Science Map

pLED
Institute of Post-LED Photonics, Tokushima University

※ Yellow = Previous research content Green = Current research content.

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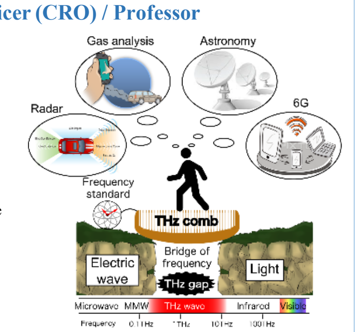
Web

Wavelength (μm)
1000 100 10 1 0.1 0.01 0.001

Terahertz
(100 μm–1 mm)

The terahertz region, characterized by a longer wavelength compared to that of visible light, is widely recognized as the "final frontier" of electromagnetic waves, with continuous progress in its development. Its ability to penetrate solid objects has garnered attention as a potential source of light for applications such as non-destructive inspection of infrastructure and detection of foreign substances in food.

Chief Research Officer (CRO) / Professor YASUI Takeshi

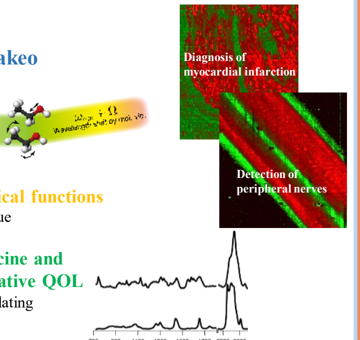


THz comb
A THz comb is a frequency ruler that bridges the THz gap located at the boundary between light and electric waves. A wide range of industrial applications will be possible by establishing a highly reliable THz frequency standard technology "THz comb".

Infrared
(0.7 μm–100 μm)

Given its ability to serve as a highly accurate ruler when shone upon objects, the utilization of this technology in the realm of healthcare is anticipated, particularly in areas such as diagnostic evaluations based on the analysis of breath components.

Associate Professor MINAMIKAWA Takeo

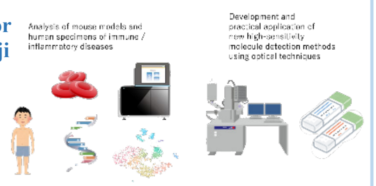


Raman spectroscopy to visualize biological functions
Raman spectroscopy can visualize biological tissue function noninvasively
Interdisciplinary collaboration of medicine and photonics aimed at improving postoperative QOL
We aim to improve postoperative QOL by formulating surgical procedures based on molecular function sensing of biological tissue

Visible light
(400 nm–700 nm)

The electromagnetic waves that we commonly experience as "light" can be perceived as colors by the human brain, the hue of which varies as a function of its wavelength.

Co-CRO/Professor YASUTOMO Koji
Assistant Professor TSUKUMO Shin-ichi



Detection of biomolecules using new light technology
Elucidation of disease mechanisms by analyzing pathological mice models based on genetic analysis of immune and inflammatory diseases in humans and mice, and development of optical devices that can detect blood molecules correlated with the pathological conditions

Co-CRO/Professor YASUTOMO Koji
Assistant Professor OTSUKA Kunihiro

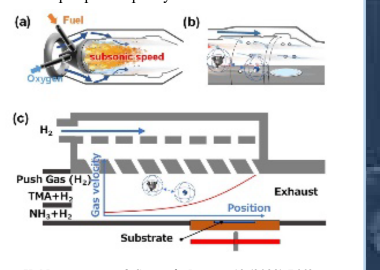
Elucidation of the pathogenesis of intractable diseases and development of new diagnostic and therapeutic methods
Our goal is to clarify the pathogenesis of diseases that are difficult to diagnose and treat, such as autoimmune diseases, cancer, and infectious diseases, at the molecular level, and to apply to medical treatment by integrating it with the new technology of Institute of Post-LED Photonics.
【Research theme】
1.Identification of autoimmune disease-specific molecules and development of new diagnostic and therapeutic methods based on single-cell transcriptome analysis
2.Elucidation of the pathogenesis of COVID-19 and development of new diagnostic and therapeutic methods
3.Elucidation of the pathogenesis of intractable diseases by Raman spectroscopy and development of new diagnostic methods.

