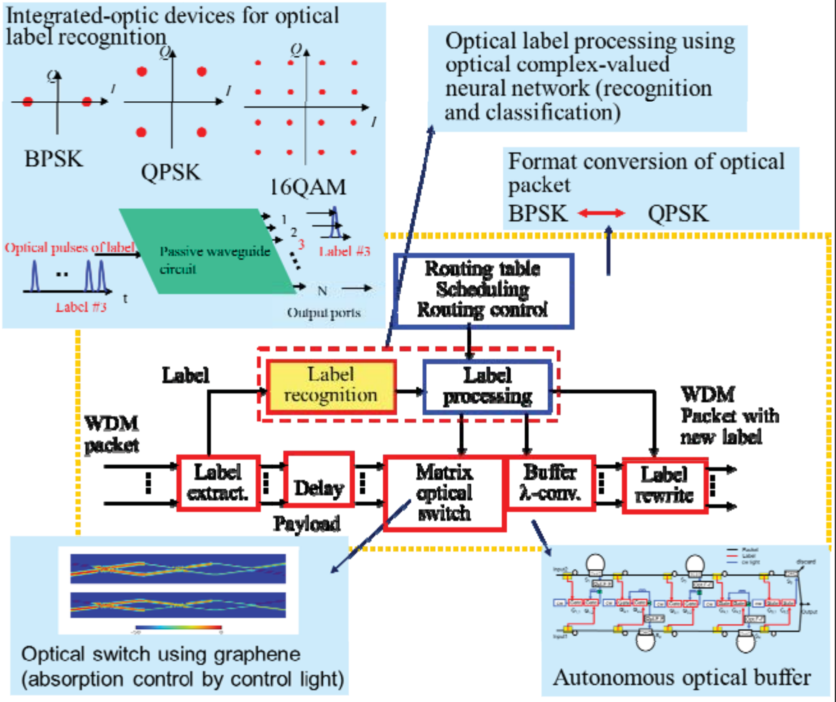
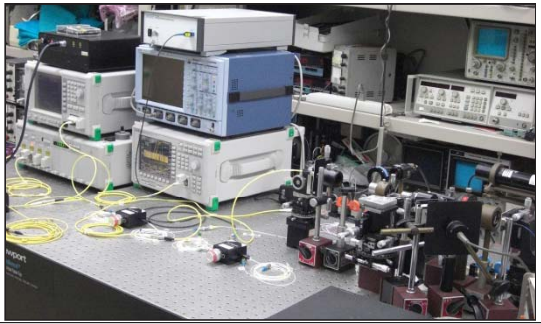
Faculty of Engineering
Tokushima University

Optical Signal Processing Circuits for Photonic Router

Professor　Nobuo Goto



Research for photonic router



Experimental setup for all-optical switching using graphene

Content:

In future high-speed large-capacity networks, named as photonic networks, optical packet processing in network nodes such as routers is expected to be to reduce power consumption at high bit rates.

In my group, we study integrated-optic devices and optical systems for processing packets without converting to electric signals.

- Optical label processing such as label recognition and label classification. (OOK, BPSK, QPSK, 16QAM)
- Autonomous optical buffer systems which does not require external control signals.
- All-optical flip-flop circuit, which will be required to generate control signals for switching and buffering
- All-optical high-speed switches and wavelength-selective switches
- All-optical packet format conversion systems

（between BPSK and QPSK, QPSK and16QAM etc.）

Keywords：photonic router, integrated-optics, all-optical signal processing

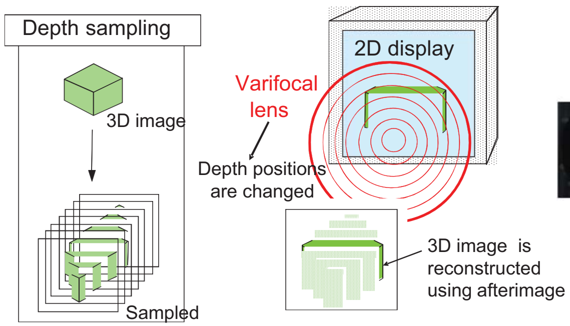
E-mail: goto.nobuo@tokushima-u.ac.jp
Tel. 088-656-9415
Fax: 088-656-9415
HP：http://www.opt.tokushima-u.ac.jp/lab/b-3/index_ja.htm

Human- friendly 3D display systems

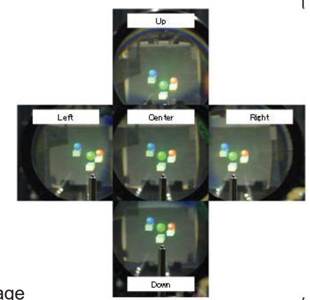
Professor Shiro Suyama

Faculty of Engineering
Tokushima University

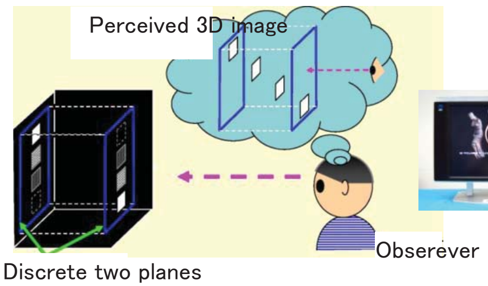
"3D display using varifocal lens"



