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Development of Electrical Discharge Machining Devices for Curved Holes

Professor Tohru ISHIDA

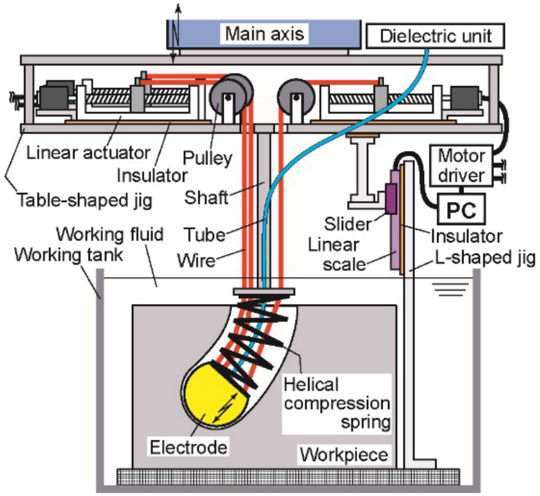

Fig.1 Schematic view of one of curved hole EDM devices

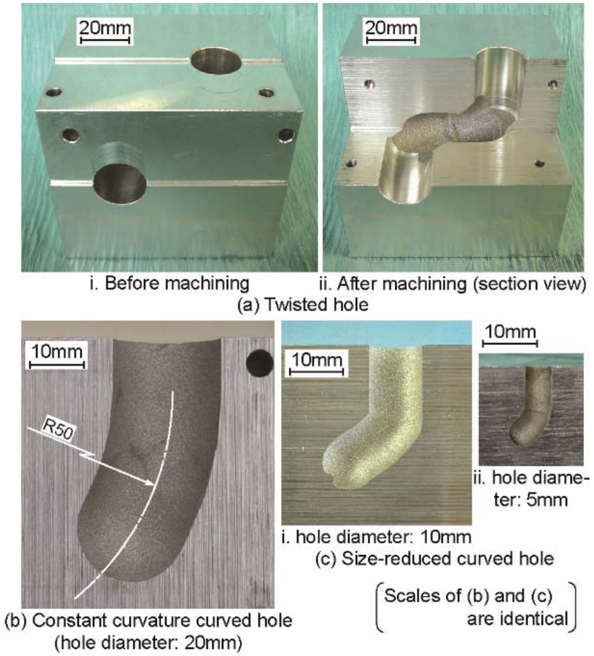

Fig.2 Examples of curved holes machined in this study

Content:

Mechanical engineers have taken it for granted that drilling is to machine a straight hole. Therefore, straight holes have been used even in unsuitable cases. The typical example of the cases appears in fabricating the water channels of molds. The water channels are the pipe lines built in molds and play an important role to properly control the temperature and thermal flow of molds in molding process by regulating the flow rate and temperature of the coolant running through the water channels, which prevents defects from occurring in products. Accordingly, the shapes and positions of the water channels are very important for achieving high productivity. However, the water channels are inevitably formed as the straight or polygonal-line-shaped pipe lines, since they are generally fabricated by drilling.

To solve the problem, the development of a curved hole machining method is strongly desired. Therefore, our laboratory has developed the devices to machine curved holes by means of electrical discharge machining (EDM). Figures 1 and 2 respectively show one of the devices and the curved holes machined by the devices.

Keywords: curved hole, electrical discharge machining (EDM), CAD/CAM

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Analysis and Control of Turbulent Flow Phenomena

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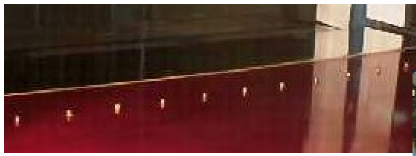
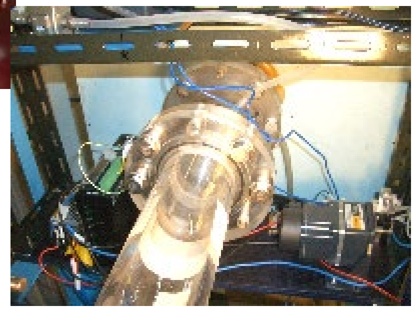
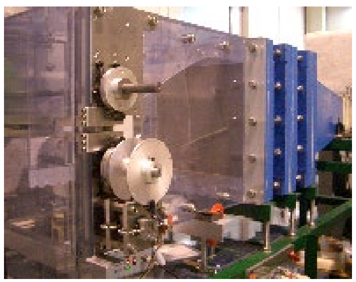


(a) A line of roughness elements



(b)Jet injection section in pipe



(c) Mixing layer exit oscillation plates

Fig. 1 Apparatuses in present investigation

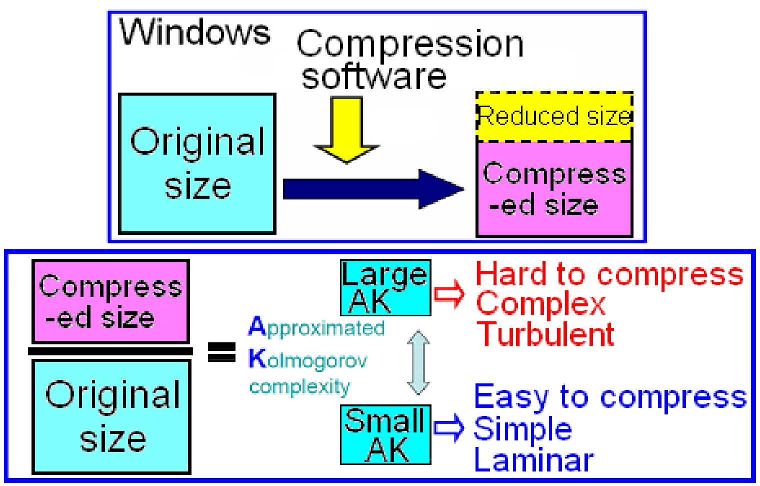


Fig. 2 Schematic diagram of K-complexity analysis

Content:

In fluid flows, although a turbulent flow and laminar-turbulent transition are often seen in a nature or industrial apparatus, it is hard to say that the details have been clear. Therefore, in our research, especially the laminar-turbulent transition is observed. In the laminar flow, forced transition is generated and the mechanism of transition progress is investigated experimentally.

Main experimental apparatuses are shown in Fig. 1. In (a), from a line of three-dimensional roughness elements in a flat-plate laminar boundary layer a wedge-shaped turbulent region is formed downstream from each roughness elements. In (b), an intermittent jet is periodically ejected in a circular pipe radially, then an isolated turbulent patch is generated within a laminar boundary layer and moves downstream. In (c), oscillating plates at the exit of a rectangular nozzle promote the transition of a mixing layer between the jet and surrounding quiescent air.

Moreover, the new measure which shows the transition process quantitatively is developed based on the Kolmogorov complexity and Shannon entropy analysis. Figure 2 shows the schematic diagram of the Kolmogorov complexity analysis.

Keywords : turbulent flow, laminar-turbulent transition, boundary layer, complexity analysis

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Research on Environmentally Friendly Energy
Transport dynamics of ion and electron in solids

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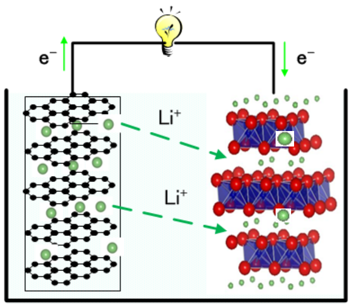
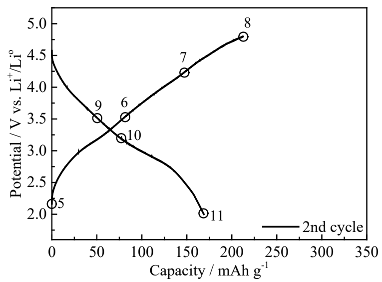
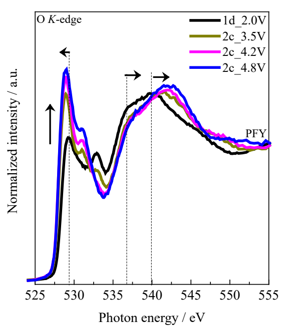
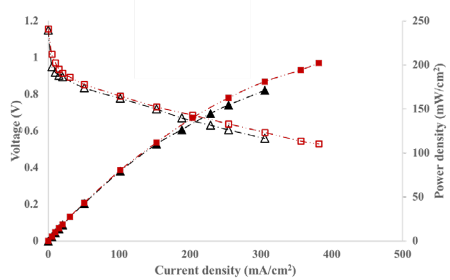




Lithium Ion Battery



O *K*-edge XAS spectra for Li_2MnO_3 electrode.



IV curves of SOFC cell at 800 C.

Solid state lighting.

Content:

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.

Our study is based on solid-state chemistry, thermodynamics, and electrochemistry. We are working to elucidate the transportation dynamics of ions and electrons, and the electronic/local structure using spectroscopic techniques such as synchrotron radiation X-rays in the solid oxides.

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・ Li-rich layered oxide materials for the positive electrode in Lithium Ion Secondary Batteries.

・Ionic transportation properties in Solid Oxide Fuel Cells.

・Thermal stability of (oxy)nitride phosphors for White-LEDs and solid state lightings.

Keywords: Solid-state chemistry, Electrochemistry, Secondary Battery, Fuel Cell, solid state lightings.