Ultraviolet /deep ultraviolet / X-ray
(1 pm–380 nm)

The deep ultraviolet region is anticipated to play a central role as the successor to mercury lamps in the treatment and sterilization of water. Efforts are underway to realize a prolonged lifespan through the suppression of internal crystal defects in LED technology, and to exploit this capability in innovative ways across a wide range of fields, including medicine, air purification, and cellular research.

Associate Professor NAGAMATSU Kentaro

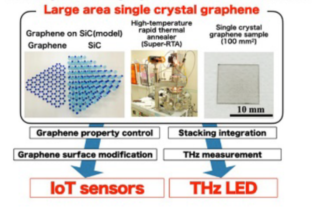
High-temperature growth is realized by imitating jet engine gas flow metalorganic vapor phase epitaxy.



K. Nagamatsu et al. Scientific Reports,12 (2022) 7662,

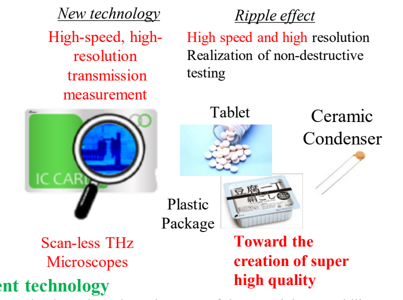
Development of an ultra-high temperature MOVPE for deep UV LEDs and a novel microscope for observing crystal defect
We aim to realize deep UV LEDs at a long lifetime by suppressing crystal defects.

Professor NAGASE Masao



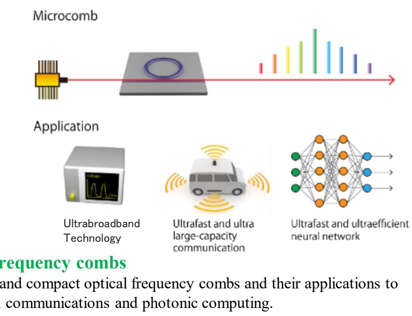
Fabrication of large-area monocrystalline graphene
Focusing on the electronic properties of graphene, which is expected to become a post-silicon material, we established a graphene fabrication technology on single crystal SiC substrates.
Fabrication of advanced devices using graphene
Development of graphene devices applicable to terahertz LEDs and high-performance IoT sensors

Associate Professor TOKIZANE Yu



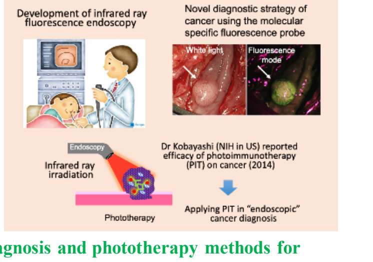
Non-destructive terahertz wave
Development of novel measurement technology
Development of non-destructive measurement technology that takes advantage of the material permeability of terahertz light, the spectroscopic ability to distinguish materials, and the safety towards the human body

Associate Professor KUSE Naoya



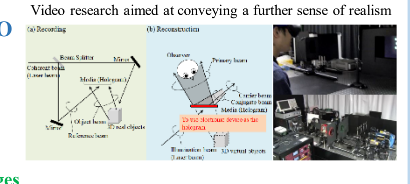
Microresonator optical frequency combs
Development of cost-effective and compact optical frequency combs and their applications to ultrabroadband wireless/optical communications and photonic computing.

Professor TAKAYAMA Tetsuji



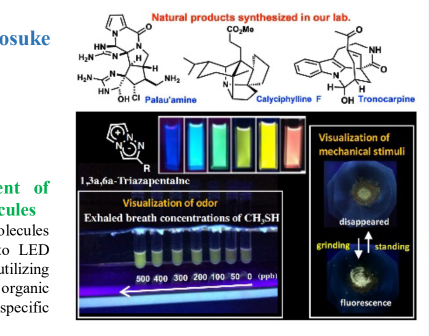
Development of novel endoscopic diagnosis and phototherapy methods for cancer using special light
Development of fluorescent probes targeting molecules specifically observed in cancer cells, development of molecular imaging diagnostic methods, and creation of novel light therapy that cauterizes only cancer cells

Professor YAMAMOTO Kenji



Immersive and stereoscopic images
Various research and development are being conducted for images that give a sense of realism, but among them, we are researching shooting technology, information processing technology, and display technology with a focus on stereoscopic images. Regarding photography techniques, we are conducting research on a camera for light field photography that can capture images in natural colors. Regarding display technology, for example, we are researching displays that use holography, and we are working on making it possible to display moving images that could previously only be displayed as still images.