Floating 3D image



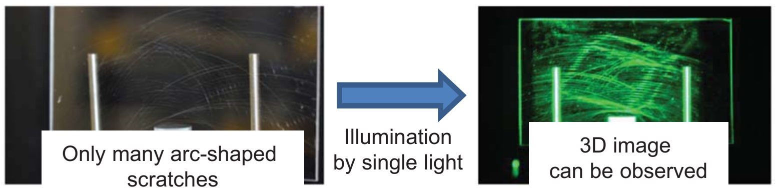
"DFD (Depth-fused 3D) display"



Contiunous 3D image using discrete planes

"Arc 3D display"

Smooth movement parallax by arc-shaped scratches



Content:

In our laboratory, human-friendly 3D display systems have been developed, based on liquid-crystal devices and perceptual phenomena.

"3D display using varifocal lens"

We have developed the varifocal lens using a liquid-crystal devices. By using this varifocal lens, floating 3D images have been realized. These floating 3D images is promising for human-friendly 3D images.

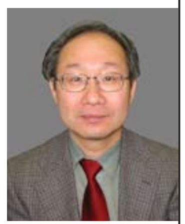
"DFD (Depth-fused 3D) display"

We found the depth-perception phenomenon that the continuous depth can be perceived only by using discrete two planes. By using this DFD phenomenon, simple 3D display system can be realized from 9-inch to 200-inch size.

"Arc 3D display"

Many arc-shaped scratches or protrusions easily provide 3D image with smooth movement parallax, which will be switchable by using liquid-crystal devices.

Keywords: 3D, DFD, Volmetric, Depth perception
E-mail: suyama.shiro@opt.tokushima-u.ac.jp
Tel. +81-88-656-9425
Fax: +81-88-656-9435



Faculty of Engineering
Tokushima University

Photophysical and Photochemical Studies at Nanoscales

Professor Shuichi Hashimoto

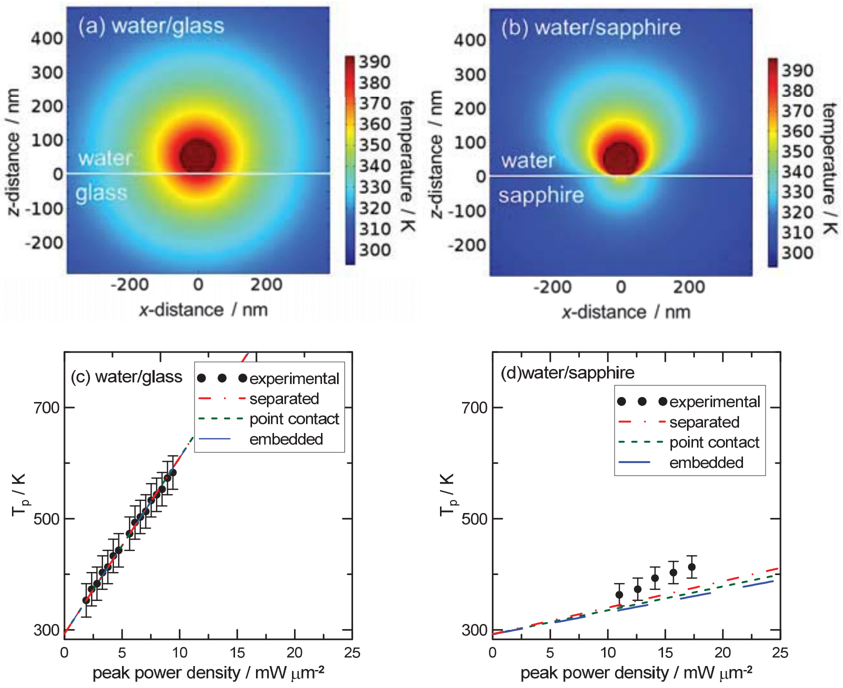


Fig. 1 CW Laser heating of a single 100-nm Au NP on a substrate in a medium

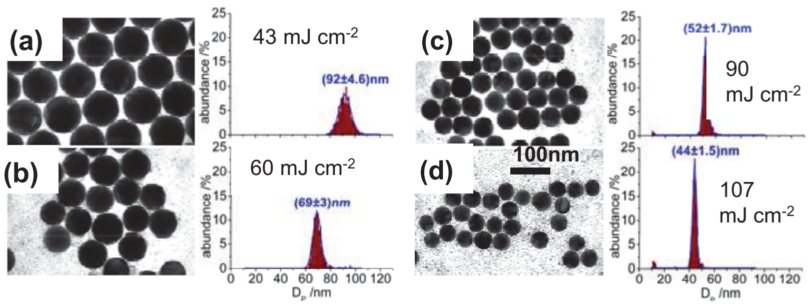


Fig. 2 Laser-induced size reduction of 100-nm Au NPs at 100 MPa

Scope:

