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AIST Today

International Edition

National Institute of Advanced Industrial Science and Technology (AIST)

2001 -No.2

Special Issue : Guide to AIST Part II

National Institute of Advanced Industrial Science and Technology

AIST Today
2001-No.2
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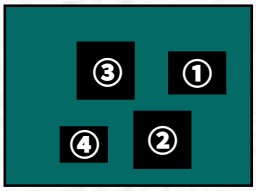
CONTENTS

Cover Photo
Human Friendly Robot ①
Humanoid ②
Self-organizing Robot ③
Wearable Vision ④



Opening of Tokyo Academic Park

The grand ceremony for the opening of Tokyo Academic Park, was held on the 9th of July, 2001 which has been under construction in Tokyo Waterfront, the Aomi area (Koto-ku, Tokyo) since 1998.

Tokyo Academic Park consists of three facilities: AIST Tokyo Waterfront (under control of AIST), Tokyo International Exchange Center (under Association of International Education, Japan) and National Museum of Emerging Science and Innovation (under Japan Science and Technology Corporation).

Dr. Yoshikawa, President of AIST was appointed as Park Superintendent of Tokyo Academic Park.

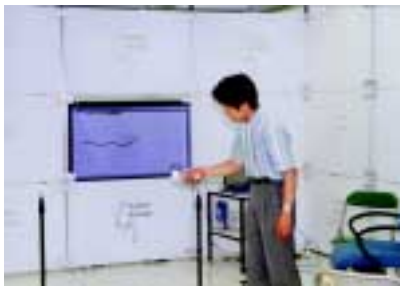
Park Superintendent
Hiroyuki Yoshikawa

Tokyo Academic Park as the Network Hub of Leading-edge Research Information

By smoothly combining its three functions, "International Exchange", "Information Sharing" and "Industry-Academia-Government Collaboration", Tokyo Academic Park aims to promote a highly intellectual exchange and encourage the creation of new philosophies and technologies beyond any barrier between generations or academic fields. The Park is given a significant role to form an intellectual network nurturing academic leaders world wide. The results of such activities will be publicised through the various media.

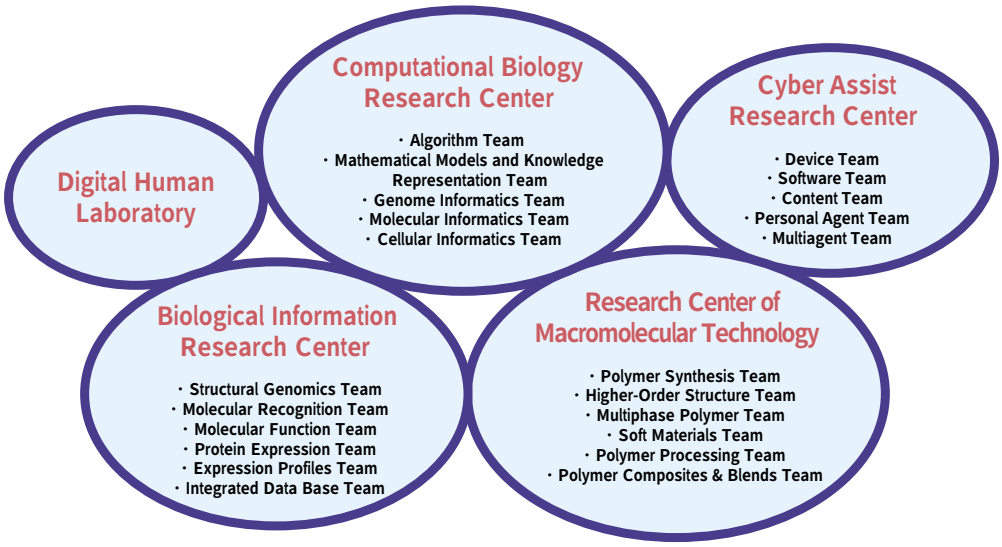
AIST Tokyo Waterfront

AIST Tokyo Waterfront plays an integral role in industry-academia-government collaboration as an international research base, pursuing the research and development projects of cutting-edge technologies, which will promise the creation of new industry and market expansion. Their another significant role is to encourage academic exchange of researchers active both domestically and internationally aiming at publicising their research results and promoting information sharing amongst different research fields.



Research Units

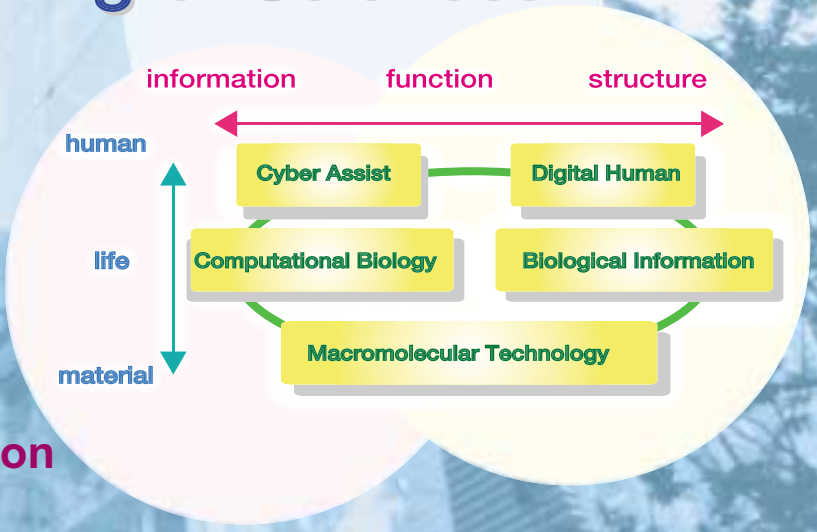
Currently AIST is conducting its research activities at a number of research units including 23 research centers, 22 research institutes, 2 special divisions and 7 research initiatives nationwide, amongst which 4 centers and 1 research initiative have been incorporated into the AIST Tokyo Waterfront. They pursue the research and development projects of cutting-edge technologies, which will promise the creation of new industry and market expansion.



AIST Waterfront Symposium

AIST International Symposium

- The Ring of Sciences -



July 12th, 2001

MIRAI-CAN Hall on the7th floor
In the National Museum of Emerging Science and Innovation

AIST Waterfront Symposium was held on 12 July, 2001, at MIRAI-CAN Hall in National Museum of Emerging Science and Innovation in commemoration of the opening of Tokyo Academic Park.

The symposium began with the opening address by Dr. Hiroyuki Yoshikawa, President of AIST. In his speech, he emphasized the necessity of science and technology (S&T) in sustainable development and the importance of mission of AIST & AIST Tokyo Waterfront. After that, prominent invited speakers, Dr. Jeffrey Skolnick, Dr. William Mark and Dr. Hideki Shirakawa, gave stimulating lectures.

Dr. Naohiro Soga, Director of AIST Tokyo Waterfront, introduced the organization structure and activities of five research units (Biological Information Research Center, Computational Biology Research Center, Cyber Assist Research Center, Digital Human Laboratory, Research Center of Macromolecular Technology).

Dr. Naohiro SOGA
Director, AIST Tokyo Waterfront

Dr. Jeffrey Skolnick

Director of Computational and Structural Biology at the Donald Danforth Plant Science Center (DPSC, http://bioinformatics.danforthcenter.org), Adjunct Professor of Biochemistry at Washington University.

http://www,danforthcenter.org/lcg/labfiles/index.html

Prediction of Protein Structure and Function on a Genome Scale

A novel method for the prediction of protein function based on the sequence-to-structure-to-function paradigm has been developed. First, the tertiary structure of the sequence of interest is predicted from either ab initio folding or threading. The resulting structures are then refined using novel techniques. Then, using a library of three-dimensional descriptors of protein active sites, thrmed ''fuzzy functional forms'' or FFFs, the resulting structures are screened. If the geometry and residue type in the predicted structure match an FFF, then the protein is predicted to have the specified molecular function. The FFFs correctly identify the active sites in a library of experimental structures as well as in models produced by ab initio folding or threading. This shows that low-to-moderate resolution models whose α-carbon root mean square deviations from native range from 3.5-6 Å are sufficient to identify protein active sites. Next, this approach is applied to the screening of a number of genomes. In general, the method is found to be very robust and is subject to fewer false positive functional predictions than alternative sequence-based approaches.

New Directions in Information Technology

The last decade of the 20th century saw remarkable advances in information technology. The first decade of the 21st century will see even greater advances in exciting new directions:

· Physical/Information Systems – pervasive computation requires information technology that is physical as well as computational

· Human Augmentation – information technology will be designed to participate in the activities of people's work and daily life

· Bio Computation – biological processes are inherently computational; information technology and biology are intersecting in bold new ways

This talk will describe these new directions and illustrate them with examples of current research.

Dr. William Mark

Vice President of the Information and Computing Sciences Division of SRI International (http://www.sri.com), one of the largest independent research institutions in the world.PhD in Computer Science from MIT. His personal research interests include pervasive computing and system design.

Prof. (Emeritus) Hideki Shirakawa

Emeritus Professor of University of Tsukuba. A member of the Council for Science and Technology Policy at the Cabinet Office, Japan. Ph. D. in Chemical Engineering from Tokyo Institute of Technology. The 2000 Nobel Prize winner in Chemistry with Dr. A. Heeger and Dr. A. MacDiarmid in recognition for the their work on the discovery and development of conductive polymers.

The discovery and development of conductive polymers

Reviewing the development of polymer science, from the polymer concept established in 1920-30s by Dr.H. Staudinger to the present progress, contingency and inevitability in the discovery and development of conductive polymers will be mentioned.

Dr. H. Staudinger successfully verified the existence of macromolecular compound based on physicochemical evidence. In 1958 when Dr. Natta succeeded in synthesizing polyacetylene, they couldn't identify its property as polymer because it is insoluble and infusible. This made researches on organic semiconductor be at a standstill.

The discovery of thin-film preparation of polyacetylene brought an important breakthrough in understanding the structure of polyacetylene. Consequently, with doping method, it led to the research with Prof. MacDiamid for conductive polymers, which promotes several applications of conductive polymers in Japan.

During the study on conductive polymer, collaboration with Dr. Akamatsu, who had been in the forefront of the research on high-conductivity of perylene-iodine complex, would have researched more efficiently. But, the obstacle to the collaboration was the prejudice that macromolecule has different properties from low molecular compounds. It is important but not easy to overcome such a prejudice.

Introduction of Research Unit

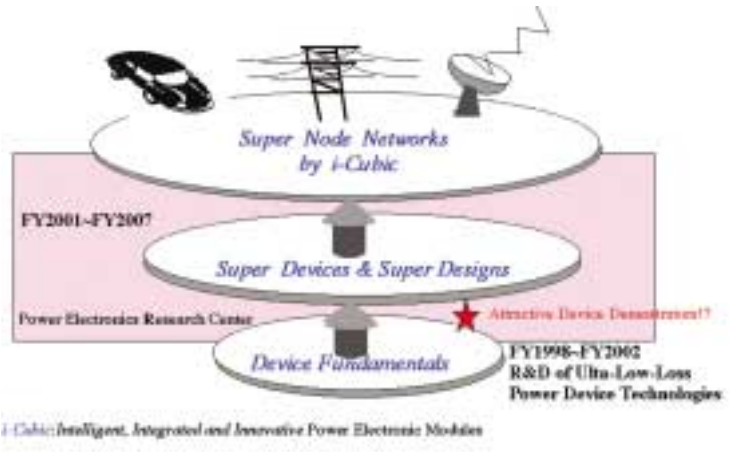
Research units of AIST are the core of its research activities, among 54 research units, 40 are already introduced in the first issue of AIST Today. The rest of 14 units are introduced in this second issue, completing the profile of all the research activities at AIST.

Power Electronics Research Center

At present the electric energy power ratio in total energy consumption (electrified %) is 41% in Japan. Extraordinary progress in information technology, spread of electric cars and dispersed power supply stations, such matter will certainly cause increase of electric power demand in energy supply much more. The technology making electric power optimum in generation, storage, transportation and consumption is the power electronics technology. The key issues in it are developing the electric power conversion unit with low loss, compact in size and working in high speed. The crucial components in the conversion units are the power devices. Of course at present Si devices are dominated, but their capabilities come to their limits due to the material parameters of Si semiconductor. Wide band gap semiconductors like silicon carbide (SiC), gallium nitride (GaN) and diamond (C) show high capability beyond the limit of Sidevices.

