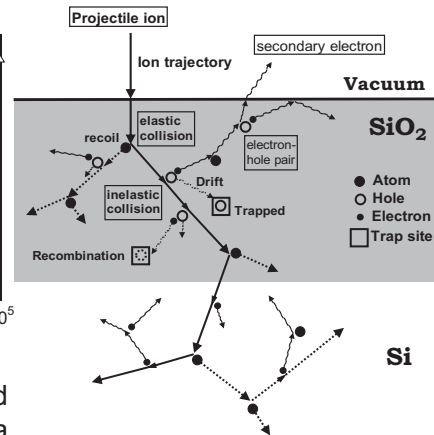
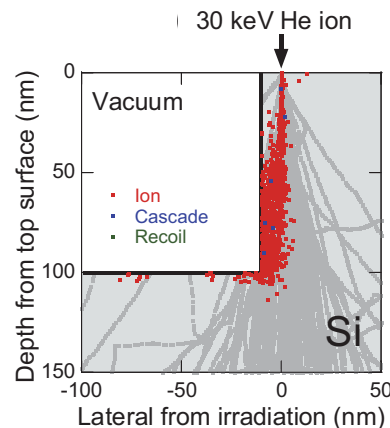


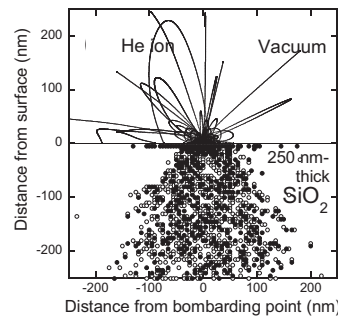
(a) Secondary electron yield from a gold sample as a function of helium ion energy.



(c) Schematic diagram of secondary electron emission and charging of a  $\text{SiO}_2$  layer formed on a Si substrate.



(b) Origins of secondary electrons escaped from the step structure irradiated by a helium ion beam.



(d) Charge distribution accumulated in a  $\text{SiO}_2$  layer and trajectories of secondary electrons emitted from the surface.

## Content:

A scanning ion microscope (SIM) using a gallium (Ga) focused ion beam, like conventional scanning electron microscopes (SEMs), has been used to detect secondary electrons (SEs) emitted from a sample by scanning the ion beam across it, as an observation tool in micro-fabrication processes.

Recently, a SIM using a helium gas field ion source, generally called HIM, has attracted interest for its impressive capability not only to observe nanostructures but also to fabricate them. Although the image formation mechanisms of the HIM are similar to those in the SEM, there are some differences in image properties.

We have performed Monte Carlo simulations of the SE emission in Ga-SIM and HIM to compare with those obtained using SEM. The approach has revealed the theoretical spatial resolution and the origin of the image differences from those in the SEM.

Recent development of the modeling work presents charging characteristics of insulating layers on a conducting substrate and image contrast for nanostructured materials.

Keywords: ion microscope, ion-solid interaction, secondary electron emission, computer simulation

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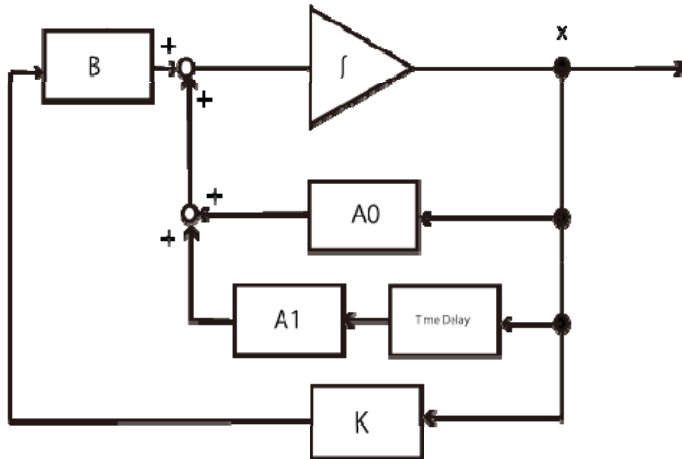


Fig.1 Feedback control of a time delay system

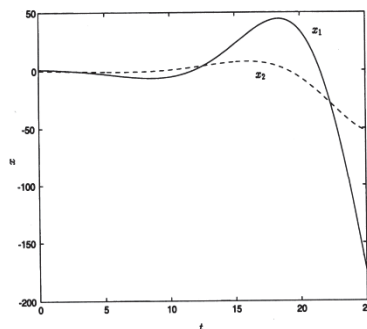


Fig.2 Open loop system

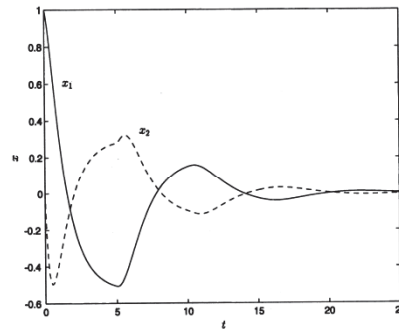


Fig.3 Closed loop system

### Content:

Systems with time delay belong to a class of infinite dimensional systems. To construct a linear quadratic regulator of such a system, generally a solution of an infinite dimensional Riccati equation is required to calculate the feedback gain and a real-time integral operation is included in the feedback law.

To stabilize such systems, we propose a method to construct an inverse linear quadratic regulator. The feedback gain can be calculated from a solution of a finite dimensional Riccati equation or a finite dimensional linear matrix inequality, and the feedback law is so-called the memoryless feedback which doesn't include a real-time integral operation as shown in Fig. 1. The resulting closed loop system can be shown to be stable (compare Fig.2 and Fig. 3 for example), and to be a linear quadratic regulator for some quadratic cost functional. Moreover, it is assured to have a good robustness property against a class of static nonlinear perturbations or dynamic linear perturbations in the input channel as well as a linear quadratic regulator for systems without time delay.

Keywords: time delay, LQ regulator, robust stability

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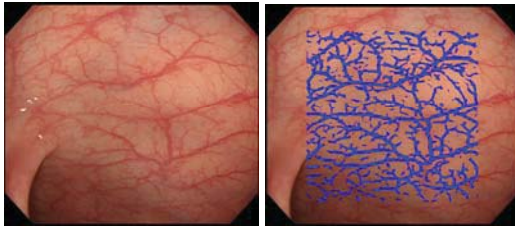


Fig. 1 A large intestine endoscope image and a blood vessel extraction result

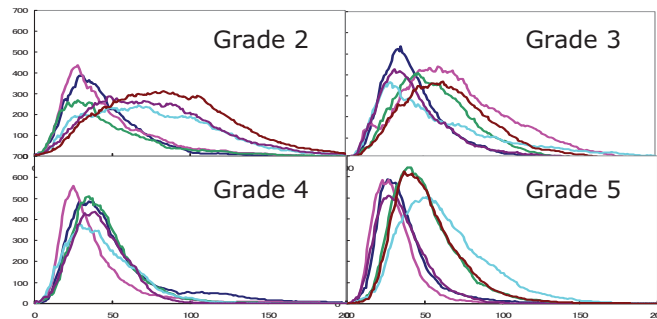


Fig. 2 Extracted blood vessel numbers curves for each histological classification of Matts grade from 2 to 5

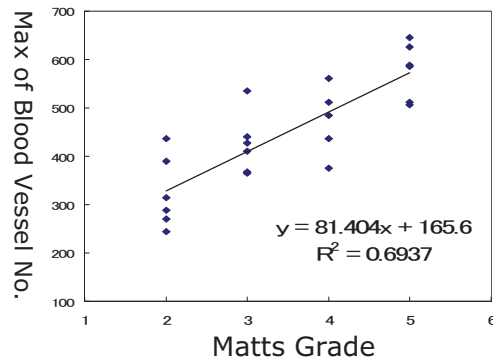


Fig. 3 The good correlation between the histological Matts grades and extracted maximum of blood vessel numbers

### Content:

The ulcerative colitis is appointed in an intractable disease in Japan to repeat a recurrence by the inflammatory disease that a sore and the ulcer are formed on the mucous membrane (the inside) of the large intestine. The endoscope is used for the diagnosis. The purpose of this study is to support diagnosing it by computer image processing for the blood vessel pictures of the large intestine inside. By the blood vessel image extraction and characteristic parameter research, the degree of inflammation from the state of a mucous membrane would be intended to estimate by the image processing instead of the histological classification.

At first, blood vessels are extracted from an endoscope image, as shown in Fig. 1, and the blood vessel characteristic parameter is researched, that is effective to estimate an inflammatory diagnosis degrees. The matching filter of the Gaussian distribution type is used to extract blood vessels. By changing the threshold value for the binarization, blood vessel number is computed through labeling process for each threshold value. The curve profiles of the blood vessel number are shown in Fig.2 for the histological Matts grades of 2 of slight illness to 5 of most serious case. Figure 2 includes 23 cases so that 23 curves are shown in total. Shapes of curve profile for each the histological grade level are clearly different, that is, the lower grade shows the flatter curve profile. To examine our image processing performance, the correlation between the Matts grade of 2 to 5 and maximum of blood vessel numbers are shown in Fig. 3. As the results, the correlation coefficient is as good as  $R = 0.833$ .

**Keywords :** Large intestine endoscope image, blood vessel extraction, Matts grade evaluation by computer-aided image processing

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Near Field Pattern  $\lambda=470\text{ nm}$

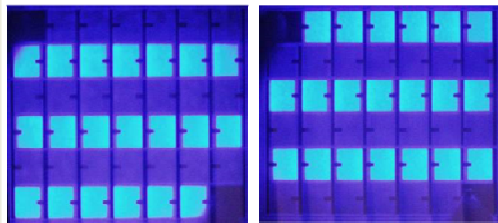
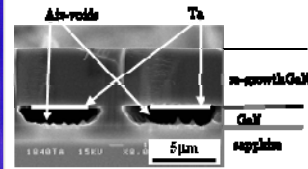


Fig.1



The cross-sectional SEM image of GaN on Ta-GaN/sapphire.

