevila Torres

Ph. D. Student
GROC·UJI, INIT, Universitat Jaume I
Address: E12071, Castelló, Spain
Phone number: +34 622 21 19 88
E-mail: fsoldevi@uji.es
HP URL: https://www.facebook.com/theharrymanback
@TheHarryManback

My research:

Computational imaging with single-pixel detection: applications in scattering media

Research interests: Multi-dimensional imaging, scattering media, computational imaging, single-pixel imaging, compressive sensing

Educational Background:

2013 MSc Applied Physics - Photonics, Universitat de Valencia, Spain
2012 BsC Physics, Universitat de Valencia

About me:

I believe that optical sciences are a key element in order to improve our standard of living. From optical communications to medical applications, photonics has become an essential tool in the world we live in. I would love to contribute to this development, so I am currently studying computational imaging techniques and its applications in biomedical imaging.

Name: S.Karuppasamy Pandian

B.Tech Nanotechnology,
Department of Physics and Nanotechnology, S.R.M.University.
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HP URL:
1. https://www.facebook.com/funwithjana (Facebook)
2. https://www.linkedin.com/profile/view?id=242929290&trk=nav_responsive_tab_profile (LinkedIn)

My research:

"Polarization-Dependent Infrared Spectroscopy of Macroscopic Films of Aligned Carbon Nanotubes"

Research interests: (Photonics and CNT)

Educational Background:

2011-present Undergraduate student in S.R.M.University, Chennai.

About me:

I am a dry because of the thirst in photonics. I love research which helps in learning new acreages and setting up new milestones.

Name: S.Sanjay Kumar

B.Tech Nanotechnology,
Department of Physics and Nanotechnology, S.R.M.University.

Address:
Kattankulathur,

Chennai,
603203.
Phone number: +917200764282

E-mail:
1. nick_sanjaykumar@yahoo.com (private)

HTTP URL:
1**.** https://www.facebook.com/nick.sanjaykumar?fref=ts

My research:
"Solar powered membrane distillation"
Research interests: (Photonics and CNT)
Educational Background:
2011-present Undergraduate student in S.R.M.University, Chennai.
About me:
I am a cool guy who thinks to apply science in our day to day basic life cycles.

Name: Takemasa Suzuki

Master course 1st year
Laboratoy of Photo-System Physics,
Photonics, Hokkaido University,
Address: Sapporo, Hokkaido 001-0020, Japan.
Phone number: +81(11)-706-9393
E-mail: t_suzuki@es.hokudai.ac.jp

My research:

*"*Optical property of dye doped DNA-surfactant complex film made by immersion method*"*

Research interests: Solid state dye laser, DNA photonics, Organic materials

Educational Background:
2014 B.S. Photonics, Chitose Institute of Science and Technology

About me:

Hi, I'm Takemasa Suzuki. I like listening music, playing the guitar.
My english skill is very cheap lol. But, I would like to enjoy IONS with you.

Now I'm reserching about plasmonics and nanophotonics.
But, recently, my undergraduate reserch was published in Optical Material Express (OSA's new journal). So, I will talk about it in poster session.

Name: Natsuo TAGUCHI, 田口 夏生

Ph. D. course
Kawata Group, Applied Physics, Osaka University
Address: 2-1 Yamadaoka, Suita, Osaka 565-0871, Japan
Phone number: +81-6-6879-7846
E-mail: natsuo@ap.eng.osaka-u.ac.jp, n.taguchi1988@icloud.com (private)
accounts of social networking service: Facebook

My research:

"Molecular orientation in polymer wires with nanosized radii unveiled by polarized micro-Raman spectroscopy"

Research interests: Nanophotonics

Educational Background:

2014 ME, Applied Physics, Osaka University
2012 BE, Electronic Enginnering, Doshisha University

About me:

I would like to deepen my knowledge by talking with various types of people. Please feel free to talk with me to have interesting conversations if you have chances.
Professional skill: Two-photon fabrication, Polarized micro-Raman spectroscopy, SEM, Optical system with Laser, Laser microscopy
Career plan: After graduation from PhD course, I want to get jobs in companies and apply my skill and knowledge to produce novel and useful products.
Favorite music: Jazz, Funk, Blues, Rock, etc.
Hobby: Traveling, Camera, Cycling, Finding new restaurants, Drinking

Name: Ryo Takei

Master course 2nd year
Photo-System Physics Laboratory,
Research Institute for Electronic Science, Hokkaido University
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tkry.323.neige@gmail.com (private)
HP URL: http://optsys.es.hokudai.ac.jp/~optsys/
accounts of social networking service:
facebook "ryo takei"

My research:

"Enhanced optical activity of chiral molecules in 2-D nanogap plasmonic fields"

Research interests: Plasmonics, Localized Surface Plasmon Resonance (LSPR), Chirality,

Educational Background:

2013 B.S. Information and Science Technology, Hokkaido University

About me:

Hi, I'm Ryo Takei. I have a strong interest in the phenomenon of light in the natural world.
And, I love the illumination and the beautiful lighting space.
From next year, I plan to work with manufacturers of the light source.
I have a dream to invent the next generation of lighting source beyond the LED and Organic-LED.

Yun Chi Tsai

Master course (1st Year)
PHOTOMS Lab, Institute of Biophotonics,
National Yang Ming University
Address: No. 155, Sec. 2, Linon St., Beitou Dist.,
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Phone number: +886925389601
E-mail: mirrownight@gmail.com

My research:

Research Assisstant Work: Studies of Neural Curcuits and Molecular Mechanisms Contribute to Learning and Memory in Drosophila.

Master Course Foucus: Drosophila Eye Development by Single Plane Illumination Microscopy (SPIM).

Educational Background:

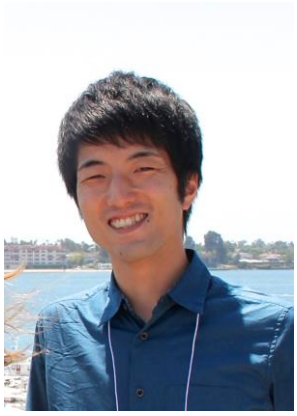
2014~ MS program, Institute of Biophotonics, National Yang Ming University, Taipei, Taiwan

2012 B.S. Department of Biomedical Science, Chang Gung University, Taoyuan, Taiwan

About me:

Wondering what I would be inspired from the aspect of biophotonics. Hope to turn the inspiration into something contributive.

Takayuki Umakoshi



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HP URL: https://sites.google.com/site/takayukiumakoshiwebsites/publication
accounts of social networking service:
Takayuki Umakoshi (Facebook)

My research:

“Optical nano-imaging via plasmon focusing on metallic tip”

Research interests: optical-nanoimaging and nanospectroscopy, plasmonics, Raman spectroscopy

Educational Background:

(ex.)2013 M.S. Applied Physics, Osaka University
2011 B.S. Applied Physics, Osaka University

About me:

I’m so excited to hold this student meeting as the student chair and meet you all student attendees! I believe the network built here, among the great students studying optics and photonics all over the world, gives huge benefits to your career. Enjoy this meeting and networking!

