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Topics

A Talk with an Asahi Prize Winner, Dr. Yoshinori Tokura

Pioneering Prodigy of Correlated Electron Research

A Talk with an Asahi Prize Winner, Dr. Yoshinori Tokura



● Yoshinori Tokura

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- 1984-1986 Assistant Professor, Department of Applied Physics, University of Tokyo
- 1994-present Professor, Department of Applied Physics, University of Tokyo
- 1993-present Group Leader, Joint Research Center for Atom Technology, National Institute for Advanced Interdisciplinary Research
- 2001-present Director, Correlated Electron Research Center, National Institute of Advanced Industrial Science and Technology
- 2001-present Project Director, Tokura Spin Superstructure Project, Exploratory Research of Advance Technology, Japan Science and Technology Corporation

Dr. Yoshinori Tokura, Director of Correlated Electron Research Center and winner of the Asahi Prize in 2001 for correlated electron research, talked about his achievements in past researches and aspirations for the future.

— Congratulations again on your receiving the Asahi Prize. You won the prize for the "Study on Correlated Electron Materials". How did you start this research?

Tokura: There was a boom in the research of high temperature superconductors towards the end of 1986. At first, I was reluctant to participate in to such a craze. But when I went to a IBM laboratory as a one-year visiting scientist at the end of January of the following year, I was convinced there was no way, but to work on this subject. New oxide superconductors have characteristics somehow common to organic material series I had been studying at the time. They were familiar to me in a way. And yet, as it was completely a new field to me, I was fascinated by freshness of the research and enjoyed learning.

— Did you create the term "correlated electron" ?

Tokura: No. The term has been used extensively at least for 10 years by many researchers. I don't think the term was created by anyone in particular. Actually, the theoretical concept of "correlated electrons" has a long time been known. But the theory is very complicated and sample preparation was not easy. So, this theory could not be applied to an exact materials science until the discovery of high temperature superconductors. This aroused interest in the correlated electron as a new electron material accelerated the research. We are now at the stage where we can explore ways to apply the academic principle to practical technology.

— The new concept was introduced into so-called classic compounds including Perovskite transition-metal oxide. You mean the discovery of oxide superconductive material led to the rapid advancement in the field of "correlated-electron system" that may overturn the common belief of physics based on band theory. Could you explain more about

the new field?

Tokura: Electrons which have a negative charge repel each other by the coulomb force. When this happens in multiple electron systems, we call it correlated-electron systems. In strongly correlated electronics, we address a group of electrons which can barely move under the effect of this strong correlation. In the strongly correlated-electron systems, although they are supposed to be metal under normal conditions, they could become solids as they localize at each atom site by the repelling force acting among them, or otherwise could be liquid or liquid-crystal. Slight stimulation such as magnetic or electric fields, pressure, light, etc. cause a phase transition of such electrons in the form of solids, liquid or liquid-crystal in a moment. As a result, their electric, magnetic and optic properties can be changed instantly.

— Strongly correlated electron systems sound like a "gold mine" of new phenomena and functions. Could you tell us about your achievements in the discovery of electron-type high temperature superconductors and giant magnetoresistance?

Tokura: The phenomenology of high-temperature superconductors is quite simple. The non-metal material can be transformed into metal by adding or reducing electrons on the copper-oxygen sheet which is full of electrons. Here comes the superconductor! The superconductor appears next to the electrically insulating material. High-temperature superconductors are a typical strongly correlated-electron material. It is not difficult to extract an electron but it was hard to obtain a suitable crystal structure to insert an electron. I invented a simple rule for material design of high-temperature superconductors. This led me to the study on electron-type high-temperature superconductors.

After the study on high-temperature superconductors produced a certain result, I was obsessed by the fascinating transition-metal oxide and went through transition-metal elements one by one, from titanium to copper which have a mobile d-electron. I encountered manganese oxide which has a great potential. It has been known for some 20 years that manganese oxide shows magnetoresistance. Now we have a marked advancement in researches on giant or colossal magnetoresistance. More interesting characteristics specific to strongly correlated electron systems have come into focus.

— What application can be possible? Strongly correlated electronics seem very different from semiconductor electronics.

Tokura: Strongly correlated electronics is a concept which is

orthogonal to semiconductor electronics. Basically, the movement of an independent electron matters in semiconductor electronics. It was a bold but correct supposition that 10^{14-18} electrons per unit volume can be treated as one independent particle. I think this concept serves well to design a precise electronic device. As you know, a single electron device is an ideal model in silicon electronics where it is desirable to keep the number of active electrons to a minimum. What differentiates our approach from this is that we lump the electrons together. It is true that there is a question as to the possibility of miniaturization. But 1 million electrons in a box of 40nm would be enough to define an electronic phase. There is no problem for miniaturization.

In terms of application, quite a number of functions cannot be materialized with just one electron. Taking an MO disc for instance, highly complex and tedious functions are integrated in this magneto-optical technology. It would be much more functional if a magnet can be produced by simply applying light. In my opinion, application of "phase change" of electrons is a short-cut to the smarter functions inherent to materials.

— You have been taking the lead in this field as a pioneer of strongly correlated-electron studies. What attracts you the most in this branch of physics?



Asahi Prize

The Asahi Prize was established by Asahi Shimbun in 1929 commemorating its 50th anniversary celebration. The award is conferred on an individual or organization that has made outstanding accomplishments in the fields of academe or art, greatly contributing to the development of our culture and society. Winners of the most honourable awards including a Nobel Prize and an Order of Cultural Merit Award appeared from the recipients of the Asahi Prize in later years.



Tokura: I was educated in physics but had an interest in developing new materials. When a physician tries to develop some new substance, he is certainly inspired by interesting theory which may have a lot of potential. Otherwise this kind of research will not appeal to him.

When electrons in different states are competing with each other, just a tiny stimuli can bring about a great change in the state of matter and lead to a dramatic switching of variety of functions or properties. One of the possible ways to create a new material is going after the optimization of the composition where the competition of electronic phases are so crucial. Something really remarkable may happen only if we could reach that stage. There is no limit in the variety of such material designing. It is very interesting.

— You have been proposing that basic studies should be made the center of applied studies at Tokyo University and AIST.

Tokura: Most of the AIST researchers are professionals. But not all the graduate students are aiming to become a professional researcher. So I need to be careful about the research plan. When I say "basic studies at University", it means, a basic learning. Applied studies at AIST would be a slightly developed version of basic ones. It might be too much if we add an adjective like "advanced" or "applied".

— Strongly correlated-electron technology also seems to be at its early stage. How do you evaluate the research

framework of industry-academia-government collaboration of JRCAT (Joint Research Centre for Atom Technology).

Tokura: I have a very high opinion about this project. At first, I was worried because basic studies for the project would not be beneficial for a number of researchers from the industrial sector. But there was nothing to worry about. Those who engaged in basic studies on leading edge technologies with us are now playing an important role in R&D of each field. I am hoping to welcome as many researchers as possible from different areas.

— Is there anything particular that has changed since AIST was reorganized?

Tokura: Before AIST, I was at NAIR (National Institute for Advanced Interdisciplinary Research). Budgetwise, we had access to ample funding. I think budget allocation has become very strict since the start of AIST. When we achieve some positive results and need to work intensively, it would be good if there is a system which can provide necessary budget and facilities to support the research quickly.

— You have won many prizes including Nishina Memorial Prize and IBM Science Prize. You were also listed in ISI Citation Laureates in the field of applied physics. Do you see a special significance in receiving the Asahi Prize this time?

Tokura: Material physics is not easy to understand for people outside the field. Taking the phenomena that an electron

makes liquid, solid etc. , a great deal of background knowledge, which is extremely intricate, is essential in a research. I am particularly happy in receiving the prize because that means the media appreciated the value of a study of this kind.

It is very convincing that Dr. Akimitsu received the Prize for his discovery of new superconductive material. But our achievements are not the kind to be easily recognized. I hope the term "strongly correlated electron" becomes popular just like "semiconductor". It was rather annoying to me though, as my family was much happier about being able to meet Mr. Hayao Miyazaki, director of the animation film "Sen to Chihiro no Kamikakushi" at the ceremony.

— The film was excellent. I don't mind going and watching it again myself.

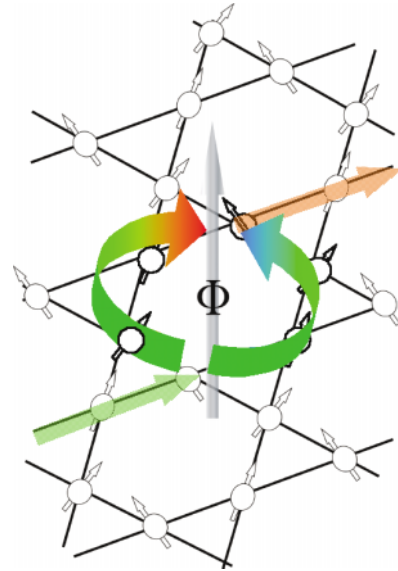
Tokura: Mr. Miyazaki said "Younger ones come to me full of dreams but in reality, it is their energy that drives me. I should remember that" in his speech. His account was rather extreme, but I, myself, am revitalized by the youth or perhaps some of them are sapping my energy because I have plenty to give.

— Recently, you have launched the "Tokura Spin Superstructure Project" with the Exploratory Research of Advanced Technology (ERATO). Could you tell us about the project and your aspirations for the future?

Tokura: I would like to achieve something momentous in ERATO. Dr. Noyori, this year's Nobel prize laureate in chemistry, invented right and left hand systems of a molecule. We are aiming at creating something equivalent within a spin superstructure. If applying an electric current under a magnetic field set to a certain direction, the resistance differs depending on the current flowing in the right or left direction. We can replicate the phenomenon which occurs in a coil by using a substance.

We have proved that a fictitious magnetic field reaching tens of thousands of tesla is effective in a strongly correlated electron structure of a certain kind. This level is comparable to that of a magnetic field in outer space. Considering about a magnetic field that we can easily create in a laboratory is only 10 tesla, this is really enormous. We are not sure if this finding will be useful for anything. But we are expecting to increase the rotation angle of the polarized light from the present 0.2° to 20° in optico-magnetic effect utilized in the mechanism of MO disk data storage. A completely new principle has the potential to lead you to a positively wonderful result.

Control of quantal Berry phase



Control of quantal Berry phase: A moving electron in a ferromagnet with specific lattice and spin topology may gain a strange quantal phase. This is equivalent to the motion of an electron in a fictitious magnetic field of several tens of tesla.