Fig.2

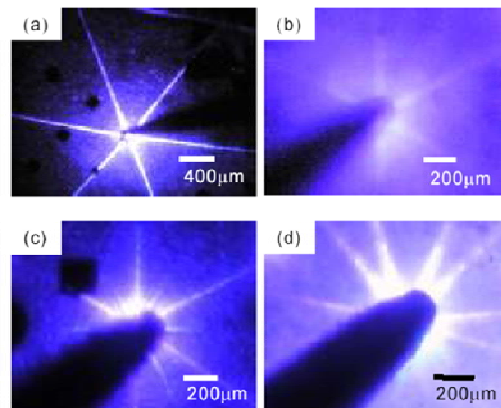
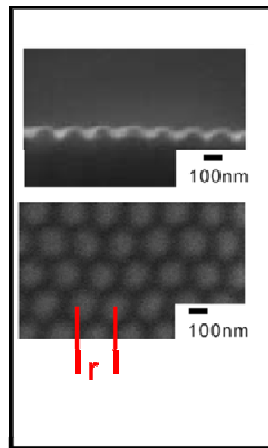


Fig.3

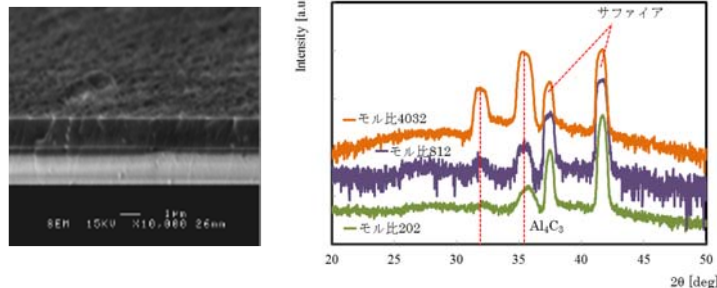


Fig.4

InGaAlN and AIC LEDs are researched.

A high voltage LED is developed. (Fig.1)

Ta-GaN is etched to sapphire during growth, and GaN, the epitaxial layer, is peeled off on Si, for example. (Fig.2)

Nano-pattern is formed on GaN, and their far field pattern are viewed as shown in Fig.3 (a)  $r=200\text{ nm}$ , (b)  $r=300\text{ nm}$ , (c)  $r=400\text{ nm}$  and (d)  $r=500\text{ nm}$ . It is clear that the 6<sup>th</sup> fold pattern is clearly visible for 200 nm which is 6 times for the emitting light.

P-type Mg-Ga $_{1-x}$ Al $_x$ N for  $x>0.3$  is affected by the too deep level of Mg from the valence band, and it becomes an insulator, while C-doped AlGa $_x$ N is possible candidate for p-type conduction. We are making an effort to make carbon-doped AlGa $_x$ N or AlN a p-type conduction.

We are growing AIC on sapphire, SiC and Si. SEM and X-ray rocking curve are shown in Fig.4, where a substrate is sapphire.

Keywords : MOCVD, LED, AlGaInN, AIC

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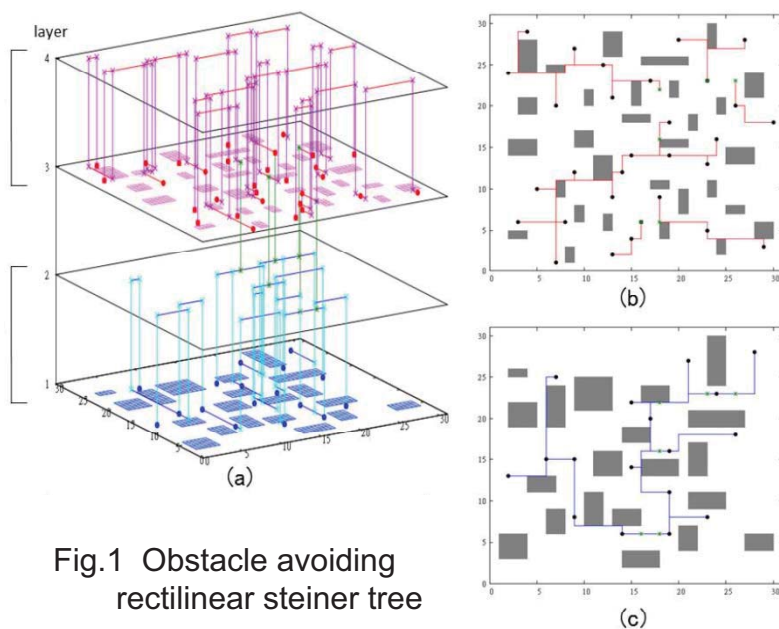


Fig.1 Obstacle avoiding  
rectilinear steiner tree

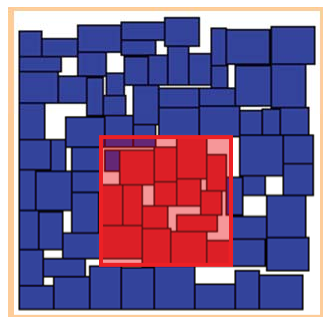


Fig.2 Voltage assignment in floorplan

### Content:

Research of heuristic algorithm  
for optimization problems in LSI layout design

For example,

- Obstacle avoiding rectilinear steiner tree (Fig.1)
- Voltage assignment in floorplan (Fig.2)
- 3-D IC floorplanning with TSV co-placement

Keywords : Heuristic Algorithm, Optimization Problem,  
LSI Design

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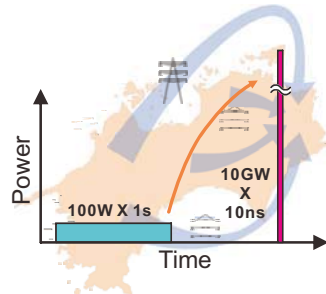


Fig.1 What is pulsed power

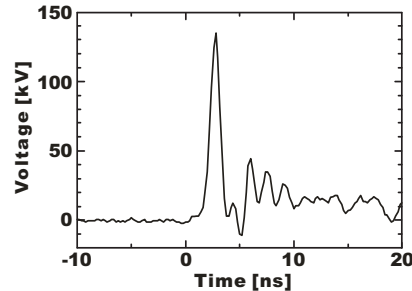
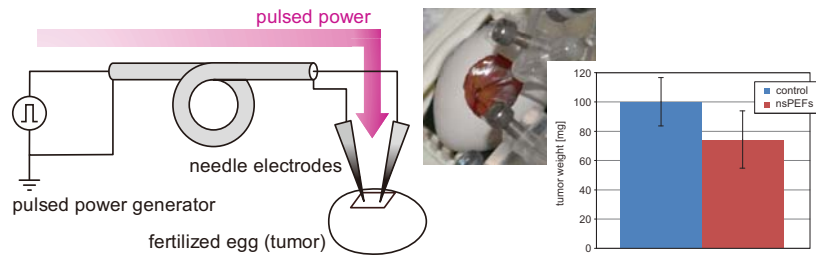
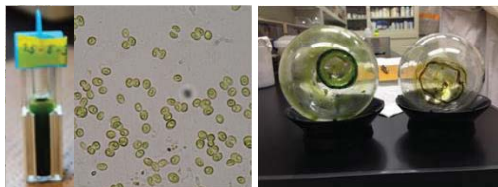


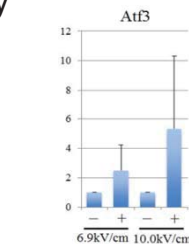
Fig.2 Ns voltage pulse



(a) New cancer therapy



(b) Production of biomass fuel



(c) Control of gene expression

Fig.3 Studies of application of electric pulses

## Content:

There must be some electrical and magnetical influences in biological body and bioelectrics is a field of pulsed power applications recently. Pulsed power is technology of applying high compressive power pulse and according to the electric magnetism and we have focused on green technology and bioelectrics in applications of pulsed power. Some applied researches for effects of electrical pulses on biological body are introduced here.

Different parameters of electric pulses as spectrum would bring different actions and responses on biological body or cells. The control of the parameters and responses will introduce new biological applied-technologies. The responses and their mechanisms, however, have not been still clear. The effects of electric pulses on various object and their mechanisms have been studied and gene expression level as a response has been particularly considered. Some examples of applied study using electric pulses are as follows: new cancer therapy, production of biomass fuel from micro algae, and effects on endoplasmic reticulum stress responses for pulsed electric fields for prevention or therapy of disorders.

Keywords: pulsed power, bioelectrics, pulse electric field

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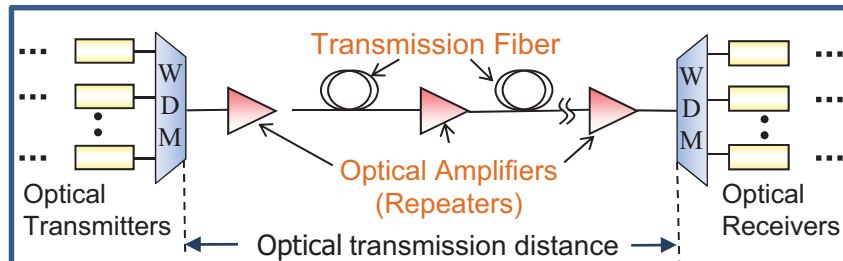
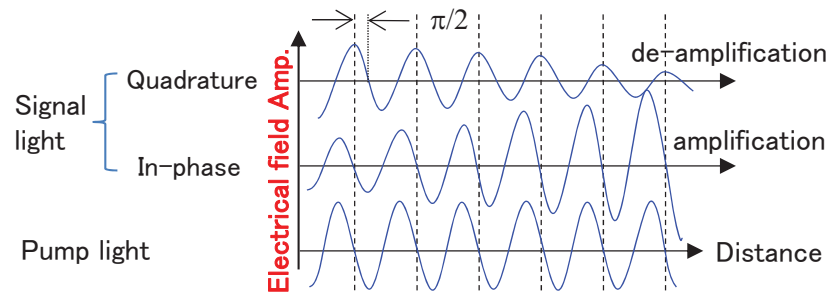
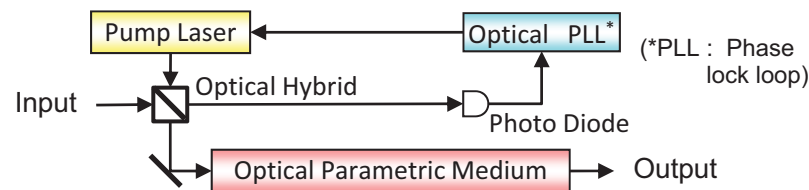


Fig.1 Configuration of backbone optical fiber transmission system



(a) Fundamental operation of PSA



(b) Basic configuration of PSA

Fig. 2 Optical parametric phase sensitive amplifier (PSA)

## Content:

The performance of communication network has been drastically enhanced by adopting fiber-optic transmission technologies into the backbone networks and access networks. Recently, the demand for communication capacity is increasing even more, because of popularization of cloud type-application and transportation of ultra-broadband contents such as high-definition moving pictures. The purpose of our laboratory is bringing a significant progress of communication network by introduce novel functionality into the optical communication network.

One of our topics of research is expanding optical transmission distance in backbone networks (Fig.1) by introducing phase-sensitive optical amplifiers (PSA) (Fig.2) as optical amplifier repeaters. The PSA amplify in-phase and de-amplify quadrature component with reference to phase-locked pump light in parametric amplifiers. From the fundamental operation, significant extension of optical transmission distance is expected.