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The Dynamics of Bubbles and Drops in Viscous Liquids

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Fig. 1 Bubble motion rising in viscous liquids.

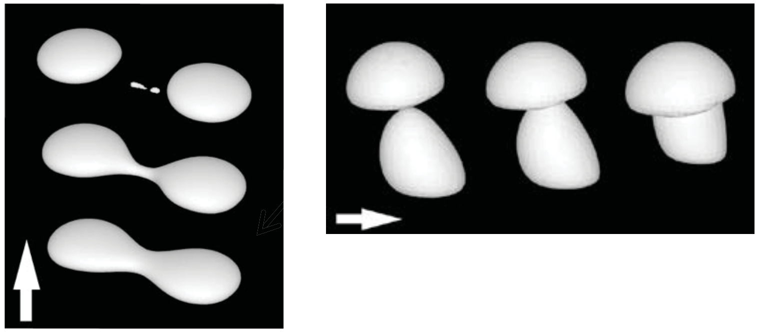

Fig. 2 Complex motion of bubble and drop.
Left: drop breakup Right: bubble merging

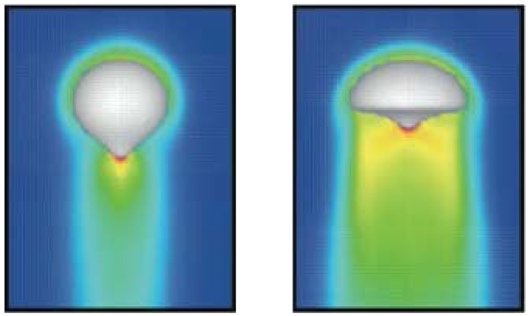

Fig. 3 Bubble motion rising in viscoelastic liquids.
(Elastic stress distribution)

Content:

Computational fluid dynamics (CFD) can be a useful tool for understanding detailed flow structures and mechanisms of the dynamic motion of bubbles and drops. Our laboratory computationally explores various motion of single bubbles and drops in immiscible viscous liquids including non-Newtonian fluids:

- Bubble/drop rise motion (Fig. 1)
- Complex (deformation/break-up/coalescence) bubble/drop motion (Fig. 2)
- Bubble/drop rise motion in non-Newtonian fluids (Fig. 3)

Our computations are implemented using sophisticated numerical methods such as Volume-of-Fluid, Coupled Level-Set/Volume-of-Fluid, Moment-of-Fluid methods to numerically track the interface.

Keywords: Two-phase flow, Bubble/Drop, Non-Newtonian fluid
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Microstructural Analyses Using Electron Microscopy

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(1)

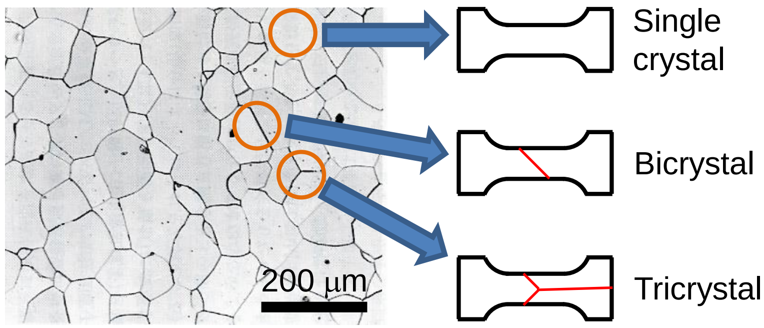


Fig. 1 Polycrystal (left), and single-, bi-, and tri-crystals.

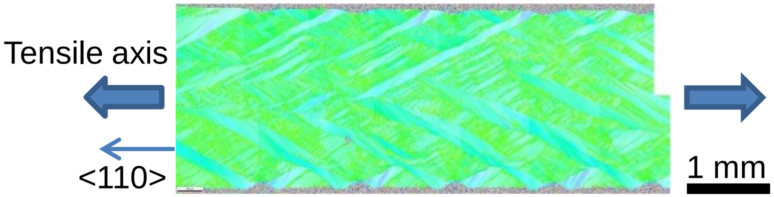
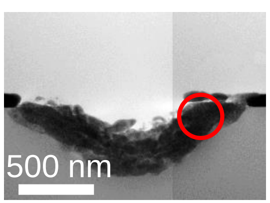
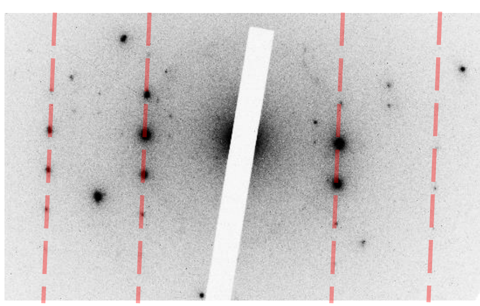


Fig. 2 SEM/EBSD orientation map of Cu single crystal deformed in tension (25%).

(2)





Diffraction spots from Ni_2Si phase are arranged on the dashed lines. →

Fig. 3 Ni silicide formation at the Ni/SiC interface. (Left) Cross-sectional TEM bright-field image, (Right) Selected area diffraction pattern from the circular area.

Content:

(1) We have been studying plastic deformation of orientation-controlled single-, bi- and tri-crystals of aluminum and copper. Polycrystalline materials are composed of numerous grains with a grain size of several ten to hundred μm. Hence, single-, bi- and tri-crystals are considered as enlarged portions in a polycrystalline material (Fig. 1). In our studies, we carry out orientation analyses of deformation microstructures using the SEM/EBSD method (Fig. 2).

*SEM: scanning electron microscopy

*EBSD: electron back-scattered diffraction

(2) We have been carrying out microstructural analyses using transmission electron microscopy (TEM). Presently, we focus our attention on the analyses of femtosecond (fs) laser-induced modifications in silicon carbide (SiC) and diamond crystals. Fs laser pulses were irradiated along lines on the SiC surface. A nickel (Ni) thin film was deposited on the SiC surface and subsequently annealed at 773 K. Cross-sectional TEM observation unveiled the formation of a Ni_2Si phase at the Ni/SiC interface (Fig. 3).

Keywords: electron microscopy, microstructural analysis

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Clean Burner-combustion of Fire-resistant Fuels

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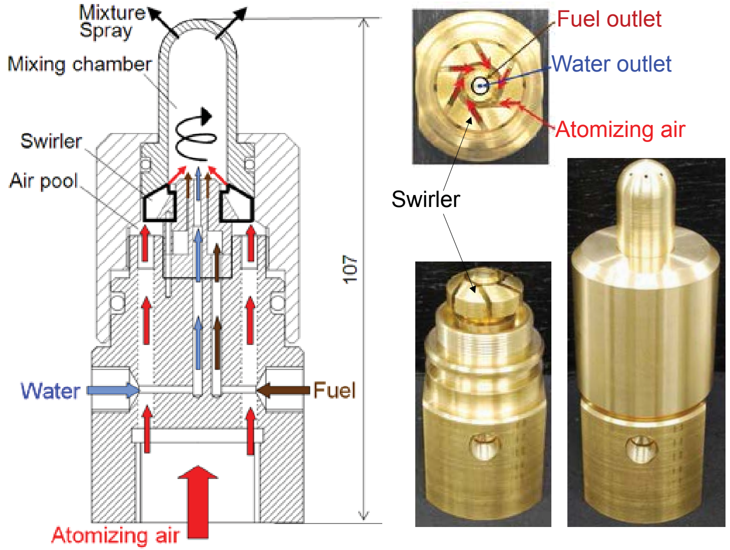

Fig.1 Fuel-water internally rapid mixing type of injector

Fig.2 Burner flame

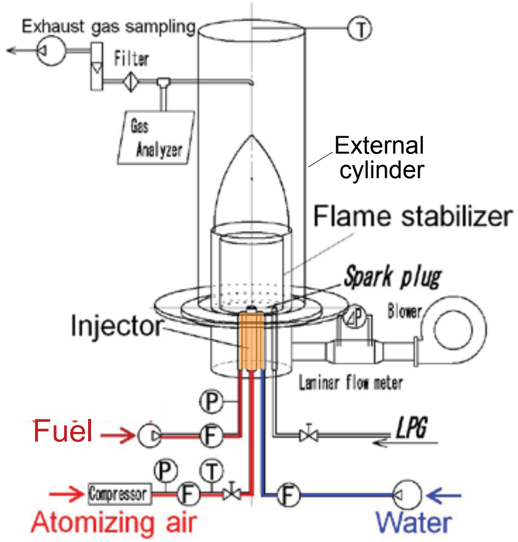

Fig.3 Experimental setup of burner combustion

Content:

Water addition to combustion field is known effective to reduce NOx and soot emissions simultaneously for fire-resistant fuels. Therefore, water-emulsified technology has been used in burner combustion. However, water-emulsified fuel needs fuel-manufacturing process. In this process, some surfactant is required to prevent separation of oil from water, which leads to an increase in cost of the fuel; further, the fuel also has problem of time stability as fuel.

This study tries to use water directly in burner combustion with a newly developed injector shown in Fig. 1. Fuel and water are separately supplied to the injector. The supplied fuel and water are rapidly mixed with support of pressurized swirling air in a small chamber inside the injector. The well-mixed fluids are injected into combustion field from several small holes on the top of the chamber. The flow ratio of water to fuel can be easily adjusted in response to combustion condition. Low emission combustion achieved by this injector enables high load operation, which leads to high combustion efficiency with less thermal loss of exhaust gas.