— It was a fascinating story. Thank you very much for your time. You often say that you must be prepared before an expedition. We look forward to your continued success in future academic adventures.

(Interviewer: Dr. Yoshio Niwa, Trustee)



Abstracts (December - March 2001-2002) ▶▶▶▶

The abstracts of the recent research information appeared on the Vol.1 No.11-Vol.2 No.3 of "AIST Today" are introduced and classified by research area.

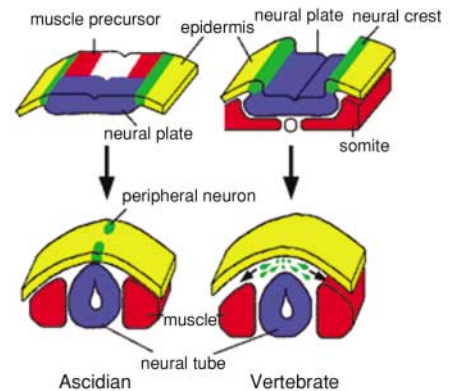
For inquiry about the full article, please contact the author directly.

Life Science & Technology

Ascidian as a Model for Neural Crest Development

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AIST Today Vol. 1, No. 11
(2001) 8

The vertebrate neural crest cells give rise to a variety of cell types including peripheral neurons, endocrine cells, and pigment cells. Although understanding of the neural crest development is important for tissue engineering and treatment of human disorders, little is known about its molecular mechanism. By using gelsolin, an actin-binding protein as a molecular marker, we have recently found that the formation of the peripheral neurons of ascidian larva is similar to that of vertebrates in a fundamental aspect. Thus, by adopting ascidians, a primitive chordate as a model system, it will provide new insights to understanding the molecular basis for neural crest development.



Development of peripheral neurons in ascidian and vertebrate

Drosophila Female Mating Rhythm is Governed by Clock Gene

Mating rhythms of flies are abolished in circadian clock mutant flies. The mating rhythms were lost when circadian rhythm mutant females were paired with wild-type males, demonstrating that female mating activity is governed by clock genes (PNAS 98,9221-9225,2001).

An anti-phasic relationship in the circadian rhythms of mating activity was detected between *D.melanogaster* and their sibling species *D.simulans*, both of which are from Ogasawara Island. The data suggested that female- and species-specific circadian rhythms in the mating activity of *Drosophila* cause reproductive isolation which is an important factor

in evolution and reproduction.



Mating behavior of male fly (lower is male)
Wing vibration behavior is called a courtship song

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AIST Today Vol. 1, No. 11
(2001) 9

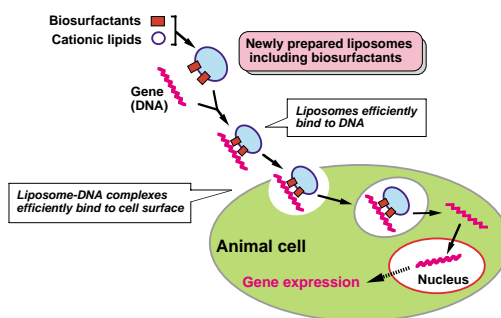
Dramatic Increase in Efficiency of Gene Transfer into Cells

- Potential to greatly accelerate research into gene functions and cancer gene therapy -

The Research Institute for Green Technology in collaboration with Prof. M. Nakanishi of Nagoya City University have achieved a dramatic increase in the efficiency of gene transfer into cells using a new type of liposome.

We have developed a liposome that contains "biosurfactants," functional lipids produced by yeast. Compared to previous commercially available liposomes, the new method enables a 50- to 70-fold increase in the rate of gene transfer into a range of cultured mammalian cells. The biosurfactants are extremely practical to use because they are not toxic to cells at concentrations used and can be mass-pro-

duced from plant oils through a yeast fermentation reaction.



Gene delivery system by liposomes including biosurfactants

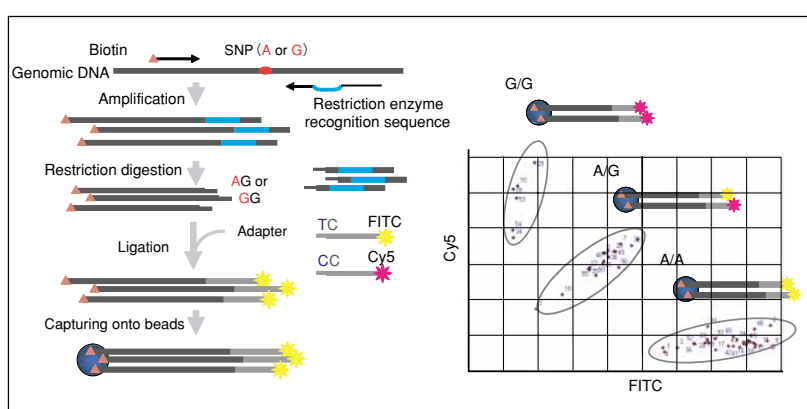
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(2001) 10

Technology for Fluorescently Labeled Paramagnetic Bead Array

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 (2001) 11

We have developed a highly reliable SNP typing protocol based on the sequence-specific ligation of fluorescently labeled DNA. The protocol was fully automated by a high throughput robot for handling paramagnetic beads which we have also developed in collaboration with a Japanese venture company. We are currently focusing on the enhancement of the

throughput by introducing multiple-colored paramagnetic bead array technology which allows the multiplexed typing of tens of SNPs at the different locus in parallel. The technology will enable us to produce a small, easy-to-use instrument for biotechnology fields including medical inspections.



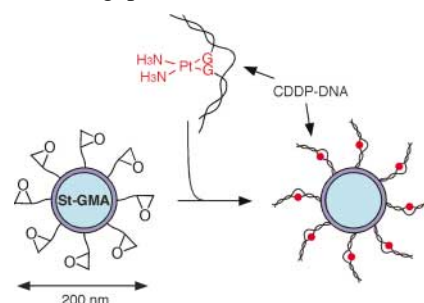
SNP typing by paramagnetic beads and fluorescence detection

High Performance of Submicron Beads to Purify Damaged-DNA Binding Proteins

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AIST Today Vol. 1, No. 11
 (2001) 12

A high-performance affinity purification technique has been developed for cisplatin (CDDP)-damaged DNA binding proteins directly from crude protein extracts of HeLaS3 cell using novel submicron beads synthesized by copolymerization of styrene (St) and glycidyl methacrylate (GMA). It is usually difficult to purify affinity proteins with lower binding constants than sequence-specific DNA binding proteins by ordinal affinity chromatography. The new beads dramatically decreased both non-specific protein adsorption on solid surface and elution volume and simplified handling tech-

niques. At least nine proteins clearly showed their higher affinity including several proteins that were previously reported to be as CDDP-DNA binding proteins.



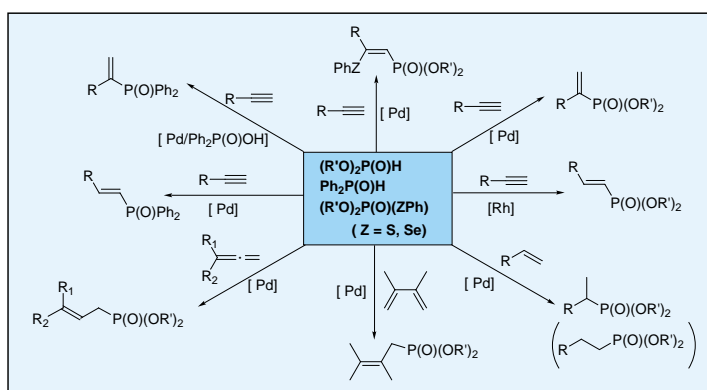
Preparation of CDDP-DNA bead

Catalytic Synthesis of Organophosphorus via Transition Metal Complexes

Oxidative addition of heteroatom bonds of phosphorus compounds (P-H, P-S, P-Se) to transition metal complexes readily takes place and triggers a variety of catalytic addition reactions of the bonds to carbon—carbon un-

saturated linkages. These new catalytic reactions have a wide generality as well as high regio- and stereoselectivity and provide efficient new methodologies for the synthesis of versatile organophosphorus compounds.

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 AIST Today Vol. 1, No. 11
 (2001) 13



New efficient catalytic reactions for the synthesis of organophosphorus compounds

Development of Novel Scaffold for Tissue Engineering

A novel kind of biodegradable porous scaffolds has been developed by our group by introducing collagen microsponges in the pores or interstices of a synthetic polymer sponge or mesh. Use of the synthetic sponge or mesh as a skeleton facilitated formation of the hybrid scaffolds into the desired shapes, reinforced the hybrids and resulted in easy handling, while collagen microsponges contributed good cell interaction and hydrophilicity. Bovine articular chondrocytes were cultured in the hybrid scaffold to engineer articular cartilage. The chondrocytes expressed type II collagen and aggrecan, suggesting the formation of articular cartilage-like tissue.



Tissue Engineered Cartilage

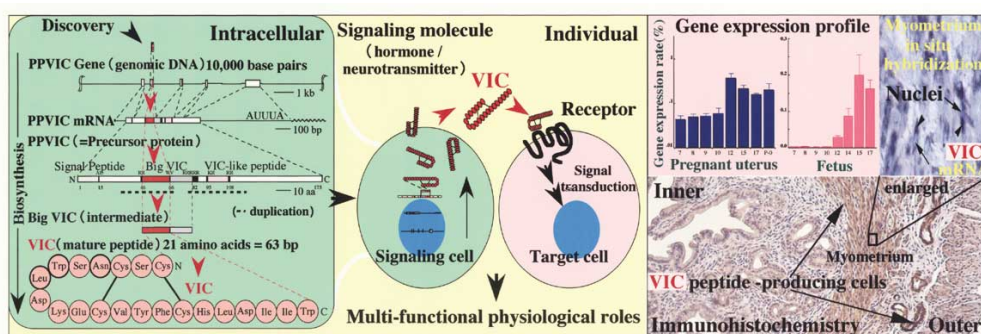
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 AIST Today Vol. 2, No. 2
 (2002) 8

Elucidation of VIC/ET-2 Biosignaling System

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 AIST Today Vol. 2, No. 2
 (2002) 9

We discovered a novel signaling peptide (VIC/ET-2) from mammalian genome. The VIC induces hypertension, intestinal contraction, vasoconstriction, secretion, cell growth, differentiation, and apoptosis. At higher doses, VIC, which is structurally similar to snake venom SRTX, induces sudden death. Gene expression profiles have revealed an organ-specific expression in the brain, uterus, ovary, fetus, and intestine. The VIC holds great promise in

displaying intriguing physiological functions during neuronal differentiation, embryonic development, and reproduction in addition to its effects on the gastrointestinal system. Currently we are focusing on revealing the organ-specific functions of VIC using VIC-specific quantitative gene expression analysis and in-situ hybridization/histochemistry technique that we established.