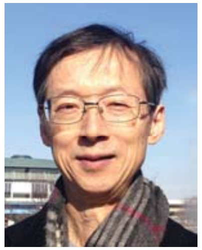
Photophysical and photochemical studies at nanoscales have attracted considerable attention in the past decade inspired by potential application in biomedical fields and solar energy harvesting. We have been working on gold nanoparticles (Au NPs) and nanostrctures aiming at finding new phenomena characteristic of nanoscales.

Currently, our primary research interest is to construct a thermometer at nanoscales. We want to measure temperatures with a space resolution of 50-100 nm, which is below the diffraction limit of light. We used a single Au NPs of 100-nm diameter and heated the particle by laser illumination through a microscope objective. Fig. 1a and 1b display the 2D temperature profiles on glass and sapphire substrates in water. The temperature distribution is remarkably dependent on the substrate. The experimental laser intensity-dependent temperature is in good agreement with a simulation and reliable temperature estimation is feasible (**ACS Nano, 2013, 7, 7874**.).

We have also been interested in laser-induced morphological changes of aqueous colloidal Au NPs. We used external high pressures of 60-400 MPa for the morphological control. Fig. 2 shows the laser intensity-dependent size changes of initial 100-nm Au NPs at 100 MPa. Five nanosecond (FWHM) laser pulses with a wavelength of 532 nm was employed for excition. The result indicated that the extent of the size reduction is remarkably dependent on the laser fluence and the size control is possible via the laser intensity (**Langmuir, 2013, 29, 1295**.).

Keywords : gold nanoparticles, lasers, optical microscopy

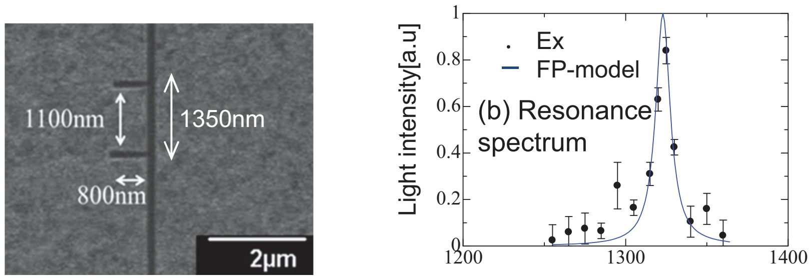
E-mail: hashichem@tokushima-u.ac.jp
Tel. +81-88-656-7389
Fax: +81-88-656-7598
HP : http://www.opt.tokushima-u.ac.jp
/lab/a-4/index.html



Research on plasmonic nanophotonic devices

Faculty of Engineering
Tokushima University

Professor Masanobu Haraguchi



(a) SEM image

Fig. 1 Resonator in SPP waveguide

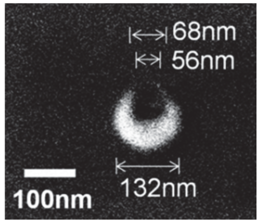
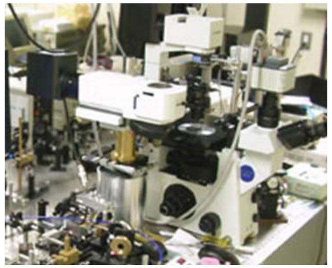
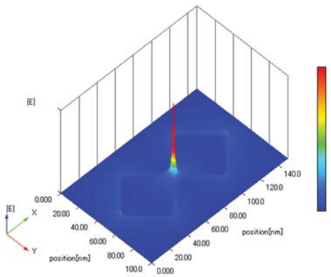


Fig. 2 Sprit ring resonator



Microscopic measurement system



Numerical light intensity distribution of metal nano dimer

Electron beam drawing system

Content:

Surface plasmon polaritons (SPPs) exist on a metal-dielectric interface. SPPs will provide the spatial field enhancement and the field localization beyond the diffraction limit at the interface. A lot of researchers is working on ultra-compact optical devices and/or high sensitive sensors by using characteristics of SPPs. The engineering based on SPPs is often called “Plasmonics.”

We are working on researches of plasmonic waveguides, which provides narrow width of the deep sub wavelength, and the related devices, eg ultra-compact optical resonators, sensors and SPP sources. Figure 1 shows an example of resonators built in a plasmonic waveguide with Q factor = 100 and an area size of = 2 μm. We also shows a scanning electron microscopy image of a sprit ring resonator with a diameter of 132 nm, providing a optical resonance in near infrared region.