Shota USHIBA 牛場 翔太

Ph. D. (3rd year)
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HP URL: https://sites.google.com/site/shotaushibapersonalhomepage/
accounts of social networking service: Facebook

My research:

"Direct laser writing of 3D microstructurl carbon nanotube/polymer composites"

Research interests: 3D micro/nano fabrication Plasmonics, Raman spectroscopy

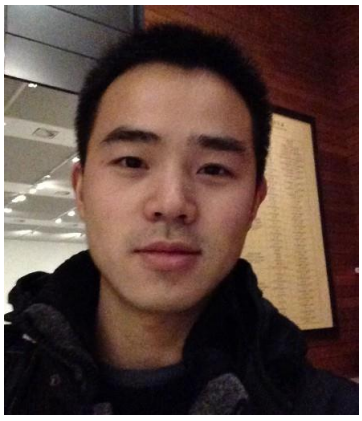
Educational Background:

2012 M.S. Department of Applied Physics, Osaka University
2011 Jun.-Aug. Visiting student in Rice University, USA
2010 B.S. Department of Applied Physics, Osaka University

About me:

I am the ex-president of Osaka University student chapter. It's a very nice opportunity to meet you all up at once for creating worldwide networks. I'm looking forward to meeting you all at Hokkaido. Please feel free to come to chat with me. Let's have very nice food and bear together.

Name: Bo Wang



Ph. D
Department of Physics, Peking University, China
Phone number: +86-15652673757
E-mail: wangbopkuu@gmail.com

My research:

"Spin Hall effect of light: in a view of cross-polarization"

Research interests: (polarization, angular moment of light , chirality)

Educational Background:

2012-Now PhD candidate Optics, Peking University

2012 B.S. Applied Physics, Huazhong University of Science and Technology

About me:

I like sports such as badminton, swimming and hiking. Rcently I learned rock climbing and it's very exciting. There is a fantastic feeling when you managed to top a line.
Now I am studying for my doctor's degree. I hope one day I can become a professor in colleage.

Name: Huimin Wang

Master course (Grade 2)
Laboratory of Plasma Applications, Graduate School of Engineering, Hokkaido University
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wanghuimin198877b@yahoo.co.jp (private)
accounts of social networking service: wanghuimin (skype), Huimin Wang(facebook)

My research:

"Studies on the Application of Plasma Electron Density Measurement by Saturation Spectroscopy" Research interests: Plasmas, Saturation Spectroscopy

Educational Background:

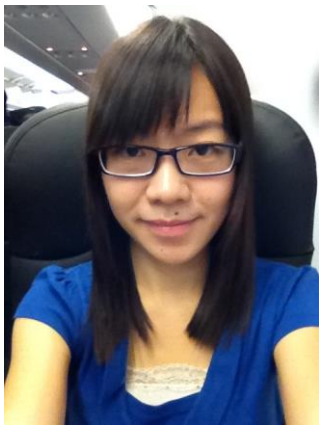
2013-2015 M.S.	Quantum Science and Engineering, Hokkaido University
2012-2013 Research Student	Faculty of Engineering, Hokkaido University
2007-2011 B.S.	Applied Physics, Heilongjiang University

About me:

Language: Chinese, English, Japanese
Hobbies, interests and achievements: (Sports) skiing, swimming, cycling, table tennis (Instrument) playing the piano and guitar

2001.8 Central Conservatory of Music School of Music Piano Grading Test, Level 9 certificate (top level)
2004.4 "Hong Kong-Paris" International Piano Competitions, Second Prize
2006.6 "KAWAI" International Piano Competitions, China Shenyang Division Second Prize
2012.4 Kagurazaka Music Festival (Tokyo), First Prize
Career plan: I would like to work in Japan for several years, and then go back to China to found my own company on semiconductor manufacturing equipment in the future. Toward my dream, I am currently studying quantum electronics and semiconductor engineering.

Name: Wong Ying Qian



Ph. D.
Faculty of Engineering, Multimedia University
Address: 23, Jalan Bukit Pandan Bistari 6,
Taman Bukit Bayu, Cheras 56100, Kuala Lumpur, Malaysia
Phone number: 012-9790688
E-mail: lana_1123@hotmail.com

My research:

"Performance Optimization of Organic Solar Cell"

Organic solar cell, plasmonics

Educational Background:

2013 October-December Exchange student in National Chiao-Tung University, Taiwan
2010 B. Eng. (Hons) Mechatronic Engineering, UCSI University, Malaysia

About me:

My carrer objectives are to contribute my knowledge and skills in related areas with a particular emphasis on Engineering research & development to improve the quality of human lives and the environment. To continuously improve and broaden my skill set to ensure up-to-date knowledge and to continue to be an asset to colleagues and to the organization.

Name: Xiguo Xie

Ph. D.
State Key Laboratory for Mesoscopic Physics, Department of Physics, Peking University
Address: Beijing, 100871, China
Phone number: +8618810505924
E-mail: xiexiguo@pku.edu.cn
xiexiguo@gmail.com (private)

My research:

"Presentation title"

Imaging Isomers of Carbon Dioxide Clusters using Laser-Driven Coulomb Explosion

Research interests: Femtosecond laser, strong laser field interaction with atom and molecules

Educational Background:

2011-Now Ph. D student. optics, Peking University
2011 B.S. optcial science and technology, Qingdao University

About me:

I like programming. Recently, I have a lot of interest in Python, a fascinating programming language. With Python, I manipulate and visualize the experimental data. The diagram generated by Python is pretty, and the manipulation is flexible.
Bicycling is another hobbit. At the weekend, I often ride a bike around Beijing, a city which has many interesting places to go.

Name: Isao Yoshimine

Ph. D. Course (D3)
Shimura Lab, Department of Applied Physics
Graduate school of Engineering, the University of Tokyo
Lab Address: Ce-302, 4-6-1 Komaba, Meguro-ku, Tokyo 153-8505 Japan (My home is in Musashino city, Tokyo)
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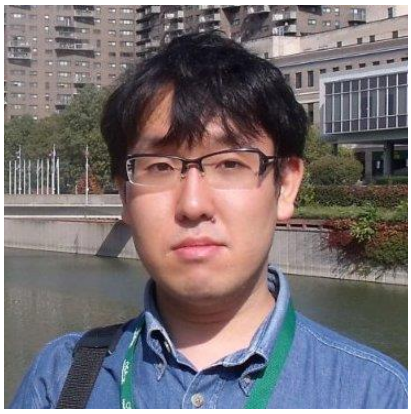
i.yoshimine@gmail.com (private)
HP URL:
https://sites.google.com/site/utosachapter/
(Homepage of OSA-UT Student chapter)



My research:

"Presentation title"

Research interests: interaction between light and spins ("opto-magnonics"), ultrafast phenomena (mainly that induced by light)

Educational Background:

2012 M.S. Engineering, the University of Tokyo (Applied Physics)
2010 B.S. Engineering, the University of Tokyo (Applied Physics)

About me:

I am interested in interface of information and "real" phenomena (ex. information processers, automation). I want to improve their technologies and I also love new gadgets themselves. Table games are my another hobby (If you like, let's play!).