Keywords: optical communication,  
optical fiber, optical amplifier  
optical signal processing

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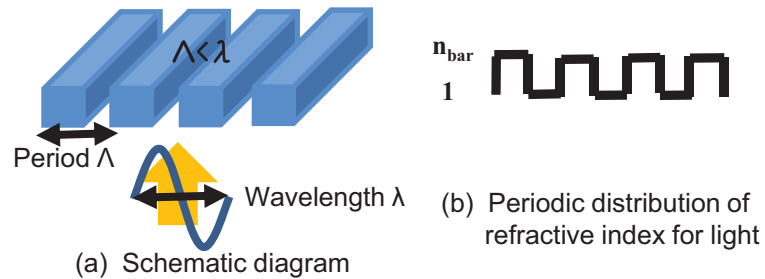


Fig.1 Sub-wavelength grating structure

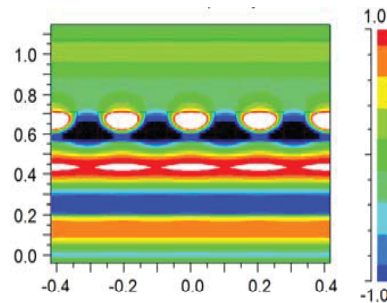


Fig.2 Electrical field distribution for TM light by FDTD theory (in case of  $\lambda/\Lambda=1.8$ )

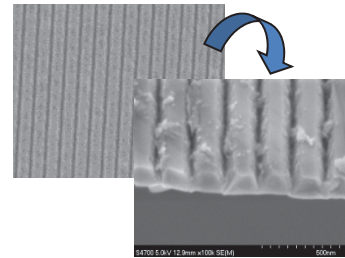


Fig.3 Fabricated sub-wavelength grating on UV-LED surface

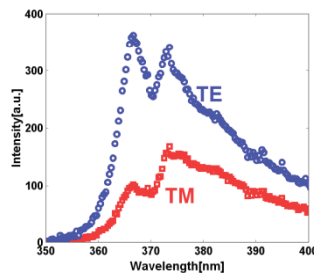


Fig.4 Emission spectra from UV-LED

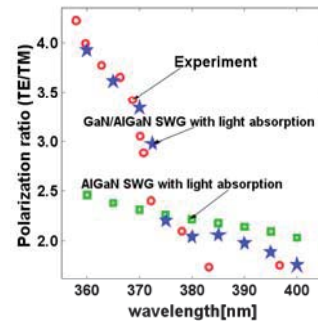


Fig.5 Polarization ratio from UV-LED with sub-wavelength grating

### Content:

Highly polarized UV emission devices were expected to develop the applications, such as high resolution imaging, high sensitive sensors, etc. The compact polarization control device with high transmittance is required in order to develop integrated device for these applications.

One of the candidates to overcome the issue is the device using high contrast dielectric subwavelength grating (SWG) structure. In SWG, the pitch of the grating is shorter than the wavelength of incident light. The Bloch like eigen-modes within SWG region resulting from the spatial periodicity of refractive index distribution interacts with incident light. As a result, the desirable optical characteristics such as broadband high reflectivity and polarization sensitivity are obtained with optimal structures.

We have investigated the polarization characteristics of AlGaIn-based UV-LED with SWG fabricated on the top of LED surface, and demonstrated the feasibility of high polarized UV-LED grown on c-plane sapphire.

Keywords : photonic device, sub-wavelength grating, polarization control, nano device

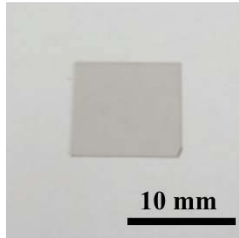
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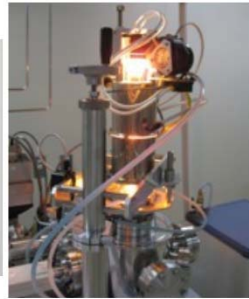
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### Graphene growth on SiC substrate

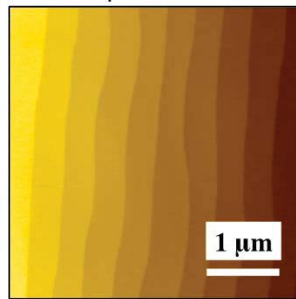
10 mm-sq single-crystal mono-layer graphene sample



Super-RTA for graphene growth

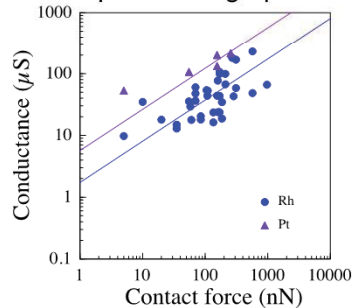


graphene on controlled step structures

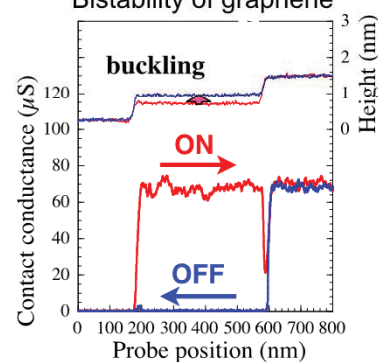


### Graphene properties

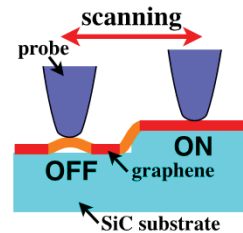
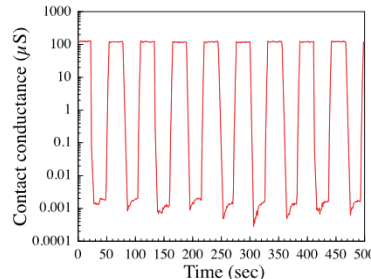
Contact conductance between nanoprobe and graphene



Bistability of graphene



Repeatability of Atomic layer switching



Graphene is very promising for future micro- and nano-electronic systems, because of its outstanding properties. Now, our main research interest is “graphene on SiC”. We can fabricate 10 mm-sq single-crystal mono-layer graphene using super-RTA (rapid thermal annealer). The high-quality and uniform epitaxial graphene was grown on controlled step structures of 4H-SiC (0001) substrate. Graphene properties were evaluated using various kinds of nano-metrology tools. By using scanning probe microscopy (SPM), contact conductance between nanoprobe and graphene was measured. The contact resistance value was estimated to be the order of  $10^{-9} \Omega \text{ cm}^2$ . The novel phenomena of graphene nanomembrane with bistable contact conductance states was observed. This electro-mechanical bistability of atomic layer switch could represent a new path to nano-electro-mechanical systems. A final goal of our graphene research will be new functional devices for the post-Si era.

Keywords: graphene, SiC, nano-metrology

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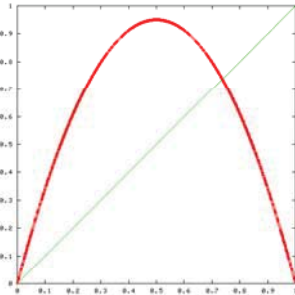


Fig. 1: Logistic map, one of the most famous one-dimensional map generating chaos.

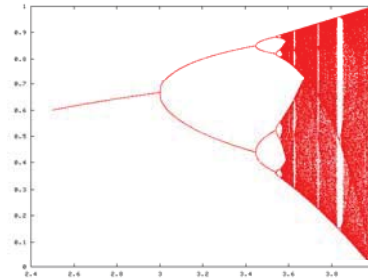


Fig. 2: One-parameter bifurcation diagram of the Logistic map.

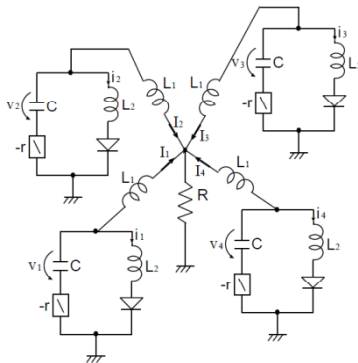


Fig. 3: Four autonomous chaotic circuits coupled by one resistor.

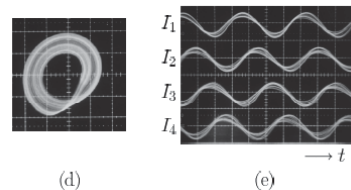
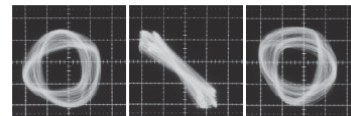


Fig. 4: Four-phase quasi-synchronization of chaos observed from the circuits in Fig. 3.

Content:

1. Chaos Cryptosystems

Sensitive dependence of chaos on initial conditions and parameters is exploited for various security issues.

2. Chaos Communication Systems

Continuity of chaotic sequences generated from an identical chaotic map is exploited to recover data correctly.

3. Complex Networks

Various synchronization phenomena in coupled chaotic circuits are good models of various complex networks.

4. Nonlinear Time Series Analysis

Chaos analysis is utilized to predict a trend of nonlinear time series or to diagnose medical signals.

5. Data Mining

Self-organizing feature of artificial neural networks is exploited to carry out clustering of various data.

Keywords: chaos, chaos cryptosystems, chaos communication systems, complex systems, nonlinear time series analysis

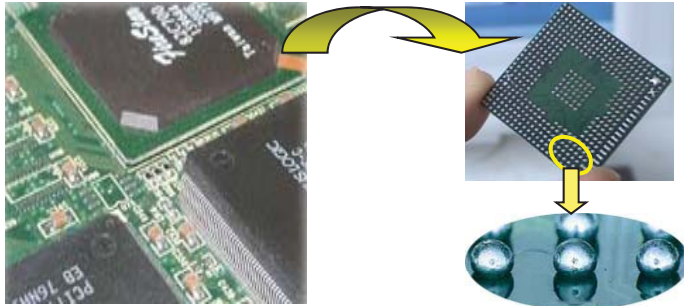
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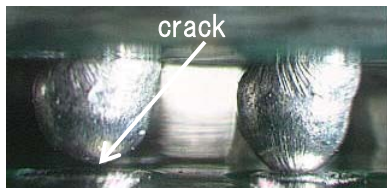
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(a) Assembled printed circuit boards



(b) Open defect occurring in soldering process

Fig.1 Targeted defects

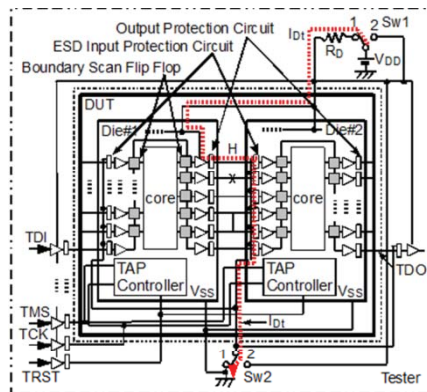


Fig.2 Electrical test of assembled PCB

### Content:

BGA ICs have been often used for realizing electric circuits of smaller size. The ICs are soldered on a fine pitched PCB. Open defects may occur at interconnects between the ICs and the PCB in the soldering process. An example of the defects is shown in Fig.1. The interconnects are impossible to be observed by visual inspection. Also, logic signals of the interconnects can not be measured with a test probe. Thus, IEEE 1149.1 test circuit has been implemented inside the ICs.