Final goals of our researches are establish of a plasmon-electron hybrid integrated circuits for optical communication information processing with high energy efficiency and drastic compact size and a compact sensor with ultra high sensitivity, eg, single molecule detection, for various application.

Keywords : Plasmonics, Nanophotonics

E-mail: haraguchi.masanobu@tokushima-u.ac.jp

Tel. +81-88-656-9411

Fax: +81-88-656-9435

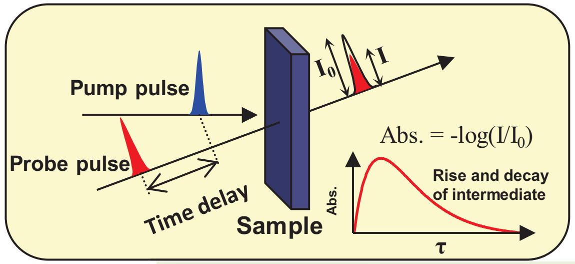
HP :

Faculty of Engineering
Tokushima University

Advanced laser spectroscopy of nanomaterials for photonics

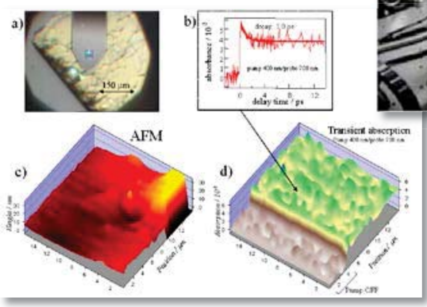
Professor Akihiro Furube

Femtosecond transient absorption to reveal ultrafast process

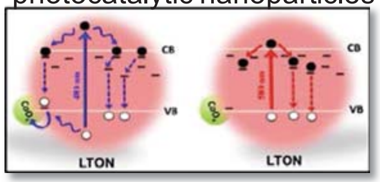


Solar cells (Si, polymer, quantum dots)
Photocatalyst（semiconductor nanoparticles, water splitting）

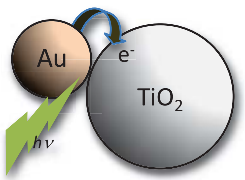
Imaging of excitons in organic solid



Carrier dynamics in photocatalytic nanoparticles



Mechanism of plasmon-induced charge transfer



Time resolved spectroscopic systems are developed using ultrafast lasers with pulse duration of ~100 fs.

These systems are especially customized for measuring devices and materials under operational conditions.

Fundamental studies for the material properties to understand the reaction dynamics are undertaken for the following dynamics in several nanomaterial systems.

1. Charge transfer in organic-inorganic hybrid solar cells such as dye-sensitized solar cells and polymer photovoltaics.
2. Carrier dynamics in photocatalysts that are used for water splitting.
3. Plasmon induced charge separation in gold nanoparticle composites.
4. Exciton fission dynamics relating to a novel solar cell.

Keywords：Ultrafast spectroscopy, Dynamics, Solar cell, Photocatalyst

E-mail: furube.akihiro@tokushima-u.ac.jp
Tel. +81-88-656-7538
HP : http://www.opt.tokushima-u.ac.jp/lab/a-4/A4_top.html

Metallic split-ring resonator and Metamaterial

Associate professor Toshihiro Okamoto

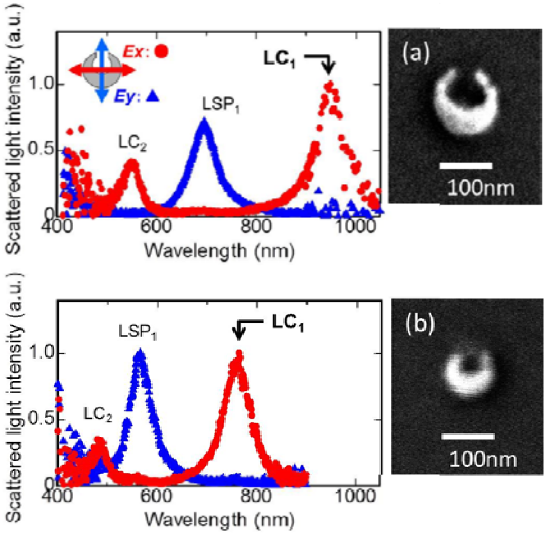


Fig. 1 Light scattering spectra of a single isolated silver split-ring resonator

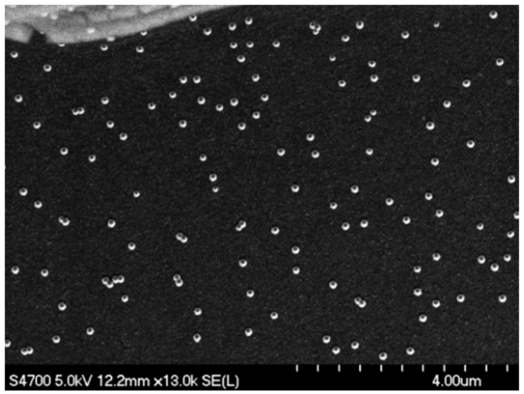


Fig. 2 Gold split-ring resonators distributed on substrate

Content:

Metamaterials are artificial media structured on a size smaller than the wavelength of incident light. A split-ring resonator (SRR) causes magnetic resonance near the LC resonance frequency and changes the permeability of its metamaterial. The size of the SRR must be reduced to around 100 nm for operation in the visible/nearinfrared region; however, it is technically difficult to make an SRR this small with high accuracy. Electron beam lithography was used to fabricate SRRs that operated in this region. However, this method is unsuitable for mass production because the process is complex and the system is expensive.

Recently, we succeeded in making the silver SRR of the diameter of approximately 100 nm by the nanosphere lithography method. In addition, we succeeded in the observation of the LC resonance of single SRR excited by the magnetic field of light.

Keywords：sprit-ring resonator, metamaterial

E-mail: toshi-okamoto@tokushima-u.ac.jp
Tel. 088-656-9412
Fax: 088-656-9412

顔写真
（省略可）

Organic Photovoltaic Devices prepared by Electrodeposition

Faculty of Engineering
Tokushima University

Associate Professor Yoshihiko Tezuka

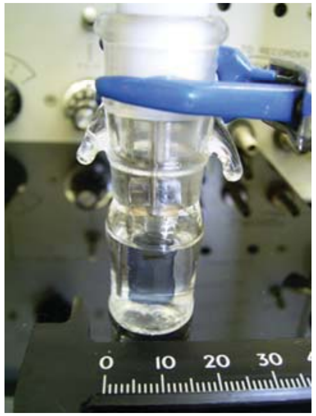


Fig.1 Electrodeposition of PT films on ITO electrodes.

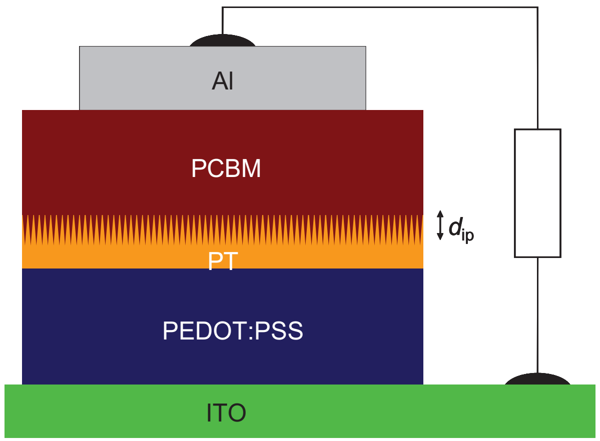


Fig.2 Partially interpenetrating donor/acceptor interface (d_{ip}=9 nm) in ITO/PEDOT:PSS/PT/PCBM/Al devices.

Content:

Organic photovoltaic devices have attracted much attention because of low-cost fabrication of light, flexible, and large scale devices. Most of these devices are based on the concept of "bulkheterojunction" in which donor and acceptor molecules form phase separation in nanometer scale. Most conducting polymers used as a donor molecule are high in material cost because they have long alkyl side-chains for improving solubility. The presence of alkyl chains also leads to low open circuit voltage in photovoltaic devices because electron-donating alkyl groups shift the HOMO level of conducting polymers to anodic values.

We have prepared organic photovoltaic devices using unsubstituted polythiophene (PT) as the donor material. Although PT is an infusible and insoluble solid, it can be formed on ITO electrodes through electrodeposition (Fig.1). The PT films have nanoporous structure through which acceptor molecules such as a fullerene derivative (PCBM) permeated into the film to form a partially interpenetrating donor/acceptor interface (Fig.2).

Keywords: conducting polymer, polythiophene, fullerene

E-mail: ytezula@tokushima-u.ac.jp>

Tel. +81-88-656-9435

Fax: +81-88-656-9435

HP : http://www.opt.tokushima-u.ac.jp/lab/a-3/index.html

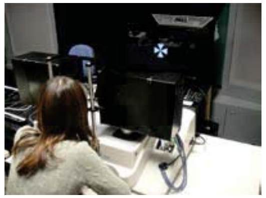
Faculty of Engineering
Tokushima University