Keywords：
Fire-resistant fuels, Burner combustion, Fuel-water mixing type of injector

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Construction of Industrial and Human support Devices Utilizing Pneumatic Drive Systems

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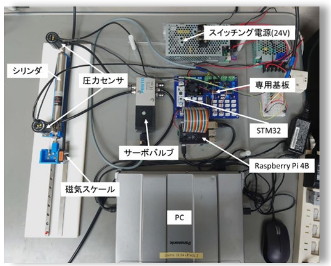
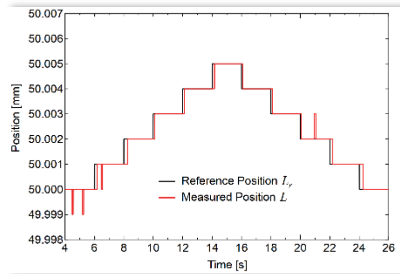
High precision positioning control using pneumatic cylinder



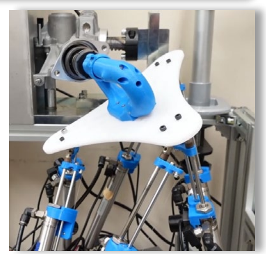
Realtime Linux environment



1micron step motion

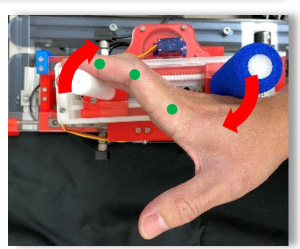
Precision work by pneumatic multiple D.O.F. robot

Simultaneous insertion with gear and bearing



Application to human support system

Walking support shoes



Wrist hand rehabilitation device

A feature of the pneumatic drive system is the air compressibility, which makes it easily be affected by frictional force during precise position control. We have developed a high-precision positioning technology with a repeat positioning accuracy of ±0.2 μm using a commercially available pneumatic cylinder.

In the mean while, the air compressibility brings absorb function of trajectory errors even it involves contact with the environment without generating excessive contact reaction force. By utilizing this function, we aim to propose a paradigm shift in which flexible robots perform precision assembly work, and to develop it into practical applications.

The pneumatic actuator also has a high output/weight ratio and the low stiffness characteristics, which is attractive to be used as wearable device. We are also conducting applied research on pneumatic walking support shoes without electric power but wearer's body weight and wrist/finger rehabilitation devices using parallel sticks driven with pneumatic actuators.

Keywords：human support, pneumatic drive

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Development of Monitoring and Control Technologies of Industrial Systems Using Advanced Laser Diagnostics

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Professor Yoshihiro Deguchi

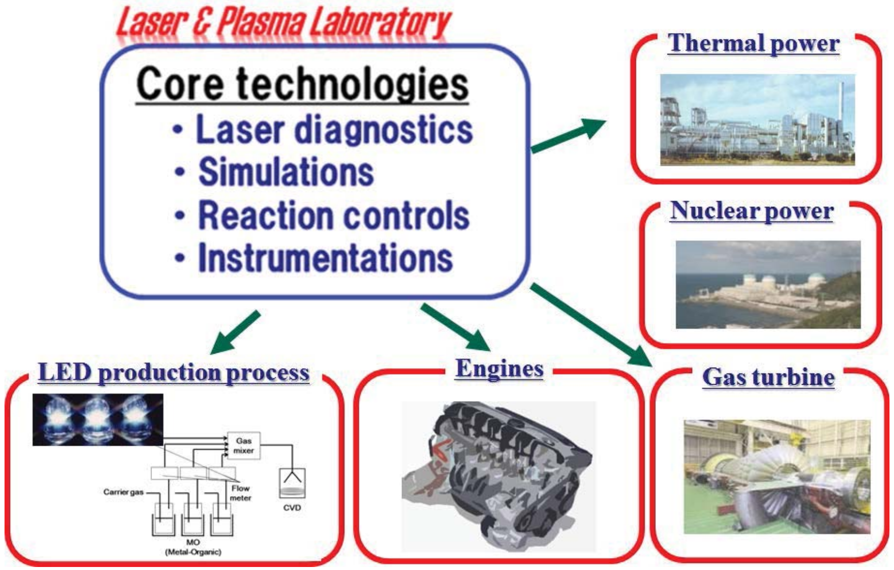

Fig.1 Application diagram of core technology

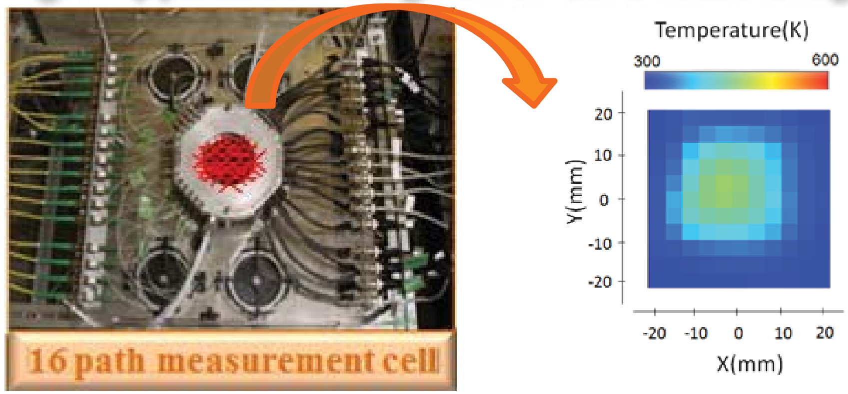

Fig.2 2D temperature and concentration measurement using CT-TDLAS (Application to engine, boiler and gas turbine)

➢ Background

It is becoming more important to reduce anthropogenic carbon dioxide emissions and improve the efficiency of industrial systems. Considering the situation mentioned above, detailed measurement techniques using advanced laser diagnostics have been developed to monitor and control the industrial systems such as engines, boilers, and gas turnines.

➢ Merit of laser diagnostics

	Conventional method	Laser Diagnostics
Physical Probe	Necessary	Unnecessary
Response	Slow (sec.～day)	Fast (ms～min.)
Measurement	One point	Multi-point(2D, 3D)
Sensitivity	Low	High

➢ Applications

1) Combustion systems : Exhaust gas, Combustion control
2) Plants(thermal, nuclear) : Process monitor and control
3) Semiconductor : Raw material monitor, Trace species
4) Food and medical application : Visualization and analysis

Keywords : Laser Diagnostics
Real-time Monitoring
Industrial Applications

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NOx Emission Characteristics of High Temperature Air Combustion

Professor Yuzuru Nada

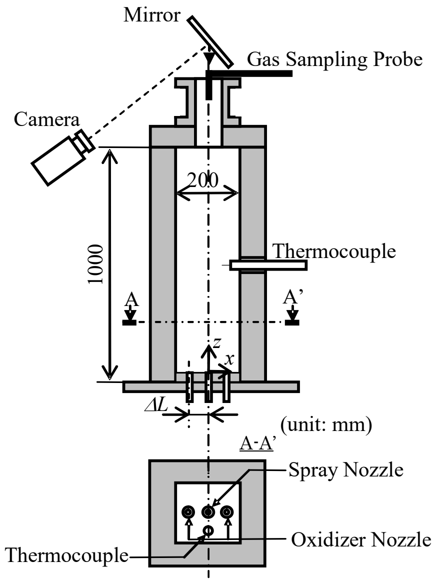

Fig. 1 HiTAC furnace.

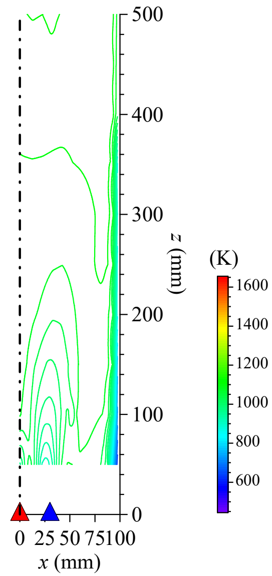

Fig. 2 Temperature distribution in HiTAC furnace.

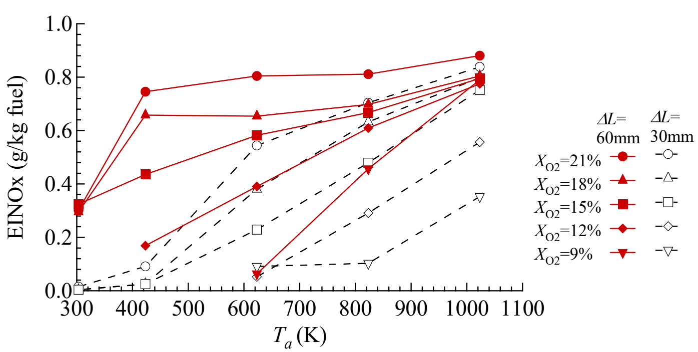

Fig. 3 Effects of properties of preheated oxidizer and nozzle distance on NOx emission.

Content:

To date, various combustion technologies based on dilution with burned gases have been developed to allow further reductions of NOx and soot emissions and to improve the thermal efficiency of furnace systems. These technologies are referred to as MILD combustion in Italy, flameless oxidation in Germany and high temperature air combustion (HiTAC) in Japan.