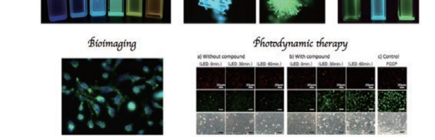
Professor NAMBA Kosuke



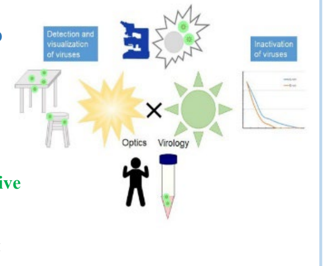
Research on the development of photoresponsive organic molecules
Development of light-responsive molecules that express function in response to LED irradiation of specific wavelengths, utilizing the technology for synthesizing organic molecules that glow by detecting specific components in exhaled air

Associate Professor YAGISHITA Fumitoshi

Exploring the optical function of pi-electron organic molecules
Development of highly luminescent organic molecules that can be applied to displays, solid-state lasers, bioimaging, and photodynamic therapy, and chiroptical materials with circularly polarized luminescence that can be applied to 3D displays and security inks.

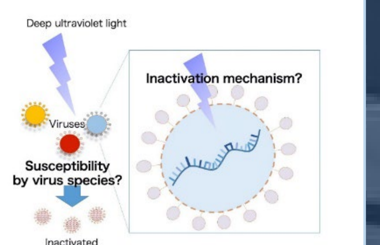


Professor NOMAGUCHI Masako



Promotion of medical and optical collaborative research in the field of viral infections.
We tackle to create a fundamental technology for "visualization" and "detection" of viruses by combining virology and optics.

Associate Professor KOMA Takaaki

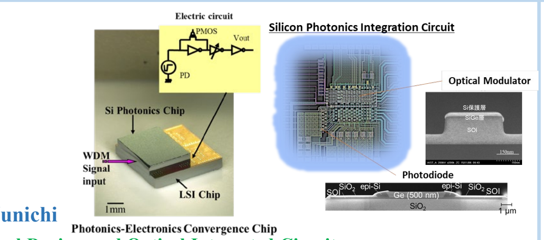


Virus inactivation using deep ultraviolet light
We will elucidate the mechanism of virus inactivation by deep ultraviolet light and conduct research on differences in inactivation effects based on virus type.

Professor HOSAKA Keiichi

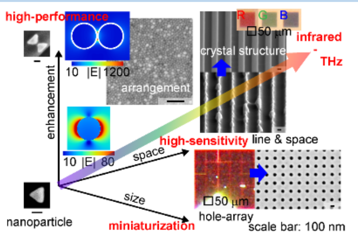
Interdisciplinary Research of Minimally Intervention Dentistry and Photonics
Dental caries affects all ages, and resin composite is key for its aesthetic and mechanical benefits. Effective adhesion is vital for creating a durable 'super-tooth' interface. Using biocompatible adhesives and photonics, we aim to investigate this interface's mechanics, aiming to innovate minimally invasive treatments that benefit everyone from children to the elderly, while mitigating economic impact.

Professor FUJIKATA Junichi



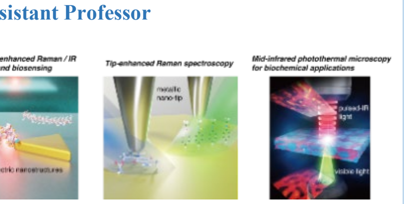
Functional Optical Devices and Optical Integrated Circuits
We are researching optical information processing technology using functional optical devices and optical integrated circuits to realize high-speed and high-capacity communications and neural network computing. Furthermore, we are researching optical and THz-waves seamless-connection technology for Beyond5G next-generation information communications to realize low-carbon and secure network society.