Yuan-Yuan ZHAO:

Ph.D candidate(Grade 2)
Laboratory of Organic NanoPhotonics and Key Laboratory of Functional Crystals and Laser Technology, Technical Institute of Physics and Chemistry, Chinese Academy of Sciences
Address: No. 29, Zhongguancun East Road, Beijing, P. R. China, 100190
Phone number: +86-10-82543598
E-mail: zhaoyuanyuan@mail.ipc.ac.cn

My research:

"3D Luneburg Lens at Optical Frequencies"

Research interests: Multiphoton lithography, Metamaterial, Photoenic devices

Educational Background:

2011 B.S. Applied Physics, Henan University of Science and Technology

2011-now PhD candidate Technical Institute of Physics and Chemistry, Chinese Academy of Sciences

About me:

I like to make global friends very much. I like hiking, listening to music, watching movies, playing billiards etc. I have a dream to have my own research team on nanophotonics in the future. I am very interested in photonic computer. I hope my own team can make contributions to the application of photonic computer as early as possible.

Name: Zhu Yu

Ph. D
Department of Physics, Peking University

Address: Peking University, No.5 Yiheyuan Road, Haidian District, Beijing,P.R.China
Phone number: +8618810506043
E-mail: zhuyu_pku@pku.edu.cn

My research:

"Micro-nano photonics"

Research interests: Plasmonics, metamaterial

Educational Background:

2007 M.S. Applied Physics, Huazhong University of Science and Technolog
2011 B.S. optical, Peking University

About me:

I love myself as I love the wonderful life, the sport such as swimming, running and badminton.

Name:

Ahmed Zubair
Ph. D. Candidate
Junichiro Kono Laboratory
Department of Electrical and Computer Engineering
Rice University
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6100 Main Street, MS-378, Houston, TX 77005, USA
Phone number: +1 832 914 5161
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Accounts of social networking service:
Facebook: https://facebook.com/azubair.buet
Twitter: @a_zubair

My research:

"Photothermoelectric Broadband Photodetector Based on Carbon Nanotube Fibers"

Research interests: Optoelectronics, Nanophotonics, Terahertz, Carbon Nanotube

Educational Background:

2013- PhD Candidate Electrical and Computer Engineering, Rice University
2011 M.S. Electrical and Electronic Engineering, Bangladesh Uni. of Engineering and Tech.
2009 B.S. Electrical and Electronic Engineering, Bangladesh Uni. of Engineering and Tech.

About me:

I would like to contribute to research for prosperity of Human.
I like to travel and explore the beauty of nature.

EXCURSION

HOKKAIDO

IONS® -Asia 5 Hokkaido

International OSA Network of Students

JSAP Student Meeting

Asia Core Student Meeting

Hokkaido University, Sapporo, Japan

15-16
SEPT.
2014

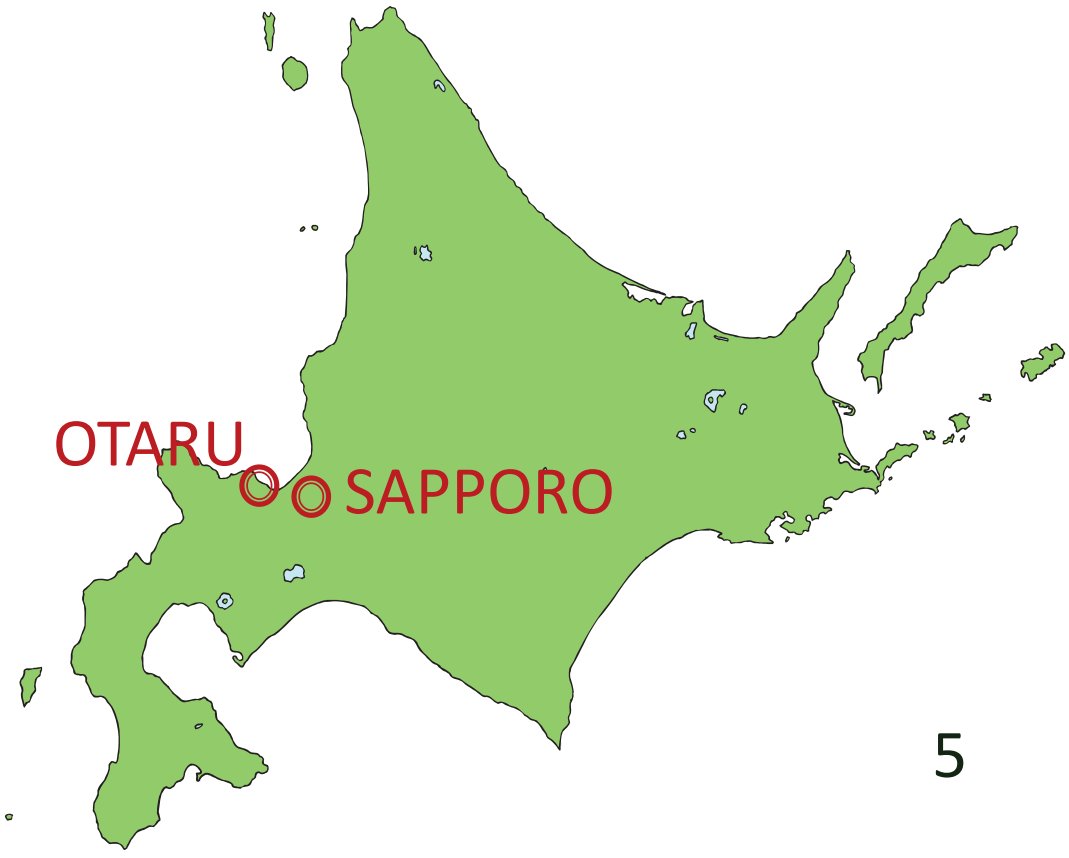
OUTLINE


4
6
10
14
18
20

The Best Spots of HOKKAIDO!!

OTARU city

Otaru is a city and port in Hokkaido, northwest of Sapporo. With its many historical buildings, Otaru is a popular tourist destination. You can enjoy rich and beautiful nature of each season: cherry blossom in Spring, fireworks in Summer, red and yellow leaves in Autumn, skiing in Winter.

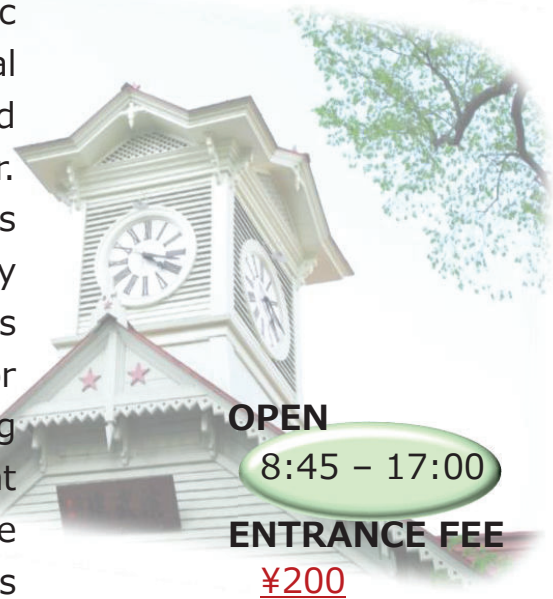


1. ODORI area

1-1. Sapporo Clock Tower

札幌市時計台

Sapporo Clock Tower is a historic building of Sapporo Agricultural College (now called Hokkaido University) and it was built in October 1878, planned by Dr. W. Halt. The feature of this building is wooden architecture style constructed by red-tiled roofs and the white walls. This building was utilized by gymnasium for physical education class or military training of students, and a lecture hall for the event such as entrance ceremony. We will see the history of this building and the clock which is actually used in this place.