We focus on the flame stability and NOx emission characteristics of high temperature air combustion with liquid fuels. Figure 1 shows schematics of a HiTAC furnace used in our studies. The furnace has a parallel jet burner incorporating a central spray nozzle and oxidizer nozzles with electric heaters for preheating oxidizers. As shown in Fig. 2, in this furnace, a MILD combustion state with a uniform temperature distribution can be reproduced even in the laboratory-scale furnace. We investigate effects of nozzle distance between spray and oxidizer nozzles on NOx emission characteristics as shown in Fig. 3.

Keywords：combustion, NOx emission, flame stability

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Ultrasonic Material Measurement and Evaluation

Professor Hideo Nishino

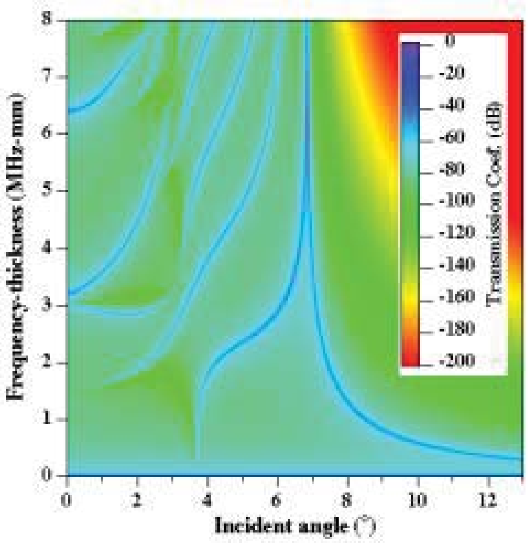

FIG. 1 Ultrasonic transmission coefficients of steel plate immersed in water

FIG. 2 Piezoelectric guided wave sensor system for piping inspection

Main Research Fields

- Nondestructive Ultrasonic Materials Evaluation

Projects

- Development of efficient inspection methodology using axial and circumferential guided waves
- Development of wall thinning monitoring using noncontacting air-coupled ultrasound
- Novel approach for laser ultrasound

Keywords : Ultrasonic Measurement, Wave Propagation Problem, Ultrasonic Nondestructive Evaluation, Guided Wave Inspection

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Research on Thermoelectric Semiconductor for Exhaust Waste Heat Recovery

Professor Kazuhiro Hasezaki

Fig.1 Photograph of Thermoelectric module

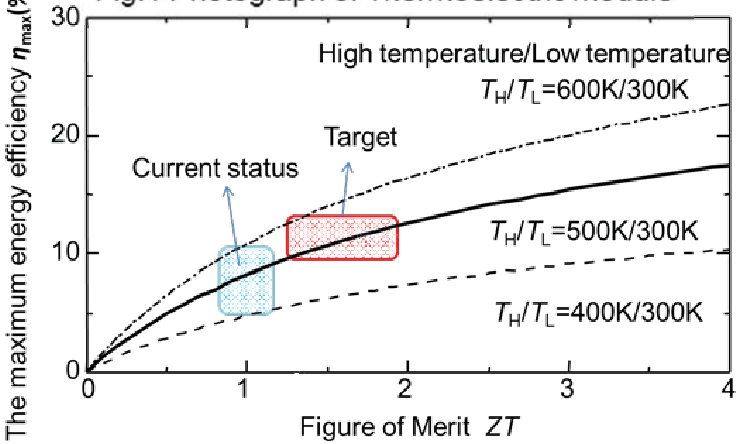

Fig. 2 Relationship of the maximum energy efficiency η_{max} and figure of merit ZT high temperature and Low temperature.

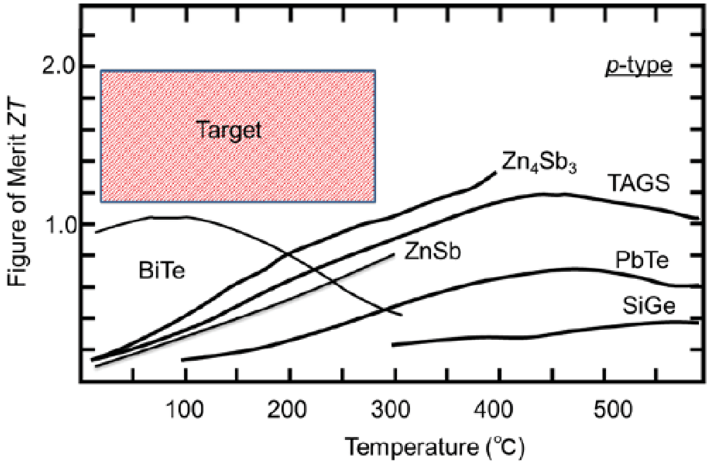

Fig.3 Figure of merit ZT versus temperature of thermoelectric materials

Content:

Thermoelectric semiconductor have been widely used as cooling and generating materials. Fig. 1 shows photograph of commercially available thermoelectric cooling module. These materials can be used to recover exhaust heat by thermoelectric conversion. The efficiency of a thermoelectric device is expressed by a dimensionless figure of merit, which is defined as $ZT = \alpha^2\sigma\kappa^{-1}T$, where α, σ, κ, and T are the Seebeck coefficient, electrical conductivity, thermal conductivity, and absolute temperature, respectively. Fig. 2 shows relationship of the maximum energy efficiency and dimensionless figure of merit. The heat of the low temperature range below 500 K generated from industrial apparatus has not been used effectively in the world. In our research, we propose to prepare the thermoelectric generation module for exhaust heat recovery of the low temperature range. We would like to clarify influences by the modularization to the thermoelectric properties of thermoelectric elements. Fig. 3 shows figure of merit versus temperature of thermoelectric materials. Furthermore, it is necessary to improve the figure of merit for BiTe, ZnSb and PbTe thermoelectric materials. We ultimately would like to contribute as the foundation of the effective use technology of exhaust waste heat.

Keywords：thermoelectrics,
energy conversion

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Bone response to mechanical stimuli

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Quantification of 3D bone microstructure is essential for evaluating bone functions, such as mechanical strength, fracture risk, or bone metabolism. Synchrotron radiation computed micro-tomography has opened up new possibilities in the analysis of bone microstructure. With the high intensity and natural collimation of synchrotron X-ray sources, bone images can be reconstructed with high resolution and high quality. The monochromatization of synchrotron lights also permits the enhancement of image contrast of a target material through harnessing its K-edge absorption jump. By taking these advantages, we have been working on in-vivo/vitro imaging of rodent bone microstructure in the 3rd generation synchrotron radiation facility, SPring-8 (Japan). In addition, we evaluate bone material properties by using nano-indentation test and FTIR microscopy. Our research interests are the effects of mechanical stimuli on bone development, fracture healing, and bone tumor growth, especially with focusing on bone vascularization.

Keywords：medical engineering, synchrotron radiation CT, osteoporosis, bone cancer

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Fatigue Properties of PVD coatings

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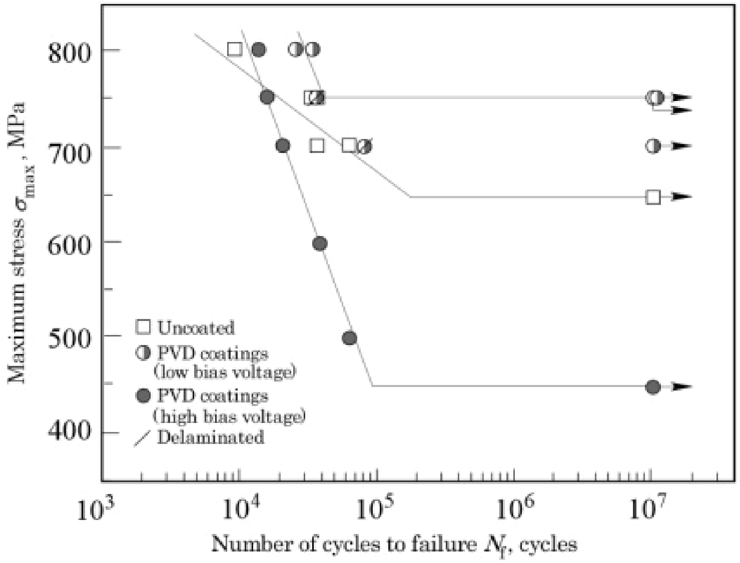
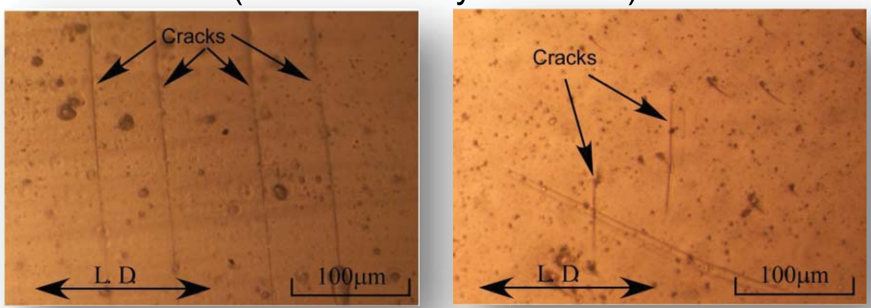


Fig. 1 S-N curves of uncoated samples & CrN coatings. (Ti-6Al-4V alloy substrate)



(a) High bias voltage, σ_a = 400 MPa, N = 1.5x10^5 cycles.

(b) Low bias voltage, σ_a = 650 MPa, N = 4.0x10^5 cycles.