Since 1998 we have put forward the national project "R&D of Ultra-Low-Loss Power Device Technologies" as a five year plan together with companies and universities, and have been aiming the establishment of basic technologies for making SiC and GaN devices. Cooperative research together with Advanced Power Device Laboratory conducted by FED (R&D Association of Future Electric Device) is applied to basic R&D on crystal growth, device process and device design and evaluation. Three distributed laboratories have been developing the fundamental devices to demonstrate the superiority of SiC to Si.

In order to realize the conversion units with ultra-low-loss, higher temperature and higher speed operaion utilizing the advantage of SiC and GaN devices (called super devices), it is not enough only developing the devices. The development of the new design techniques (super design) on circuit, elemental parts, materials, packaging and also reliability are necessary. The system design for introducing such units into the node in electric power networks (super node network) is of another importance. In addition the feasibility study on the technological and economical impacts of this new technology on the society is indispensable. We are planning to promot these three subjects concurrently.



Computational Biology Research Center

Bioinformatics is a comprehensive science that treats a wide range of biological phenomena from the standpoint of information theory. These phenomena range from the genome sequence to the 3D structures and functions of protein molecules and the mutual relationship among such elements within a cell and a body. With the aim of becoming a core base for bioinformatics research in Japan, the Computational Biology Research Center features advanced information science theory and large-scale high-speed computational systems to its R&D efforts to help achieve dramatic advances in bioinformatics study and to contribute to its systemization.

Gene finding and protein structure prediction using a large-scale PC Cluster (1024 processors)

Institute of Mechanical Systems Engineering

Missions and Activities

Mechanical Engineering, an integrated art of extended scientific disciplines and technologies, serves a common foundation for a wide variety of industrial sectors. With continued effort into research and development of materials, processing techniques, integration and system assembly, together with a quest for their associated basic sciences, our institute is dedicated to the advancement of manufacturing technologies in industry and proposes technological guidelines that will allow us to realize a sustainable growth in the society of the 21st century.

Bearing these missions in mind, we will not only present the study results to academia but evolve them into practical products by maintaining a close contact with those in global industries. To meet the our society's requirement in an appropriate and timely manner, we will promote research to provide a solution to immediate needs of industries and also to tackle high-risk technological challenges to achieve intermediate- and long-term goals.

- Main Research Items
  - Environmentally Conscious Manufacturing System
  - Micro/Nano scale fabrication
  - Reliability Engineering

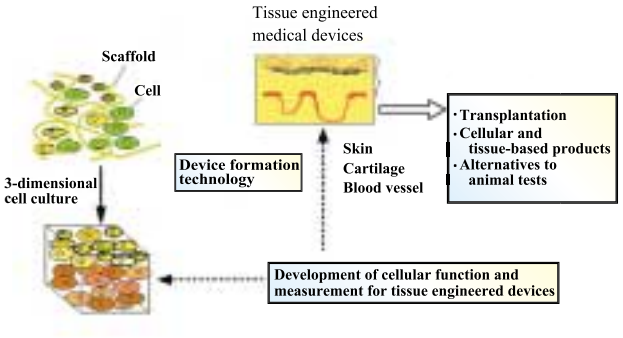
Tissue Engineering Research Center

Tissue engineering is a technology to create tissues or organs formed by cells. The products, tissue engineered medical devices (TEMDs), are applied for repair and regeneration of tissue or organ function. The technology is a key for advanced medical technologies to cure incurable diseases. It is also needed to solve the shortage of human organs for trans-plantation and to reduce the cost of medical care, which is now suppressing national economy. TEMDs are also applicable to evaluating and sensing chemicals, which are currently assayed by animal tests for the purpose of screening the efficacy of newly developed medicines.

Tissue engineering requires the integrated development of generic technologies.

Research items are as (1) technologies of three-dimensional cell culture, (2) genetic technologies and genome informatics, (3) development and differentiation biology, (4) screening of stem cells and its application. Some detailed technological research subjects, on item (1) for example, are novel design of scaffolds, three-dimensional culture of cells, mixed and controlled culture of variety kinds of cells, biochemical and physical stimulation of cells to regulate the functions, etc. Controlled cell proliferation and tissue formation methods should be realized also by the combination of the fundamental researches of (2) - (4). On a par with these R&D subjects the production of TEMDs is to be implemented by the operation of a cell-processing center (CPC) in TERC in close cooperation with medical schools of universities. Process and quality control of cell growth, proliferation and tissue/organ formation are to be developed.

The exploration of technological value and the possibility of industrialization will be investigated as a basis for future research and technological development.



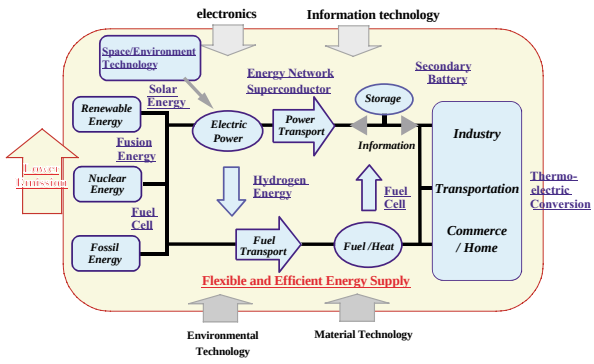
Energy Electronics Institute

Energy is essential to support ever growing and spreading human activities, and must be supplied sufficiently and steadily. One the other hand, it is also required to minimize environmental effect, like global warming, and to hand over healthy earth to the next generation. To fulfill these requirements, a totally new energy supply system with maximum use of clean energy sources and efficient and flexible energy flow through generation to consumption must be constructed.

The Energy Electronics Institute conducts research and development of innovative electric power technologies to realize the future energy system by combining rapidly progressing electronics/ionics, material and information technologies.

Major research subjects are, distributed power generation by fuel cell, solar cell and thermoelectric conversion, efficient and flexible power transmission by superconductor and power electronic device with network and information technologies, and long term R&Ds of ultimate energy sources like hydrogen energy or fusion energy.

Major Research Subjects of Energy Electronics Institute



Advanced Semiconductor Research Center

The semiconductor industry offers wide variety of core technologies for the advancement of the information society. The mission of Advanced Semiconductor Research Center (ASRC) is to deploy the R&D works on the semiconductor technology and to contribute to the growth of the semiconductor industry.

ASRC is applying to the NEDO project "Fundamental Research and Development of Next-Generation Semiconductor Materials and Processes" also known as " Semiconductor MIRAI Project" through collaboration with the industries and universities, to carry out the R&D works. It is expected that this effort will bring up ASRC to the leading-edge R&D center of the semiconductor technology based on broad cooperation among scientists and engineers of the industrial, academic and government sectors, functioning as a COE (Center of Excellence) with sophisticated R&D potential for the semiconductor technology.

ASRC is obliged to contribute to the technology development in the semiconductor industry and to the progress in related science and technology. For this purpose, ASRC selects R&D themes of primary importance on the basis of the future trend of the semiconductor technology and finds the pathway to overcome the technology roadblocks through the scientific approach. In this way, the basic semiconductor technology will be consolidated to ensure continued development of the semiconductor industry. Particularly, with intention of contributing to the technology innovations for realizing the 70-50 nm technology-node ULSIs and beyond, extensive research on new materials, fabrication processes, and device and circuit technologies will be conducted as explained below.

Research Initiative for Thin Film Silicon Solar Cells

In the 21st century, it is one of the most important issues to solve the trilemma to provide the sufficient energy for the sustaining development of economy under the restrictions of resources and environmental preservation. Solar cells have attained increasing attentions as a promising candidate for this solution. Especially in these several years, improvement in the cell performance, price reduction and grid connection to electricity line have successfully facilitated the introduction of solar cells up to 100,000kW in Japan (about the half of the total amount in the world). Japanese government announced that they are planning to increase the total amount of solar cells up to more than 50,000,000kW (200 times the present value) in the next 30 years. In order to achieve this target, further development of thin film solar cells with lower cost and higher performance is strongly required. Figure 1 shows the roadmap of solar cell technology development. Silicon and compound semiconductors (such as $CuInSe_2$) have been studied as thin film materials extensively. And it is silicon solar cells that are thought to be crucial from its environmental safety and natural abundance.

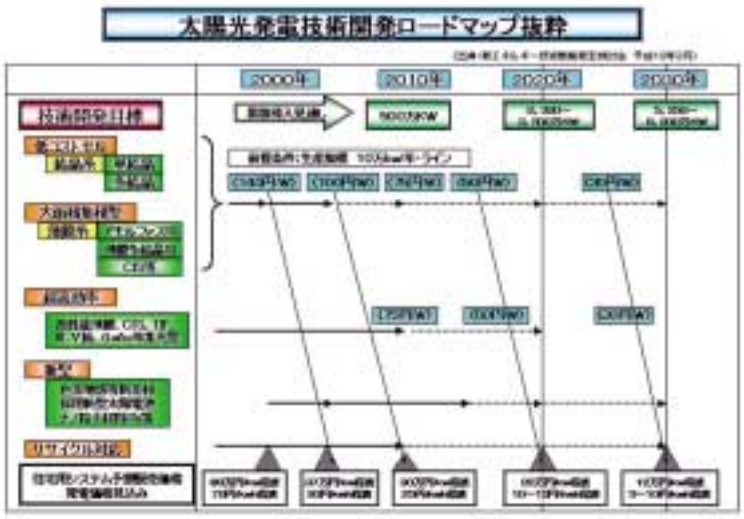


Figure 1: (by courtesy of PVTEC)

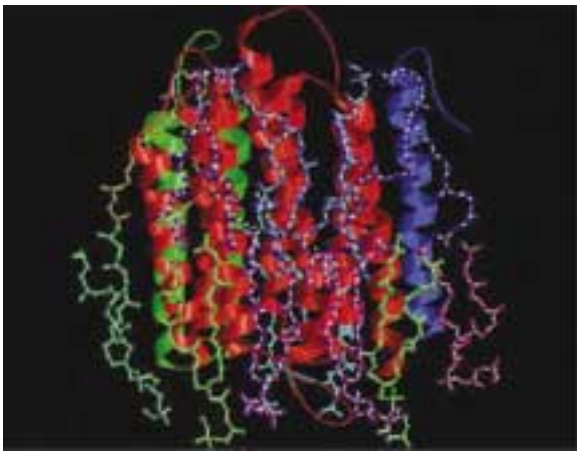
Biological Information Research Center

It is expected that the Life Science Era is coming, since the most of the human genome sequence was roughly analyzed by the end of the 20th century.

That is also the era that genome science is moving closer to Industry through researches on functions of genes and proteins based on human genome sequence data. They are so called post-genomic researches.

From standpoint of bioscience, the center (BIRC) purports to acquire, arrange and integrate biological information contained in the genome sequence data.

There are three research groups in BIRC. Main projects are i) three dimensional structure determination of membrane proteins, ii) functional analysis of human full-length cDNA and iii) construction of integrated biodatabase.



Structure of GPCR

Smart Structure Research Center

The Smart Structure Research Center (SSRC) is a leading international center for smart structure research to enhance the performance, safety, and reliability of civil infrastructures, ground and space transportation systems as well as biomedical instruments and devices, etc. The mission of the SSRC is to provide a R&D focus for broadening of fundamental understanding of smart materials and material systems that possess multifunctional capabilities, and for development of new technologies that utilize the materials for the design of smart structures and systems to optimize their services, performance, and safety.

SSRC will invest its intellectual, financial, and facility resources in new knowledge discovery, and new technology development, adaptation and utilization to support the industries for the continued growth of intelligent engineering-including planning, design, construction, inspection and diagnosis, monitoring, maintenance, and renewal-that are civil, mechanical, or aeronautic and astronautic based.