OPEN
8:45 – 17:00

ENTRANCE FEE
¥200

1-2. Sapporo TV Tower

さっぽろテレビ塔

Sapporo TV tower is built in the occasion to beginning of the TV broadcast in Sapporo. The height of this tower is 147.2m and it is located at the east end of Odori Park, which is the central park of urban area in Sapporo and is familiar with citizen and tourists as a place of relief. The sightseeing place of this tower enables us to see the overview of the city. If the weather permits, we can also see the mountain or the sea surrounded with Sapporo.

Observation Deck

OPEN
9:00 – 22:00

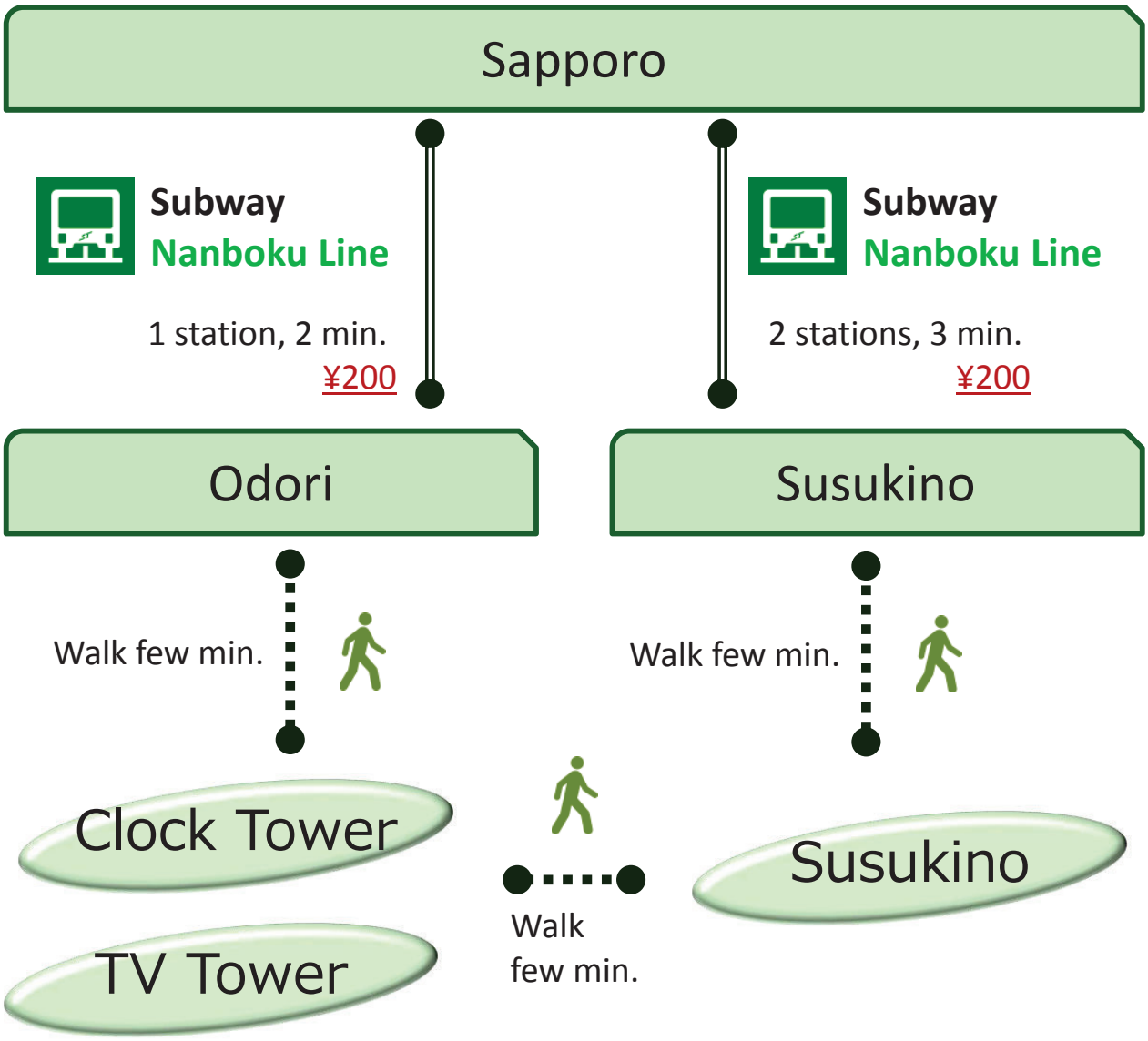
ENTRANCE FEE
¥720

1-3. SUSUKINO

すすきの

Susukino is the amusement area which is distinguished for the city that never sleeps in Sapporo. The feature of this area is the number of stores and the variety of the business type. Almost of all business, such as restaurant, adult entertainment shop, hotel, and so on, gets centered on the building in Susukino. Another feature of this area is the public security. It is well known that Susukino is a safe amusement area in Japan enough to drink till dawn with a group of young women.

Access – ODORI area



Map

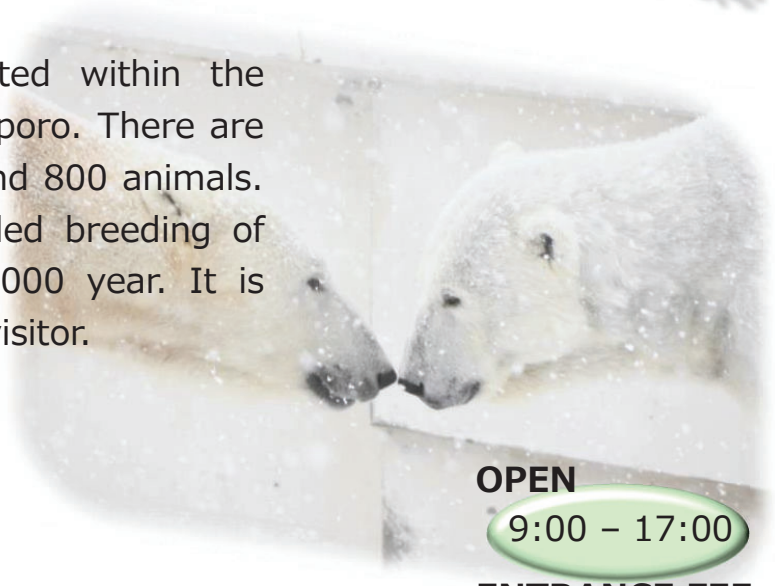
① **Sapporo Clock Tower**
② **Sapporo TV Tower**
③ **Susukino**
④ Hokkaido University Botanical Gardens
⑤ nORBESA [amusement]

2. MARUYAMA area

2-1. MARUYAMA ZOO

円山動物園

Maruyama Zoo is located within the Maruyama Park in Sapporo. There are about 180 kinds of animal and 800 animals. It is only zoo have succeeded breeding of Polar bear in Japan after 2000 year. It is very popular spot for family visitor.