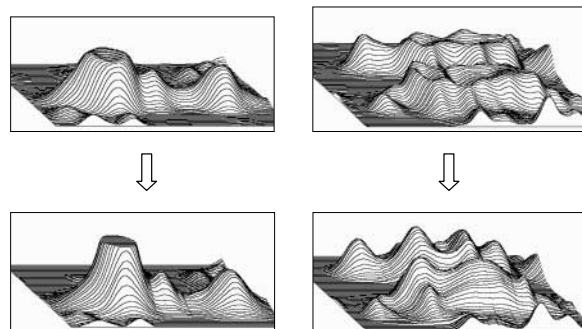
Biosynthetic pathway, biosignaling system, and elevated gene expression in uterus and fetus

Automated Processing System for Protein 2D-PAGE Images

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 AIST Today Vol. 2, No. 2
 (2002) 10

We have established the automated processing algorithm that deals with the images of protein 2-dimensional poly-acrylamide gel electrophoresis (2D-PAGE) which is thought to be a key technology in "proteome" analysis. Our processing algorithm automatically extracts the locations and intensities of the protein spots separated and visualized in 2D-PAGE, then automatically compares it with the huge number of such images. We have also developed a WWW (World Wide Web) based 2D-PAGE image processing system "PiKA2", that realizes automated 2D-PAGE image submission,

automated spot detection and automated spot pattern comparison via a computer network with a WWW browser.



Spot shape fitting by Gaussian-type function

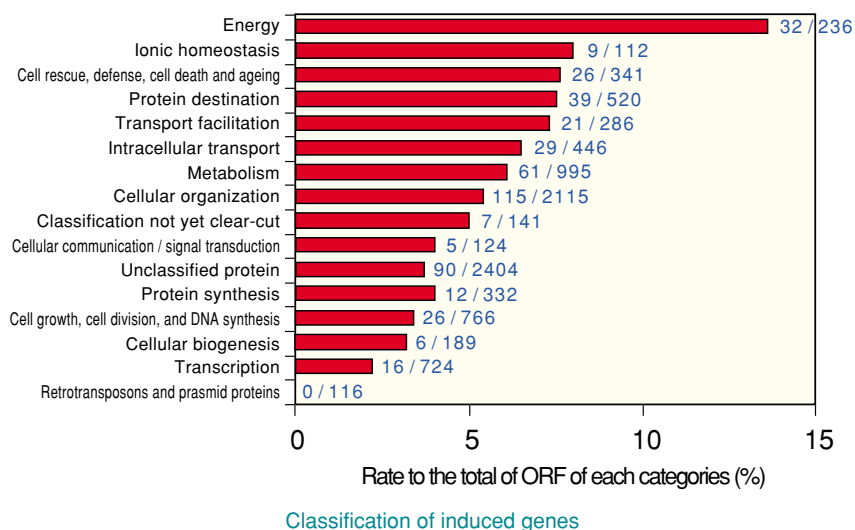
Screening of Genes that Respond to Freeze-Thawing Stress using DNA Chip

The International Patent Organism Depository (IPOD) is authorized by the Commissioner of the Japanese Patent Office as the sole depository for the organization patent in Japan. Deposited organisms are preserved in optimum conditions such as freeze-drying, cryopreservation and subculture. However, there may be a possible deficit in biological activities and transformed characters in the deposited organisms. Therefore, we should understand the damage caused by preservation and develop new preservation methods. It may be possible that the characteristics of organisms may change by the present preservation method. This problem has discussed by organism-related inventors. Therefore, it is quite important to maintain the precious property in this depository for clarifying details of the damage and establishing an efficient preservation method.

Freeze-thawing stress is one of the main stresses that can be caused during preservation. In order to analyze the effect by freeze-thawing stress, we have carried out DNA microarrays containing approximately 6,000

open reading frames (ORFs) from *Saccharomyces cerevisiae*. The yeast cells were cultivated until the logarithmic phase, and the cells were frozen at -80 °C. These cells were thawed and cultivated for 15 min, 30 min, and 60 min. From these cells, we isolated mRNA and compared them with those obtained from the cells without freeze-thawing stress. Consequently, 282 ORFs showed more than a two-fold increase in expression levels at 60 min, 15 and 30 min. When the induced genes at 60 min were classified according to functional categories of MIPS (<http://mips.gsf.de/>), it was suggested that the number of genes concerning the function of “energy” were induced. Many other induced genes may belong to the categories on “ionic homeostasis”, “cell rescue, defense, cell death and aging”, and “protein destination” (Fig). These results suggest that the expression of these genes may be induced for the proteinic restoration and decomposition caused by freeze-thawing. These elevated expression levels may also be related to their energy. These genes can be a good marker for searching the best freeze-thawing condition and developing new preservation methods.

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(2002) 11



Development of Quick, Precise and Complete Body Scanners

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AIST Today Vol. 2, No. 2

(2002) 15

New body scanners have been developed by the Digital Human Laboratory and Research Institute of Human Engineering for Quality Life (HQL). One of the new scanners can measure the 3D surface shape of the whole head, and another can measure the whole body. These scanners are (1) accurate (0.5 mm for head, 1.0 mm for whole body), (2) precise (resolution : 1.0 mm for head, 2.0 mm for whole body), (3) quick (0.93 sec for head, 1.8 sec for whole body) and (4) complete (reduction of hidden areas such as back of the ear, under the chin, arm pit and crotch). We have been

conducting anthropometric research of 3D body shape and dimensions on 200 senior Japanese with the new scanners. These data will be disclosed to public in June, 2002.



Whole body scanner and scanned data

Homology-Based Prediction of Eukaryotic Gene Structures

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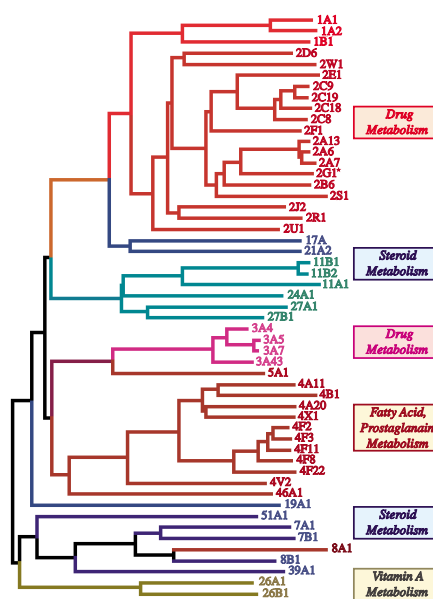
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AIST Today Vol. 2, No. 3

(2002) 10

We have developed a method for prediction of eukaryotic gene structures (exon-intron organizations) based on sequence homology together with several lines of statistical information such as coding potential and signal strength around exon-intron boundaries and translational start sites. Based on testing upon sets of human and *C. elegans* genes of known structures, we found that the method predicts coding nucleotides at an accuracy of 96% or more, when the amino acid identity between the reference and target sequences exceeds 50%. Using this method, we are attempting to identify all genes involved with drug metabolism in organisms whose entire genomic sequences have been determined.



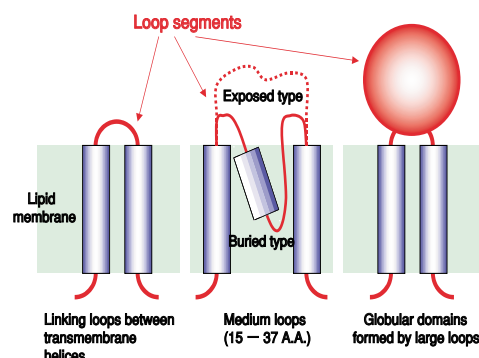
A phylogenetic tree of human cytochrome P450 genes

Analysis of Inter-Helical Loop Segments in Membrane Proteins

Recent crystallography and diffraction studies of membrane proteins have revealed that the structure of specific medium loop segments between transmembrane helices fold back into membrane positions and play an important role in membrane protein folding and biological function. However, previous structure prediction methods of membrane proteins have not classified the type of loop segments. We have developed a new method for classification and prediction system of the specific medium loop segments in membrane proteins from amino acid sequence. To classify the loop segments, multi discriminant analysis with three factors, loop length, average hydrophobicity

and intensity of amphiphilicity, was used.

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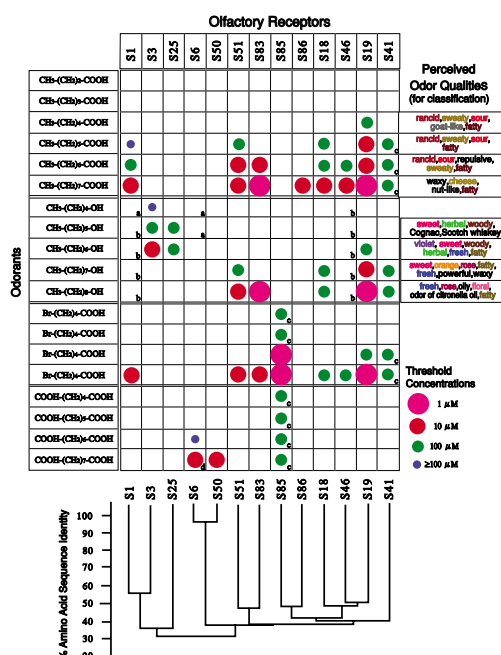
Classification of loop segments in membrane proteins

Molecular Basis of Odor Discrimination in Olfaction

- Research of Primary Odors Corresponding to RGB in Color for the Basis of Innovating the Architectures of Artificial Noses -

There are hundreds of olfactory receptors which detect various odorants in the olfactory system. Their responsiveness should correspond to primary odor information as three types of photo-receptor cells react to primary colors respectively. Using a panel of odorants with similar molecular structures, the analysis of odorant responsiveness of 13 identified olfactory receptors have revealed the principle of odor discrimination in olfaction. The results indicate that the olfactory system uses a combinatorial receptor coding scheme to encode odor identities.