Research on human visual processing

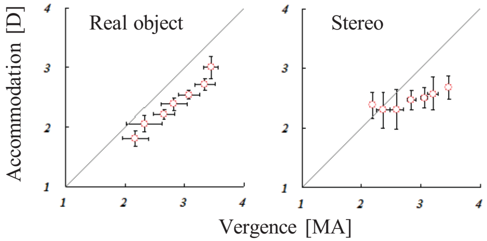
Associate Professor Haruki Mizushina

Visual function to 3D images

Measurement of visual function

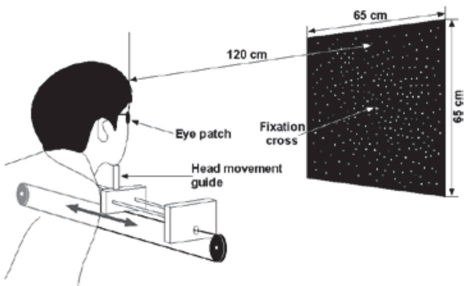


Accommodation and vergence to real objects and stereo images

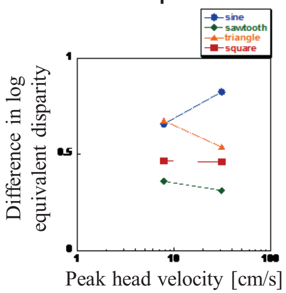


Depth and motion perception from motion parallax

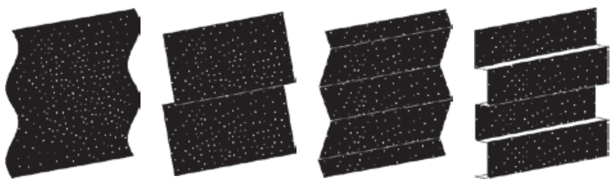
Motion parallax accompanied with head movement



Stability zone of motion parallax



Simulated surfaces



Our main research interest is human visual processing while viewing various types of 3D images. We examined visual function (mainly accommodation and vergence) to real objects, stereo images, and 3D images produced by novel techniques, by means of objective measurements. We found that accommodative responses are different between real objects (natural viewing) and stereo images. Novel 3D techniques (super multi-view and holography for now) can induce natural accommodative responses, which means that these display techniques are promising for human-friendly 3D image presentation. We also examined individual difference of visual function and susceptibility to 3D images. Besides binocular stereopsis, motion parallax accompanied with head movement is monocular depth cue and can produce unambiguous depth perception. We can perceive stable depth from motion parallax in daily life, but not in laboratory environment. We found that disparity gradient plays critical role for stable depth perception from motion parallax. A final goal of our research will be to find out human-friendly 3D presentation technique based on human visual function and characteristics of depth perception.

Keywords : human vision, psychophysics, 3D displays

E-mail: mizushina.haruki@tokushima-u.ac.jp
Tel. +81-88-656-9426
Fax: +81-88-656-9435

Faculty of Engineering
Tokushima University

Simuations Using Hard Spheres: Fandamentals to Model Colloids

Associate Professor Atsushi Mori

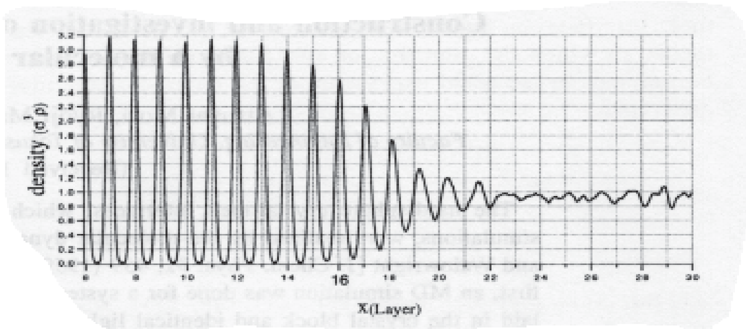


Fig. 1. A density profile of crystal-fluid interface of hard spheres. In this figure, x-direction is taken to be nornal to the interface. [Mori *et al.*, Phys. Rev. E **51** (1995) R3831.]

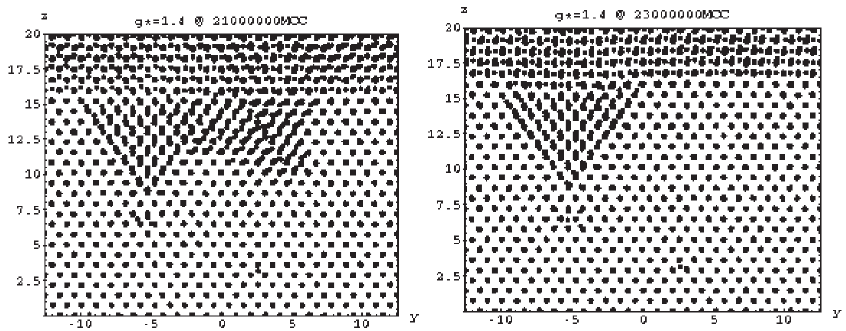


Fig. 2. Snapshot demonstrating gravitational tempering in collodal epitaxy. For first 2×10^7 Monte Carli cycles (MCCs) we grew a hard-sphere crystal under a gravitational condition of $g^*=mg\sigma/k_BT=1.6$, then g^* was decresed to 1.4. We show yz-projections at 2.1 and 2.3×10^7th MCCs. [Mori and Suzuki, submitted.]