SSRC will make creative use of its resources in research on innovative materials and smart structures and in development of emerging technologies, including sensing and actuating systems and devices of various scales, wireless data management, and condition monitoring and control systems of integrated or interfaced software and hardware. SSRC will strive to become:

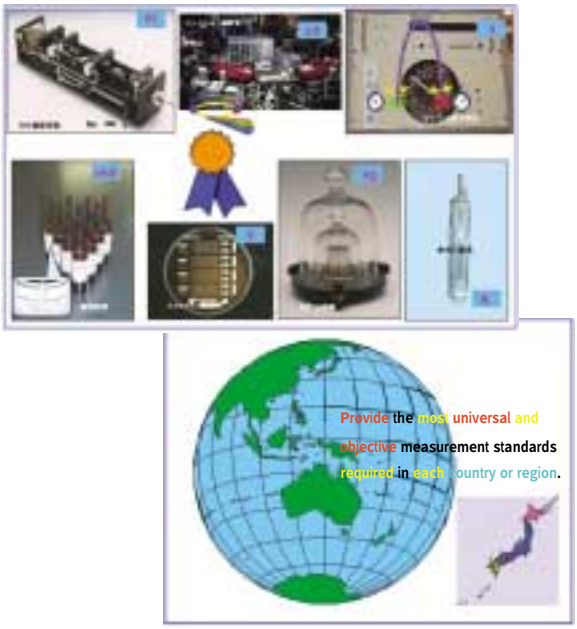
1. A technology bridge that serves as a linkage between government and industry to innovate smart structure development in industry;
2. An opportunity creators being a source of new job and new industry creation based on spin-off technologies from the center; and
3. A premier place of pioneering research that will be institutionalized as a leading international center for leading smart structure research.

It is expected that all major research work will target for prototyping and physical demonstrations in lab or field related to engineering applications with well defined purposes. Hence, SSRC emphasizes team work and center approach, targeted application research, demonstration tests, engineering products, and other knowledge and technical deliverables of engineering importance.

Metrology Institute of Japan

The Metrology Institute of Japan (MIJ) conducts R&D for the metrology and dissemination of the measurement standards over the country and takes the technical responsibility of national metrology institute of the country (NMIJ) in the global metrological activities, by cooperating with other three sectors of AIST. Measurement standards, including certified reference materials, are systematized under the standards and certifications policy of the government as the core of the national measurement system which guarantees the traceability of all measurement results to the national primary standards. The R&D for the measurement standards is dedicated to realization and improvement of primary standards according to the concept of the SI units, consisting of seven base units and many other derived units and also to improve the calibration and testing technology in order to establish the reliability of all kinds of quantitative evaluations.

The national measurement system is generic techno-infrastructure supporting the qualities of economical, social, technical and scientific activities of individuals both domestic and international, such like competitiveness of domestic economy in global market, maintenance and preservation of social capital, improvement of quality of life by environmental, medical, pharmaceutical R&D and finalization of R&D in leading edge technology to the industrial sector. The MIJ is also responsible to the technical conformity assessment of measurement instrument both legal and voluntary regulation in the society. The cooperative R&D among the different fields of metrology enables pursuit of higher precision in a primary standard and new method for the realization of the unit and calibration of standards of atomic, nanoscopic and gigascopic world.



Provide the most universal and objective measurement standards required in each country or region.

Institute of Molecular and Cell Biology

In the so-called post genomic research era, the major interest has been focused on the discovery of new genes and their corresponding new proteins based on the nucleotide sequences of the human genome. Furthermore, all biological components, including proteins and lipids as well as sugars, will be reexamined from the genomic viewpoint to understand more clearly the functions of cells, tissues, and organs. We will pursue industrial application of such drastic advancements in genomics and molecular biology as one of the core research units in this newly formed national institute.

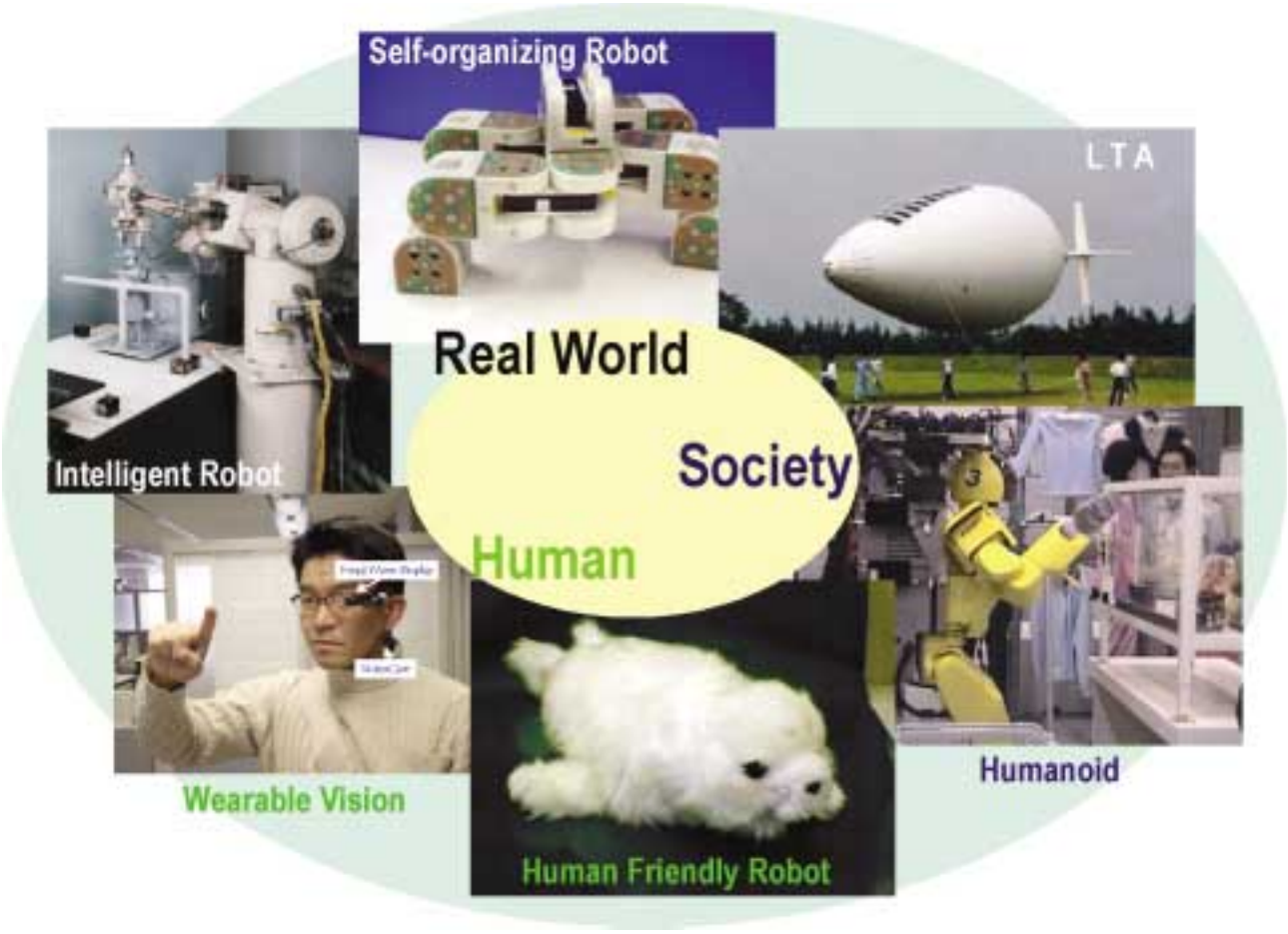
We will continuously try to increase our performance in the international academic community as before, and, as a leading institute, promote the technology transfer of our knowledge to the industrial sector to create new industrial developments in biotechnology. At the campus of AIST in Tsukuba, we have started a new national project for the comprehensive analysis of the human genes related to glycosylation in collaboration with companies under METI (Ministry of Economy, Trade and Industry) program. Additionally, a small venture company was founded to utilize our patents on DNA microarrays for diagnosis of cancers and for the survey of environmental hormones.

Intelligent Systems Institute

The objective of the Intelligent Systems Institute is to conduct researches on fundamental and component technologies, system integration technologies for the computer-oriented intelligent systems, and also physical systems which support human activities in the real world. In the 21st century, "IT" i.e. information and computer network technology is one of the key technologies to improve human life. Also the IT driven systems that provide physical services to human will be important. In order to guarantee sustainable prosperity in our society in the future, the institute promotes advanced R&Ds relating to computer/information science, robotics and mechatronics with the emphasis on the following topics:

1) Human assist intelligent systems (Human friendly robotics, Humanoid, Human support and Welfare technologies, etc.)
2) Industry-oriented / Social-need-oriented systems (Intelligent security systems, ITS, Advanced factory automation systems, Field robotics, etc.)
3) 3D Vision and its applications to real world understanding
4) Human-centered communication systems
5) Fundamental topics for intelligent systems (Learning, Robotic skill, etc.)

To achieve the above missions and to create new industrial activities, the institute will plan to challenge various researches and new projects together with industrial and/or university partners.



Nanoelectronics Research Institute

Mission

The mission is to create various innovation seeds of electronics technology by performing systematic research from physics and materials science to electron devices and their systems. Transfer of technological seeds including patents, new electronic materials and nanofabrication technologies to companies are within the mission.

Research scope and outline

Research activities are grouped in the following three subjects.

(1) Physics and material science

Search and elucidation of new electron phenomena and materials and development of their application technologies are carried out with the aim of creation of new function electron devices and breaking of performance limitations of the existing devices. Especially, researches on new superconductive phenomena and materials, new oxide materials and application to new function devices are intensively carried out. The following four research groups are collaborating for this subject.

· Condensed Matter Physics Group
· Low-Temperature Physics Group
· Superconducting Materials Group
· Oxide Electronics Group

(2) Next generation LSI technologies

Research and development of nanoscale transistors including new gate-insulating materials, spintronics devices, quantum effective devices and electronic measurement devices with ultrahigh precision are carried out for developing the technology platform required by the next generation LSI. The following six research groups are collaborating for this subject.

· Silicon Nanoscale Devices Group
· Analysis and Instrumentation Group
· Superconducting Devices Group
· Flux-Quantum Devices Group
· Spintronics Group
· Novel Electron Devices Group

(3) System integration technology

In order to connect the information space with the real human environment, it is important to realize intelligent interfaces excellent in portability and accessibility to humans. Here, the technology that integrates and interconnects image input/output devices with various LSIs onto a single Si chip is currently developed. The following two research groups are promoting this subject.

· Microsystems Group
· High Density Interconnection Group

Nanotechnology Research Institute

Mission

As a principal driving force of science and technology in the 21st century along with information technology and biotechnology, expectations are now high on nanotechnology. This is an emerging technology area laid on the nanometer (one billionth of a meter) regime, in which deliberate manipulation of materials with atomic or molecular precision gives rise to revolutionary materials, devices and systems with unprecedented density and functionality even at ultralow energy and material consumption.

Nanotechnology is a generic field with unlimited future possibilities, existing at the root of every technical discipline related to materials engineering. The Nanotechnology Research Institute (NRI) is the core of the diverse nanotechnology activity in the AIST, and is strongly committed to long-sighted and strategic advancement of methodology and concepts in nanomaterials science, elucidation and utilization of novel physical, chemical and biological phenomena on the nanometer regime, and their extension to industrially relevant technologies.

R&D Vision and Strategy

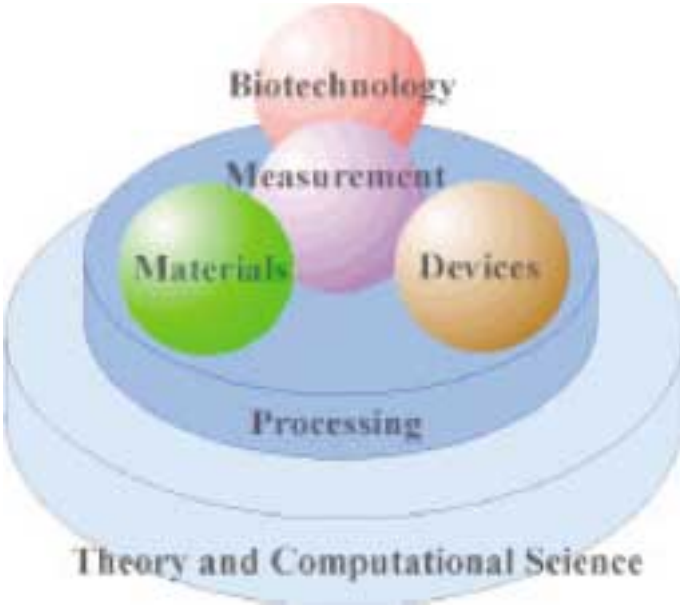
The interplay between the basic science and the applied technology is a vital element of nanotechnology. A leap from know-how driven empirical industrial technology to that with a clear theoretical logic and predictions is a characteristic feature therein. The NRI emphasizes the foresight role played by theory and computational science in nanotechnology, develop novel nano-processing and characterization technologies, and promotes substantial R&D's aimed at the development of novel nanomaterials, nanodevices and nanobiotechnology.