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 AIST Today Vol. 2, No. 3 (2002) 12

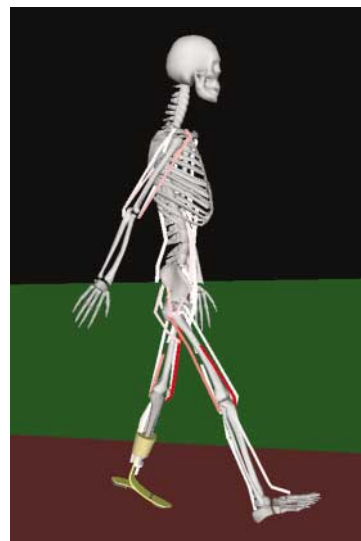


Odorant Tuning Specificities and Amino Acid Sequence Identities of 13 Olfactory Receptors Revealed Partial Receptor Codes for Odorants.
 a: not tested
 b: tested at 10 μM, but not 100 μM
 c: not tested at 10 μM or 1 μM
 d: not tested at 1 μM

Computer Simulation of Human Gait for Rehabilitation Applications

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AIST Today Vol. 2, No. 3
(2002) 13

We developed a human gait simulation system for rehabilitation applications. As an example, a human model with an artificial limb was constructed. In this simulation, both the walking pattern and optimal design of the artificial foot were determined through this research. The simulation results suggested that an artificial foot having a small and soft heel might produce a more efficient walking pattern, and the results matched with the actual prescription by prosthetists. We believe that such a simulation technique will provide novel research tools of rehabilitation consultation for physically handicapped people.



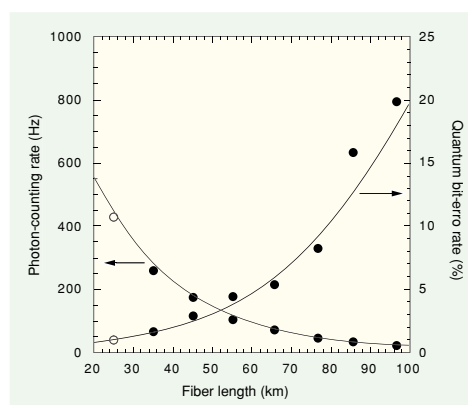
Gait simulation model with an artificial foot

Information and Communication Technology

Long-Distance Quantum Cryptography

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AIST Today Vol. 2, No. 2
(2002) 17

We report a fiber-optic quantum cryptosystem based on Bennett's two-coherent-state protocol operating at 1550 nm for long-distance quantum key distribution. Two thermoelectrically cooled (-35 degrees Celsius) gated-mode single-photon detectors are employed for establishing a secret key exchange between two remote parties who are separated by a 25.2 km single-mode optical fiber. The quantum efficiency is 22.4% with a dark count probability per gate of 4.3×10^{-5} , which yields a quantum bit-error rate of 1% for a fiber length of 25.2 km.

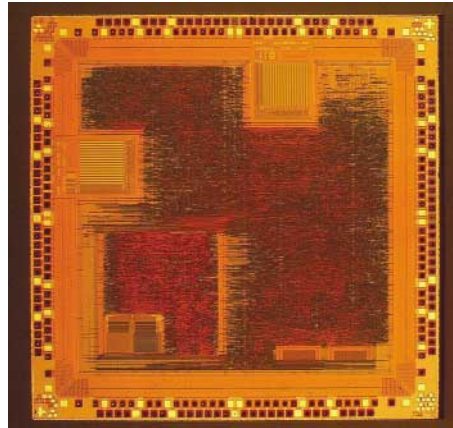


Measured photon-counting rate and quantum bit-error rate. Fiber (open circles). Attenuators (solid circles)

Development of the Evolvable Hardware LSI Chip

- A Myoelectric Hand Controller with Proven Industrial Potential -

This paper describes an innovative LSI chip, called an evolvable hardware (EHW) LSI chip, and its application to a myoelectric hand controller. In contrast to conventional hardware, where the structure is irreversibly fixed in the design process, EHW is designed to adapt to changes in task requirements or changes in the environment through its ability to reconfigure its own hardware structure dynamically and autonomously. This capacity for adaptation, achieved by employing efficient search algorithms known as genetic algorithms (GAs), has great potential for the development of innovative industrial applications.

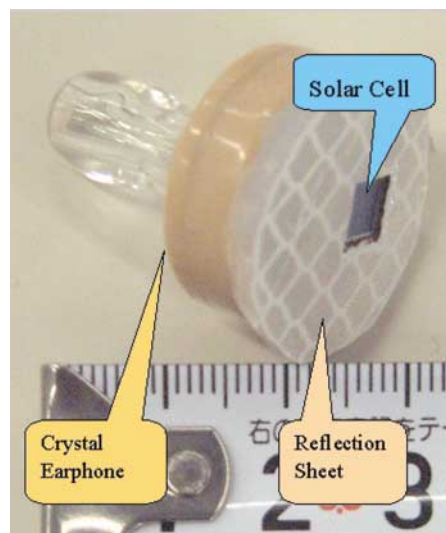


The EHW chip micrograph

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AIST Today Vol. 2, No. 3
(2002) 14

A Compact Battery-less Information Terminal (CoBIT) for Location-based Support Systems

The ubiquitous computing environment should assist people to enjoy useful information services on a situation-dependent basis. We proposed a location-based information support system with a Compact Battery-less Information Terminal (CoBIT). A CoBIT is an earphone connected with a solar cell. Therefore people wearing it hear sound only when it receives intensity-modulated light. Cameras with LEDs can easily detect some simple signs of the user and position of the CoBIT because it has sheet type corner reflectors. Thus a CoBIT, without an internal energy supply, assists people wearing it to communicate with the environmental infrastructure.



A CoBIT sample

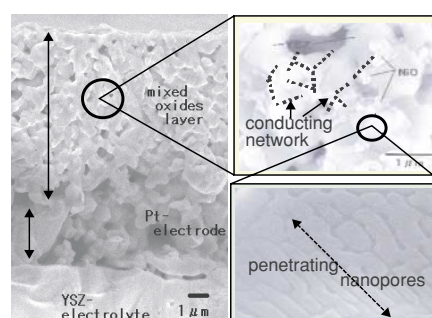
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AIST Today Vol. 2, No. 3
(2002) 19

The Highest Efficiency of NO_x Decomposition by Hyper-Structural Controlled Electrochemical Cell

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 AIST Today Vol. 1, No. 11
 (2001) 14

Electrochemical cells have become an important technology which contributes to many aspects of human life, industry and environment. The Environment Purification Materials team of Synergy Materials Research Center successfully designed and investigated a new family of electrochemical cells for the reduction of NO_x gases emitted from lean-burning engines. A novel cell structure has been proposed and optimized. A nano-porous composite working electrode consisting of a 3D network of pathways for the migration of oxygen ions and electrons was designed for covering a composite cathode. Nano and micro structure

control allows the creation of an electrochemical cell operating at the low levels of electrical power and current required for NO decomposition in the presence of excess oxygen.



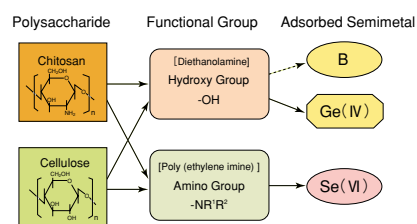
Profile micrograph of the hyper-structure controlled electrochemical cell

Selective Adsorbents for Semimetals Derived from Natural Polymer

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 AIST Today Vol. 1, No. 11
 (2001) 15

To obtain selective adsorbents for germanium (IV) or selenium (VI) derived from polysaccharide, di (2-hydroxyethyl) amine- and poly (ethylene imine)-type cellulose derivatives were newly synthesized. The di (2-hydroxyethyl) amine- and poly (ethylene imine)-type cellulose derivatives adsorbed germanium (IV) and selenium (VI), respectively, quickly and selectively from aqueous solutions containing semimetals. The cellulose derivatives adsorbed germanium (IV) and selenium (VI) more than conventional adsorbents. The selective separation of germanium (IV) or selenium (VI) from semimetals was achieved with a column method using the

corresponding cellulose derivative. The germanium (IV) or selenium (VI), adsorbed on the corresponding cellulose column, was quantitatively recovered.



Selective adsorbents for semimetals derived from polysaccharide

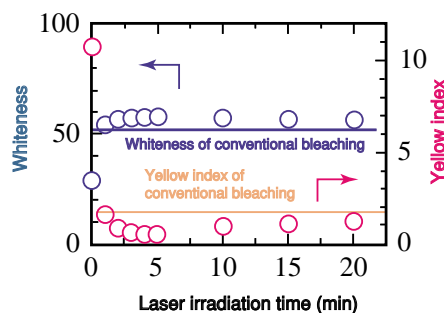
Environmentally-Friendly Bleaching of Fabrics

- Halogen-Free Laser Bleaching -

Bleaching of cotton cloths is now conducted by using halogenated oxidizing reagents at ca. 95 °C for a long time. We have developed a halogen-free bleaching process by using a combination of aqueous solutions of sodium borohydride and laser irradiation at room temperature. Whiteness and yellow index obtained by our process (1-min laser treatment at room temperature) were comparable to those of conventional processes. This process can be applied to the bleaching of other natural fabrics and pulps. Further improvement of the process is now under way to establish a more

environmentally friendly and energy conserving bleaching process.

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 AIST Today Vol. 2, No. 3
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Whiteness and yellow index vs. laser irradiation time

Energy Science & Technology

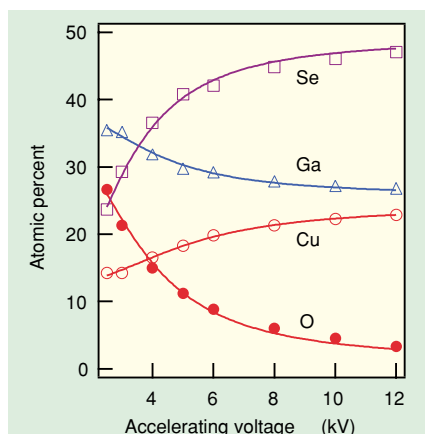
Aiming for High Efficiency Thin Film Solar Cells

- Analysis of Single Crystal Films Leads to Novel Growth Processes -

It is essential to increase the photoelectric conversion efficiency of solar cells so that cell areas can be minimized and in turn production costs can be reduced. An excellent candidate material for high efficiency cells is $\text{Cu}(\text{InGa})\text{Se}_2$ that is CuInSe_2 alloyed with Ga to match the spectral response of the finished solar cell to the sun. The optimization of $\text{Cu}(\text{InGa})\text{Se}_2$ is not yet complete, however, research on materials such as CuGaSe_2 has progressed. Our recent findings regarding single crystal thin film growth and their characterization are presented; post growth annealing of Cu-Ga-Se precursor films was found to result in the segregation of a gallium oxide surface phase leaving stoichiometric CuGaSe_2 . This suggests a possible tech-

nique for low-cost manufacture of a cell with a built-in junction.