However, open defects may not be detected, even if the circuit is implemented inside an IC. Also, it is difficult to generate test input vectors for detecting open defects and locating defective interconnects. Thus, we are developing electrical test methods and DfT(Design-for-Testability) methods for open defects in the interconnects.

One of our test methods is shown in Fig.2. Our methods are based on supply current that is made flow in our tests. Soft open defects that generate only additional delay time can be detected and the defective interconnects can be located together with hard open defects that generate logical errors with our test methods.

Keywords : electrical test, printed circuit board, soldering error , open defect

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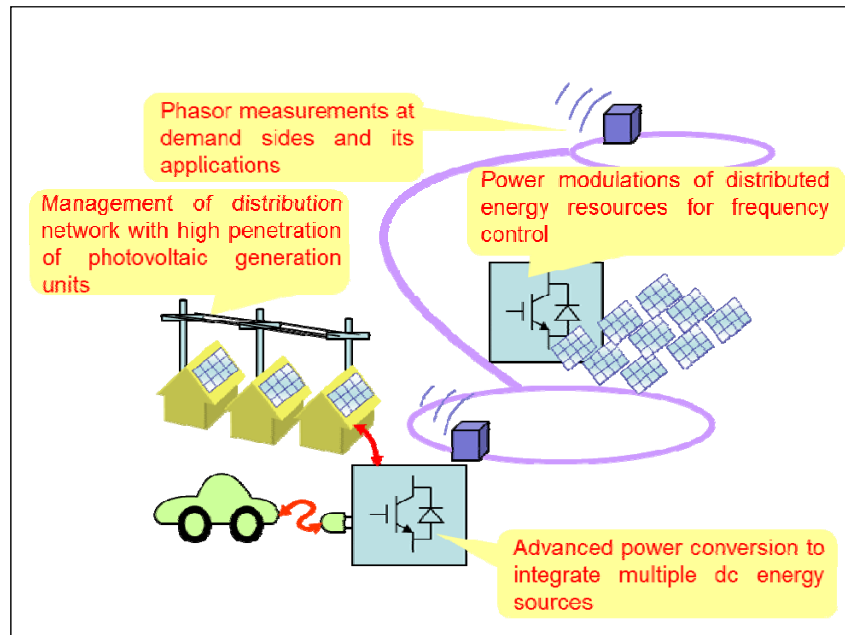


Fig. 1. My major researches.

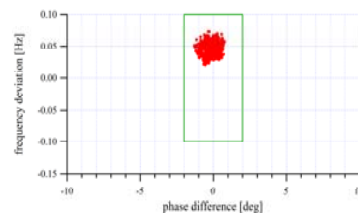


Fig. 2. Online monitoring.

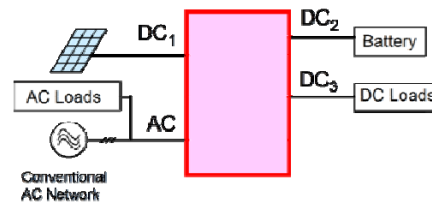


Fig. 3. Dc sources integration.

### Content:

#### 1. [Phasor measurements at demand sides and its applications](#)

Developing an online monitoring of power system by multiple phasor measurement units with monitoring voltages at the outlets on the wall.

#### 2. [Management of distribution network with high penetration of photovoltaic generation units](#)

Investigating reasonable voltage regulation on high and low voltage distribution lines by cooperation of photovoltaic generation units and other apparatus.

#### 3. [Advanced power conversion to integrate multiple dc energy sources](#)

Integrating multiple dc voltage terminals to connect solar cells, batteries and loads easily, based on multi-level converter topology with flying capacitors.

#### 4. [Power modulations of distributed energy resources for frequency control](#)

Developing a voltage phasor modulation of grid-connected converters to regulate the system frequency as much as possible.

Keywords: smart grid, reliability, stability, quality, electric vehicles, renewable energy resources

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# Control Applications of Intelligent Information Processing Technique

## Professor Takashi Yasuno

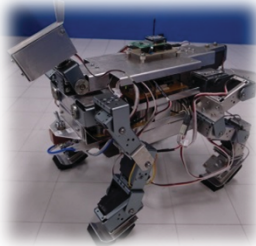
Developed experimental system in our lab.



Renewable energy system



Remote control mobile robot



Quadruped robot



Power assist knee orthosis



Multiple mobile robots



Electric wheel chair

Content:

In recent years, various systems coexisted within human such as industrial machines and life support systems tend to increase. In addition, a high performance and a high accuracy for these systems are strongly required. To meet these requirements, we make applied researches on a control system using an intelligent information processing technique on the basis of biologically inspired approaches. For example, we propose the design and implementation methods of the control system combining soft-computing techniques (fuzzy, neural network, etc.) and control theories. Current research themes are listed below:

- ❖ Output prediction of wind or photovoltaic power generator using weather forecast model
- ❖ Cooperative control of multiple mobile robot system
- ❖ Adaptive gait control for quadruped robot using central pattern generator network
- ❖ Operator's support system for remote controlled robot
- ❖ Motion control of power assist knee orthosis
- ❖ Safety driving support system of electric wheel chair

Keywords : intelligent control, robot, wind energy and photovoltaic power generation, rehabilitation system

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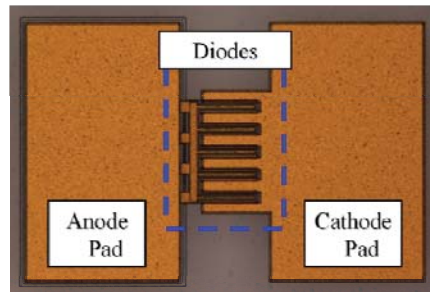


Fig. 1 GaN Schottky diode for microwave rectification

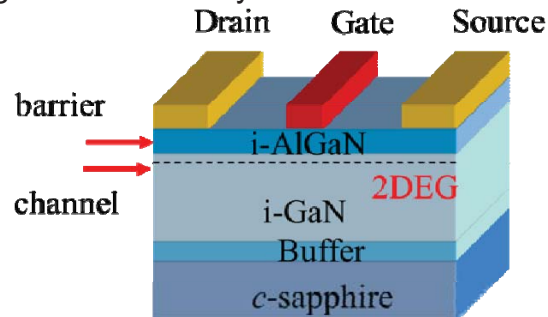


Fig. 2 A cross section of AlGaIn/GaN HFET

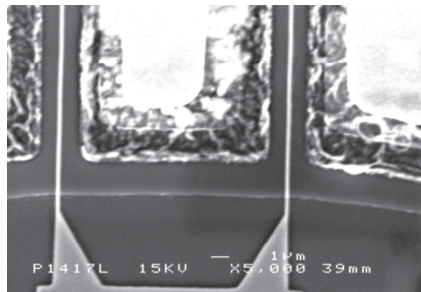


Fig. 3 Sub-micron gate AlGaIn/GaN HFET

### Content:

With the miniaturization of silicon transistors in the end of 20th century, there was rapid development in the computer information systems. The guiding principle is the scaling rule. With the decreasing of the device dimensions, high speed, low power consumption, high density integration, low price are spontaneously realized. To expand the potentials of the microelectronics to the application on communication, consumer electrical appliances, lighting and power electronics, it is necessary to achieve high voltage and high power. To maintain the high voltage and miniaturization compatibly, silicon technology is limited. It is necessary to introduce wide bandgap semiconductors. A prospective candidate is gallium nitride (GaN). GaN blue light emitting diodes have already become commercialized. It is also being developed to realize general lighting as a white source. In this laboratory, using the same material of GaN, transistors, diodes, chemical sensors and integrated circuits are being developed for the applications in microwave communication and power electronics. Recently, in detail, we are focusing on GaN Schottky diode for microwave rectification, high-frequency AlGaIn/GaN HFET using electron-beam lithography, E-mode GaN MOSFET for power electronics and chemical sensor on AlGaIn/GaN heterostructure

Keywords: wide bandgap semiconductor,  
electron device, sensor  
monolithic integrated circuit.

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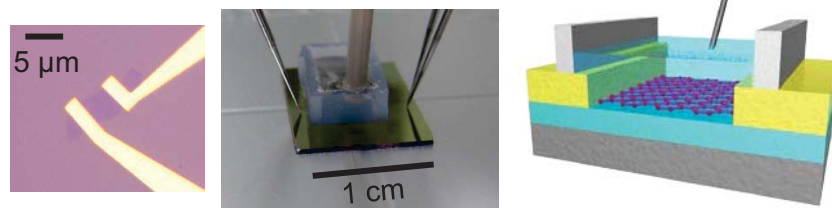
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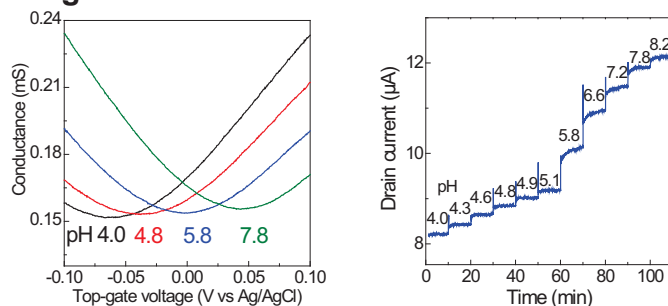
### Graphene device fabrication



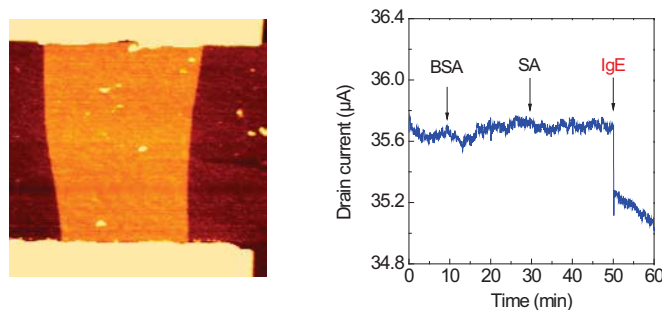
Graphene FET

Graphene-FET based biosensors

### Sensing results



### Detection of solution pH



Receptor functionalization and specific protein detection

Since the electrical characteristics of graphene field-effect transistors (FETs) are very sensitive for their environmental condition, the graphene FETs have high potential for chemical and biological sensors. In our laboratory, various sensors based on graphene FETs are investigated. The graphene FETs can be operated in the buffer solution by top-gated operation from a reference electrode without any passivation film owing to their large potential window. And their transconductance was more than 200 times larger than that of the conventional back-gated operation in vacuum. The drain current increased with increasing the solution pH. And the graphene FETs detected the charges in proteins. To detect the specific protein, aptamers were functionalized on the graphene surface. As a result, Aptamer-modified graphene FETs detected the target molecule, and their sensitivity was comparable for other aptamer-based biosensors.