Fig. 2 Typical images of film surfaces after cyclic loading.

Content:

Physical vapor deposition (PVD) coatings are well-known surface treatment methods to improve the surface properties of various materials. PVD coatings generally show high wear resistance, low coefficient of friction and seizure resistance. Therefore, the coatings are widely used for tools etc. Chromium nitride (CrN) film is one of the film materials to improve wear and corrosion resistance.

The fatigue properties of the coatings are also changed by the deposition of the hard thin film. The fatigue strength is improved by depositing of hard thin films, however, the fatigue strength often degrades by depositing of the thin films under inappropriate conditions.

We have examined the influence of the film properties on the fatigue and fretting fatigue properties of the coatings. In this study, CrN films are deposited on steels and titanium alloy under the various condition by arc ion plating (AIP) method. As a result, we have clarified the fatigue strength level is determined by the crack initiation behavior which is related to the hardness, grain size, surface morphology, defects etc.

Keywords: Surface Treatment, Physical Vapor Deposition, Fatigue, Fracture, Wear.

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Alternative low-cost extraction of cellulose nanofibers

Dr. Antonio Norio Nakagaito

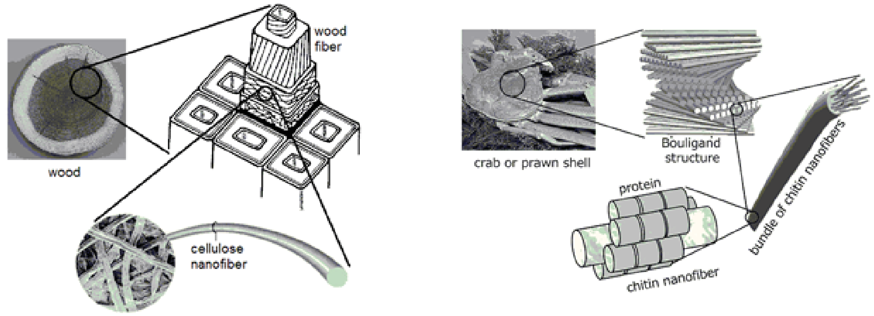
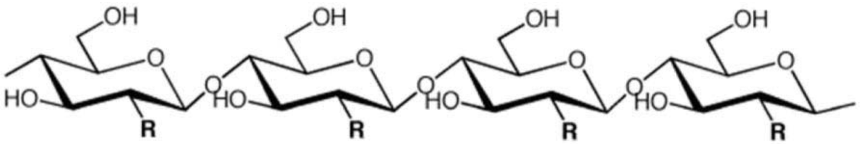


Fig. 1 Typical sources of cellulose (plant fibers) and chitin (crustacean shell) nanofibers



Cellulose: R = OH
Chitin: R = $NHCOCH_3$

Fig. 2 Structural formula of cellulose or chitin. The only difference is the functional group R

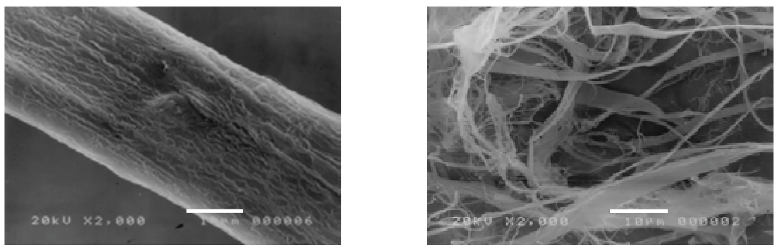


Fig. 3 SEM images of a single pulp fiber (left) and extracted nanofibers (right)

Content:

Cellulose is the most abundant biopolymer on earth, from sustainable resources, biodegradable, and photosynthesized by fixing CO_2 from the atmosphere. Cellulose is mostly found in the cell wall of plant fibers in the form of nanofibers. These tiny elements have mechanical properties similar to aramid fibers, with the potential to reinforce plastics. The extraction, however, requires specialized equipment, has high energy consumption but low yield, and therefore is costly. We are developing alternative methods using affordable and low energy input devices like kitchen blenders and ultrasonicators. Since the mechanical process of nanofibrillation is based on the application of impact and shear forces to break and fibrillate the cell wall of plant fibers, any mechanism to properly apply such forces has the potential to extract cellulose nanofibers at a lower cost.

Chitin is another abundant biopolymer present as nanofibers in the exoskeleton of crustaceans, and can be extracted by the same methods as cellulose nanofibers. Chitin nanofibers can also be used as reinforcement.

Keywords : cellulose, chitin, nanofiber, blender, ultrasonication

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Non-destructive testing using infrared thermography

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Associate professor Masashi Ishikawa

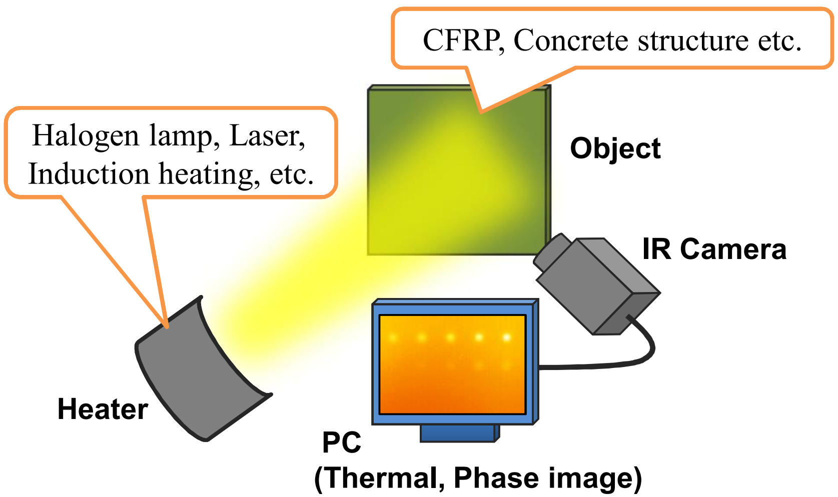

Fig. 1 Schematic illustration of infrared thermographic testing.

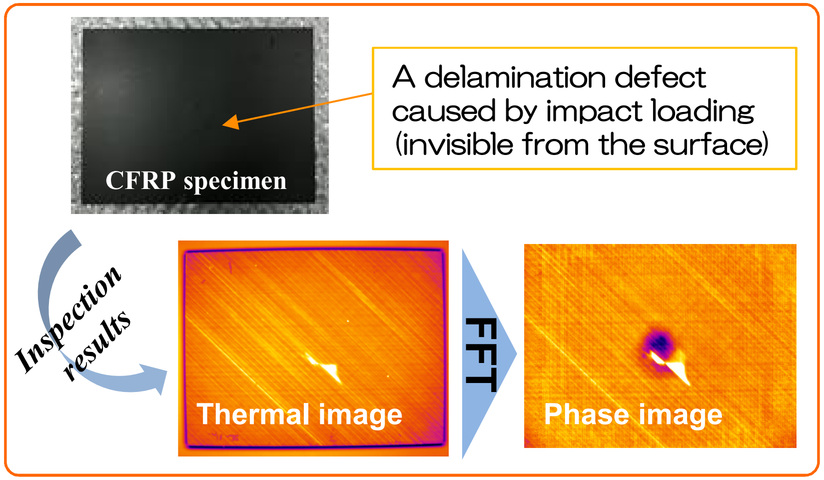

Fig. 2 Comparison of thermal and phase images obtained from experiment for a CFRP specimen with a delamination.

● *About Infrared Thermographic Testing*

Infrared thermographic non-destructive testing is an effective and convenient inspection method because it is a non-contact testing method and can inspect large area in shorter time. In this method, surface of a test object is heated and temperature distribution after heating is monitored by an infrared camera (Fig.1). When there are some inhomogeneity inside the object, heat flow from the surface is disturbed by them and such a disturbance causes irregular temperature distributions on the surface. By detecting these irregular temperature areas, inside defects can be identified.

● *Research*

We are studying:

- To improve defect detectability.

  use **phase images** constructed by applying Fourier transform to thermal data (see Fig. 2).

- To develop more effective inspection system.

  developing remote heating systems using high-power halogen lamps or scanning laser to inspect large structures (such as concrete bridges or large composite structures) located 10-20 m from observer.