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 AIST Today Vol. 1, No. 11
 (2001) 16



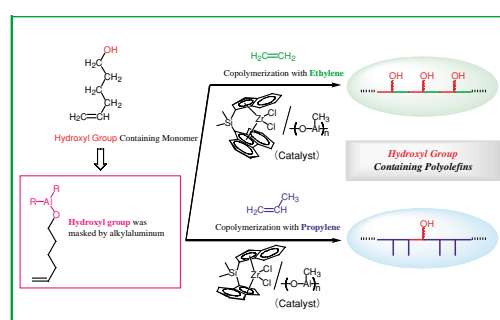
Composition change in depth of annealed gallium-excess film (EPMA accelerating voltage dependence)

Functionalization of Polyolefins: Synthesis of Polyolefins Containing Hydroxyl Group

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 (2001) 17

Recently, the introduction of polar group into polyolefins has attracted much attention. However, the copolymerization of olefin and polar monomer has not proceeded because an interaction between the polar group and catalyst inhibits the polymerization. We employed an olefin containing a hydroxyl group as a comonomer (such as 5-hexen-1-ol), which was masked by alkylaluminum before polymerization, and developed a copolymerization system with olefins (ethylene and propylene) by a zirconium catalyst. It was found that the bulky aluminum compound was effective as a masking reagent and microstructure of copolymer

could be controlled by the catalyst structure. The copolymers containing a hydroxyl group exhibited the hydrophilic property.



Synthesis of hydroxyl group containing polyolefins

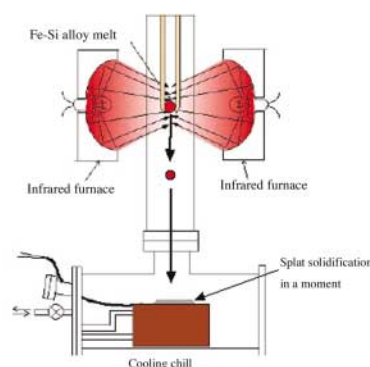
New Synthesis Process of Next Generation Semiconductor

- Synthesis of $\beta\text{-FeSi}_2$ by Use of Microgravity Environment -

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 AIST Today Vol. 1, No. 11
 (2001) 18

$\beta\text{-FeSi}_2$ is one of the promising materials for the light-emitting devices, solar cells and thermoelectric devices. However, it is difficult to synthesize it from the melt because of the complicated Fe-Si phase system. In a microgravity environment, we can keep a homogeneous melt because of no thermal convection and no segregation. We could synthesize the homogeneous material at a nanometer-level by splat solidification of this homogeneous melt and obtain a $\beta\text{-FeSi}_2$ single phase by heating to 850°C . We will synthesize $\beta\text{-FeSi}_2$ doped impurity homogeneously and $\beta\text{-FeSi}_2$

single crystal from the nanometer-level dispersed Si and Fe formed in microgravity.

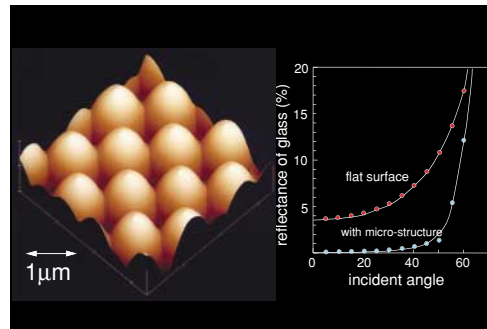


Schematic diagram of splat solidification apparatus of Fe-Si alloy

New Optical Functions brought by Micro-Processing of Glass

Micro-processing of glasses is a key technology for the future optically functional devices. A sub-wavelength cone or pyramidal shaped periodic structure, which is called a Moth Eye, was successfully formed on glass. The surface reflection of incident light from a tilted angle is effectively minimized by this structure. Such a structure is expected to be applicable on the surface of several optical devices or display. Much effort is also made for the development of athermal waveguide devices. Temperature drift of the optical signal was suppressed by 1/2 with the compositional modification of the waveguide. Electric power

required for the wavelength division multiplexing network should be minimized by this technology.



Antireflection structure formed on glass

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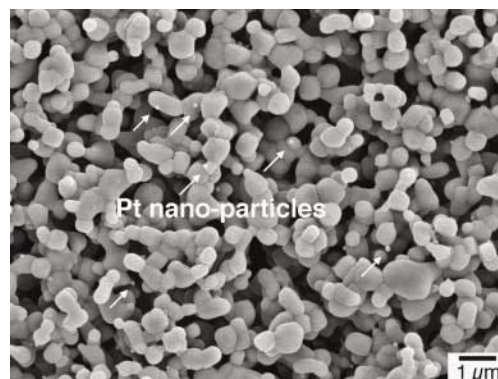
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AIST Today Vol. 1, No. 11
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Development of Porous Ceramics with Excellent Functionality

Hot-gas cleaning is a key issue for various combustion and power applications, and porous ceramics play important roles for the physical filtration of soot. Following the development of the open-porous $\text{CaZrO}_3/\text{MgO}$ composites with a 3-D network structure, we have successfully synthesized a porous $\text{CaZrO}_3/\text{MgO}$ composite with platinum nanodispersion via simple *in-situ* processing. Its catalytic NO -decomposition rate reached ~50 %, and this result suggested the possibility of the porous composite as a multifunctional filter for simultaneous hot-gas filtering and NO_x removal. Currently, we are developing porous $\text{CaZrO}_3/\text{MgAl}_2\text{O}_4$ composites with improved chemical stability and mechanical properties.



Microstructure of a porous ceramic with Pt nano-particles

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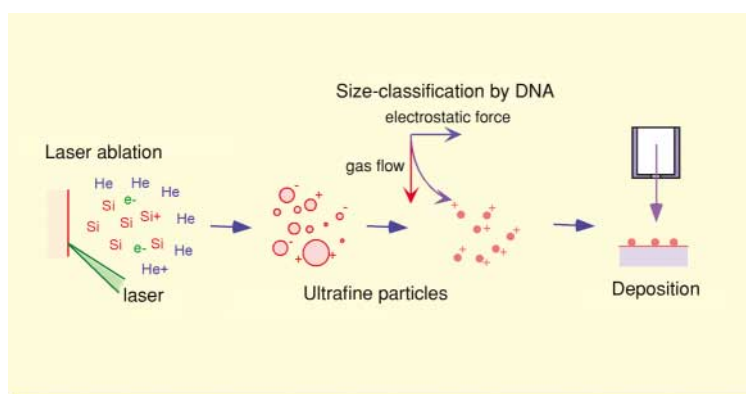
AIST Today Vol. 2, No. 1
(2002) 8

Nano-Manufacturing by Ultrafine Particles

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(2002) 9

We developed the system for the synthesis of ultrafine particles of very pure silicon single crystals with the required size less than 50 nm. Uniform silicon ultrafine particles were synthesized by laser ablation with a differential mobility analyzer (DMA) technique. From a transmission electron microscope (TEM) ob-

servation of deposited particles, it was found that they were well-isolated and uniform in size. High resolution TEM images indicated that they were single crystals. This system has a potential to supply building blocks for a new kind of quantum devices.



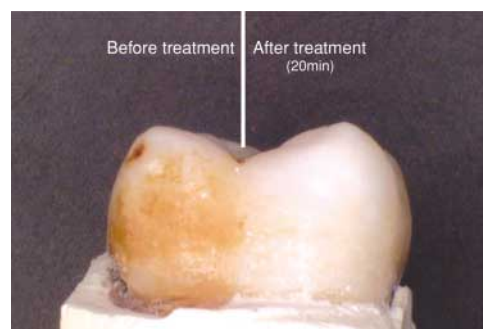
Synthesis, size-classification and deposition process of ultrafine particles

Bleaching with TiO₂ Photocatalyst

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(2002) 10

A titanium dioxide photocatalyst produces vital oxygen, OH radicals, and other species by exposure to light. This action allows ready decomposition of various organic chemical substances normally difficult to decompose. Titanium dioxide is thus believed to function effectively in the decomposition of dental colorants with a potential application as a dental bleaching agent. To establish a method for safe, simple, and expeditious tooth bleaching using titanium dioxide, we studied the potential use of titanium dioxide as a dental bleaching agent by applying a dilute, blended solution of hydrogen peroxide and titanium dioxide to the surface of extracted, discolored teeth; providing light irradiation; and observing changes in the coloration and other aspects

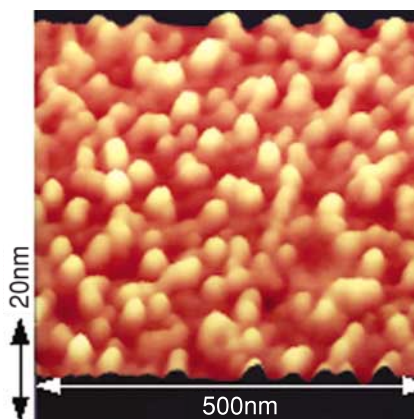
of the teeth. All teeth demonstrated an effect from roughly 10-30 minutes of bleaching. To investigate the bleaching-induced change in the properties of the enamel, the microstructure of the tooth enamel was also observed before and after bleaching. The results showed virtually no change.



Bleaching with H₂O₂:3.5% and TiO₂

Metal / Semiconductor Hybrid Nano-Material

An extremely large magnetoresistance effect has been discovered in hybrid granular films, consisting of metal nano-clusters grown on a GaAs semiconductor substrate. The hybrid nano-material exhibits magnetic-field-sensitive current-voltage characteristics. More than 10000% change of the resistance, which we term magnetoresistive switch, is driven by the current decrease under the magnetic field of about 1000 Oe at room temperature. The hybrid granular films afford great promise in terms of applications such as a high-sensitive magnetic field sensor.



Typical atomic force microscopy image of metallic MnSb nanoclusters grown on a semiconducting GaAs substrate. The yellow bump corresponds to each nanocluster.