Keywords: graphene, device, biosensor

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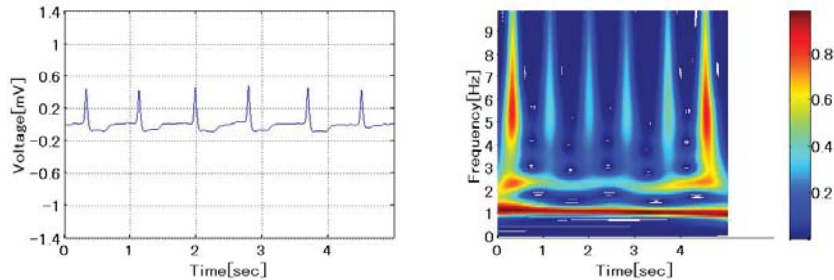


Fig.1 Sinus Rhythm (Left) and its Scalogram (Right)

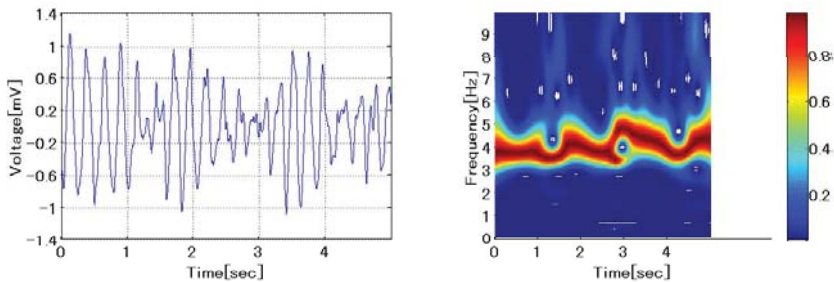


Fig.2 VF (Left) and its Scalogram (Right)

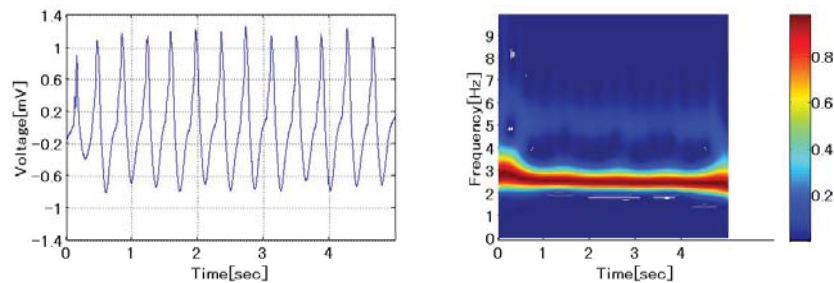


Fig.3 VT (Left) and its Scalogram (Right)

## Content:

Sudden cardiac arrest is a major public health problem and Ventricular Fibrillation (VF) and Ventricular Tachycardia (VT) are serious arrhythmic events in most of patients suffering from sudden cardiac arrest. For these serious arrhythmic events, the timely employment of an electrical defibrillator may lead to successful results. VF is the most serious variety of arrhythmia which requires accurate and quick detection to save lives. Thus widespread deployment of automated external defibrillators (AEDs) has been suggested and a pivotal component in AEDs is the detection of VF and VT by means of appropriate algorithm. However, reliable, accurate and quick detection of ventricular arrhythmia is not easy.

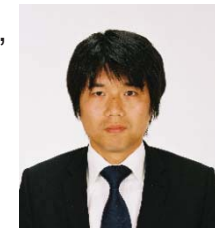
From this viewpoint, on the basis of Wavelet Transform (WT) we have proposed some detection algorithms for electrocardiogram (ECG). Fig.1--3 show ECG signals and normalized scalogram. The proposed algorithm consists two stage detection and achieves good performance comparing with the existing results.

Keywords: detection algorithm, wavelet transform, defibrillation, VF, VT, PEA, SR, sudden cardiac arrest

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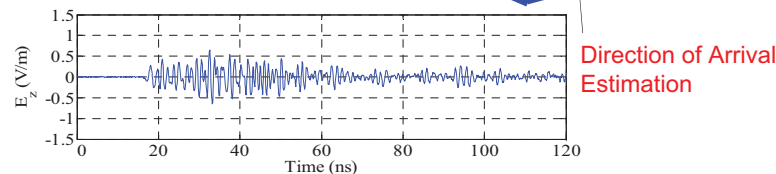
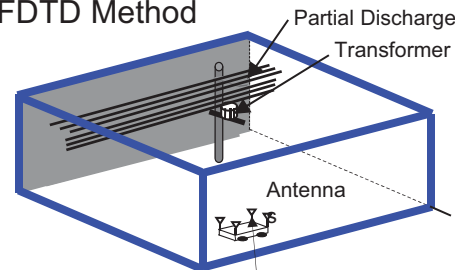
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# Development of Diagnostic Techniques for Power Equipment Using Radio Remote Sensing and Signal Processing

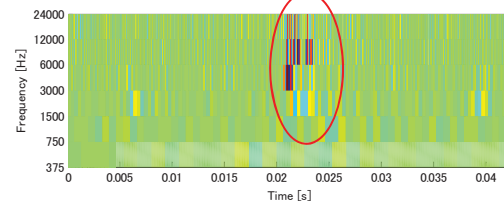
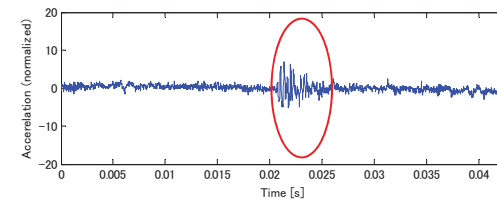
Associate Professor Masatake Kawada

## Development of Insulation Diagnostic Techniques for Distribution Line Using FDTD Method



Electromagnetic Waves Emitted from Partial Discharge, which is a Symptom of Degradation of Insulating Materials.

## Detection of Abnormal Vibration Using Wavelet Transform



Time-Frequency Visualization of Abnormal Vibration

Content:

### 1. Subject

Can faults due to deterioration over time or unexpected faults occurring in power equipment be detected beforehand ?

### 2. Research Contents

How to detect a symptom of faults ?

- (1) Radio Sensing, to locate deterioration of insulating materials
- (2) Signal Processing, to locate abnormal positions in turbines, generators, and pumps

### 3. Record of Joint Research

- (1) Chubu Electric Power Co. Inc. and Mitsubishi Heavy Industries Ltd. for diagnosing turbine generators
- (2) Chubu Electric Power Co. Inc. and Hitachi Ltd. for diagnosing pumps
- (3) Railway Technical Research Institute for diagnosing ground coils of superconducting Maglev

Keywords: Radio Sensing and Signal Processing

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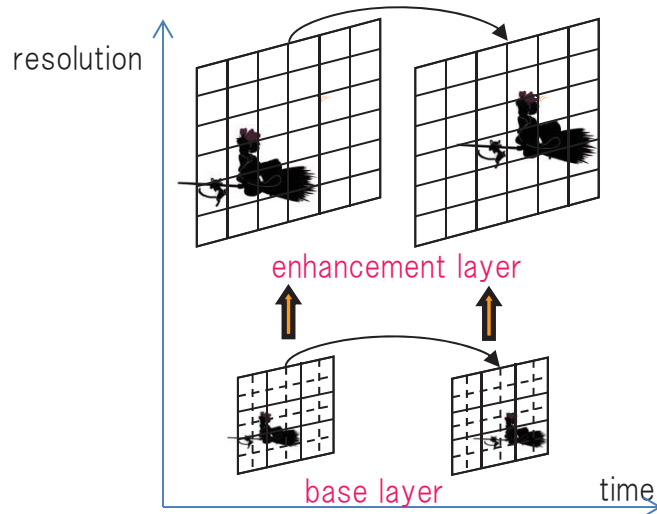


Fig.1: H.264/SVC inter layer prediction

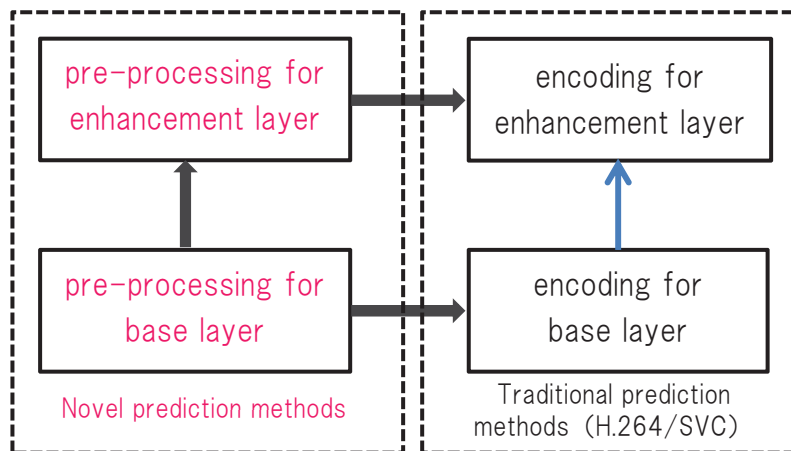


Fig.2: The proposed coding structure

With the widely spread of video applications, novel coding algorithms which can answer many kinds of emerging demands are highly required. Our research group is devoting to propose good ideas concerning the following themes.

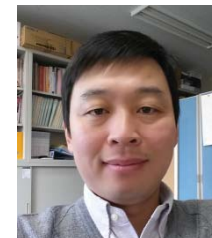
1. Improvements of the algorithms of HEVC and its low complexity and low power VLSI architecture for the next generation applications which are over 4K resolutions. The algorithms and architectures are concerning the intra coding, motion estimation, and deblocking filter.
2. Scalable video coding algorithms which are suitable for high resolution applications. We will make full use of the high correlations between base layer and enhancement layer to propose new algorithms to improve the coding efficiency.
3. Highly parallel processing video coding algorithms on many-core platforms. Most of traditional coding algorithms utilize the coding parameters of adjacent blocks to improve coding efficiency. However, this coding structure has essential demerit for parallel processing. As shown in Fig.2, our motivation is to find new coding structure which can achieve higher parallel coding performance.