Content:

In soft matters, no bonds are formed between their entities. A typical example is a colloid. Despite of absence of bonding between collidal particles, at a high particle density the collidal system crstallizes. Nowadays, we understand that such kinds of phase transisions are driven entropically. Hard shere is an idealized model of a colloidal particle. In 1995, coworkers and I sucesfully perfoemed a molecular dynamics simulation of crystal-fluid interface of hard sphres; this is the first relization of the two phase coexistence in the hard-sphre system. A density profile is shown in Fig. 1.

Recently, cowokers and I have developed a method to reduce defects in a collodal crystal base on results of Monte Carlo simuations. After growing a collidal crystal at a relatively high gravitational condition, one can erase some defects by slightly weaken the strength of gravity and maintaing for a perioid of time. We call this method gravitational tempring. Snapshots are shown in Fig. 2.

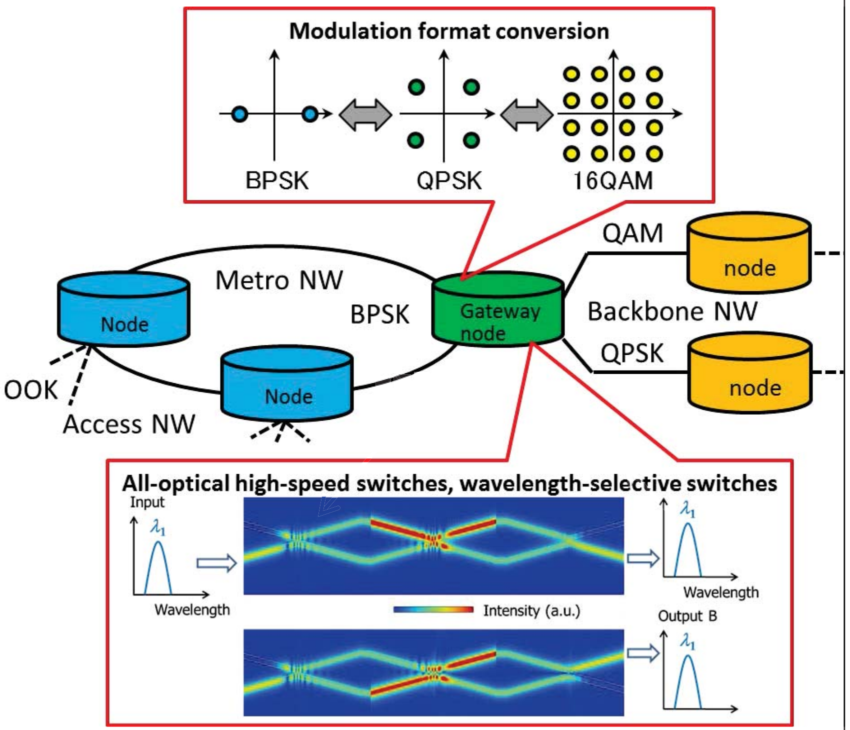
Keywords : crystallization, collodal crystal, defect

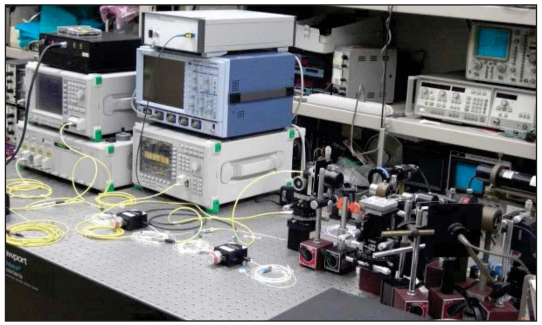
E-mail: atsushimori@tokushima-u.ac.jp>
Tel. +81-88-656-9417
Fax: +81-88-656-9435

Optical signal processing for photonic network

Faculty of Engineering
Tokushima University

Assistant Professor Hiroki Kishikawa





Experimental setup for all-optical switching using graphene

The amount and the change of communication traffic continue to grow year by year. In order to meet such growing demands for future network, further capacity increase is indispensable as well as flexibility and efficiency.

In our group, we study integrated-optic devices and all-optical systems without converting to electric signals as follows so that flexible, efficient, higher-capacity network is realized by improving spectral efficiency with effective use of limited wavelength resources.

- Modulation format conversion systems

Are studied to establish adaptive modulation and demodulation technologies that adaptively choose a modulation format by considering desired capacity and optical reach, especially in quadrature amplitude modulation (QAM) suitable for future 400Gb/s and 1Tb/s transport systems.

- All-optical high-speed wavelength-selective switching

Technologies are studied to equip the optical switch with faster operating speed and wavelength selectivity as well as lower power consumption by using Raman amplification and saturable absorption in nonlinear medium such as graphene.