Our R&D vision and strategy rest on the concept of "fusion" of:

- Technical disciplines,
- Approaches:Unification of top-down (fabrication) and bottom-up (self-organization) approaches,
- People: Intimate collaboration among industry and academia, and the balance between the team play and the individual activity,
- Basic and applied research:Identification of industri-ally relevant basic R&D subjects and encouragement of technology spin-offs.

Research Groups:

- Nanomaterials Theory Group
- Nano-dyanmics Group
- Near-field Nano-engineering Group
- Single Molecular and Interfacial Engineering Group
- Nanocluster Group
- Molecular Nano-Assembly Group
- Supramolecular Chemistry Group
- Molecular Nanophysics Group
- Bio-nanomaterials and Surface Interactions Group



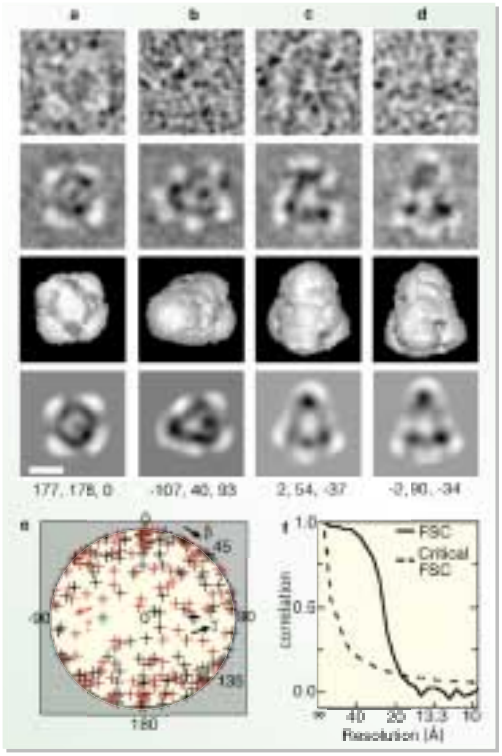
Abstracts (April - July 2001)

The abstracts of the recent research information appeared on the Vol.1 No.1-No.6 of AIST today are introduced, classified by research area.
For inquiry about the full article, please contact the author directly.

Life Science & Technology

3D Structure Map of the Voltage Sensitive Sodium Channel

The voltage gated sodium channel generates the action potential. This 300 kDa protein has four homologous regions. We isolated sodium channels from Electrophorus electricus electroplax by detergent solubilization and immunoaffinity chromatography and studied their structure by the combination of He-stage cryo-electron microscope and single particle analysis at 19 Å resolution. The channel had a bell shaped outer surface of 135 Å heights and 100 Å in side length at the square shaped bottom.



Cryo-electron Microscopy of sodium channel and the reconstructed sodium channel. a-d, raw images of molecules (row 1) are compared with the corresponding 2D averages (row 2), the surface view of the 3D reconstruction (row 3) and the projections of the 3D reconstruction (row 4) along the corresponding Euler direction. Scale bar 50 angstrom. e, Surface projection of the Euler angle distribution. f, Fourier shell correlation function calculated between two reconstructions. Figures was from Nature 409, 1047-1051 Sato et al. (2001) and shown for the details in the original paper.

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Medical Vision Technologies

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AIST Today Vol. 1, No. 2
(2001) 12-16

Medical Vision is a technology to measure and visualize a human body non-invasively. Among the medical vision technologies, functional magnetic resonance imaging (fMRI) is one of the advanced tools to evaluate human linguistic function which is indispensable for qualified life. By listening of comprehensive but non-native language, activation representing enhanced semantic and syntactic processing was observed, although only augmentation of phonological processing was observed by non-comprehensive language (Fig.1). In an experiment of cocktail party phenomenon, cooperation among sound source detection, phonological processing and semantic processing for selective auditory attention was indicated (Fig2).

Fig.1

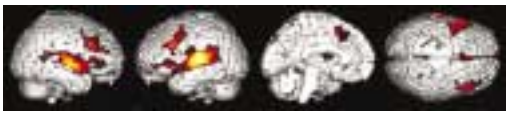

Fig.2

MEG Technology and Its Application for Medical Welfare

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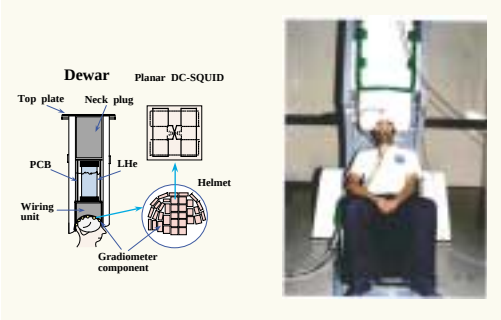
AIST Today Vol. 1, No. 2
(2001) 24-29

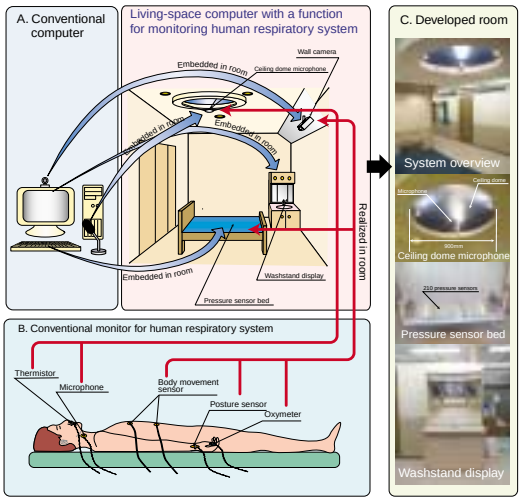
Magnetoencephalography (MEG) is one of the most important non-invasive measurements of human brain activity and a valuable technology to understand human sense, cognition, and various actions in daily life. Using the advantage of MEG; the excellent time resolution and good signal source localization, we found the olfactory nervous center in the orbito-frontal area and a fine control mechanism on attention and emotion. Ultrasonic hearing has been recently revealed by bone conduction method with an ultrasound vibrator using MEG, so that the development of a ultrasonic hearing aid is expected for hearing deaf people.



Whole-head type neuromagnetometer using 122-channel SQUID sensors(left) and olfactory MEG experiment(right)

Daily-Living-Space Computer with a Model of Human Functions

In Digital Human Laboratory, we are developing a daily-living-space computer with a model of human functions. In our system, the daily living space is sensorized so that the living space can digitize daily activities of inhabitants without any explicit human operation. Moreover, using a digital human model, the system can monitor physiological conditions of him or her without any contact-type sensors. This system is useful for supporting healthcare at home.



Daily-Living-Space computer with a model of human functions

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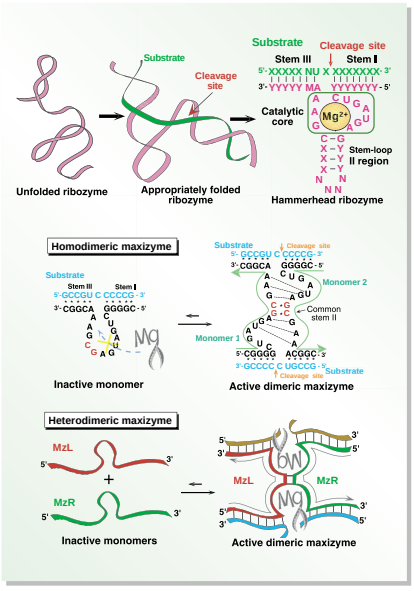
AIST Today Vol. 1, No. 3
(2001) 8-11

Gene Discovery by Nobel Hybrid-Ribozymes

Appropriate folding of catalytic RNA is the prerequisite for the effective catalysis. We succeeded in controlling the structure of a ribozyme at will and created an allosterically controllable ribozyme, the maxizyme. The maxizymes work not only in vitro, but also in vivo including mice indicating the potential utility of this novel class of ribozyme as a gene-inactivating agent with a biosensor function. Moreover, we have also created novel hybrid enzymes that couple the site specific cleavage activity of the hammerhead ribozyme with the unwinding activity of endogenous RNA helicases. This ribozyme technology represents a powerful tool for the development of gene-inactivating reagents of both therapeutic and general importance and for the rapid identification of functional genes in the post-genome era.



Creation of dimeric maxizymes (center, bottom) from a catalytic RNA, ribozyme (top)

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AIST Today Vol. 1, No. 3
(2001) 16-20

New Performance of Porous Ceramics as Structural Components

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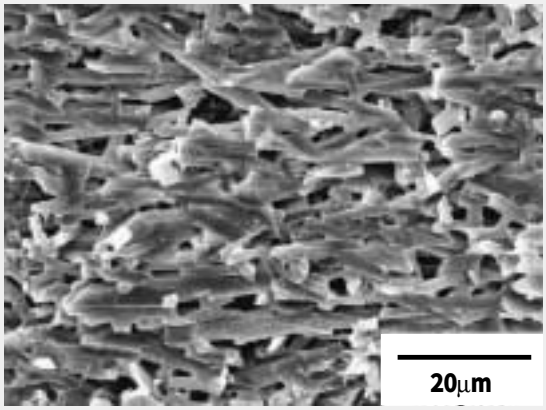
AIST Today Vol. 1, No. 3
(2001) 28-31

In structural ceramics, pores are generally believed to deteriorate mechanical properties. However, the presence of pores does not always lead to degradation, but on the contrary, can give rise to improved or unique performance whenever carefully controlling the microstructural factors such as sizes, shapes, and alignments of pores and matrix grains. As an example, 14% porous silicon nitride where large fibrous grains are aligned together with flat-shaped pores is demonstrated. This material shows 7 times larger fracture energy than that of conventional dense silicon nitride, due to grain-pullout *etc*. enhanced by the pores. Another is 24% porous silicon nitride with aligned fine fibrous grains and uniformly dispersed minute pore. This material maintains strength equivalent to that of dense one while the elasticity is lowered almost half, making the strain tolerance about double.



Scanning electron microscopy micrograph of the porous silicon nitride. The fibrous silicon nitride grains are well aligned toward the casting direction, and pores are present between the grains.

A "Remote Speaker" Stands Next to Me (in the HyperMirror) !

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AIST Today Vol. 1, No. 5
(2001) 15

Users of the remote-communication HyperMirror feel as if they are looking into a mirror that displays both their remote selves and anything in the background as an integrated, single image. One user looked by reflex toward the “real” speaker when this speaker started to explain the system. The user soon realized, however, that this was remote communication and turned to the HyperMirror. It took just a second to understand what was happening, clearly demonstrating the “reality” of communication through the HyperMirror even when users understand a virtual image is involved in such remote communication.

A "remote speaker" stands next to me (in the HyperMirror)!

Systematic Circular Permutation Analysis for Revealing Essential Elements for Protein Folding

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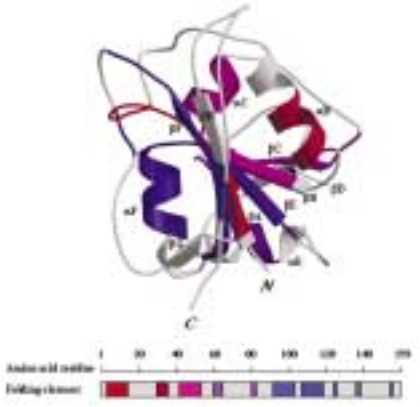
AIST Today Vol. 1, No. 5 (2001) 4

With increasing genomic information by genome projects, it becomes more and more important to reveal the meanings of genomic information in terms of protein structures and functions. However, "protein folding problem", that is, how amino acid sequence determines its tertiary folded structure, has not been solved, and this limits the interpretation of the DNA sequence information. Efforts towards understanding the protein folding problen have mainly focused on native protein. Alternatively, we started to understand the factors that make a sequence foldable or un-foldable. We propose a new concept, "folding elements", which we have investigated by systematic and complete circular permutation analysis. Based on this analysis we conclude that breaking at least one of the folding elements of a native protein abolishes it ability to fold. While a structural approach is important for solving the protein folding problem, it could be misleading since folding elements identified by us do not always correspond to any two- or three dimensional structural elements.



Mapping of the folding elements onto the structure of DHFR. Colored regions represent the folding elements. The location of secondary structure motifs and the N-terminus and C-terminus are also shown.