Associate Professor YAMAGUCHI Kenzo



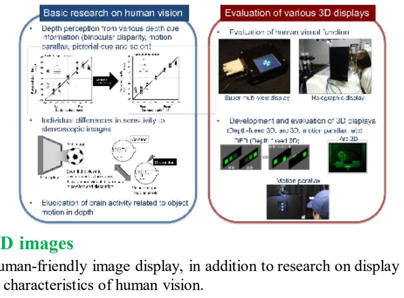
Multifunctional plasmomechanical devices with on-chip integrated MEMS/NEMS actuators
Surface plasmons (SPs), the collective oscillations of conduction electrons, can be supported metallic nano-structures and manipulate the light in the nanoscale. This is one of key technologies combined with MEMS/NEMS for developing a nano-optical device to miniaturization and power efficiency.

Designated Assistant Professor KATO Ryo



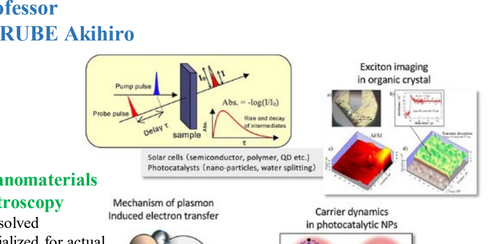
Advanced optical spectroscopy using visible and infrared light and its biological applications
The interaction of light and matter allows us to observe unique chemical, optical, and physical properties of samples. Our aim is to develop advanced bio-sensing and bio-imaging based on optical spectroscopies, such as Raman and Infrared absorption spectroscopy for studying fundamental of biological phenomena and for the early detection and treatment of diseases.

Associate Professor MIZUSHINA Haruki



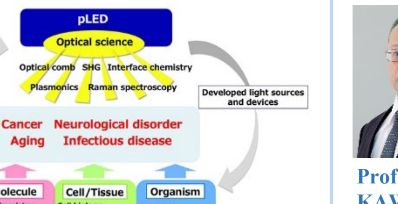
Visual information processing/3D images
In order to realize highly realistic and human-friendly image display, in addition to research on display technology, it is necessary to clarify the characteristics of human vision.
We have clarified human visual perception mainly spatial perception and depth perception, and are conducting research on technologies to apply these characteristics to displays.

Professor FURUBE Akihiro



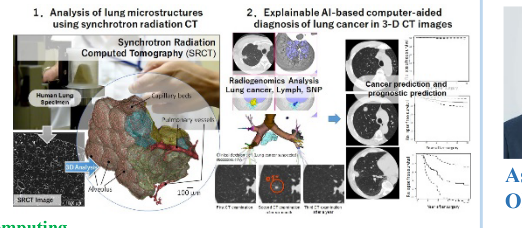
Optical functional nanomaterials
Advanced laser spectroscopy
Development of a time-resolved spectroscopy system specialized for actual device measurements based on a femtosecond laser light source that glow only for a very short period of time (10^{-13} seconds)

Associate Professor SAKANE Ayuko



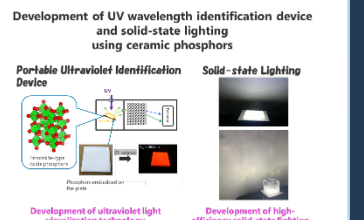
Basic research aimed at elucidating disease pathogenesis and creating optical devices leading to innovative diagnoses and treatments
Aiming to elucidate the pathogenesis of various diseases, we develop new integrated research with photonics scientists, and promote the development of new light sources and devices.

Professor KAWATA Yoshiki



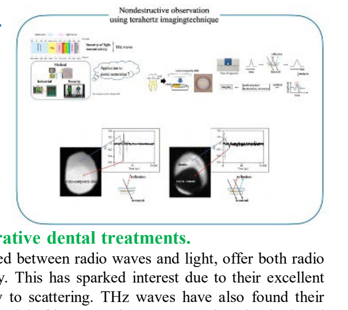
Medical imaging and computing
This field is related to medical imaging and medical image analysis. We are working on three-dimensional CT image processing algorithms, which are the core computer-aided technology mainly based on three-dimensional CT images, and high-performance computer-aided technology that supports lung cancer detection, differential diagnosis, and prediction of malignancy and prognosis from three-dimensional CT images.