Keywords : H.265/HEVC, Scalable Video coding(SVC), Parallel Video Coding

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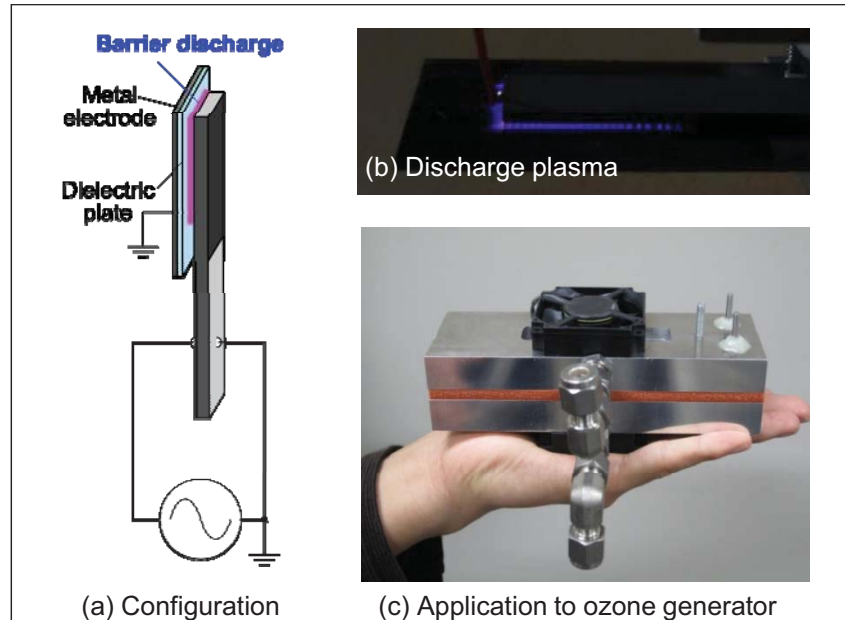


Fig. 1 Compact plasma reactor using piezoelectric device and its application

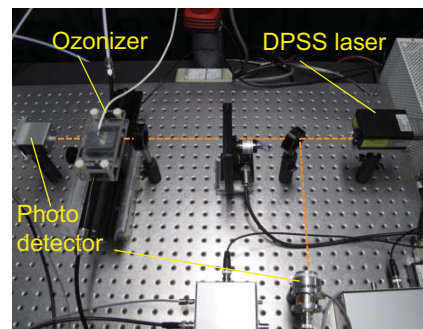


Fig. 2 *In-situ* O<sub>3</sub> measurement by laser optical absorption

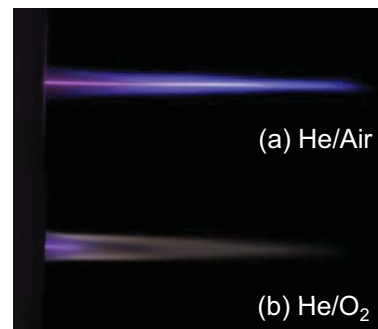


Fig. 3 SGF Plasma jet

## Content:

Discharge plasma reactors consisting of a massive high voltage generator and discharge electrodes are more likely to become large-scale system. We have proposed and studied various types of compact plasma reactors using piezoelectric devices. Piezoelectric transformers (PTs) that act as compact high-voltage generator have been widely embedded in a backlight inverter for LCDs. Our proposed plasma reactors feature compact configurations because the devices serve as both high-voltage source and discharge electrode. Non-thermal plasmas, such as corona discharge, glow discharge and dielectric barrier discharge (Fig. 1(a)(b)) can be produced using the plasma reactors. Several applications of the plasma reactors to ozone generators (Fig. 1(c)) and vacuum ultraviolet light source have been demonstrated.

We have also promoted actively other research in generation, diagnosis and applications of non-thermal atmospheric pressure plasma, including *in-situ* measurement of ozone density inside DBD ozone generator (Fig. 2) and surrounding gas-fed (SGF) plasma jet (Fig. 3).

Keywords: Dielectric barrier discharge, ozone, plasma jet

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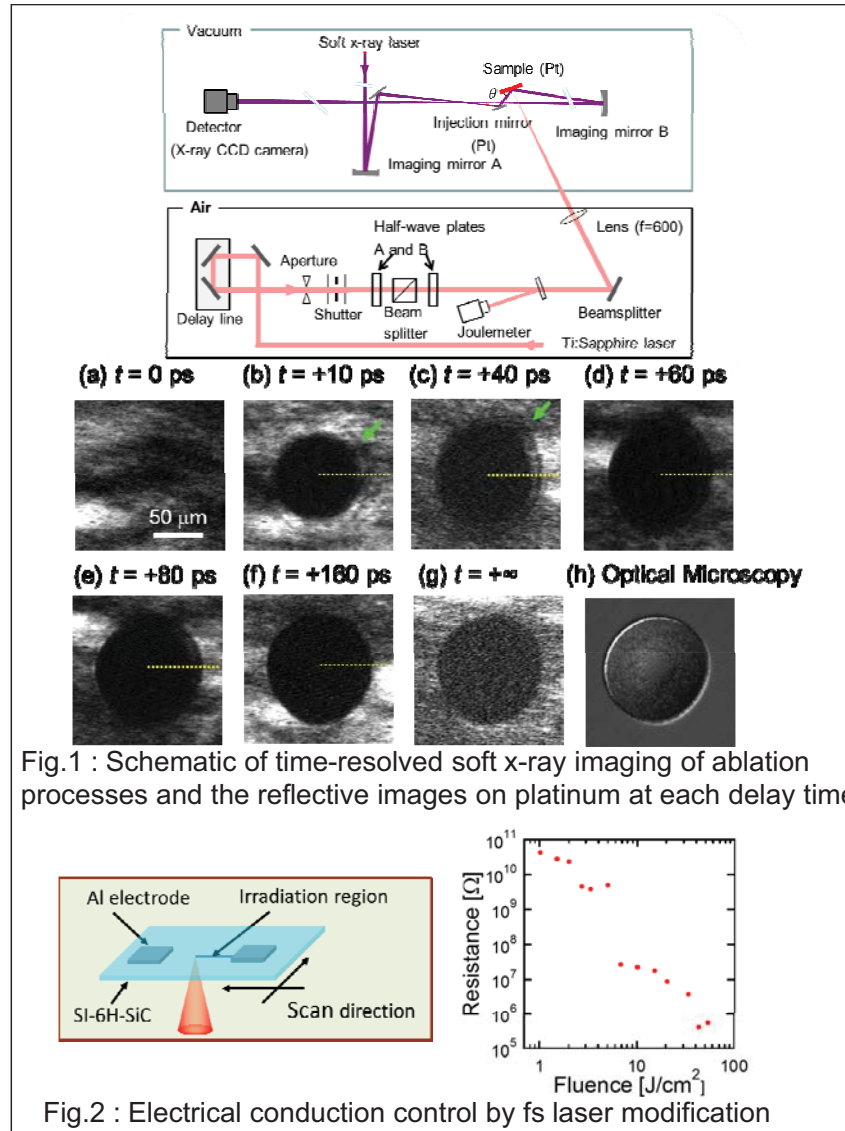
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### Content:

We are studying the ablation and modification of materials associates with femtosecond laser irradiation. In addition, we are also interested in the transient state of materials during femtosecond laser irradiation.

The schematic of time-resolved soft x-ray imaging of ablation processes and the reflective images on platinum at each delay time are show in Fig. 1. From this figure, it was found that the ablation phenomena is already started at 10 ps, and finished at 160 ps. We also observed the nano-bubble formation and nonthermal ablation processes related to the femtosecond laser irradiation.

Fig. 2 shows the schematic of electrical conduction control by fs laser modification. The femtosecond laser beam is irradiated between two metal contacts on semiconductor. With increasing the irradiation fluence, the local electrical conductivity abruptly decreased at the threshold fluence.

Keywords : femtosecond laser, ablation

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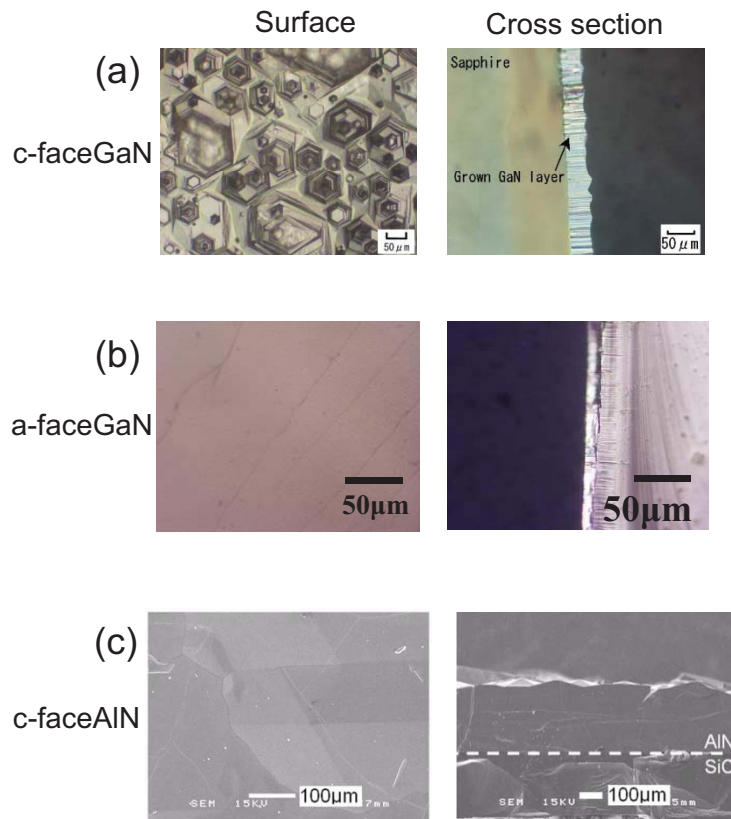


Fig.1: Surface and cross sectional images of the grown layers.

### Content:

Nitride semiconductors are one of the most attractive candidates for LEDs. The problem of the crystal growth of nitrides is no suitable substrate with good lattice matching and low price.

In order to obtain nitride substrates at low cost, we grow GaN by a direct synthesis method (DSM) and AlN by a sublimation method (or physical vapor transport). Both methods are low-cost growth method.

Figure 1(a) shows the surface and cross sectional images of the c-face GaN grown on c-plane sapphire and (b) a-face GaN on r-plane sapphire. Both grown layers are relatively high quality and can be used as substrates for the growth of nitrides.

Figure 1(c) shows the AlN layer grown by a sublimation method. The grown layer is relatively high quality. We grew AlGaN by MOCVD on the AlN substrate and the grown AlGaN layer shows good luminescence.