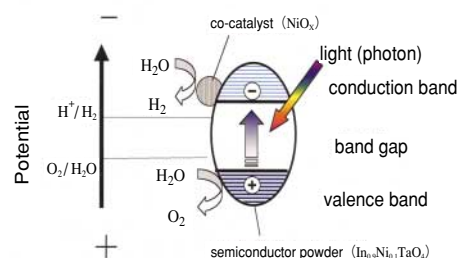
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(2002) 11

Direct Splitting of Water with Visible-Light Photocatalyst

- Artificial Photosynthesis for Light Energy Conversion -

Photocatalytically splitting water utilizing solar energy to generate “clean-energy” hydrogen and taking advantage of the photosynthetic process as green plants for direct H₂ production have been a dream of mankind for several decades. The UV light only accounts for about 4% of the solar energy spectrum, while visible light forms about 43%, which is as much as 10 times of the UV light region. As most green plants use a photosynthetic process from water utilizing visible light, the research and development of visible light responding photocatalyst is crucial for the practical applications. Recently, water was successfully split directly into stoichiometric H₂ and O₂ (mol ratio of H₂/O₂ = 2) under visible light irradiation ($\lambda > 420\text{nm}$) using NiO_y (partly oxidized Ni) or RuO₂ loaded In_{1-x}Ni_xTaO₄ photocatalyst powder as shown in Fig. We demon-

strate the efficient evolution of stoichiometric H₂/O₂ mixtures from pure water under visible light irradiation ($\lambda > 420\text{nm}$) using these photocatalysts. The quantum was estimated to be 0.66%.



Photocatalytic H₂ and O₂ evolutions from pure water on NiO_y/In_{1-x}Ni_xTaO₄ and RuO₂/In_{1-x}Ni_xTaO₄ ($x = 0-0.2$). 0.5g powder sample was suspended in 250 ml pure water in a Pyrex glass cell under visible light irradiation ($\lambda > 420\text{ nm}$). Light source: 300 W Xe lamp.

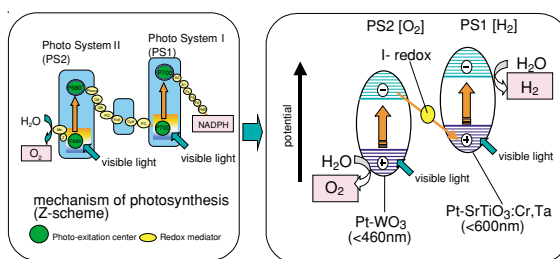
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Water Splitting Reaction under Visible Light using Artificial Photosynthesis (Z-Scheme) Mechanism

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AIST Today Vol. 2, No. 2
(2002) 7

The stoichiometric water decomposition into H_2 and O_2 ($H_2/O_2 = 2$) under visible light irradiation (> 410 nm) took place for the first time using an IO_3^-/I^- redox mediator and mix-

ture of $Pt-WO_3$ and $Pt-SrTiO_3$ (Cr-Ta doped) photocatalysts suspension. The quantum efficiency was ca. 0.03% (at 420.7 nm).



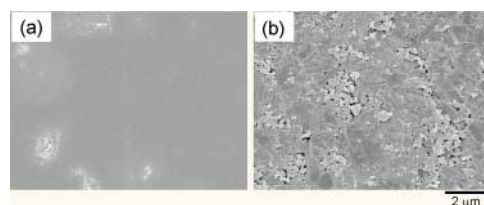
Mimetic mechanism of photosynthesis in plant (artificial photosynthesis)

Development of Silicon Nitride with High Wear Resistance

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AIST Today Vol. 2, No. 2
(2002) 12

Advanced structural ceramics such as Al_2O_3 , SiC and Si_3N_4 , are promising frictional materials. Because of their high hardness, high heat resistance and chemical stability, Among them, silicon nitride (Si_3N_4) is well known as a representative structural ceramic having excellent mechanical and thermal properties. However, the wear resistance of Si_3N_4 is rather low compared to Al_2O_3 or SiC as the relatively weak interfacial strength between the Si_3N_4 grains gives rise to grains dropping during sliding. This problem could be resolved in Si_3N_4 with uni-directionally aligned elongated grains, which can be fabricated by the combination of seeding and extrusion: the plane normal to the grain alignment in the textured Si_3N_4 exhibits a low wear rate (1/10 compared to the conventional Si_3N_4) combined with a low friction coefficient (about 0.3). The worn surface after sliding was quite smooth in the specimen, although that for the conventional Si_3N_4 was

irregular owing to grain dropping, as shown in the figure. The high wear resistance achieved in this plane is attributable to the inhibition of crack propagation along the sliding surface by the stacked elongated grains normal to the sliding surface. It is expected that this material can be used in a wide range of applications as a frictional material having superior mechanical, thermal and wear properties.

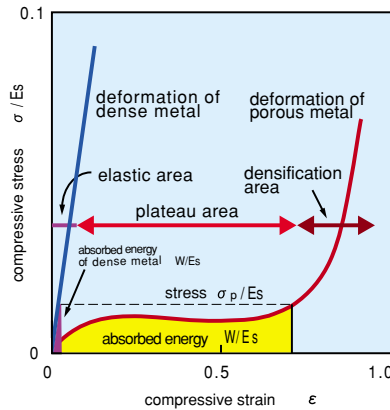


Worn surfaces of (a) the plane normal to grain alignment in a textured Si_3N_4 , and (b) a conventional Si_3N_4 : wear tests were carried out using a Block-on-Ring tester under dry condition in air at a sliding speed of 1.5 m/s, a normal load of 5 N and a sliding distance of 75 m.

New Application of Porous Metals

- Technology to Control the Material Porosity -

Recently, processing technology has been improved and many kinds of porous metals with a higher porosity than 80% can be obtained. New functional materials made of porous light-weighted metals have been promoted by their lightness and their special functions. For example, the following new materials are purchased in the laboratory, magnesium materials with such low density as 50 kg/m^3 , titanium implant materials with higher bio-compatibility, and better crash worthiness of aluminium materials for light-weighted vehicles which are the most effective material to reduce the emission of greenhouse gas.



Compressive deformation of porous material;
remarkable absorption energy can be obtainable

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Development of Coloration of Glasses and its Application for Recycling of Glass Products

The technology to color glasses with X-ray radiation and ultraviolet rays and decolor glasses by heating was developed. The coloration and decoloration can be repeatedly done, and the technology can be applied to glass recycling and reuse. Coloration can be done without damaging the hardness of the surface of glasses. The coloration of whole glasses as well as the painting of characteristics and pictures on glasses are possible. Decoloration with no change in the shape of glasses is also possible.



Example of coloration by use of ordinary sheet glass

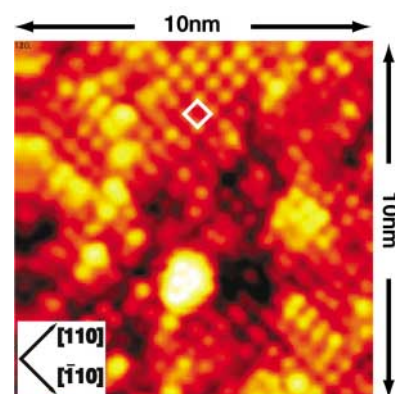
- 1 Ag nanoparticle
- 2 Change of Mn ion valence
- 3 Color center
- 4 Decorated glass by Ag nanoparticle

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(2002) 14

Formation of Monolayer Silicon-Nitride on Si(001) Surface

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AIST Today Vol. 2, No. 3
(2002) 8

Well-ordered nitrogen-covered Si(001) surfaces were formed for the first time by thermal nitridation using an N₂/H₂ gas mixture. The scanning tunneling microscope images showed a clear Si(001)-2x2 reconstruction over the entire surface. The ordered structure of the nitrated surfaces can be explained by a model in which the surface nitridation by N₂ and the termination of the remaining Si dangling bonds by hydrogen atoms occur simultaneously to minimize the surface free energy during the nitridation reaction.



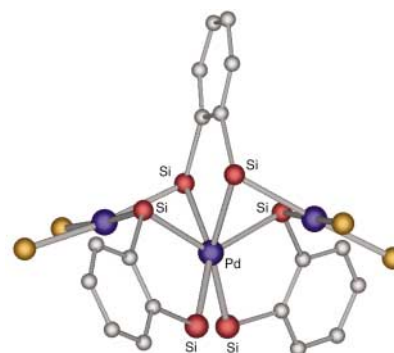
Magnified (10x10 nm) STM image of nitrated Si(001) surface. The atomic arrangement of the 2x2 reconstruction can be clearly recognized on the Si(001) surface, and the 2x2 unit cell is superimposed in the figure.

Discovery of A New Oxidation State for Palladium

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(2002) 9

A new oxidation state, VI, has been discovered for palladium. Palladium forms one of the most versatile transition metal catalysts for the transformation of organic compounds as well as for vehicle exhaust gas treatment. Palladium generally prefers lower oxidation states such as 0 and II. The highest oxidation state so far known for palladium was IV.

The first Pd(VI) complexes were synthesized by the condensation reaction of three molecules of a simple Pd(II) complex bearing a silicon ligand. This discovery will help the understanding of catalytic processes and design of new catalytic reactions.



6 Si atoms (red) are bound to the central Pd atom (blue)

Synthesis of the Pd(VI) Complexes

Applications for Air Purification and Antibacterial/Antimold/Antifouling Coatings

We developed a multifunctional composite material with a titanium dioxide surface covered by apatite for application in air purification and as an antimicrobial, antifungal, and antifouling coating. This composite material has the following characteristics; (1) the apatite adsorbs materials even without exposure to light; (2) materials adsorbed by the apatite are decomposed by the titanium dioxide photocatalyst on exposure to light; (3) the apatite is used as a spacer, allowing blending of the material with resins, organic coatings, and other organic materials; (4) even though the photocatalyst requires a fixed period to decompose organic materials, the capture of materials by the apatite ensures decomposition.

When this composite material was applied to artificial decorative plants, we created a unique environmental improvement system which performs efficient environmental purification. Indoor air was monitored, a ventilation fan function was checked, the required surface area of the artificial decorative plants was calculated from the air volume to be treated, and the artificial decorative plants were installed. After several weeks, the effect was measured and environmental improvement results were determined.

The apatite-covered titanium dioxide coating developed jointly with Marutake Sangyo (Ltd.) has superior transparency and durability. This coating dried and adhered at ambient temperature in approximately two hours (conforming to Food Hygiene Law specifications for safety testing of utensil and container packaging). Mold developed in approximately two

days in closed non-coated polystyrene containers left at room temperature filled with items such as rice cakes and bread, but no mold developed in apatite-coated containers even after one week. This experiment was performed with containers left at room temperature without exposure to light, showing that bacterial and other reproduction can be prevented through the use of apatite adsorption, even without exposure to light.

In building material applications, conventional coatings using only titanium dioxide require the application of an inorganic undercoating to protect the substrate, a process requiring two days or longer. The ability to directly apply Apatatek allows the completion of the process in half a day. Comparison of coating with titanium dioxide alone versus coating with apatite-covered titanium dioxide clearly demonstrated that the antifouling effect was greater in the latter case including an apatite covering. The effect is also obtained in the coating of guard rails, signs, and automobile bodies.