Associate Professor OISHI Masatsugu



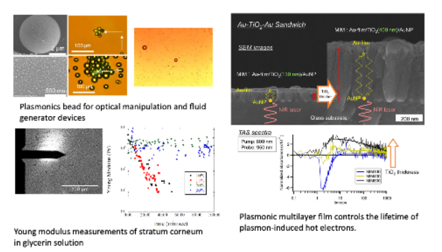
Development of UV wavelength identification device and solid-state lighting using ceramic phosphors
Researches on the environmentally friendly-energy conversion devices which achieves high-efficiency energy conversion such as fuel cells, storage batteries and solid-state lightings, with the goal of contributing to the global environmental problems.

Assistant Professor YONEKURA Kazuhide



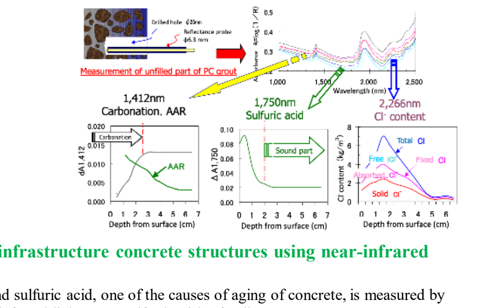
Integration of dental engineering offers the potential for innovative restorative dental treatments.
In recent years, Terahertz (THz) waves, positioned between radio waves and light, offer both radio wave-like transmissivity and light-like directivity. This has sparked interest due to their excellent material transmissivity and limited susceptibility to scattering. THz waves have also found their application in dentistry. We are exploring the potential of incorporating THz wave imaging in dental restorative procedures, aiming to enhance our understanding of caries and restorative treatment.

Associate Professor YANAGIYA Shin-ichiro



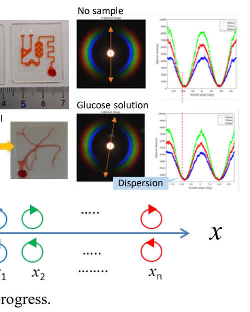
Physical properties of medical nanomaterials
Development of photothermal composite-materials and devices for nanosurgery applications.

Professor UEDA Takao



Health diagnosis of infrastructure concrete structures using near-infrared spectroscopy
Internal erosion of salt and sulfuric acid, one of the causes of aging of concrete, is measured by spectroscopy using near-infrared light to quantify the risk of collapse

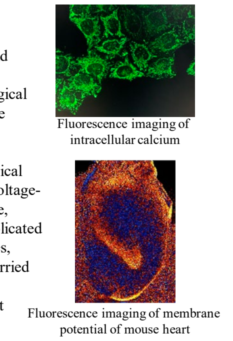
Designated Associate Professor EMOTO Akira



Polarizing Devices/Polarizing Measurements
We will work on the application of polarized light regardless of wavelength, from deep ultraviolet to THz waves.
Microprocessing/flow channel device development
Research on processing technology and device manufacturing to advance optical measurement is also in progress.

Associate Professor TAKANARI Hiroki

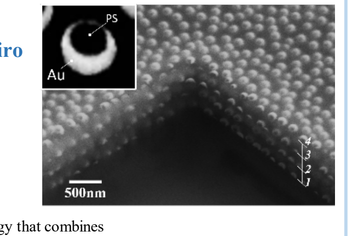
Visualization of the electrical activity of cells and tissues
In many organs such as the heart and nerves, the electrical activity of cells controls various subsequent physiological activities. We observe and analyze the electrical activity of cells using conventional patch-clamp electrophysiological methods and optical mapping methods using membrane voltage-sensitive fluorescent dyesFurthermore, since conventional methods are complicated and require the use of fluorescent dyes, research and development is being carried out aiming for a new technology that measures membrane potential without staining, labeling, or contact.