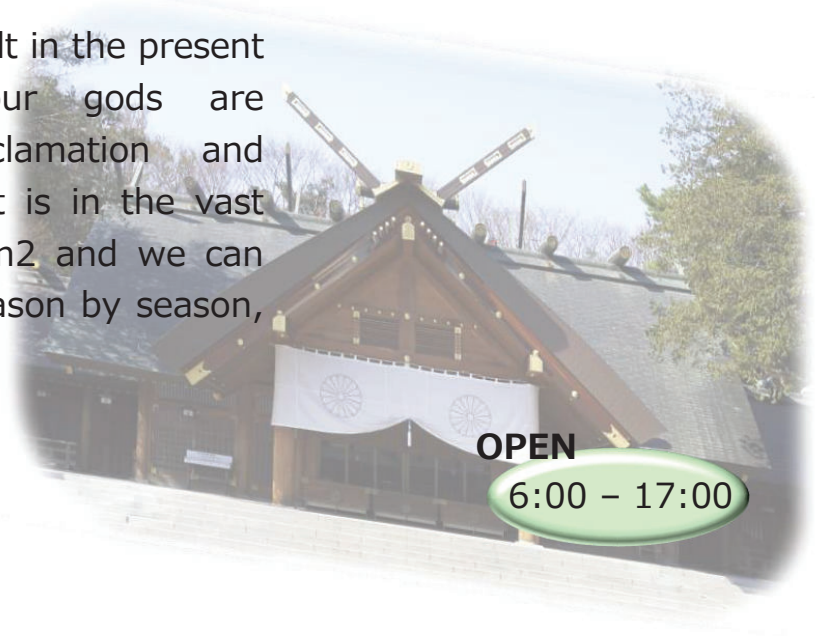
OPEN
9:00 – 17:00

ENTRANCE FEE
¥600

2-2. HOKKAIDO SHRINE

北海道神宮

Hokkaido Shrine was built in the present place in 1871. Four gods are enshrined to guard reclamation and development of Hokkaido. It is in the vast extent of land of 180,000 m2 and we can enjoy view of rich nature season by season, so it is popular tourist spot.



OPEN
6:00 – 17:00

2-3. Mt. Moiwa

もいわ山

Mt. Moiwa is known to one of three major night views of Hokkaido. It has an elevation of 531 meters and we can climb it by ropeway. In the top of it, we can see an around view of Sapporo. There is a bell called “fortunate bell” in the observatory and it is popular date spot for lovers because it is said that they don’t break up forever when they padlock to the bell together.

OPEN

10:30 – 22:00

ENTRANCE FEE

¥1700 (ropeway)

Access – MARUYAMA area

Sapporo

Subway
Nanboku Line

1 station, 2 min.
¥200

CONNECT Odori

Subway
Tozai Line

3 stations, 5 min.
¥240

Walk few min.

Walk few min.

Nishi 4 Chome

Nishi 18 Chome

Nishi 15 Chome

Subway
Tozai Line

1 station, 2 min.
¥200

Tram

6 sta., 15 min.
¥170

Tram

9 sta.,
20 min.
¥170

Maruyamakoen

Walk 15 min.

Ropeway Iriguchi

Free Shuttle Bus
5 min.

Sanroku

Hokkaido Shrine

Maruyama Zoo

Ropeway
¥1700
(return ticket)