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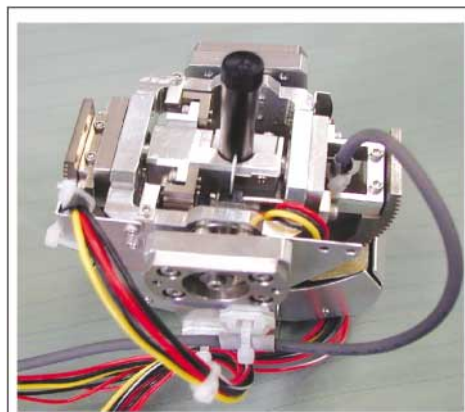


Antifouling effect

A Small Spherical Stepping Motor

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 AIST Today Vol. 2, No. 1
 (2002) 16

A small spherical stepping motor with two degrees of freedom is developed. The motor is composed of two sub stepping motors. Each sub motor is a two-phase permanent-magnet bipolar linear stepping type, and the shape is semi-circle. The rotational axes of two sub motors cross at the same point, and this structure enables the developed motor to move in any direction. The experimental results show that the developed motor can hold the output shaft in any direction and has high positioning accuracy. This motor will be applied to the robotics eye with small CCD camera.



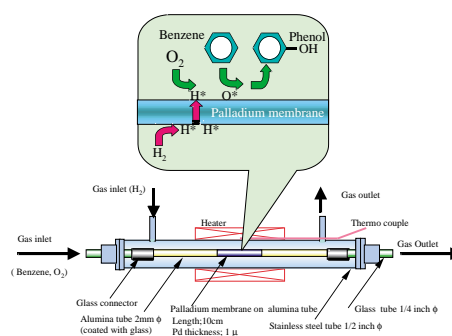
A Small Spherical Stepping Motor with CCD Camera

A One-Step Conversion of Benzene to Phenol with a Palladium Membrane

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 AIST Today Vol. 2, No. 3
 (2002) 15

Existing phenol production processes tend to be energyconsuming and produce unwanted by-products. We report an efficient process using a shell-and-tube reactor, in which a gaseous mixture of benzene and oxygen is fed into a porous alumina tube coated with a palladium thin layer and hydrogen is fed into the shell. Hydrogen dissociated on the palladium layer surface permeates onto the back and reacts with oxygen to give active oxygen species, which attack benzene to produce phenol. This one-step process attained phenol formation selectivities of 80 to 97% at ben-

zene conversions of 2 to 16% below 250°C (phenol yield: 1.5 kilograms per kilogram of catalyst per hour at 150°C).



Apparatus for direct hydroxylation of aromatics and the working principle of palladium membrane

Standards and Measurement Technology

Investigation of Measuring Technique for Liquid Volume in Micro-Gravity

Measurement of liquid volume in a micro-gravity condition is an important aspect of space technologies. In an attempt to create an effective and low cost measurement system, we have proposed a new measuring technique based on Helmholtz resonance. We have tested our methods with a micro-gravity experiment using water and liquid nitrogen as test liquids. It was found that the measurement technique is applicable in a micro-gravity condition. However, it was also found that the measurement of the spatial temperature distribution in a container is necessary to apply this measurement technique to cryogenics because the veloc-

ity of sound has a strong temperature dependency.



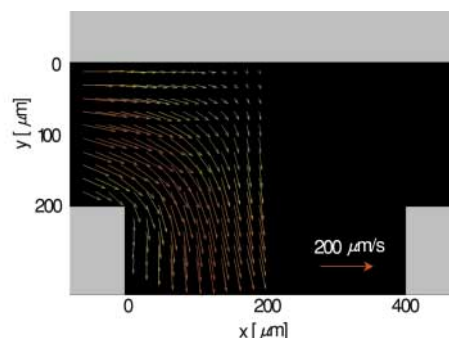
Picture of the experimental set up for water

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AIST Today Vol. 2, No. 1
 (2002) 14

Temperature and Velocity Measurement Techniques in Microspace

Two-dimensional temperature and velocity measurement techniques in microspace were developed using a CCD camera and microscope in order to investigate flow structure in a microchannel. Velocity measurements were performed using 400 nm fluorescent particles that induce the Brownian motion affecting velocity detection. The present study proposed a new method to eliminate the effect of Brownian motion on velocity information. Temperature measurements utilized fluorescence dye whose fluorescent intensity is strongly dependent on temperature. The present technique

enabled us to measure a microchannel flow with high spatial resolution.



Distribution of velocity vectors in a T-type microchannel

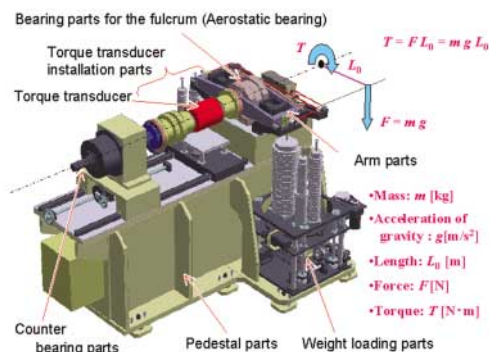
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 (2002) 13

Development of The Primary Torque Standard Machine

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 AIST Today Vol. 2, No. 1
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Research is being conducted at the National Metrology Institute of Japan (NMIJ), AIST, for the purpose of creating a technical base for a national torque standard and constructing a widely accepted torque traceability system. As part of the research, a torque standard machine of rated capacity 1 kN·m was developed. This machine has a variety of features enabling it to perform a precise measurement of torque. The arm length was precisely compensated for the influence of the deadweights loading, and temperature variation. An aerostatics bearing was adapted in order to minimize torque loss caused by fric-

tion at the fulcrum. The best measurement capability in the machine was brought within ± 50 ppm for the calibration range from 5 N·m to 1 kN·m.



Standard machine

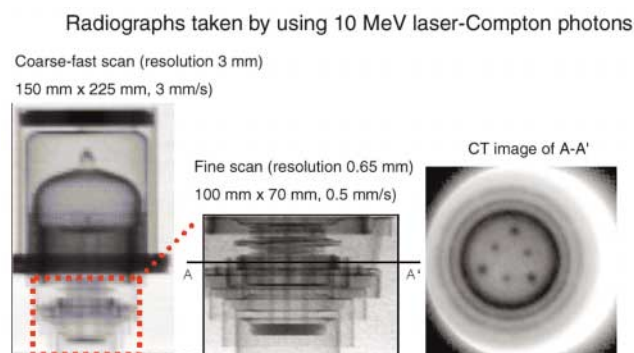
High-Energy Gamma-Ray CT using Laser-Compton Gamma-Rays

- A Novel Method for Nondestructive Evaluation of Bulk Materials -

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 (2002) 12

Transmission radiography and CT system for inspection of industrial products using a laser-Compton photon beam in the energy range 1 - 40 MeV have been developed. The photon beam, which is generated with the 300 - 800 MeV electron storage ring "TERAS" and various laser light systems, is continuously energytunable. The effectiveness of this method has been examined with radiographs and tomographies of metals, ceramics, and concrete blocks. The spatial resolution of the

radiograph was measured to be 650 μ m using a 10 MeV photon beam.

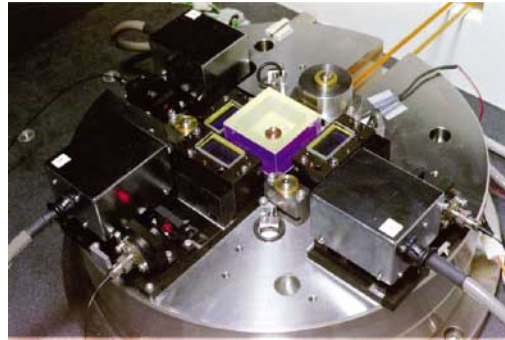


An example of nondestructive evaluation of bulk material using 10 MeV high-energy laser-Compton gamma-ray beam

Precision Measurement of Nano-dimensional Scales by Using High-resolution AFM

As nanotechnology has developed, precision measurement on a nanometer order (nanometrology) has become important. In order to meet this demand, we have developed and investigated an AFM system with a high-resolution three-axis laser interferometer (nanometrological AFM). We have performed precision measurements of 1-dimensional (1D) gratings as a nano-dimensional scale and uncertainty estimation in pitch measurements. The calibrated dimensions of AFM images are traceable to the international unit of length through a laser wavelength. The resolution of the interferometer was approximately 0.04 nm. For a pitch measurement of a 1D grating with a 240 nm pitch in nominal value, we obtained a

pitch value of 239.98 nm and estimated an expanded uncertainty of 0.280 nm.

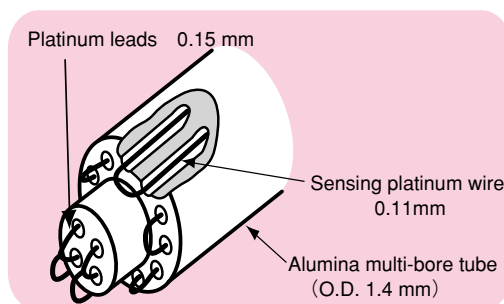


AFM with XYZ three-axis laser interferometer (Nanometrological AFM)

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(2002) 15

Development of a High-Temperature Platinum Resistance Thermometer

High-Temperature Platinum Resistance Thermometer (HTPRTs), using alumina as an insulator, were developed at AIST. The HTPRTs were designed for practical purposes and their stability in the horizontal use was tested. The result showed that they were stable enough in the horizontal direction up to 800 °C.