Fluorescence imaging of intracellular calcium

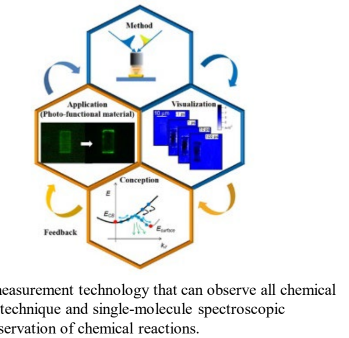
Fluorescence imaging of membrane potential of mouse heart

Associate Professor OKAMOTO Toshihiro



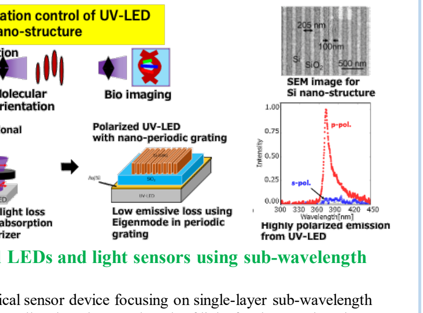
Metamaterial development
Development of metamaterial fabrication technology that combines nano processing and mass production
Elucidation and application development of novel phenomena derived from metamaterials
Elucidation of novel phenomena such as negative refractive index, optical magnetism, and complete light absorption, and the application to various sensors

Assistant Professor KATAYAMA Tetsuro



Elucidation of reaction mechanisms by spatio-temporal spectroscopy
Development of spatio-temporal spectroscopic measurement technology that can observe all chemical species by combining pump probe measurement technique and single-molecule spectroscopic measurement technique that can enable direct observation of chemical reactions.

Professor NAOI Yoshiki



Development of multifunctional LEDs and light sensors using sub-wavelength nanostructures
Development of an integrated LED/optical sensor device focusing on single-layer sub-wavelength nanostructures having a period slightly smaller than the wavelength of light for the wavelength range of ultraviolet to visible light.

Assistant Professor TAKASHIMA Yusuke

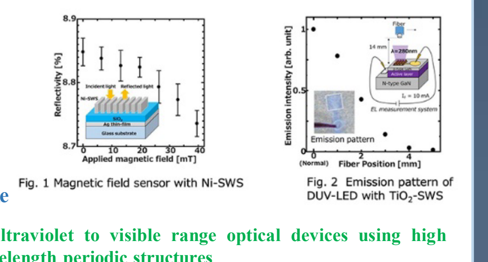


Fig. 1 Magnetic field sensor with Ni-SWS
Fig. 2 Emission pattern of DUV-LED with TiO_2-SWS

Development of deep ultraviolet to visible range optical devices using high refractive index sub-wavelength periodic structures
Development of novel optical elements, sensors, and light-emitting devices in deep ultraviolet to visible light regions using a high refractive index subwavelength periodic structure (SWS) with periods smaller than optical wavelengths.

Associate Professor KISHIKAWA Hiroki

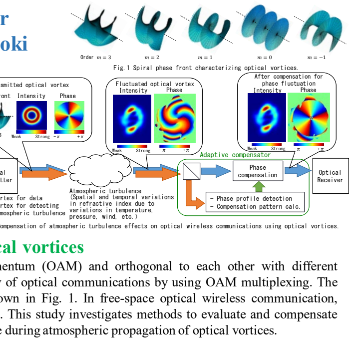
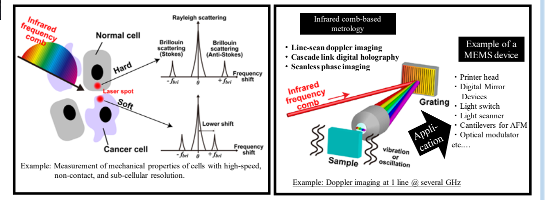


Fig. 1 Spiral phase front characterizing optical vortices.
Fig. 2 Compensation of atmospheric turbulence effects on optical wireless communications using optical vortices.

Research on high-capacity optical communication technology using optical vortices
Optical vortices are beams with orbital angular momentum (OAM) and orthogonal to each other with different azimuthal orders. It is expected to increase the capacity of optical communications by using OAM multiplexing. The spiral phase front characterizing optical vortices is shown in Fig. 1. In free-space optical wireless communication, optical vortices are distorted by atmospheric turbulence. This study investigates methods to evaluate and compensate for the effects of phase fluctuations caused by turbulence during atmospheric propagation of optical vortices.

Designated Assistant Professor HASE Eiji

Measuring mechanical properties of biological materials
Development of Brillouin scattering microscope based on frequency combs and application for the measurement of mechanical properties of biological materials.
Application of infrared combs to industrial measurement
Development of infrared comb-based measurement techniques for industrial measurements, such as MEMS devices.