Mt. Moiwa

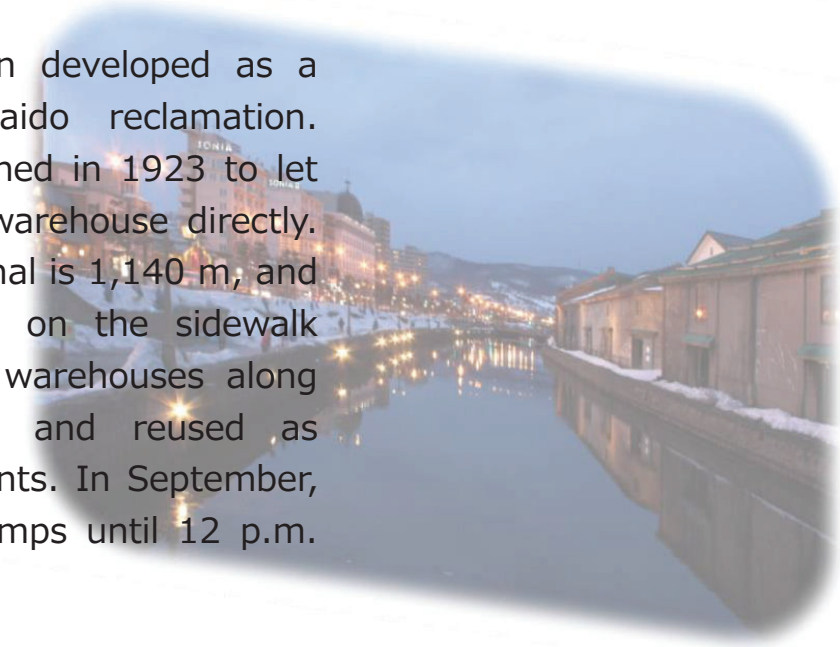
Map

① **Maruyama Zoo**
② **Hokkaido Shrine**
③ **Mt. Moiwa**
④ Maruyama Park

3. OTARU area

3-1. Otaru Canal

小樽運河

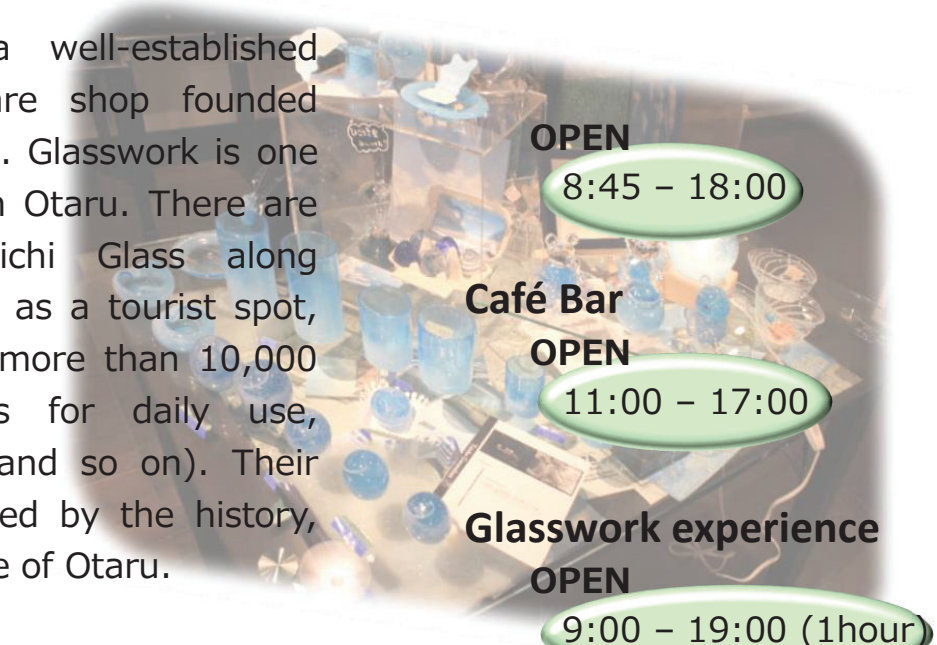


Otaru Port had been developed as a gateway to Hokkaido reclamation. Otaru Canal was established in 1923 to let ships enter near to the warehouse directly. The total length of the canal is 1,140 m, and 63 gas lamps were set on the sidewalk beside the canal. Stone warehouses along the canal are retained and reused as facilities such as restaurants. In September, the canal is lit by gas lamps until 12 p.m. from sunset.

3-2. Kitaichi Glass

北一硝子

Kitaichi Glass is a well-established handmade glassware shop founded more than 110 years ago. Glasswork is one of the major industries in Otaru. There are several stores of Kitaichi Glass along Sakaimachi Street known as a tourist spot, and these stores exhibit more than 10,000 glassware (e.g., vessels for daily use, accessories, art objects and so on). Their design has been influenced by the history, culture and natural feature of Otaru.



OPEN
8:45 – 18:00

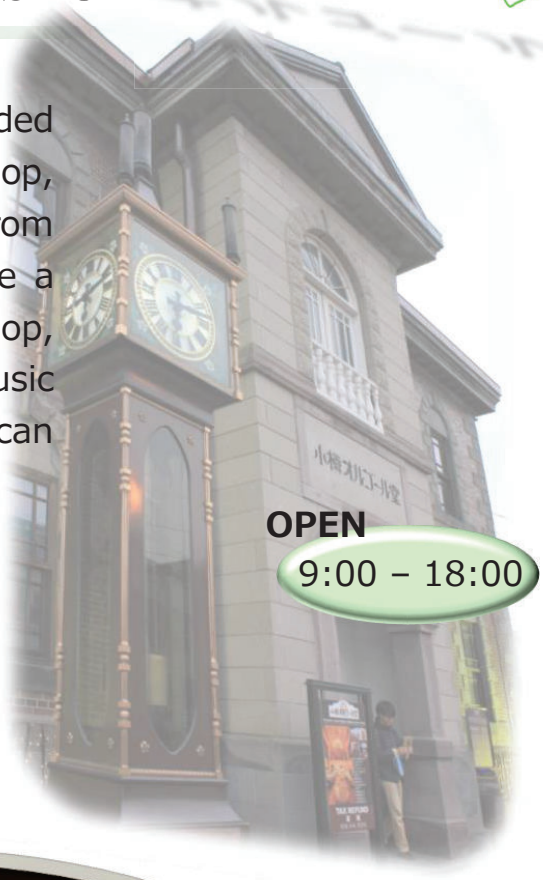
Café Bar
OPEN
11:00 – 17:00

Glasswork experience
OPEN
9:00 – 19:00 (1hour)
FEE
about ¥1,000

3-3. Otaru Music Box Museum

オルゴール堂

Otaru Music Box Museum was founded in 1912. When you enter the shop, you are surrounded by beautiful sound from a great number of music boxes. Because a lot of music boxes are displayed in the shop, you will struggle to find your favorite music box. If you want to buy a small one, you can buy it for about 2,000 yen.



OPEN
9:00 – 18:00

Access – OTARU area

Sapporo

JR Hokkaido
(for Otaru)

Rapid: 5 stations, 30 min.
or
Local: 14 stations, 40 min.
¥640

Otaru

Walk around Otaru Sta.

Kitaichi Glass

Otaru Canal

Music Box Museum

Map

① **Kitaichi Glass**
② **Otaru Canal**
③ **Otaru Music Box Museum**
④ Kamaei [fishjelly products]
⑤ LeTAO [cake, café]
⑥ Sankaku Market [fish market]
⑦ Former Otaru District Meeting Hall [historical building]
⑧ Former Okazaki Noh Stage [historical building]
⑨ Sakaiya [historical building]
⑩ Ika Taro Honpo [squid snack]

Launch Map around Hokkaido Univ.

⟨ Japanese ⟩

1. [SET MEAL] TSUMUGI (お食事の店つむぎ) 11:00 - 21:00
2. [SOBA] MIZUKI (みず木) 11:00 - 15:00
3. [SOBA] SAKATA (そば切りさか田) 11:30 - 15:00
4. [SUSHI] IKEDA SUSHI (いけだ寿し) 11:30 - 14:00, 16:30 - 22:00
5. [SET MEAL] FUJIYA (味処富士屋) 11:00 - 14:30, 17:00 - 22:00
6. [SUSHI] KIYOSUSHI (清寿司) 12:00 - 14:00, 17:00 - 23:00
7. [SOBA] SOBABOU (そば坊) 11:30 - 14:30, 17:30 - 22:00
8. [ROAST MEAT] MIKAKUEN (味覚園) 17:00 - 24:00
9. [ORIGINAL DISHES] YU(遊) 11:00 - 14:30, 17:30 - 22:00
10. [SET MEAL] FUKAGAWA (ふか河) 11:00 - 22:00
11. [SOBA] BANKEISOBA (盤渓そば) 11:00 - 17:00
12. [SUSHI] HOKUSAI (北斎) 17:00 - 23:00

⟨ Western ⟩

13. [MEAT] GYUSHA (牛舎) 11:30 - 14:00, 17:00 - 21:00
14. [SET MEAL] CLERK TEI (クラーク亭) 11:30 - 23:00
15. [JINGISUKAN(mutton)] YAMADAMONGORU (ヤマダモンゴル) 17:00 - 24:00

⟨ Chinese ⟩

16. [SET MEAL] NAMIHANA (波華) 11:30 - 22:00
17. [NOODLE] MARUTAKA (まるたかラーメン) 11:30 - 21:00
18. [NOODLE] IKKOKUDO (一国堂) 11:00 - 25:00
19. [NOODLE] BARIKITA (ばりきや) 11:00 - 22:00

⟨ Italian ⟩

20. [PASTA] MAR'S CAFE 11:30 - 14:00, 17:00 - 22:30
21. [PASTA] RESAN (レサン) 11:30 - 22:00
22. Costeria EST EST EST 11:30 - 23:30
23. [PASTA]KUCCHINA (クッチーナ) 11:30 - 24:00