Reversal of Subjective Temporal Order due to Arm Crossing

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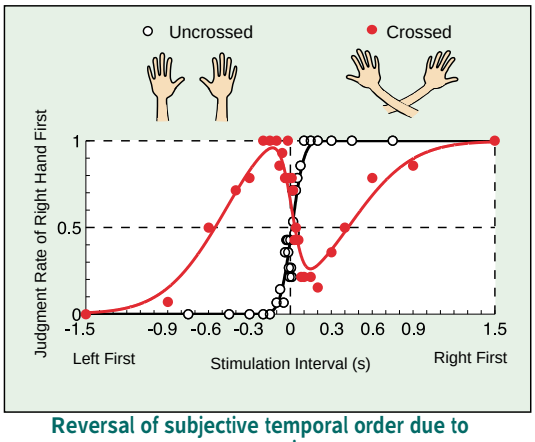
AIST Today Vol. 1, No. 6 (2001) 12

How does the brain order successive events? We have recently shown that crossing the arms caused many subjects to misreport (that is, invert) the temporal order of two stimuli delivered in succession, one to each hand, at moderately short intervals (< 300 ms), though at longer intervals (> 1 s) they generally responded correctly. In contrast, when the arms were uncrossed, the subjects could respond correctly at intervals as short as 70 ms. We conclude that it is not until the spatial locations of the hands are taken into account that the cutaneous signals from the respective hands are ordered in time.



Reversal of subjective temporal order due to arm crossing

Yamamoto S & Kitazawa S (2001) *Nat. Neurosci* **4** 759-765

Plastic Based Lab-on-a-Chip Devices using LIGA Process

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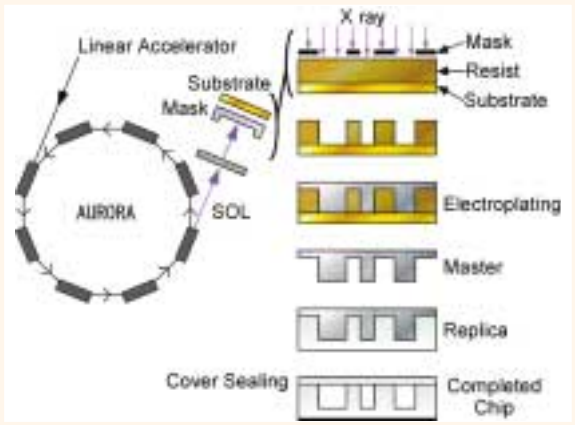
AIST Today Vol. 1, No. 6
(2001) 14

Microfluidics based Lab-on-a-Chip (LOC) technology has been attracted significant attention due to its novel ad-vantages. Most of LOC was made from glasses as it is eas-ily control of microfluids using the quartz chip. We focused on the fabrication of plastic chip, which has additional ad-vantages of disposable chip especially for body fluid, cell and so on using LIGA process as shown in Figure in re-search cooperation with the Ritsumeikan University. We are now under investigation of chip tests, improvement of fabrication process.



Plastic fabrication using LIGA process

Tissue Engineered Bone Derived from Marrow

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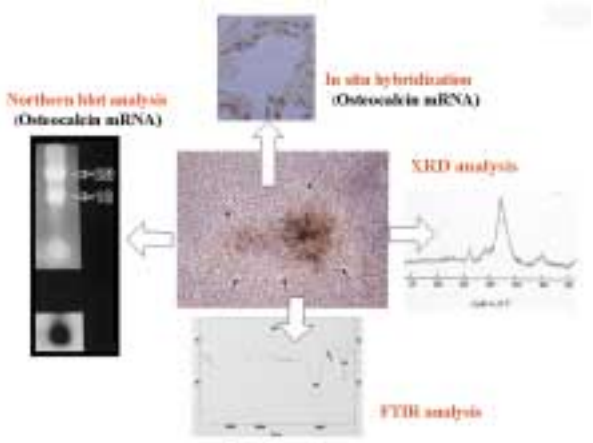
AIST Today Vol. 1, No. 6
(2001) 20

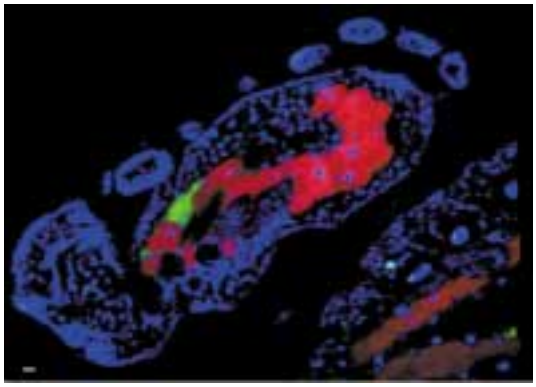
Many geriatric patients need total joint replacements; these prosthetic devices have problems including aseptic loosening of the implants. To prevent the loosening, we propose a new concept, which is to coat joint prostheses with osteogenic cells or their precursors. Fresh bone marrow would be collected from the patient, and the mesenchymal stem cells (MSCs) isolated, expanded in number in culture, and subsequently cultured on the surface of the prostheses under osteogenic conditions. The surface of the prostheses would be covered with bone (osteoblasts and bone matrix) derived from the patient's own cells. This bone would possess the capability for bone bonding as well as new bone formation. Due to this biologic surface reconstruction, loosening can be avoided, while the post-operative rehabilitation program can be shortened due to early and secure bone formation around the implanted prosthesis.



In vitro bone formation
Cultured marrow cells can differentiate into osteoblasts evidenced by Osteocalcin mRNA expression (Northern blot analysis and In situ hybridization). The osteoblasts fabricate mineralized bone matrix comparable to natural bone evidenced by XRD and FTIR analysis.

Diversity of Unseen Microbes on the Earth

It is well recognized that uncultured or uncultivable microbes account for more than 99% of total microbes existing in environment, hence, it would be impossible to overview the microbial world by conventional methods in microbiology. We are analyzing diversity of microorganisms in natural and engineered ecosystems using molecular approaches and histological methods. We are also attempting to cultivate microbes yet-to-be-cultured by classical methods combined with new techniques to uncover the unseen majority on the earth.



Endosymbiotic system of the pea aphid, *Acyrthosiphon pisum*. Fluorescence imaging of the endosymbiotic system in an aphid embryo. Host cells are visualized in blue, and the primary and secondary endosymbiotic bacteria are stained in red and green, respectively. The histological technique enables us to investigate spatio-temporal distribution and population dynamics of the endosymbionts in vivo.

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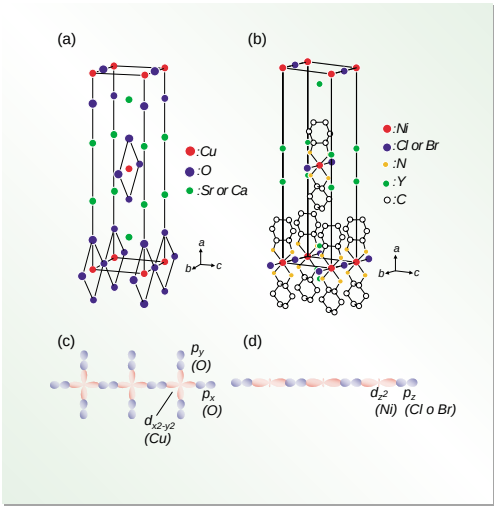
AIST Today Vol. 1, No. 6 (2001) 22

Information and Communication Technology

Correlated Electron Optoelectronics

Strongly correlated electron materials, which show interesting transport and magnetic properties such as high-T_c superconductivity or colossal magnetoresistance, are also promissing for optoelectronics materials. Large third order optical nonlinearity ($c^{(3)}$ ~10^{-5}-10^{-8} esu) and ultrafast ground state recovery (~ 2 ps) are observed in one-dimensional copper oxides and halogen-bridged nickel compounds. In these materials, existence of nearly degenerate and spatially overlapped excited states enhances optical nonlinearity. In a layered manganite $La_{0.5}Sr_{1.5}MnO_4$, on the other hand, optical anisotropy, which is induced by orbital ordering, is drastically changed upon photo-irradiation. Photo-irradication melts the orbital ordering within 200 fs. The phenomenon may also be applied to ultrafast optical memory and switching.



Crystal structure of one-dimensional copper oxides (Sr_2CuO_3, Ca_2CuO_3)(a), and one-dimensional halogen bridged nickel compounds ($[Ni(chxn)_2X]Y_2$: X=Cl,Br, Y=Cl,Br,NO_3)(b). Configuration of orbitals constructing one dimensional electron system in copper oxides (c) and halogen bridged nickel compounds (d).

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AIST Today Vol. 1, No. 3 (2001) 32-35

A New Doping Process in SiC at Low Temperature

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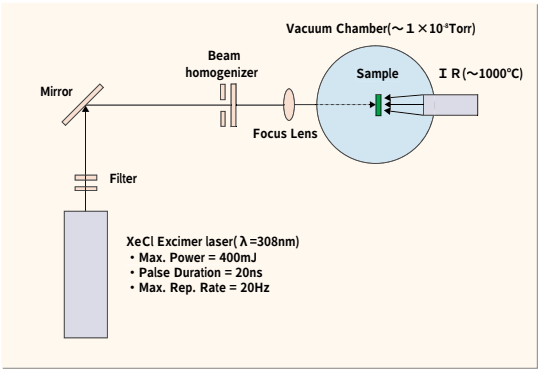
AIST Today Vol. 1, No. 5
(2001) 6

We succeeded to develop a new doping process in silicon carbide below 700°C by the excimer laser annealing combined with the thermal annealing. After irradiation of XeCl excimer laser(λ=308nm) on P^+ ion-implanted 4H-SiC sample(p-type expitaxial layer) with heating at 700°C by infrared lamp we confirmed the high electrical activation ratio of the implanted P^+ ion without the evaporation of the surface atom and the redistribution of the dopants in comparison with the case of furnace annealing at 1500°C. A minimum sheet resistance of laser annealed sample was 164.7Ω/□.



A schematic illustration of the laser annealing system

Local Plasmon Photonic Transistor by Silver Oxide Thin Film

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AIST Today Vol. 1, No. 5
(2001) 5

Recently, we found that a specially designed optical disk has the potential to amplify optical signals by surface plasmons generated over recorded marks. Since 1997, we have focused our research on super-density optical data storage specially using near-field optics and developed the novel disk structure named "super-resolution near-field structure (super-RENS)." Super-RENS was originally designed to enhance the signals of marks recorded in less than the diffraction limit. However, introducing and crossing two laser beams at one focused spot, one of the beams passing through the disk was amplified by adjusting another laser beam power. The amplifier was operated in a thin and small area in less than 100 nm and 1.0 μm.

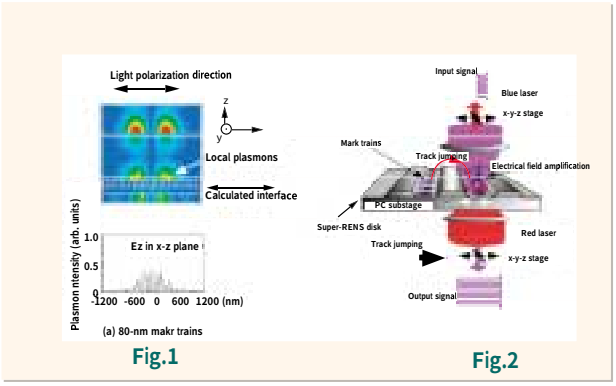


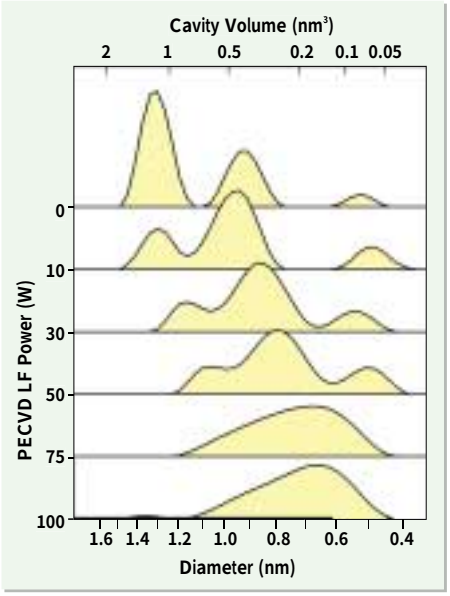
Fig.1 Fig.2

Fig.1 Plasmon reservoir by mark terains
Fi.2 Experimental setup ofplasmon transistor

J. Tominaga et al., " Local plasmon photonic transistor," *Appl. Phys. Lett.* **78** (2001) 2417-2419.

Characterization of Sub-Nanometer-Sized Voids in Low-Dielectric-Constant Films by a Slow Positron Beam

For future generation high-speed LSI devices, copper interconnection with low dielectric constant (low-k) interlayer films is required to decrease RC(R: interconnect resistance, C: interlayer dielectric capacitance) delay. Recently, a new process for low-k films, utilizing dual frequency plasma enhanced chemical vapor deposition (PECVD) with source gas of polysiloxane, has been developed for copper damascene integration. To characterize micro-structures in the PECVD grown low-k films, we have carried out positron-positronium lifetime measurements with a slow positron beam. We have found sub-nanometer-sized voids and clear relation between the void size and dielectric constant.