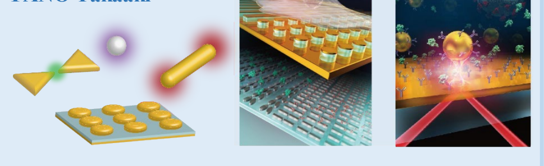


Example: Measurement of mechanical properties of cells with high-speed, non-contact, and sub-cellular resolution.

Example: Doppler imaging at 1 line @ several GHz

Research involving a wide range of wavelengths

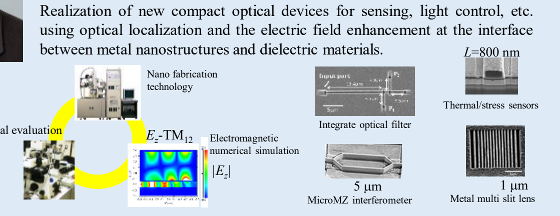
Professor YANO Takaaki



Development of nanoscale optical devices/structures for highly sensitive optical sensing and imaging
Plasmonics and metamaterials for nanoscale manipulation of light in DUV, visible, infrared and THz regions

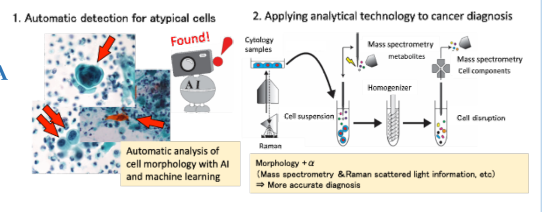
Co-CRO/Professor HARAGUCHI Masanobu

Realization of new optical devices using functions derived from nanostructures
Realization of new compact optical devices for sensing, light control, etc. using optical localization and the electric field enhancement at the interface between metal nanostructures and dielectric materials.

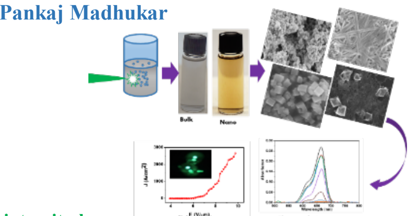


Professor TSUNEYAMA Koichi

Research and development of new cancer diagnosis technology
Establishment of auxiliary morphological diagnosis methods combining AI and machine learning, and development of rapid diagnostic methods for heteromorphic cells using Raman scattered light analysis/mass spectrometry with the aim of improving the quality of cancer diagnosis



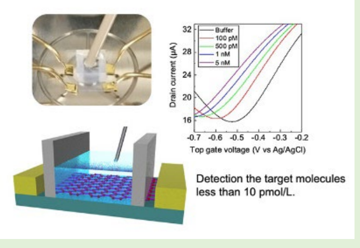
Associate Professor KOINKAR Pankaj Madhukar



Nanomaterials made with high-intensity lasers
Synthesis of two-dimensional nanomaterials is performed with pulsed laser ablation technology in liquid
We aim to control integrated two-dimensional materials and apply them to energy-related devices, such as optoelectronics and photocatalysts, utilizing metal nanostructures

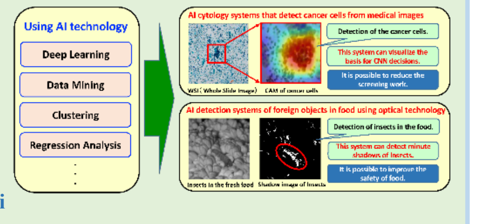
Research in collaborative fields

Associate Professor OHNO Yasuhide



Biosensors using epitaxial graphene
For graphene biosensors that had issues with reproducibility up until now, extremely high reproducibility and sensitivity have been achieved using epitaxial graphene.

Professor SHISHIBORI Masami



Development of multimedia systems utilizing AI technology
Development of intelligent multimedia systems such as cytology systems that detect cancer cells from medical images (cell images) using AI technology, and detection systems of foreign objects in food using optical technology and deep learning model.

Associate Professor SHIRAI Akihiro

Sterilize with UV plus α
Sterilizing power can be improved with UV plus α (substances with weak antibacterial activity, addition of low concentrations of antimicrobial agents)
Synergistic sterilizing power with light plus natural products
Used to control pathogenic microorganisms and spoilage-causing microorganisms in the food and medical fields