⟨ Curry ⟩

24. [SOUP CURRY] KOKORO (カレー食堂心) 11:30 - 22:00
25. [SOUP CURRY] PICANTE (ピカンティ) 11:30 - 23:00
26. [SOUP CURRY] kochoo 11:30 - 22:00
27. [THAI CURRY] SURIYOTHAI 11:30 - 15:30, 17:00 - 22:00
28. [CURRY] CoCo Ichibanya (CoCo 壱番屋) 11:00 - 24:00
29. [SOUP CURRY] hirihiri 2gou (hirihiri 2号) 11:30 - 21:30

⟨ Fast food ⟩

30. McDonald (マクドナルド) 24 hours
31. MOS BURGER (モスバーガー) 9:00 - 25:00

⟨ Cafe ⟩

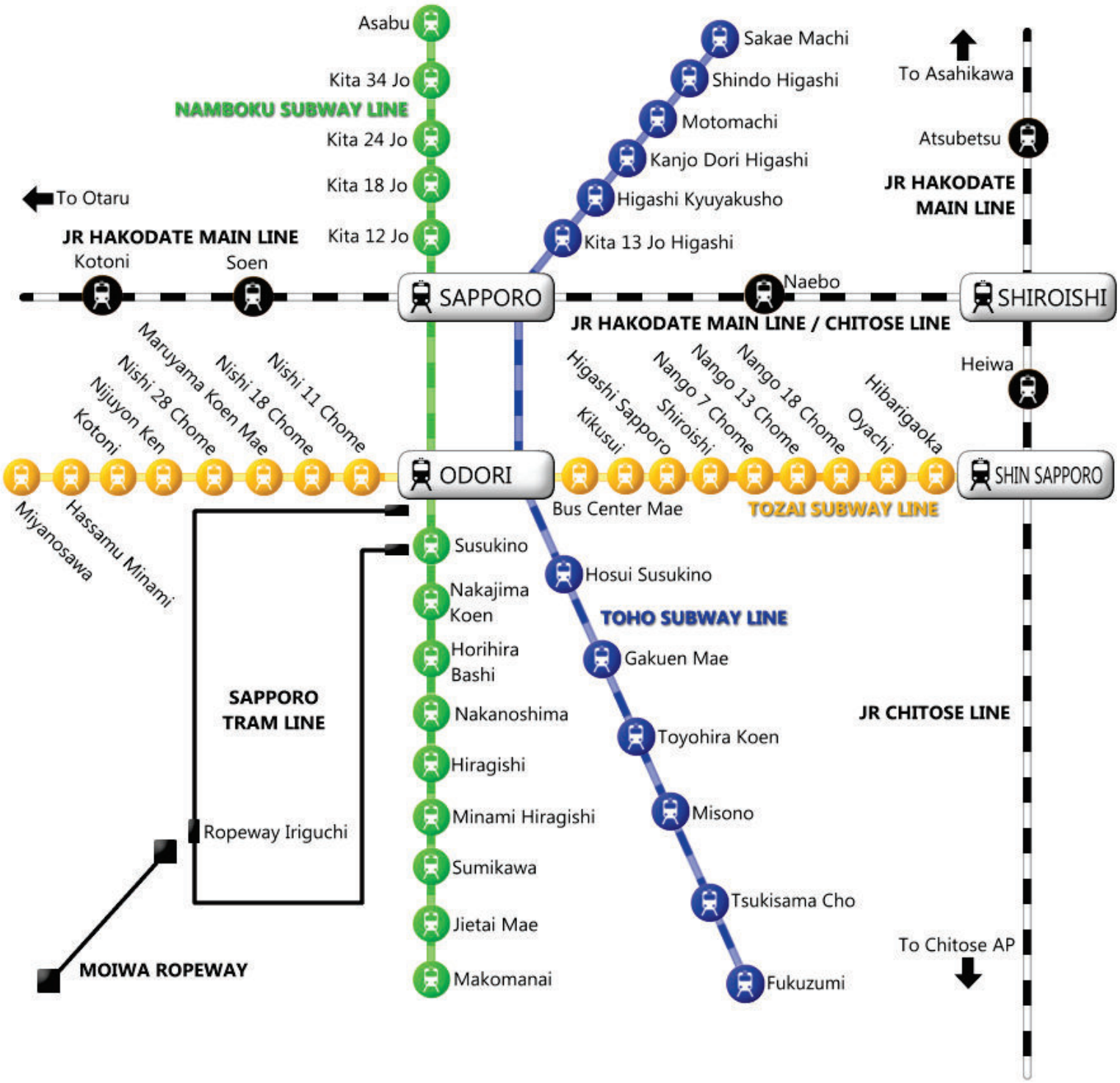
32. ARABIKA (珈琲工房あらびか) 10:00 - 21:00
33. Starbucks Coffee (スターバックスコーヒー) 8:30 - 19:00
34. Saint Marc Café (サンマルクカフェ) 7:00 - 23:00
35. FLAGSTAFF CAFE 11:00 - 19:00

⟨ Bar ⟩

36. [ROAST CHICKEN] TORINOSUKE (元祖札幌味噌とりのすけ) 17:00 - 26:00
37. [OKINAWA FOOD] UMINTYUNU YAMANTYUNU (うみんちゅぬやまんちゅぬ) 17:00 - 26:00
38. [ROAST CHICKEN] KUSHIGON (串ごん) 18:00 - 28:00
39. [JAPANEESE FOOD] UOUSAOU (魚桜酒桜) 17:00 - 26:00
40. [JAPANEESE FOOD] NEMUROSYOKUDO (根室食堂) 17:00 - 23:30
41. [ROAST CHICKEN] TORIGEN (鳥源) 17:00 - 21:00
42. [KUSHIKATSU] HANA (串カツはな) 17:00 - 24:00
43. [ROAST CHICKEN] ITADAKI KOKKOCHAN (いただきコッコちゃん) 17:00 - 26:00
44. [SOBA] TAKADAYA (高田屋) 11:00 - 15:30, 17:00 - 23:30
45. [SEAFOOD] NIHONICHI (居酒屋日本一) 17:00 - 24:00
46. Buono 17:00 - 24:00
47. [BAR] TAKEUCHI (バー竹内) 18:00 - 25:00
48. [JAPANEESE FOOD] SHUN (和食屋駿) 11:30 - 14:00, 17:30 - 23:00
49. [SEAFOOD] UMI (海) 17:00 - 24:00
50. [ROAST CHICKEN] KUSHIDORI (串鳥) 4:30 - 24:30
51. DEDENGADEN (ででんがでん) 17:30 - 25:00
52. [SEAFOOD] SAKAGURA (咲か蔵) 16:00 - 24:30
53. BUAISO (ぶあいそ別邸) 17:00 - 23:00
54. [JAPANEES FOOD] BASUENOWAGAO (場末の和顔) 17:00 - 24:00
55. KANRO (かんろ) 17:00 - 24:00
56. CHABO (ちゃぼ) 17:00 - 24:00
57. ERIMOTEI (えりも亭) 17:00 - 23:00

★ = Our Recommendation!