Construction of the sensing element of the high-temperature platinum resistance thermometer

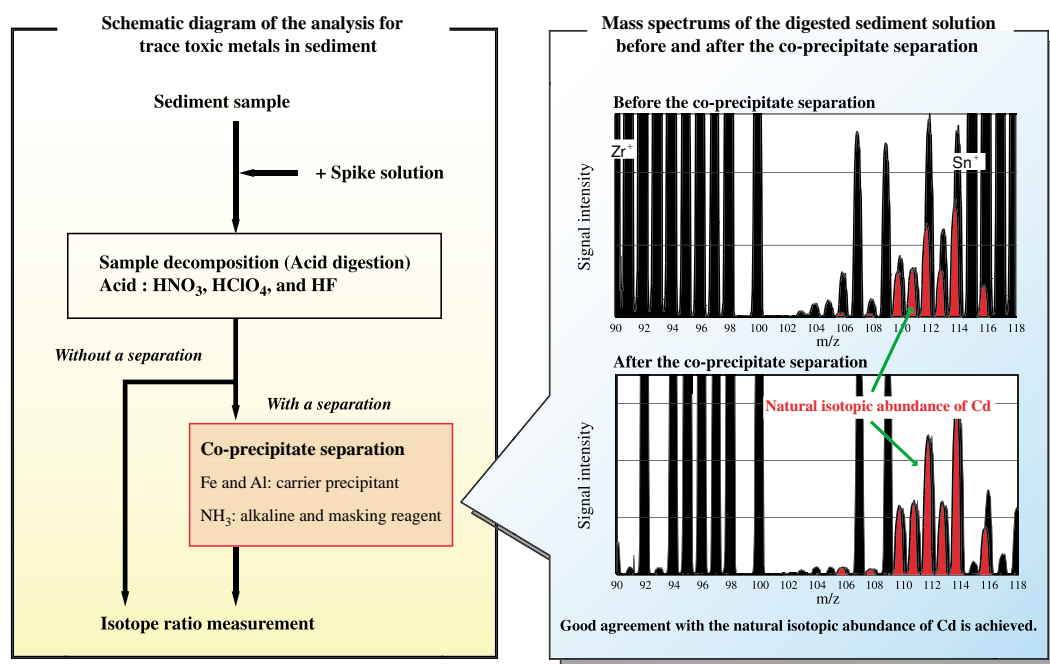
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(2002) 16

Precise Analysis for Trace Toxic Metals in Sediment

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An isotope-dilution / inductively coupled plasma mass spectrometry (ID/ ICP-MS) is recognized as a precise measurement technique for the determination of toxic metals in sediment. In the application of the ID-ICP-MS measurement of trace elements in sediment, isobaric interferences from concomitant elements in the sample often cause serious analytical errors. For example, all

cadmium isotopes are overlapped with the isobaric interferences, and the separation procedure must inevitably be performed. We have proposed a new co-precipitate separation method utilizing major constituents in the sample as the carrier precipitant. This separation method is simple, reliable and has been applied for the certification for the reference material.

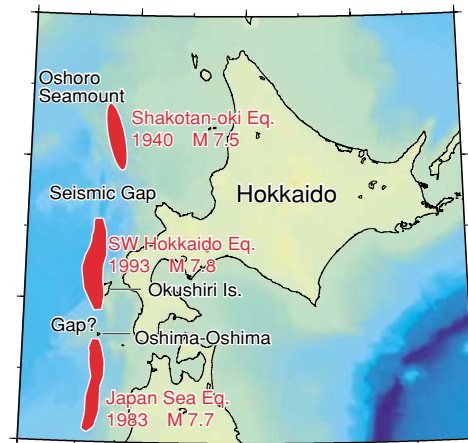


Schematic diagram of the analysis for trace toxic metals in sediment
 (mass spectrum black: sample solution, red: Cd natural isotopic composition)

Geological Survey and Geoscience

Seismic Gaps in Japan Sea Inferred from Submarine Surveys

Scientists of the Institute for Marine Resources and Environment (MRE) and Active Fault Research Center (AFRC) claim that a large earthquake may occur in the near future, to the north and south of the 1993 Southwest Hokkaido earthquake. They found evidence of old earthquakes from visual observation by using submersibles of the Japan Marine Science and Technology Center. A lack of features from recent events lead them to conclude that seismic gaps exist in both regions.



Recent large earthquakes and seismic gaps along the Japan Sea coast of Hokkaido

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International Symposium and Workshop for Geoinformation

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International Symposium on Geoinformation via Internet” and “International Workshop for CCOP Metadata” organized by the Geological Survey of Japan (GSJ), AIST and Coordinating Committee for Geoscience Programmes in East and Southeast Asia (CCOP) were held in Tsukuba, Japan on 18–22 February 2002. About 75 participants from the Geological Surveys of East and Southeast Asia (11 countries) and Europe (3 countries), and three international organizations: UNESCO, UN-ESCAP and CIFEG, have actively joined in the two meetings.

It was a kickoff meeting to construct an Asian geoinformation network system in geoscience organizations for promoting public access to geoinformation via the Internet. A goal is the actualization of the interoperable system enabling the organizations to communicate to each other and disseminate geoinformation to the public.

The symposium included topics: 1) strategies for dissemination of geoinformation, 2) clearinghouse and metadata, 3) Geographical Information System (GIS) application and geological standards, and 4) digital geological mapping and geoinformation management. Some results of research project activities also were reported by poster presentations.



The workshop highlighted on-going activities related to geoinformation via the Internet and development of CCOP regional GIS metadata for geological maps including the introduction of advanced metadata systems in Europe. The workshop finally resolved the establishment of a Working Group under CCOP to facilitate the urgent task of developing the CCOP Regional Metadata. Japan was elected as the Working Group Chairman. Now the GSJ, AIST is expected to be the leader for the metadata system actualization in cooperation with the related organizations.

Research Exchange Meeting with Mr. Koichi Wakata, astronaut and AIST researcher



A research exchange meeting took place inviting Mr. Koichi Wakata, Mission Specialist of Space Shuttle at Techno Growth House on 23rd January, 2002. Mr. Wakata told of his interesting experiences in robot arms which play a major role in the ongoing construction of the international space station. AIST researchers introduced their research on machinery, system and theory from the viewpoint of "space research" and had a lively and unique exchange of views with Mr. Wakata, as an astronaut who is a highly specific user of such equipment.

The Asia Pacific Nanotechnology Forum (APNF) Inaugural Conference

Making its first step, the inaugural conference of Asia Pacific Nanotechnology Forum (APNF; <http://www.apnf.org/>) was held at Tsukuba Central 1 in AIST, the leading sponsor, on 26-28th February 2002. The APNF is a multinational organization established in 2001 as a platform where policy makers, R & D entities related to nanotechnology (both in governmental and private organizations), and entrepreneurs in member nations exchange opinions freely. It also aims at producing synergetic effects through participants' interaction, playing the role of a catalyst. Members are to meet annually at an international conference hosted by APNF.

Speakers came from various countries around the world such as Australia, Korea, China, Taiwan, Singapore, United States, Germany, Spain and United Kingdom. Japanese speakers are from public and private entities like Ministry of Economy, Trade and Industries (METI), National Institute for Materials Science (NIMS), The Institute of Physical and Chemical Research (RIKEN), the University of Tokyo, NEC, Fujitsu as well as AIST.

In the conference, not only United States, EU and Japan but also Asian countries such as China and Korea emphasized their strategies to strongly accelerate developing nanotechnology by concentrating their huge budgets and excellent human resources. Now, nanotechnology looks to shift their stage from precompetitive to competitive or collaborative ones.

During the three days, over 180 people participated in the conference and actively discussed in and out of the venue. Some are impressed with the eminence of speakers, saying that this would be the first time such celebrated scientists in nanotechnology gathered in one place.



AIST concluded the research co-operation agreement with Korea's two major research institutions

Conclusion of the Research Co-operation Agreement with the Korean Institute of Geoscience and Mineral Resources (KIGAM)

“AIST concluded the research co-operation agreement with the Korean Institute of Geoscience and Mineral Resources(KIGAM) on 17th December 2001. The inaugural ceremony was held at KIGAM in Daejeon city, Korea. Dr. Young-Hoon Kwak, President of KIGAM and Mr. Hiroshi Miyamoto, Director of International Affairs Department of AIST signed the agreement. The signing was followed by Dr. Kwak's speech welcoming the forward-looking agreement with the New AIST, their important partner of international co-operation, which would realize collaboration in future research activities.

KIGAM, former Geological Survey of Korea was re-established with the aim of contributing to the public and nation through geological surveys carried out both in Korea and abroad, as well as providing the information on geo-



science and mineral and energy resources to the government, industrial circles and public sector. At the New AIST, further progress in research collaboration with KIGAM is expected under this comprehensive co-operation agreement.



The most therapeutic robot “Paro”

The Guinness World Records has accepted the seal robot, Paro, developed by Dr. Takanori Shibata of Intelligent Systems Institute, AIST as the world's most therapeutic robot. It is a white, soft, fluffy, furry, seal-shaped robot with sensors for people's strokes and cuddles that improve the people's quality of existence. Therefore, the cuddly Paro is just the thing to calm you down after a stressful day. He has used the furry seal robot for livening up the lives of children in hospital. Dr. Shibata's research covers "theory and application of mental-commitment robots as a human-friendly interface".

Conclusion of the Research Co-operation Agreement with the Korean Research Council for Industrial Science and Technology (KOCI)

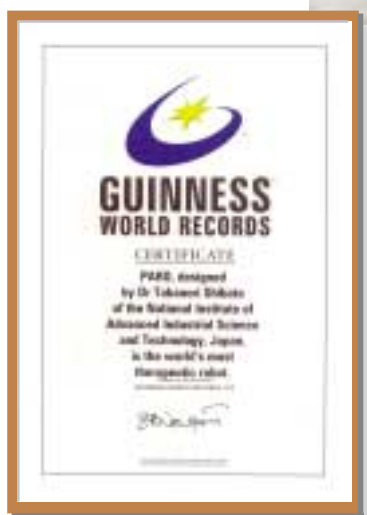
AIST concluded a research co-operation agreement with the Korean Research Council for Industrial Science and Technology (KOCI) on 8th February 2002. Both Dr. Park Kyu Tae, Chairman of the Korean Research Council for Industrial Science and Technology and Dr. Yoshikawa, President of AIST attended the signing ceremony held in Tokyo. They gave their joint opening remarks and declared that the co-operation agreement would serve as a foundation for both institutions, in co-operation and in the spirit of friendly rivalry, to endeavor to fulfil the primary commitments of science and technology for the development of mankind; pursuing their roles as equal partners in the international joint research projects. The speech was followed by the signing of the agreement.

KOCI was established in March 1999 under the direct jurisdiction of the Korean Prime Minister and supervising its seven member institutes including the Korean Institute of Oriental Medicine, Korean Institute of Industrial Technology, Electronics and Telecommunications Research Institute, Korean Food Research Institute, Korean Institute of Machinery and Materials, Korean Electrotechnology Research Insti-



tute and the Korean Research Institute of Chemical Technology. KOCI assists its member institutes in making major research policies, evaluates their achievements and co-ordinates the basic research budget allocations among its member institutes.

It is anticipated that through the co-operation agreement with KOCI, the high level research agency of the Korean government will enhance the international research activities promoted by AIST.



Unit URL : http://unit.aist.go.jp/is/index_e.html



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