Pore size distribution of low-k films grown by the PECVD method with low-frequency power of 0, 10, 30, 50, 75, and 100 W.

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Environmental Science & Technology

Decomposition of Dioxins by Photocatalytic Ecomaterial

Photocatalytic ecomaterial is prepared by coating TiO_2 transparent film on silica-gel bead. When irradiated by light, the photocatalytic ecomaterial generates strong oxidative potential and almost all organic substances are decomposed to water, carbon dioxide and others. An apparatus for decomposition of dioxins is constructed with the ecomaterial. The removal efficiency over 99% of dioxins has been obtained. The novel photocatalytic decomposition method using silica-gel beads coated by TiO_2 has been applied for the highly efficient treatment of water pollutants, acidic gases, and rank odor substances in environment.

Apparatus for decomposition of dioxins with photocatalytic ecomaterial

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AIST Today Vol. 1, No. 2 (2001) 9-11

Environmental Assessment of CFC Alternatives

- Reaction Rate Constant against OH Radicals -

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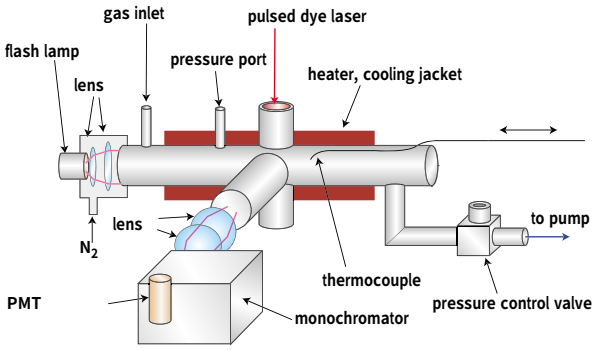
AIST Today Vol. 1, No. 2
(2001) 17-19

GWP (global warming potential) of CFC (chlorofluorocarbon) alternatives is estimated from the atmospheric lifetime and the infrared absorption intensities. In general CFC alternatives are expected to be oxidized by OH radicals in the atmosphere. Therefore, study of the reactivity against OH radicals is indispensable for the evaluation of atmospheric lifetime of these molecules. We report the kinetic measurements with high accuracy for the reactions of OH radicals with CFC alternatives.



Schematic diagram of flash photolysis/laser induced fluorescence apparatus

Catalytic Technology for Producing Clean Diesel Oil

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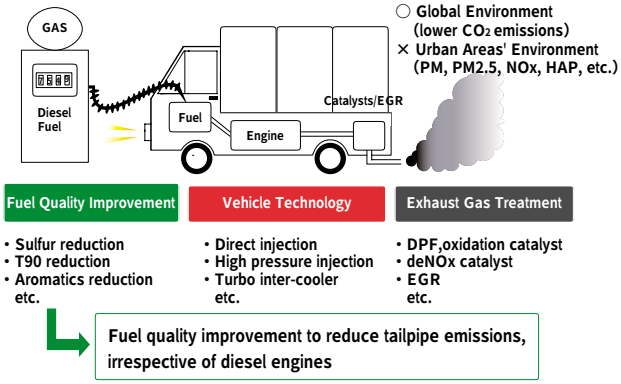
AIST Today Vol. 1, No. 2
(2001) 20-23

The environmental pressures demand high specifications for diesel oil to reduce the emissions of particulate (PM), NOx and hazardous air pollutants in diesel-exhaust gases. We developed the bimetallic Pd-Pt catalysts supported on ytterbium-modified USY zeolites that showed excellent hydrodesulfurization (HDS) and hydrodearomatization (HDA) activity, and high sulfur and nitrogen tolerance for producing clean diesel oil. We then developed the extrudated form of catalysts available in industrial use, such as Pd-Pt/Yb-USY-Al_2O_3, and confirmed their excellent performances to produce clean diesel oil containing low amounts of sulfur and polyaromatics during the time on stream of 2700 h in a bench-scale high-pressure plant. We further confirmed that the resulting clean diesel oil was effective for the reduction of PM emissions.



Technological Measures against Diesel Emissions Reduction

A Thermoelectric Oxide for High Temperature Application

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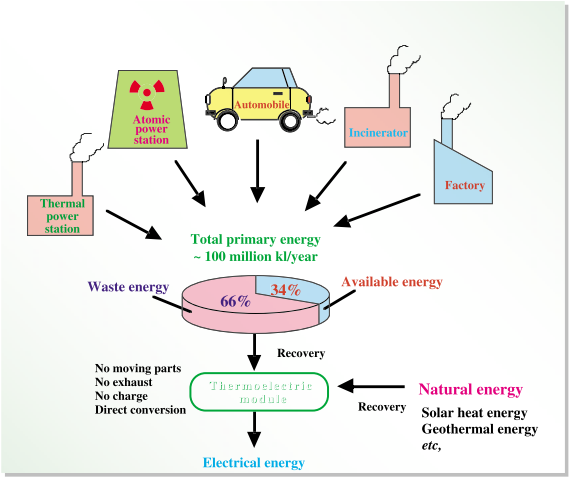
AIST Today Vol. 1, No. 3 (2001) 21-24

An oxide single crystalline whisker with high thermoelectric properties at high temperature in air has been discovered. The composition of the whisker is $(Ca, Sr, Bi)_2Co_2O_5$ (abbreviated to Co-225 whisker). Seebeck coefficient S and electrical resistivity ρ of the whisker are 200-210 μV/K and 1.4-1.5 mΩ-cm at temperatures higher than 600 ºC, respectively. Using thermal conductivity κ of a Co-225 polycrystalline sample, figure of merit ZT (= $S^2T/\rho\kappa$, T; absolute temperature) of the Co-225 whisker is estimated over 1.2 at temperatures higher than 600 ºC. The discovery of the oxide with high thermoelectric performance at high temperature in air leads to the expectation that electric power generation using waste heat from automobiles, factories, and similar sources will be realized in the near future.



Large amount of waste heat

Development of Visible-Light-Responsive Titanium Oxide Photocatalyst for Environmental Purification

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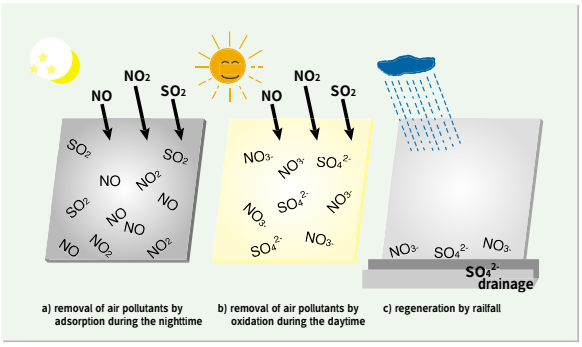
AIST Today Vol. 1, No. 5 (2001) 8

Photocatalysis is a promising method for energy-saving environmental purification. We have found that oxygen-deficient titanium dioxide samples prepared by radio-frequency plasma treatment have photocatalytic activity not only under illumination of ultraviolet light but also with visible light (400-600 nm). The new photocatalyst, which will soon be supplied by a collaborating company, is expected to work more efficiently under the sun as well as in the indoor environment.



Air-purifying material — typical environmental application of photocatalysis

Advanced Particle Separation for Environmental Protection

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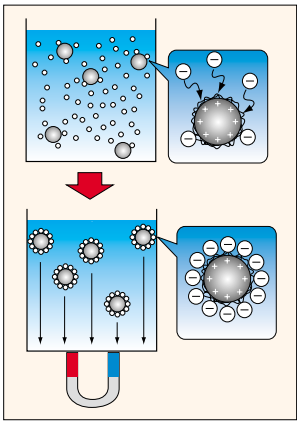
AIST Today Vol. 1, No. 6
(2001) 18

Particle separation technology is of great importance for recycling and wastewater treatment. The Particle Separation Group has recently developed a pneumatic column separator and a magnetic solid flocculant. The former separates particles depending on their density and is applicable to the separation of waste metals, plastics and glasses from various industrial and municipal wastes. The latter can flocculate suspended solids in wastewater without adding inorganic or organic flocculants. Magnetic force promotes the settling of floccules. The solid flocculant is recovered by re-dispersing the floccules through pH control and can be used repeatedly.



Removal of fine particles using magnetic solid flocculant

Energy Science & Technology

A great Success of Interface Controlled Enhancement type Buried-Channel 4H-SiC Metal-Oxide-Semiconductor Field Effect Transistor (ICE-BC MOSFET) with the Best Electrical Performance in the World

– Establishment of Channel Mobility of 140cm^2/Vs –

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Ryoji KOSUGI[2],
Junji SENZAKI[2],
Shinsuke HARADA[2],
Kazuhiro ADACHI[2],
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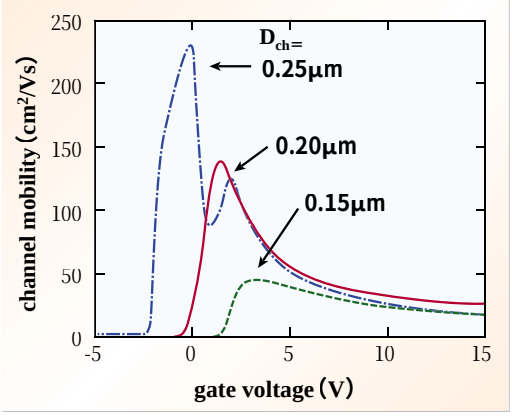
[1]*Advanced Power Device Lab.*
[2]*Power Electronics Research Center*
AIST Today Vol. 1, No. 1
(2001) 19-23

We have fabricated buried channel MOSFETs with a thermally grown gate oxide in 4H-SiC. The gate oxide was prepared by dry oxidation with H_2O annealing. The buried channel region was formed by nitrogen ion implantation at room temperature followed by annealing at 1500 °C. The optimum doping depth of the buried channel region has been investigated. For the nitrogen concentration of 1×10^{17} cm^{-3}, the optimum depth was found to be 0.2μm. Under this condition, the channel mobility of 140 cm^2/Vs was achieved with the threshold voltage of 0.3 V. This channel mobility is the highest reported so far for a enhancement type 4H-SiC MOSFET with a thermally grown gate oxide.



Gate voltage dependence of channel mobility for ICE-BC MOSFET

Development of HyperCoal Production Process by Using Solvent Extraction

A new HyperCoal (ashless coal) power generation system is being developed to introduce coal directly into gas turbine. Solvent deashing process using organic solvent extraction is a key way to develop the system. Solvent extractions were carried out using ordinary solvents to get organic components from coals. It was succeeded in produding HyperCoal (ash content < 0.1%) for seven of nine colas at a laboratory scale. Light cycle oil (LCO) was found to be a useful solvent since it gave similar extraction yields to 1-methyl-naphthalene and dimethylnaphthalene. The mechanism of solvent extraction is discussed based on the data of structural analyses.

Coal	Extraction Yield with Dimethylnaphthalene (%)	Extraction Yield with Light Cycle Oil (%)
A	–	33.5
B	74.0	44.0
C	–	32.0
D	–	47.0
E	43.8	32.1
F	–	48.5
G	69.3	55.8
H	40.4	36.8

Table Extraction Yields with Dimethylnaphthalene and Light Cycle Oil at 360 °C Using a Flow-Type Extractor

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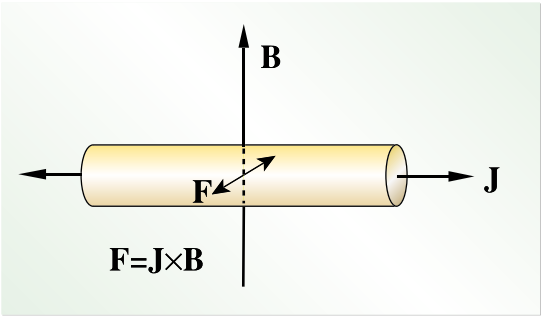
AIST Today Vol. 1, No. 5 (2001) 10

Nanotechnology and Materials Science & Technology

New microstructural Refinement Process of Metallic Materials by Electromagnetic Vibrations

Electromagnetic vibrations are induced in metallic materials during solidification by simultaneous application of alternating electric and stationary magnetic fields. Cavities form and collapse on the surface of solid crystals by application of electromagnetic vibration and then a huge pressure is exerted on the surroundings when they collapse. This pressure may result into the refinement of solid crystals. This mechanism has been applied to aluminum alloys, magnesium alloys and cast irons during solidification. It has been clarified that primary solid crystals are extensively refined.