Keywords: Non-destructive testing, Infrared thermography

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Foundation of Biomedical Engineering Techniques with Biophysical Engineering

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Associate Professor Kenichiro Koshiyama

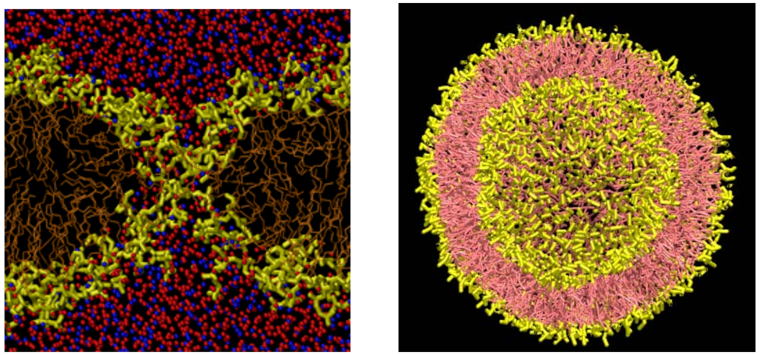

Fig. 1 Pore formation in cell membranes and nano-liposome formation. (*Physical review letters* 105 (1), 018105*, 2010, Scientific reports* 6, 28164, *2016.*)

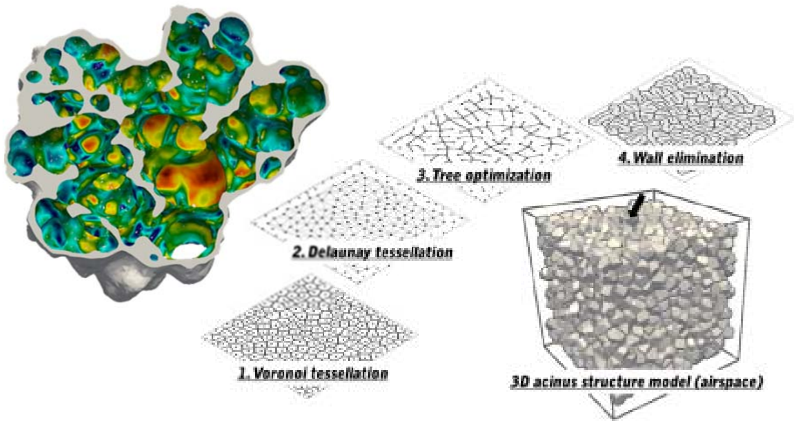

Fig. 2 Mathematical modeling of pulmonary acinus and its strain fields under static inflation with surface tension. (Computers in biology and medicine 62, 25-32,2015, Clinical Biomechanics, in press, 2018)

Content: Various medical engineering techniques such as ultrasound drug delivery systems, ventricular assist devices, and mechanical ventilation, have been developed and available these days. In such medical engineering techniques, non-physiological and non-equilibrium phenomena occur in vivo regardless of intention. For example, in drug delivery systems using physical methods (e.g., sound or electric fields), physical actions cause a non-equilibrium phenomenon of temporary permeability change in a cell membrane in an attempt to control pharmacokinetics intentionally. On the other hand, blood circulation pumps used for artificial heart and lithotripsy surgery using extracorporeal shock wave may induce erythrocyte membranes rupture, mechanical hemolysis, as blood is exposed to a non-physiological environment, e.g. high shear flows. Also, in mechanical ventilation, lung damage called ventilator-induced lung injury (VILI) may occur without appropriate settings of ventilation protocols. Physicians do not want to encounter these phenomena as much as possible when using medical engineering technology. The purpose of our study is numerically to understand the non-physiological and non-equilibrium phenomena occurring in living organisms associated with various medical engineering technologies to underlie the validity, safety, and efficiency of the technology. Our approaches are non-equilibrium molecular dynamics simulations, mathematical modeling of biological systems based on optimization, and mechanical analysis.

Keywords：Molecular Dynamics, Mathematical Modeling

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Evaluation of cellular response to mechanical stimulus using Bio-MEMS device

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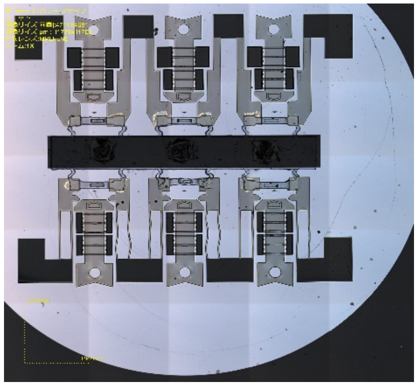
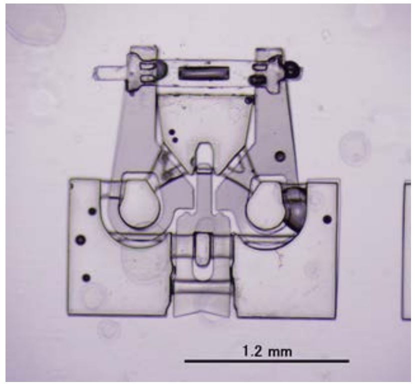
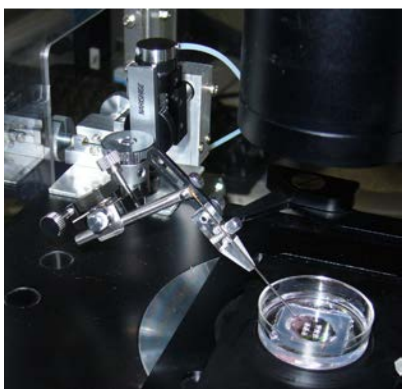


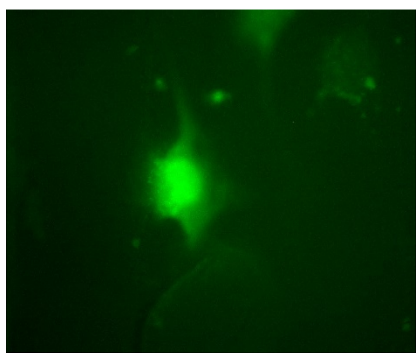
Micorodevices fabricated on the cover slip



Magnified image of a cell stretching microdevice



Micorodevices are fabricated on the 35mm glass bottom dish



Fluorescent image of bone forming cell osteoslast

Content:

we developed a novel cell stretching microdevice to observe the initial cellular response to stretching deformation. Cells change their activities by sensing mechanical stimuli such as force or deformation.

With using a conventional cell-stretching device, the cellular responses that slowly arise (ex. in minutes, hours, days) after the application of stretch was observed. One factor that hinders the *in situ* observation of cellular response to stretching is the existence of large rigid displacement during the stretch. This rigid displacement makes it difficult to observe the initial cellular response to stretch with high spatial and temporal resolution.

A novel MEMS device consists of a transparent elastic microchamber and a microlinkage mechanism. To miniaturize the cell stretching chamber enables to minimize rigid displacement during stretching operation. This device can be used to observe and evaluate the initial cellular response and microstrain field on a cell membrane during uniaxial stretching.

Keywords：<Cell Biomechanics, Bone Remodeling, Regenerative Medicine, MEMS, Mechanical Stimuli>

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Research and Development on Turbomachinery

Associate Professor　Toru, Shigemitsu

Fig.1 Inline agricultural water

Fig.2 Experimental apparatus

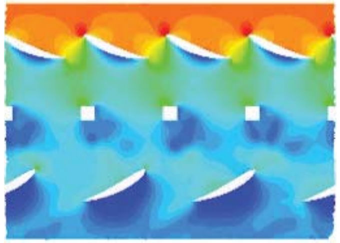

Fig.3 Blade-to-blade flow

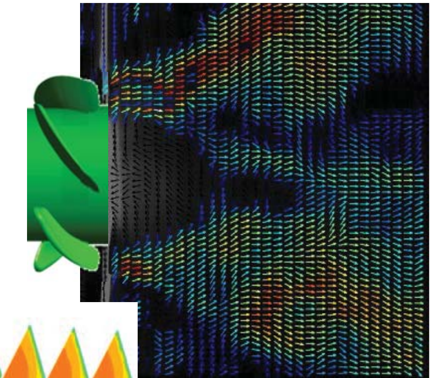

Fig.4 PIV result

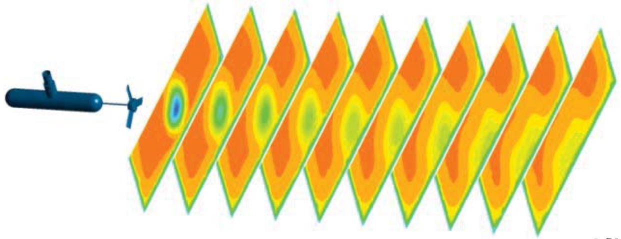

Fig.5 Wake from propeller turbine

Fig.6 rotor

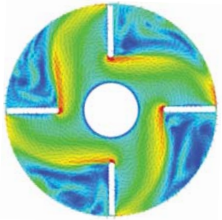

Fig.7 Internal flow of pump

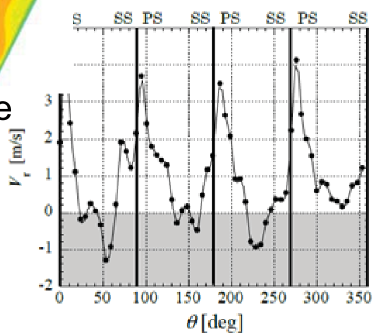

Fig.8 Outlet velocity distribution of pump

Content：Turbomachinery is used wide variety of field of renewable energy, medical and industrial pumps and so on. The targets of our research are to achieve downsizing, high efficiency, high pressure, low noise of turbomachinery based on the experiment. In addition to that, we will try to clarify the internal flow of turbomachinery by using CFD, visualization and PIV and propose the performance prediction method and design guideline based on the internal flow.