Keywords: photonic routing, photonic switching, all-optical signal processing, modulation format conversion

E-mail: kishikawa.hiroki@tokushima-u.ac.jp

Tel. 088-656-9418

Fax: 088-656-9415

HP : http://www.opt.tokushima-u.ac.jp/lab/b-3/index_en.htm

Synthesis of Stereocontrolled Polymer by Radical Polymerization

Assistant Professor Miki Niwa

Faculty of Engineering
Tokushima University

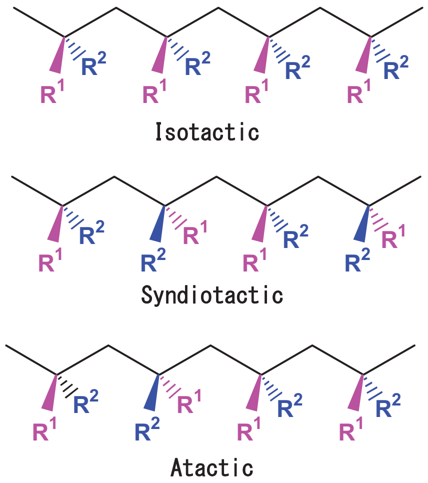


Fig.1 Tacticity of polymer

Fig.2 Applications

Content:

Radical polymerization is a general synthetic method of polymer. Radical polymerization is industrially used widely as a cheap price and simple method. However, it is difficult to control the tacticity of polymer by radical polymerization. If tacticity is controlled, the physical properties of a polymer are improved and expansion of use application.

We are studying the synthetic method and mechanism of isotactic polymer by radical polymerization.

Moreover, in our continuous works on the functional polymers synthesis through a radical polymerization of the bio-based monomers including lactic acid-, and amino acid-based monomers, we found that most of these monomers were easily polymerized with radical initiator to give a stereospecific polymer.

Keywords : radical polymerization, polymer chemistry, stereocontrolle, stereoregularity, chiral

E-mail: niwa.miki@tokushima-u.ac.jp

Tel. +81-88-656-9424

Fax: +81-88-656-9435

Faculty of Engineering
Tokushima University

Hybrid observation using optical and scanning probe microscopy

Assistant Professor Shin-ichiro Yanagiya

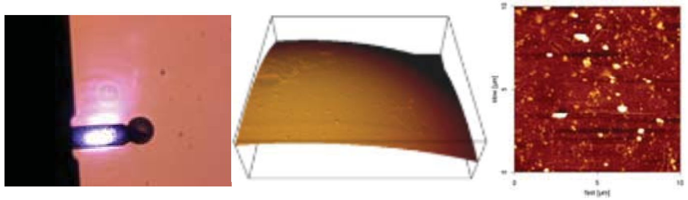


Fig.1 Observation gold nano particles on a micro glass bead.

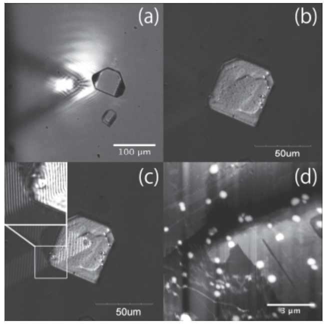


Fig. 2 Consecutive observation of crystal surface by OM, LCM–DIM, and AFM.

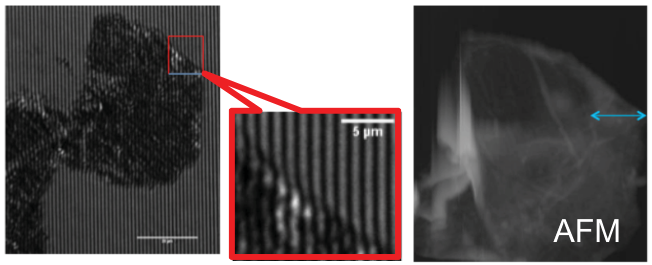


Fig.3 Interferometric observation of corneocyte

Content:

In this decade, integrated setup of an optical microscope (OM) and an optical microscope have been attractive instrument for the observation of soft materials and biological samples. I have obtained the following hybrid observation;

1. Observation of nano particles deposited on micro glass bead

Figure 1 shows the OM image and AFM images of gold nano particles deposited on micro glass bead. We successfully approached on a micro glass bead and observed the nano gold deposited on convex surface.

2. Consecutive observation of crystal surface (Fig. 2)

Crystal surface of potassium dihydrogen phosphate (KDP) was observed using a laser confocal microscope combined with differential interference microscope (LCM-DIM) and AFM. Nano-size particles are consecutively observed from mm scale.

3. Novel interference microscopy for the measurement of refractive index of a quite small volume (Fig. 3)

Keywords： Mesoscopic science, Optical microscopy, Atomic force microscopy, Interference microscopy

E-mail: syanagiya@tokushima-u.ac.jp

Tel. +81-88-656-9416

Fax: +81-88-656-9435

HP : http://www.opt.tokushima-u.ac.jp/lab/b-3/yanagiya/