Vibrating force developed by interaction of alternating electric and stationary magnetic fields

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AIST Today Jpn. Vol. 1, No. 1 (2001) 15-18

A liquid Crystalline Material Applicable to Full-Color Rewritable Recording in a Photon Mode

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AIST Today Vol. 1, No. 3
(2001) 12-15

We designed a new molecular system by combining photochromic compounds that change molecular structure by the action of light and liquid crystals that show different iridescent colors depending on the molecular alignment. In this system, information transfer from photochromic compounds to liquid crystals is regulated utilizing the glass-forming property of the liquid crystals. Medium molecular-weight liquid crystals made it possible to attain both stable molecular order in the glassy state and fast molecular re-alignment in the liquid crystalline state. This new molecular assembly responding light and temperature enables us to record color information repeatedly in a photon mode and is expected to be applied to the rewritable paper and card.

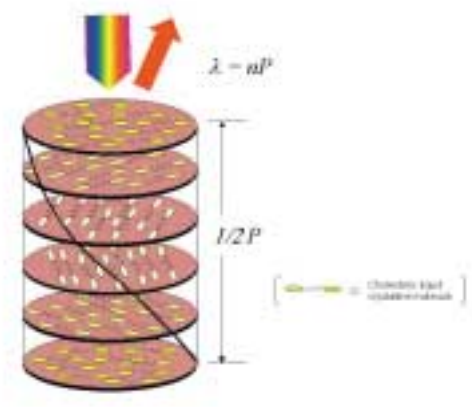

Diagram of the structure of the cholesteric phase. Liquid crystals in the cholesteric phase reflect incident white light selectively, provided that the incident light has a wavelength satisfying the Bragg condition, $\lambda = nP$

Novel Ferroelectric Thin Films Via a Tailored Liquid Source

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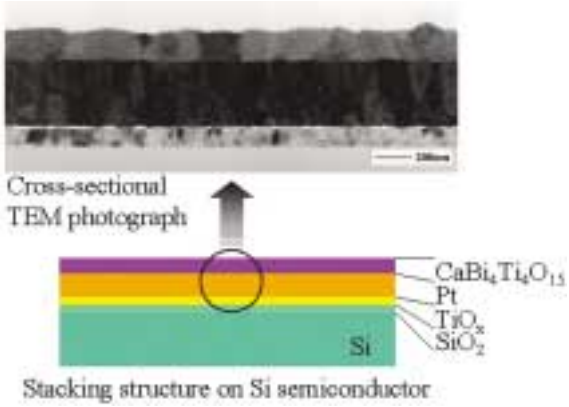
AIST Today Vol. 1, No. 6
(2001) 16

$CaBi_4Ti_4O_{15}$ thin films were prepared by spin-coating a tailored liquied source as a mixture solution of double alkoxides. As-deposited thin films began crystallization below 550ºC and reached full crystallinity of a single phase of layered-perovskite at 650ºC via rapid thermal annealing in oxygen. 650ºC-annealed $CaBi_4Ti_4O_{15}$ thin film showed random orientation on Pt-passivated Si substrate and exhibited P-E hysteresis loops. The remanent polarization (P_r) and coercive electric field (E_c) were 9.4 mC/cm^2 and 106 kV/cm, respectively, at 11 V. The polarization did not change after 10^{11} switching cycles with voltage of 5 V. The dielectric constant and loss factor were 300 and 0.033, respectively, at 100 kHz.



A cross-sectional TEM photograph of $CaBi_4Ti_4O_{15}$ ferroelectric thin film on Pt layer and its stacking structure on Si semiconductor

A New Method for the Formation of Liposome

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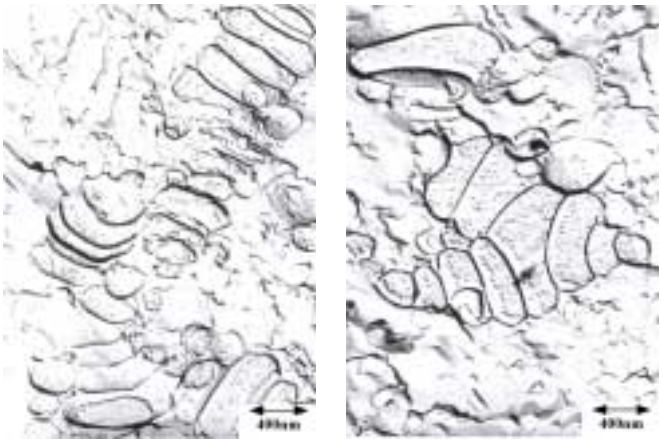
AIST Today Vol. 1, No. 6 (2001) 17

A new method for the preparation of liposomes in one step using supercritical carbon dioxide without any toxic organic solvents had developed. This method allowed to obtain aqueous dispersions of liposomes through emulsion formation by introduction of a given amount of water into a homogeneous mixture of supercritical carbon dioxide/L-a-dipalmitoylphosphatidylcholine/ethanol and subsequent pressure reduction. TEM observations using the freeze-replica method on the obtained vesicles revealed most of them are large unilamellar liposomes (LUV) with diameters 0.1-1.2μm. Trapping efficiency of the liposomes indicated more than five times higher trapping efficiency for the water-soluble solute than that of multilamellar vesicles (MLV) prepared by the Bangham method.



Typical freeze replica SEM images of liposomes.

Surface Modification using Plasma Based Ion Implantation

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AIST Today Vol. 1, No. 6 (2001) 21

A superimpose technique of RF power and high voltage pulses has been developed for Plasma Based Ion Implantation (PBII). The RF power generates plasma and ions in the plasma are implanted into specimens to modify the surface property. The features of this technique are high power efficiency, uniform distribution of ions over the specimens surface and simplicity of the apparatus. In this stage, nitridation of Ti and Cr and hard carbon coatings were performed using this technique.

Nitridation of a Ti-golf club head by the plasma ion implantation. The color after implantation is golden due to TiN formation

Successful Dismantling of Mega-Float by Mechanized Underwater Cutting

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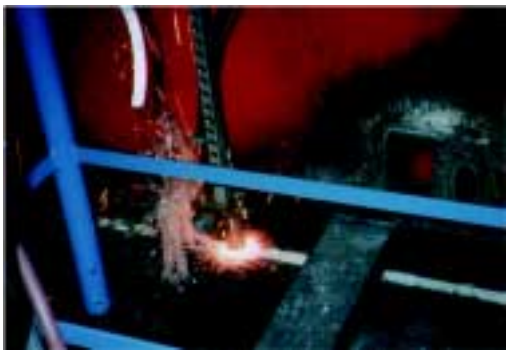
AIST Today Vol. 1, No. 5 (2001) 14

At the final stage of the Mega-float project, the main body was dismantled into twelve small units. Each separated units restarted their new lives such as floating parking area, offshore recreation park and emergency storage against earthquake.

Mechanized underwater flame cutting system had adopted for dismantling operation of the Mega-float, because of its high quality and high efficiency. An edge cut by underwater flame cutting technique can be achieved for new welding joint without any additional surface treatment. This mechanized system cut over 1000m without any troubles. One machine cut about 60 meters a day. This length is about four times superior compared by manual oxy-arc cutting.



Seawater flushes into the float during cutting operation.

All-in-Focus Camera System

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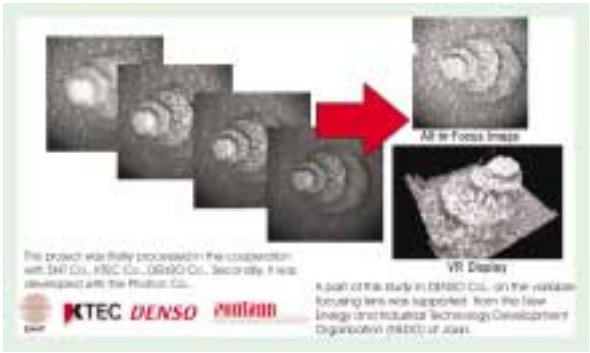
AIST Today Vol. 1, No. 6 (2001) 15

In this paper, a high-speed digital processed microscopic observational system for tele-micro-operation is proposed with a dynamic focusing system and a high-speed digital-processing system using the "depth from focus" criteria.

In micro-operation, it is not easy to obtain good visibility of objects with a microscope focused in small depth, especially when using it for microsurgery and DNA studies, among other procedures. In this sense, the "all-in-focus image," which keeps an in-focus texture all over the object, is useful to observe microenvironments with the microscope. Furthermore, this system realized to obtain the depth map, which is also important information to operate, and show the 3D microenvironments at any view angle in real-time to operate the micro-objects.



Standards and Measurement Technology

Novel Ultra-High Temperature Standards above 2000°C

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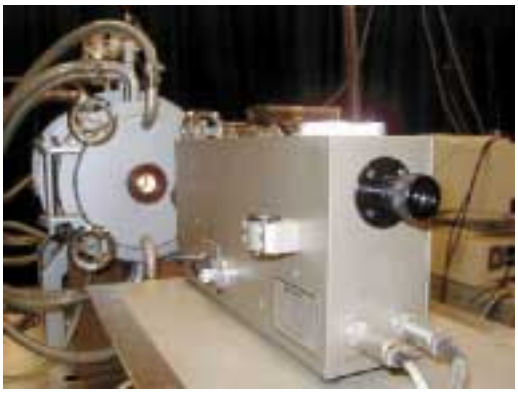
AIST Today Vol. 1, No. 1 (2001) 5-8

Temperature fixed points are widely used in defining, realizing, maintaining, and disseminating temperature scale. To extend the fixed-point temperature range above the current practical limit of copper point (1085 °C), a novel series of high-temperature fixed points have been developed at the AIST, which use metal-graphite eutectic instead of pure metal as fixed-point material. Performance evaluations for 9 fixed points in the temperature range 1100 °C to 2500 °C show the fixed points can potentially improve the ultra-high temperature scale by one order of magnitude or more. The potential impact of this technique to related fields is presented.



Eutectic point observation by radiation thermometer

Development of Josephson Junctions for Liquid-Helium Free Voltage Standard System

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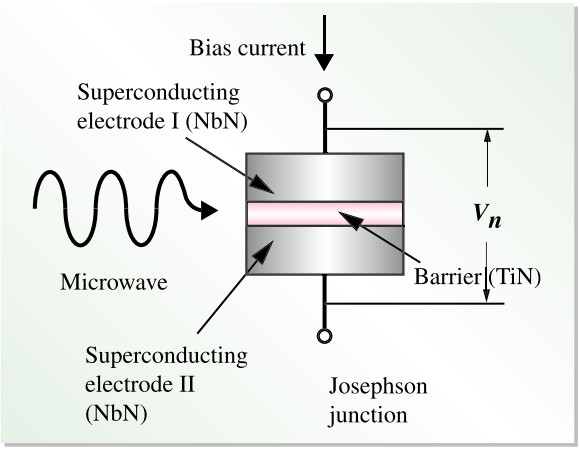
AIST Today Jpn. Vol. 1, No. 3 (2001) 5-7

With the progress of industrial technologies, need for portable Josephson voltage standard system is increasing. However, widespread use of Josephson voltage standard system is prevented by the necessity of liquid helium in the operation of the system. To overcome the problem, we have been developing niobium nitride(NbN)-based Josephson junctions for voltage standard system. NbN is known as a superconductor having a critical temperature over 15K and its high-quality thin films can be prepared by reactive sputtering without using substrate heating. We recently succeeded to develop NbN-based Josephson junctios (NbN/TiN/NbN junction) which can be operated at 10K. Using this junction, we will construct a liquid-helium-free Josephson voltage standard system within a few years.