Research on renewable energy

(1) Small cross-flow wind turbine for urban district, (2) Inline pico hydroturbine for agricultural water and small scale water supply system, (3) Propeller turbine for agricultural water, small river and tidal current

Research on turbomachinery for achieving high performance

(4) Contra-rotating turbomachinery, (5) Thruster for ship, (6) Research on Industrial pump to improve performance, (7) Small pump for medical and cooling devises, (8) Research on fluid food pump

Keywords：Fluid dynamics,
Fluid machinery, CFD

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Development of Micro Hole Drilling Tool to Hard and Brittle Material

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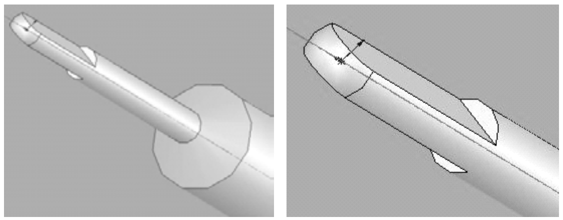

(a) Tool shape (b) Tool head

Fig. 1 Schematic drawing of designed tool

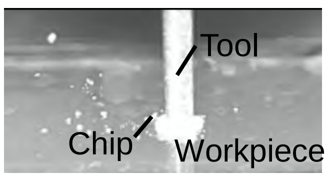

Fig. 2 Observation of chip removal

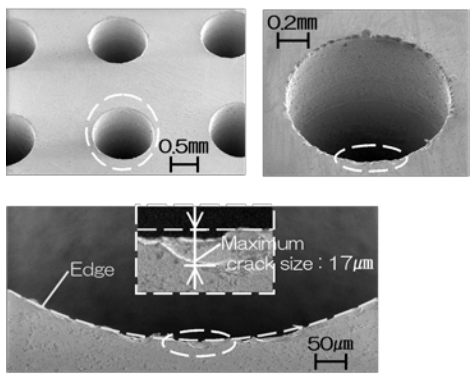

Fig. 3 Appearance of drilled hole

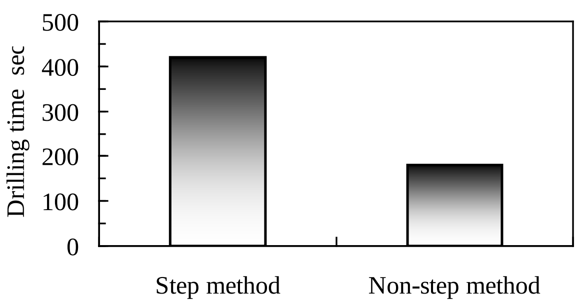

Fig. 4 Comparison of drilling time between step and non-step method

Content:

The aim of this study is the establishment of high drilling quality, high drilling efficiency and low drilling cost in through-hole drilling of hard and brittle material using an electroplated diamond tool. During drilling, the chipping is generated at the entrance side and the exit side of the material. In addition, chip generated is easy to adhere to the tool. By the adhered chip, the tool is damaged and the material is broken. In this study, we examined effectiveness of designed tool to improve chip removal in order to carry out crack-free drilling of the material.

Figure 1 shows the image of the tool designed. The tool is composed of a cylindrical body and a hemisphere shape with two straight planes. The tool has the following advantages compared to common tools.

(1) Chip adhered on the tool is little(Fig. 2).

(2) Drilling is possible without a backing plate(Fig. 3).

(3) Drilling time is shorter(Fig. 4).

(4) Drilling cost is cheaper.

Keywords : electroplated diamond tool, high quality, high efficiency

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Unmanned Aerial Vehicle Control System

Associate Professor Masafumi, Miwa

Arbitrary Attitude Hovering Control

Inverted Bicopter
Using Thrust Vectoring

Aerial / Under Water Vehicle

Multicopter Operation
by COG Shift

Attitude Control of
Manned Multicopter

Content:

The performance of UAV (unmanned aerial vehicle) is improving by the performance gain of MEMS sensors, magnet, and battery technology. UAV takes the place of the real aircraft in proportion to improve the flight control technology. Because, the operation cost of the R/C single helicopter is lower than the actual one. In addition, required heliport size is smaller than that of actual one.

However, there is a possibility of accidents such as contact and crashed due to maneuver or operation error. Moreover, rotor and propeller as thrust device are dangerous in such case. So we have been conducting research and development on thrust vectoring technology to operate UAV safely.

Currently, we present a tilt-rotor multicopter, inverted bicopter using thrust vectoring to improve UAV safety

Additionally, we study about the operation of multicopter by the center of gravity shift of the humanoid robot on it in order to develop a new personal mobility based on multicopter technology, also aerial / under water vehicle.

Keywords：<UAV, Thrust vectoring, External control>

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Development of UAV Control System Using LED Panel

Associate Professor Hiroyuki Ukida

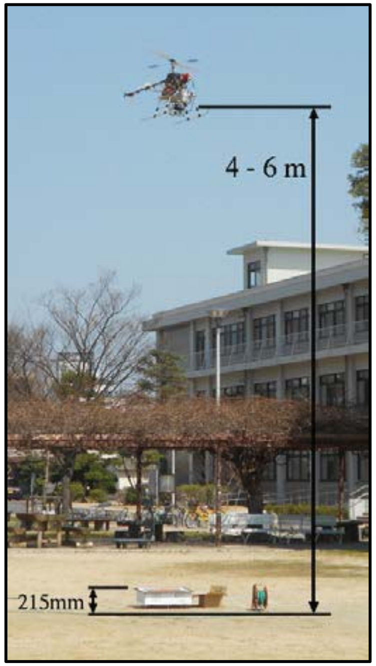
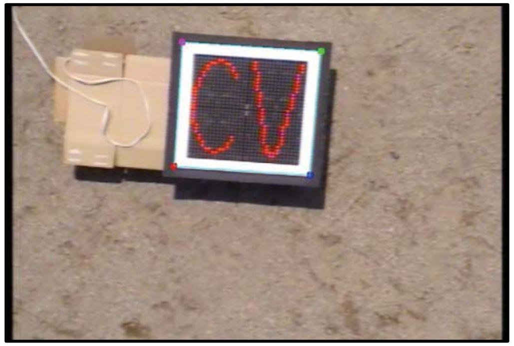


Fig.1 Scene of experiments.



(a) AR marker.

(b) QR code.

Fig.2 Captured images and LED panel detection.

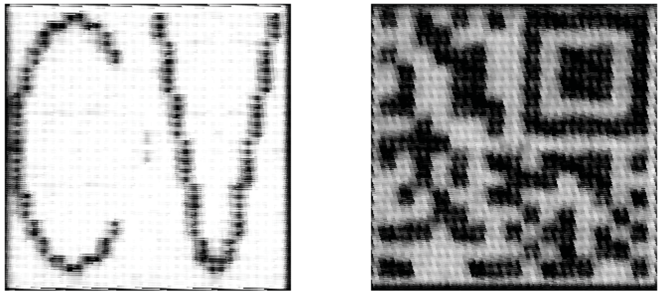


Fig.3 Corrected pattern images.

Content:

This study discusses the method to transmit the information by the LED panel and the video camera as one of the visible light communication. Here, we use the AR marker, QR and micro QR codes as 2D patterns to display on the LED panel, and propose the method to distinguish them automatically.

In the experiment, we use the video camera equipped on the radio controlled helicopter, and extract the information in the LED pattern images and estimate altitude from the LED panel by the captured images.

From the results of experiments, almost AR markers can be distinguished accurately, and the discrimination rate of the micro QR code patterns is more than 50%. But, the QR code patterns can not be discriminated. To realize the high discrimination rate of the QR and micro QR codes, it is necessary to improve the configuration of the LED panel. Moreover, to develop the flight control system of the helicopter it is also necessary to reduce the processing time.

Keywords : visual light communication, LED panel, AR marker, QR code, flight assist

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Residual Stress Measurement of Thin Films using X-Ray Diffraction

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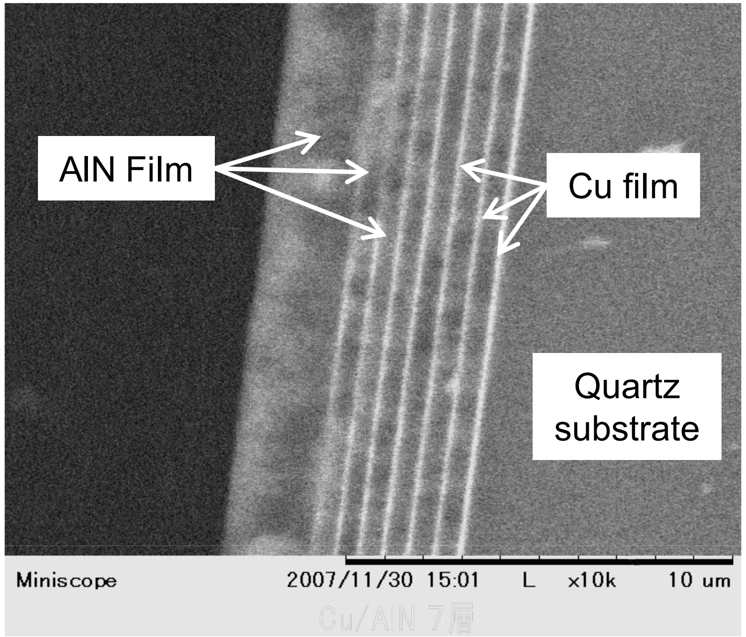

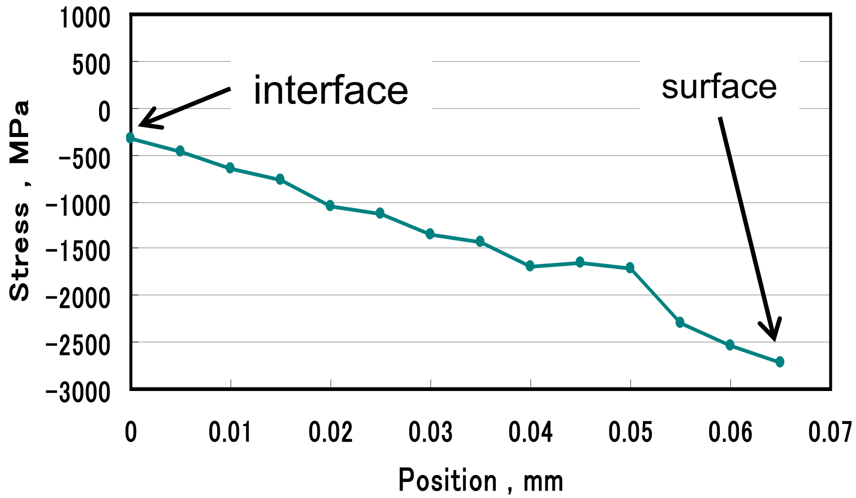

Fig.1. Internal stress of Cu layersin AlN/Cu multi-layers film

Content:

Coating is one of the surface modification technology. The mechanical properties of materials is improved by coating the film which has different mechanical properties. However, residual stresses occur in the film because of difference in lattice spacing and thermal expansion coefficient between the film and the substrate. Significant residual stress may lead to micro-cracking or cause the film to peel from the substrate. Therefore, measurement and control of residual stress is crucial for the synthesis of mechanically stable films.