SAPPORO City Subway Map



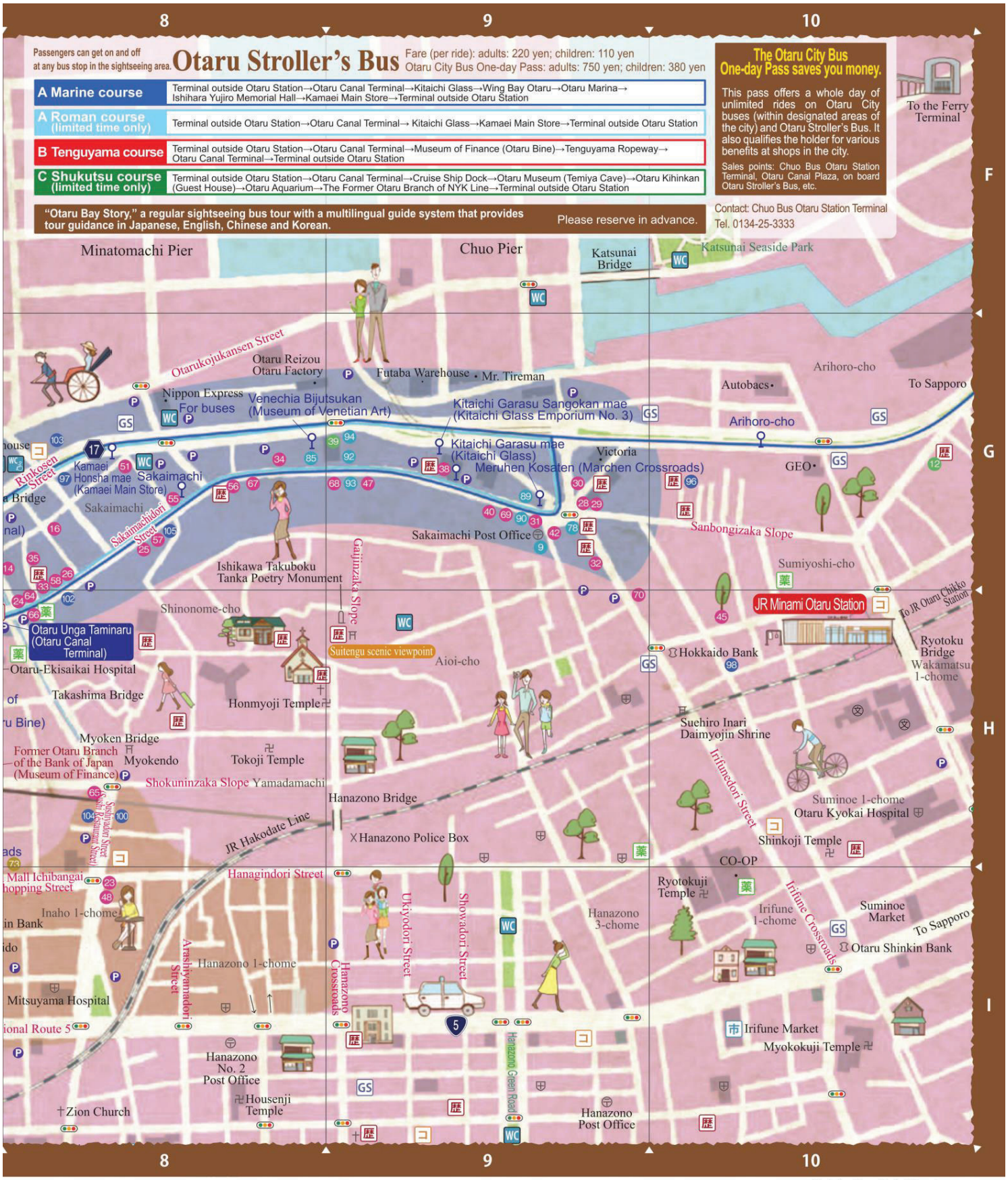

TRAM


METRO(SUBWAY)


JR

OTARU city map

1 Blue Grotto & Fishing Boat G-5	23 Sawanotsuyu Hompo I-8	34 Otaru Ruri-kobo G-8	45 Hokuhodo Co.,Ltd H-10	57 Rishiriya Minoya – Taisho Kubu-kan G-8
2 SCUBA Diving Center POSEIDON G-6	24 Otaru Roman Kan H-8	35 Otaru Ruri-kobo Canal Store G-8	46 Jewelry CONOMI I-7	58 Rishiriya Minoya – Furo-kan G-8
3 Otaru Canal Cruise G-7	25 Otaru Ishi-no-Kura G-8	36 Hiyori Aburatori-gami (facial oil blotting paper) Shop – Otaru Store G-7	47 Gin no Kane No. 7 Shop Rakuraku G-9	59 Taisho Glass Head Store H-7
4 Otaru Bay Cruise G-6	26 Music Box Kaimeiro Head Store G-8	37 Otaru Ilponte G-6	48 O.M.T. Honma Marine Products I-8	60 Taisho Glass – Creative Glass Studio H-7
9 Gin no Kane No.2 Coffee Shop G-9	27 Music Box Kaimeiro Ironai Store H-7	38 Kitaichi Glass Sangokan G-9	49 Otaru Canal Terminal H-7	61 Taisho Glass – Glass Bead Studio G-7
10 Otaru Interesting Photography Hall G-7	28 Main Building of the Otaru Music Box Museum G-9	39 Kitaichi Venetian Art Museum G-9	51 Kamaei Boiled Fish Paste Shop G-8	62 Taisho Glass – Queen of the Night Gallery G-7
12 Otaru Artisan Training Centre G-10	29 Otaru Karakuri Zoo G-9	40 Otaru Fukuro G-9	53 Tarche – Marche in Otaru Station I-7	63 Taisho Glass – Glass Studio G-7
14 Otaru Candle-kobo G-8	30 Character House "Yume no Oto" G-9	41 Craft Shop Ren H-6	54 Bakery Ondine I-7	64 Taisho Glass Sora H-8
16 Variant Art Workshop G-8	31 Otaru Music Box Museum Hall Number 2 Antique Museum G-9	42 Souvenir Otarukan G-9	55 Hokuren Fudikan Hall G-8	65 Taisho Glass Tarukko Club H-8
17 Kazu Textile-dyeing Atelier H-7	32 Music Box & Handicrafts Studio Yu-kobo G-9	43 Yuzu Kobo Glass Bead Studio H-6	56 Rishiriya Minoya Head Store G-8	66 Taisho Glass Utsuwaya H-8
22 Tanaka Shuzo Head Store H-5	33 Otaru Music Box Museum Sakaimachi G-8	44 Design and Select Goods Hokkaiya I-6		



67 Taisho Glass Kanzashiya	G-8	77 Amato Canal Branch	H-7	90 LeTAO Cheese Cake Labo	G-9	101 Otaru Masazushi Zenan	G-7	111 Charinko Otaru Rent-A-Bicycle & Baggage Storage	H-7
68 Taisho Glass Hokkoriya	G-9	78 Gin no Kane Store No.1 (café, 2F)	G-9	91 Ekimo LeTAO	I-6	102 Sokichi – Boiled Cod Milt Paste Dishes	H-8	112 Hotel Vibrant Otaru	H-7
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