Keywords: AlN, GaN, bulk crystal growth

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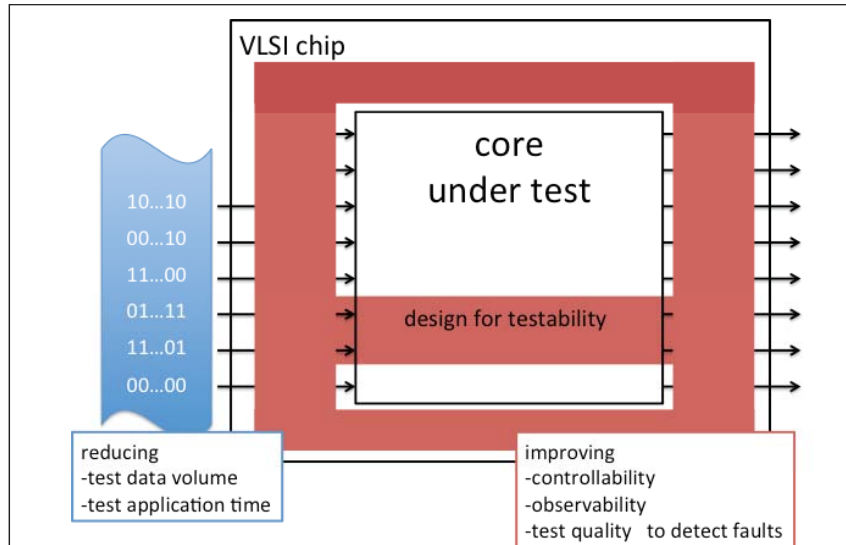


Fig.1 overview of design for testability

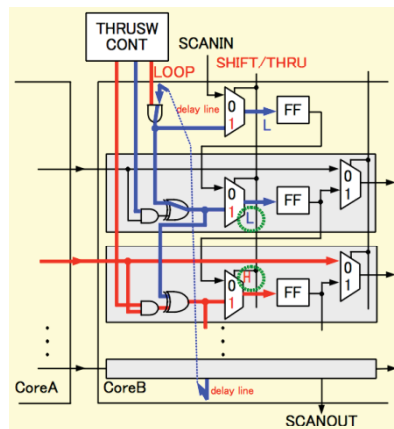


Fig.2 Boundary scan with TDC

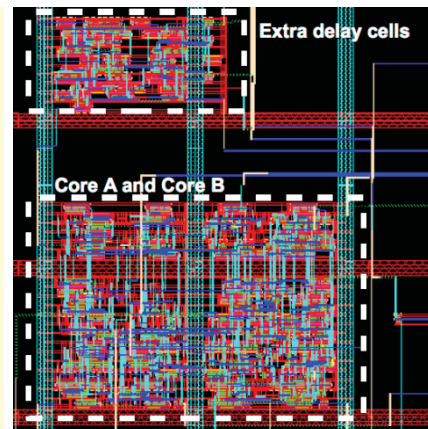


Fig.3 layout of an experimental chip

## Content:

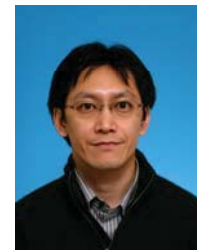
In recent highly integrated VLSIs, cost of testing is a major problem. To alleviate the difficulty in testing, design for testability techniques are widely used. In our research lab, we develop methods for reducing test cost such as test data volume, test application time, area overhead of test circuit, and for improving test quality especially in delay testing. One of the techniques is design for testability method for small delay faults using time-to-digital converter embedded in boundary scan called TDCBS, shown in the figures. The boundary scan cells are modified to be able to form a time-to-digital converter that is utilized for detecting delay. Using this architecture, defects like opens and shorts can be detected as extra delay caused by such defects even if the delay is small and cannot be detected by conventional logic test. The feasibility of the proposed methods is estimated by both simulation and experiments of fabricated chips.

Keywords: design for testability, VLSI testing, delay faults, test cost reduction

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# Development of a measurement device for blood flow velocity in the carotid artery

Associate Professor Masatake Akutagawa

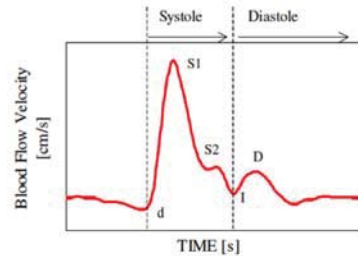


Fig 1. Prototype of a measurement device for blood flow velocity (BFV) and typical waveform of BFV in the carotid artery

Young group (age ranges: 20-38) → Middle group (age ranges: 39-57) → Older group (age ranges: 58-76)

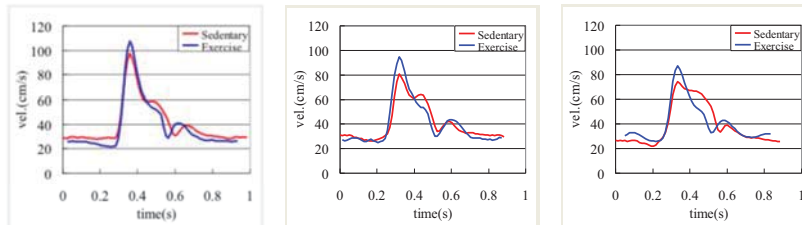


Fig 2. Change of BFV waveforms with age and exercise

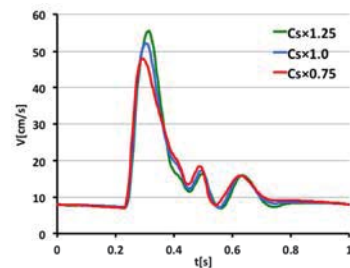


Fig 3. Change of BFV waveforms for different compliance of the arteries (computer simulation)

## Content:

According to the vital statistics from Ministry of Health, Labour and Welfare, 33% of Japanese are died by diseases related to the circulatory system. It is well-known that diet modification and an appropriate exercise are effective to prevent these diseases. If we have a portable device which can evaluate the circulatory system and exercise habit, it is expected to suppress these diseases and medical care costs.

We have developed a portable measurement device (Fig. 1) for blood flow velocity (BFV) and investigated the relationship to various conditions for hundreds of subjects. As results of them, BFV waveforms show remarkable trends corresponding to aging and exercise habit as shown in Fig. 2. These trends may reflect extent of atherosclerosis. We confirmed that they are caused by compliance of the arteries by use of the multi-branched arterial segment as shown in Fig.3.

Keywords : Ultrasound doppler, atherosclerosis, blood flow velocity

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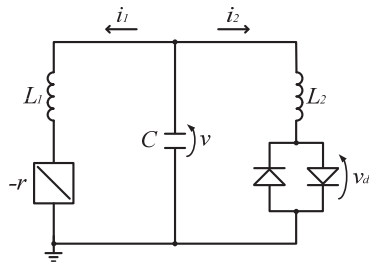


Fig. 1 Chaotic circuit

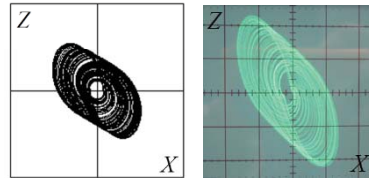


Fig. 2 Chaotic attractor

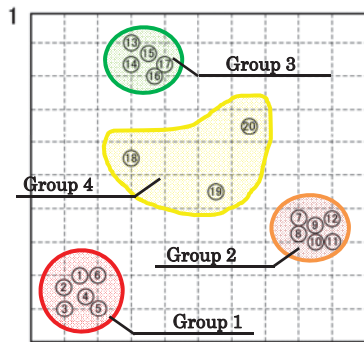


Fig. 3 Clustering result

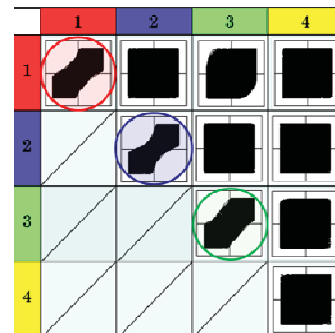


Fig. 4 Synchronization

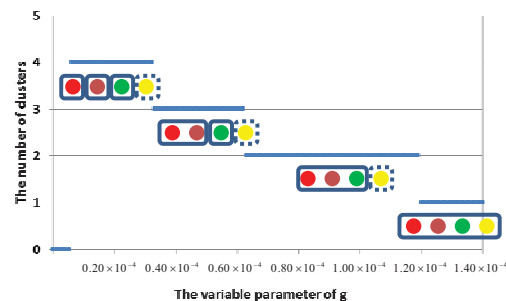


Fig. 5 Clustering phenomena with coupling strength

Content:

Coupled oscillatory systems are good models to express essential role of high-dimensional nonlinear phenomena occurring in the field of natural sciences. Recently, many studies have been investigated synchronization of chaotic circuits. It is applied in the field of engineering, physics and biology and so on.

In this study, we apply coupled oscillatory systems to modeling of social network using chaotic circuit (Fig. 1, 2). The chaotic circuits are placed on 2-dimensional space and are coupled with the distance information. By using computer simulations and circuit experiments, we obtain clustering result as shown in Fig. 3. Figure 4 shows the synchronization phenomena between the groups. Furthermore, we confirm that the number of clustering changes when the coupling strength is changed (Fig. 5).

In our future works, we would like to apply the proposed system for more complex social network by using different frequency of oscillators.

Keywords: coupled oscillators, synchronization, clustering

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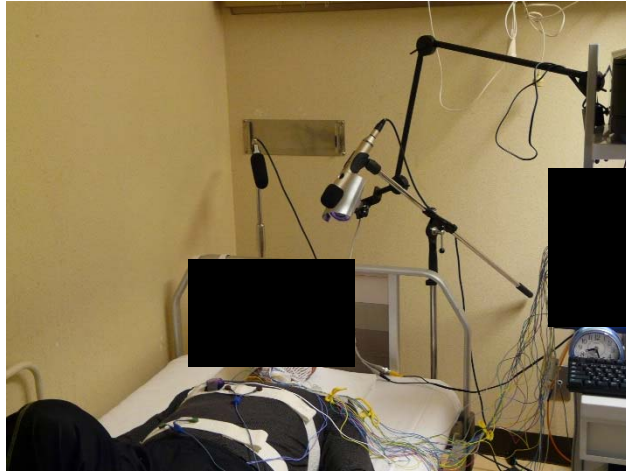


Fig.1 A sample of snoring sound recordings



Fig.2 A sample of bowel sound recordings

#### Content:

There are a lot of patients who suffer from chronic disease (obstructive sleep apnea syndrome (OSAS) and irritable bowel syndrome (IBS)). Recently the prevalence of these disease is likely to be increasing in many countries. Polysomnography(PSG) and endoscopic test have been used for the diagnosis of these disease respectively. However these test are inconvenience and expensive. Our research group hypothesize that the information on these disease should be embedded in biomedical sounds (e.g. snoring and bowel sounds) from patients. Biomedical sounds can be simply acquired via non-contact and/or non-invasive measurements. The target of our study is to develop the automated diagnosis system based on the analysis of biomedical sounds. We are currently in the process of developing new sophisticated techniques for this purpose. Biomedical sound analysis techniques can be expected to provide an attractive alternative to the conventional diagnosis method of chronic disease.