It is possible to measure the residual stress of the films non-destructively using the X-ray diffraction method. As typical results, we proposed the stress measurement method for the c-axis oriented films such as AlN, GaN, and ZnO film. Our research target is to obtain high quality films which have high crystalline and small residual stress.

Keywords：X-ray diffraction, residual stress measurement, PVD film

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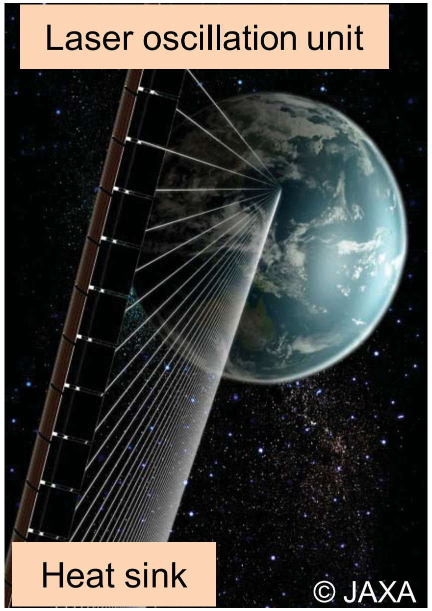
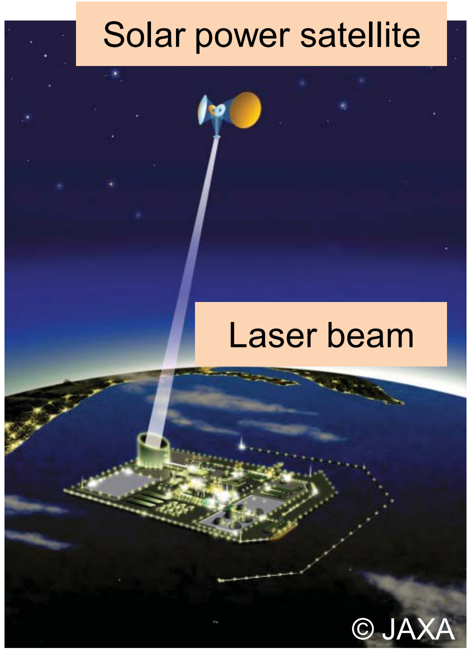
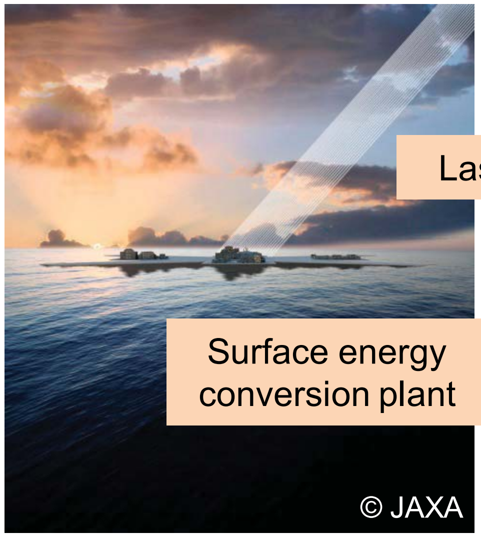
Thermal Design of Laser Beam Type Space Solar Power Systems

Assistant Professor Koji Kusano







Content:

Space solar power system (SSPS) is the concept of stable power supply system, which collects solar power and generates electric energy in space for use on earth. Today, no prospect of actually using SSPS has yet emerged because of its technical challenges but practical use in near future is expected. In SSPS, two types of energy transmitting technique from solar-power satellite to Earth's surface are planned. One uses laser beam emitting, the other uses microwave wireless transmission. In particular in former system (Laser-beam type SSPS : L-SSPS), it is important that the cooling of laser diodes on space photovoltaic module and the design of beam collector on surface, which converts from high energy density laser beam to electric power.

Our purpose is to estimate and analyze the heat balance of PV/LD joint module, and design an optical heat sink dimension or the arrangement of individual device. Furthermore, new PV and solar thermal energy (STE) combined system for surface laser beam collector is being developed for high efficiency energy conversion.

Keywords: space based solar power, radiative heat transfer, PV/STE combined system

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Development of Cuboidal γ′ Phase in Ni-based alloys

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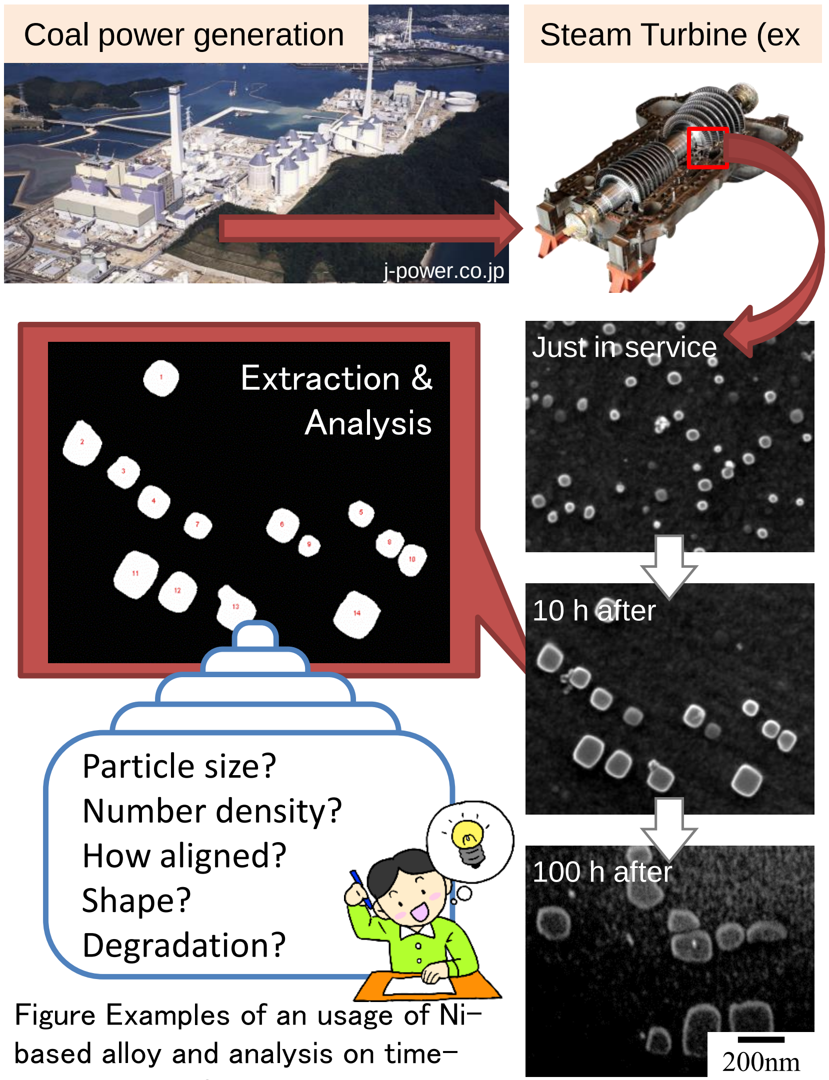

Figure Examples of an usage of Ni–based alloy and analysis on time–dependence of its microstructure.

Content: We are tying to unclear the mechanism of γ′ morphology (shape, distribution and other characteristics of γ′ precipitates) in Ni-based alloys.

Ni-based alloys are famous as a structural material at high temperature such as power generators and jet engines, whose microstructure are dramatically changing in service as shown in left figures. γ′ precipitates make the alloy strong and its morphologies should affect the performance. We are trying to understand and control them through following approaches.

① Simple alloy system and special experiment conditions were carefully selected to extract the key factor of γ′ morphologies. It is just for understanding mechanism of γ′ morphologies directly.

② The imaging process to evaluate the γ′ morphologies is being developed due to the difficulties of explanation and discovery of them. The Ni-based alloys are ones of the most simple 2 phase alloy, which is desirable as a model case of “computing microstructure quality management”.

Keywords : Ni-based alloy, precipitation morphology, gamma prime phase

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