Keywords : Physiological measurement, Pattern recognition, Digital signal processing

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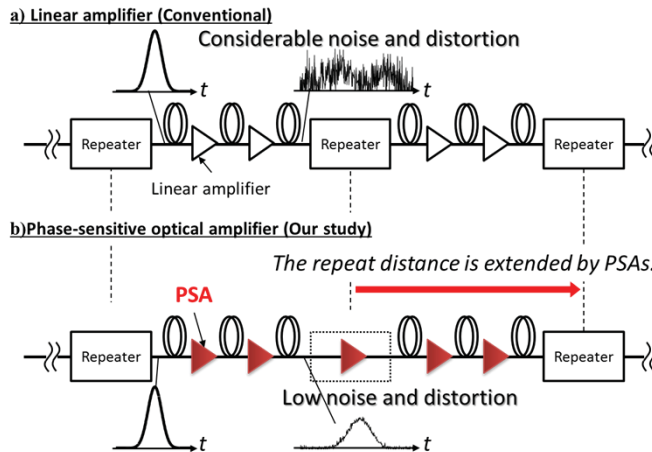


Fig.1. Backbone NWs with PSAs

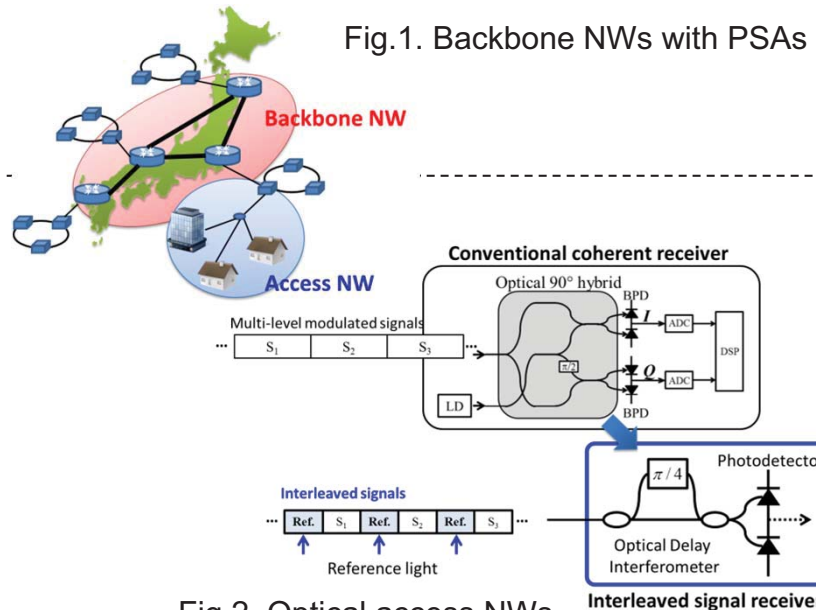


Fig.2. Optical access NWs based on interleaved scheme.

**Content:**

Coherent optical communication technologies have been studied to improve transmission capacity of optical fiber transmission systems that consist of backbone networks and access networks. However, each network has major issues concerning introduction of the coherent technologies.

[Backbone networks] The transmission distance is limited by additive noise from linear amplifiers; therefore, the transmitted optical signals frequently need to be regenerate to avoid such noise by repeaters that are relatively expensive.

[Access networks] Cost and power dissipation of the conventional coherent receiver are not acceptable for consumer use.

To solve the above problems, we are studying about phase-sensitive optical amplification as depicted in Fig. 1. and the access networks based on multi-level modulated signals interleaved with reference light as shown in Fig. 2.

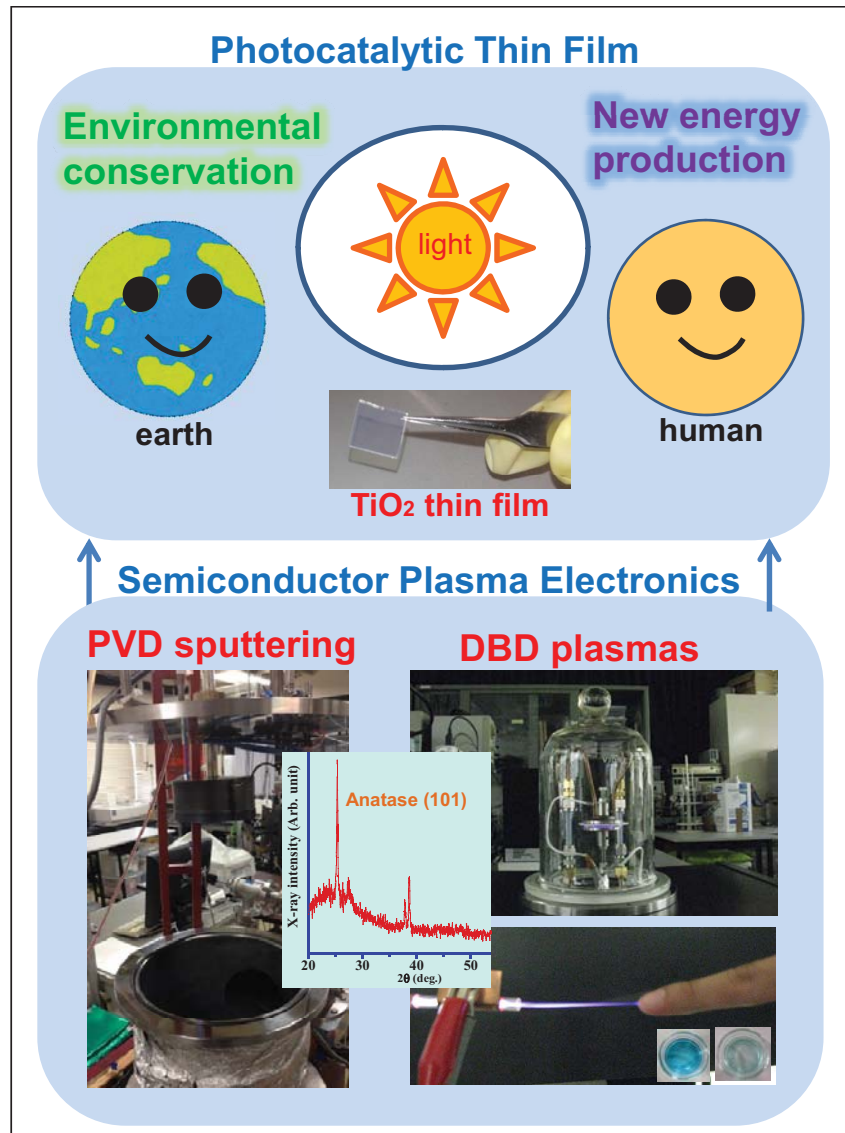
**Keywords :** Coherent optical communications, Phase-sensitive optical amplifier, Multi-level modulated signals interleaved with reference light

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# Study on Thin film of Photocatalyst for Environmental Conservation and New Energy Production by use of Plasma Electronics

Assistant Professor Retsuo Kawakami



Content:

Photocatalyst has been attracting much attention as a material for environmental conservation and new energy production. It is a strong point that the photocatalytic activity is activated semipermanently while the surface is irradiated with light. TiO<sub>2</sub> is a leading candidate as the photocatalyst. The reason is that the photocatalytic activity is activated easily under irradiation with near UV-visible light and that TiO<sub>2</sub> is hardly dissolved by its own photocatalytic activity. Since TiO<sub>2</sub> is an inorganic compound, TiO<sub>2</sub> is harmless for human and earth, and TiO<sub>2</sub> is stable in aqueous media and reactive gas. The thin film, rather than the powder, is required from the viewpoint of the practical application such as large area coating. The photocatalytic activity induced by use of the thin film, however, is less enhanced than that induced by use of the powder.

We have been studying TiO<sub>2</sub> thin film with excellent photocatalytic activity using a magnetron facing target sputtering deposition device developed by our group. The characteristic of the device is that the anatase film is fabricated without heating the substrate. We have also been studying the anatase film treated using an atmospheric pressure plasma device developed by our group, in order to further enhance the original photocatalytic activity. The characteristic of the device is that the surface treatment is performed easily without expensive vacuum pumps.

Keywords : Photocatalyst, Wide band-gap Semiconductor, Plasma electronics

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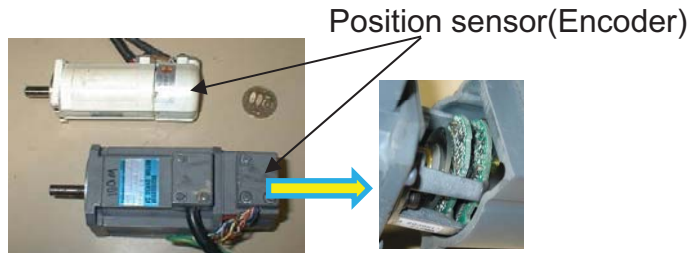
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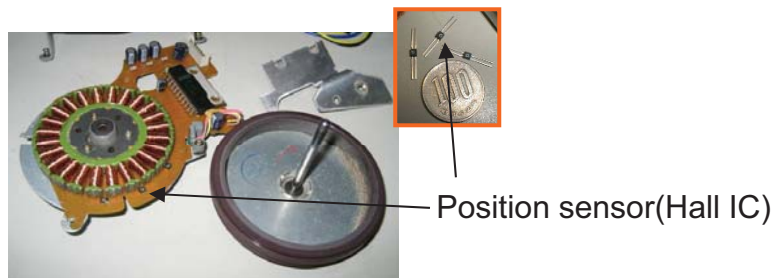


# Simplification of the Motor Controlling Device

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(a) An industrial field AC motor(AC servomotor)



(b) An ordinary homes AC motor(Brushless DC Motor)

Fig1 The example of our laboratory's AC motor

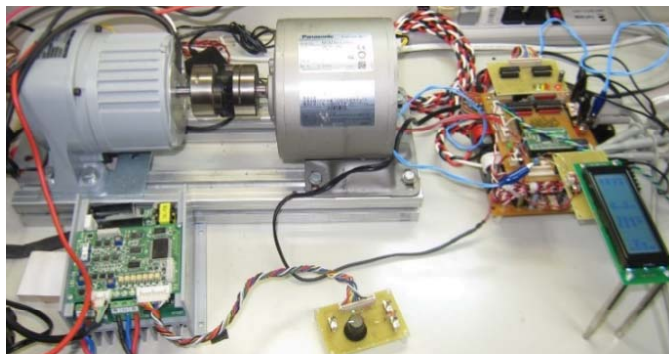


Fig2 The example of our laboratory's developing controlling circuit device

## Content:

An electric motor is used in ordinary homes, industrial field, and so on, and an AC motor is especially used from the view of the controllability, efficiency, and miniaturization. However, we need to attach a position sensor to the motor in order to control the motor. This causes the problem which is an increase in costs, increasing in size, and complication of the control device. There is a difference between industrial field motor and ordinary homes motor for method of controlling. Since the industrial field motor requires to control highly, it makes use of an expensive and high precise position sensor which is shown in Fig 1(a). The ordinary homes motor is driven by using a cheap position sensor. Nevertheless, it causes a sacrifice of controlling.

Thus, we are trying to develop controlling system which is able to give the motor high performance using the cheap sensor. It is possible to drive the motor if we add logic circuit and controlling program in order to achieve the object. It can be similar to the controlling system using a high precise position sensor. In addition, we are using a brushless DC motor as an AC motor, and we can keep the driving method which suppresses the switching loss. We also expect the improvement of efficiency.

Keywords: Brushless DC motor ,  
High speed response

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