NbN-based Josephon junction for voltage standard

A GaAs/AlAs Superlattice Certified Reference Material (NIMC CRM 5201-a)

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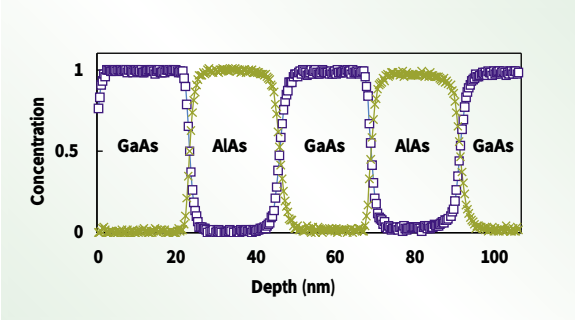
AIST Today Vol. 1, No. 3
(2001) 25-27

A certified reference material of GaAs/AlAs superlattice has been developed for surface chemical analysis. Thin films as well as multi-layered films are artifical materials fabricated that achive or modify some specific physical properties and can be applied to various advanced materials such as semiconductor devices, magnetic multilayers, otical mirros, X-ray mirrors, etc. Depth profiling by ion sputtering in surface chemical analysis is one of the most popular techniques to reveal layered materials. Excellent depth resolution on the nm level requires the use of a high quality reference material such as a superlattice which is suitable for the optimization of sputter depth profiling. The certified reference material consists of 4 layers whose thicknesses (~ 23nm) are certified with an accuracy of about 0.3nm and, in addition, whose interface roughness and surface oxide thickness are given as reference data.



Sputter depth profiling by Auger electron spectroscopy

Development of Particle Size Standards Through Absolute Mass Measurement of Aerosol Particles

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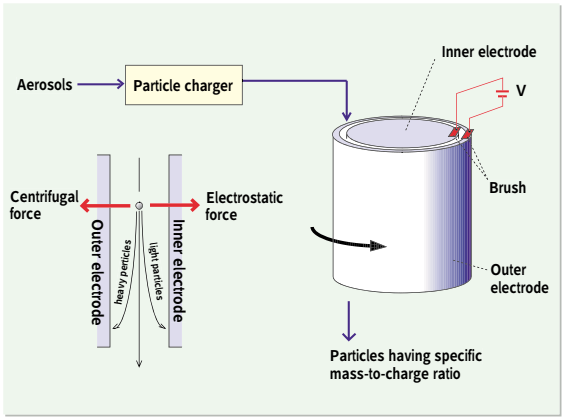
AIST Today Vol. 1, No. 5
(2001) 11

The methods for measuring the mass of fine particles suspended in the air are being studied in National Metrology Institute of Japan. In these methods, either the balance between the centrifugal and electrostatic forces or between the gravitational and electrostatic forces exerted on particles is used to classify particles according to their mass to charge ratio. These methods have been applied to the analysis of particulate matter emitted from motor vehicles in Atlanta, GA, and to the development of particle size standards.



Principle of the aerosol particle mass analyzer

Realization of Absolute Optical-Frequency Measurement

Measurements of absolute optical-frequencies of various stabilized-lasers have been realized by using a femtosecond mode-locked laser and a phonic-crystal optical fiber (produced at the University of Bath, U.K.). The uncertainty of the measurements is 10^{-11} at present, and can be potentially improved to be better than 10^{-13}. In future, this technology will be applied to the optical frequency syntheses in various fields.

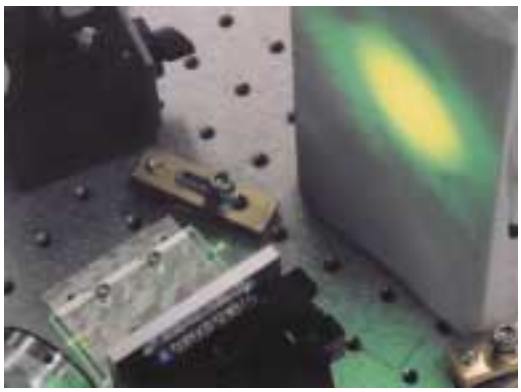


Figure shows the broad spectrum generated in a photonic crystal optical fibers using a mode-locked femtosecond pulse laser

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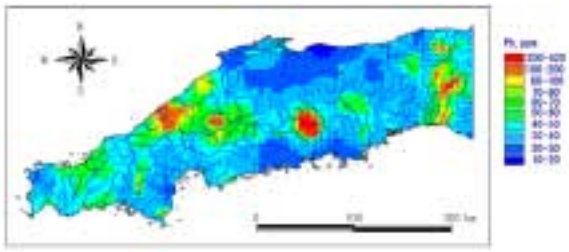
AIST Today Vol. 1, No. 6 (2001) 13

Geological Survey and Geoscience

Geochemical Map for Evaluating the Environmental Pollution

Geochemical map shows an elemental distribution in the surface of earth's crust, which gives us, for example, the concentration of toxic chemicals such as arsenic, mercury and cadmium around us and enables to evaluate what kind of influence affects our life from them.



Distribution map of Pb in Chugoku District

In 1988, a global geochemical map project covering entire world was planed by International Union of Geological Science (IUGS) and call for more than the world 70 countries to join the project. In European countries, the maps covering whole country have already been completed in England, West Germany, Finland and Poland.

The geochemical map of 53 elements in Japan covering whole country including toxic elements such as As, Be, Cd, Hg, Mo and Sb is now progressing in the National Institute of Advanced Industrial Science and Technology (AIST), and the compilation is scheduled to complete in 2003.

The geochemical map of Pb in Chugoku district is shown in Figure. The concentration of Pb is high in the several places where mineral deposits are located. The concentration of K_2O is high in east and middle of Chugoku District, where acidic rocks (granite and rhyolite) are distributed. And the elements of MgO, P_2O_5, and V are high in concentration in the west of Chugoku District, where basic rocks (andesite and basalt) are distributed. The relations between the elemental distributions, the background geology, the mineral deposits and human activities are now investigated.

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Geoslicer Survey of Liquifaction due to Earthquakes

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AIST Today Vol. 1, No. 2
(2001) 4-8

Liquefaction is a phenomenon in which loosely and water saturated sediments such as sand layer become liquefied by strong ground motion due to earthquake. Liquefaction gives rise to the loss of the earth's capacity to support and differential land subsidence or landslide occurs, which causes the damage to basic infrastructure and buildings. Active Fault Research Center makes effort not only to reveal the mechanism of liquefaction by collecting the liquefied sediments and observing them in detail, but to utilize the common feature in them as index of the past great earthquakes. We introduce our study in the area along the Columbia river in Washington State of USA which was carried out as cooperative work with USGS in fall of 2000, and reconnaissance study of liquefaction associated with the 2000.10.6 Tottoriken-seibu earthquake.

Sand blows on Oshamanbe, Hokkaido, after the 1993 Earthquake off the Southwest Coast of Hokkaido. The maximum diameter of the sand blows is about 2m

Seismogenic Zone of Great Subduction Earthquake

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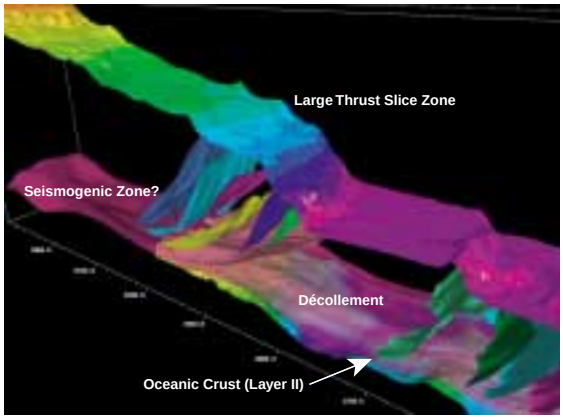
AIST Today Vol. 1, No. 5
(2001) 12

A three-dimensional seismic survey was carried out at the western Nankai trough accretionary wedge in 1999. This experiment was a Japan-U.S. collaborative investigation on seismogenic zones. The cruise imaged an 8×80 km area with 81, 80-km-long, high quality, seismic reflection lines, all of which have nearly continuous coverage. The main objective of our experiment was to image the plate boundary fault at which major earthquakes and tsunamis are generated. A preliminary interpretation was conducted based on a primary data processing and we proposed a well imaged structure of up-dip limit of seismogenic zone, where a décollement plane touches the oceanic plate (layer II) down in first. We identified that the boundary between the stable sliding zone (ocean-ward) and the unstable stick slip zone (landward) is located there.

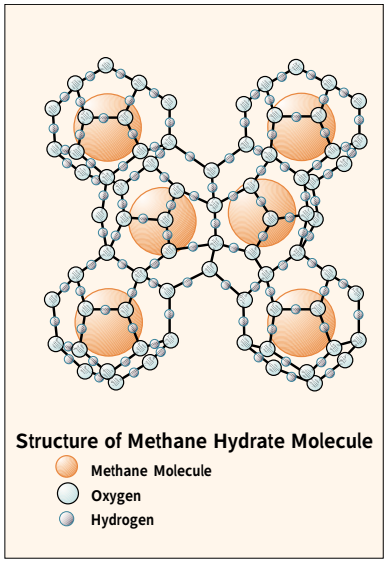


A perspective view of 3-D interpretation at the proposed inter-plate seismogenic zone (up-dip limit) in the Nankai subduction margin

Methane Hydrate

— Enormous Natural Gas Resources to Lead the Next Generation —

Natural methane hydrates are a kind of clathrates. These are solid compounds in which lattices of crystallized water molecules trap methane gas molecules. They are naturally stable in high pressure and low temparature conditions, so that seismic reflection survey profiles obtained by the Geological Survey of Japan, AIST. The total resource potential around Japan could amount to 6 trillion cubic meters as methane gases, more than 100 times the present domestic consumption of natural gases in Japan. AIST investigates such offshore methane hydrates for future development as natural gas resources.



Structure of Methane Hydrate Molecule

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AIST Today Vol. 1, No. 6 (2001) 19

Digital Geological Map: Distribution and Occurrence of Cenozoic Volcanic Rocks

Progressively improved Geological Information System extends the potential use of digital geological maps in Japan. The use of digital geological maps, however, still remains limited to those geologists familiar with the GIS. The digital geological map "Distribution and occurrence of Cenozoic volcanic rocks in Japan" is newly prepared to improve this situation. This publication comprises two CD-ROMs labeled as G-4 A and G-4B. G-4A contains conventional map files for use in the GIS. G-4B contains map-image files directly combined with explanatory files. These files work on any Web browsers, just like an illustrated guidebook and enable those people unfamiliar with both the GIS and volcanology to learn something about the Cenozoic volcanic rocks in Japan.

Cover page of G-4B on a Web browser

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AIST Today Vol. 1, No. 6 (2001) 23

Ministry of Education, Culture, Sports, Science and Technology Prize

The Ministry of Education, Culture, Sports, Science and Technology Prize is to be granted to those who have contributed to the promotion of science and technology, producing distinguished achievements and results especially in cultivation of the domestically developed technology. For the year 2001, five researchers of AIST were awarded the prize.

Takashi Iwasaki

Technology Information Department
Research Policy Survey Office

Development of novel functional materials by controlling the properties of Smectite interlyer

Hideyo Okushi

Research Center for Advanced Carbon Materials Advanced Diamond Teamy

Measurements and Analyses on Deep levels due to defects and impurities in Semiconductors

Toshio Shinbo

Institute for Materials & Chemical Process Biomimetic Materials Group

Development of isomer-separating materials by use of organic host compounds

Kenji Tatsumi

Institute for Environmental Management Technology Advanced Remediation Group

Development and practical application of an advanced coagulant that enables metal recycle

Kenichi Fujii

Metrology Institute of Japan Material Properties and Metrological Statistics Division Fluid Properties Section

Research on the development of a solid density standard and the determination of the Avogadro constant

The Special Prize at the 30th Industrial Design Awards / the Judge Committee's Special Prize

Dr. Imai respresented AIST at an award seremony.

Trustee, Dr. Hidetaka Imai

The award winning research of combined cycle engine "Research and Development of Combined Cycle Engine for Supersonic Aircrafts" was honoured with the 30th Industrial Design Awards and the Judge Committee's Special Prize, both of which are sponsored by Japan Daily Industrial Newspaper Company (Nikkan Kogyo Shimbun). The same engine is won the Von Karman Award, which is comparable to the Nobel Prize in the aerospace research field.

This research is an international collaborative project "Research and Development Project of Supersonic Transport Propulsion System (HYPR)" (funded by AIST 1989-1999), jointly carried out by both national research institutes and foreign manufacturers.

The 2001 Engelberger Robotics Award

~Technology Development~

Dr. Kazuo Tanie

Director, Intelligent Systems Institute

Dr. Kazuo Tanie, director of the Intelligent Systems Institute was presented the 2001 Engelberger Robotics Award by the International Federation of Robotics (IFR) at the special ceremony during the 32nd International Symposium on Robotics (ISR2001). Named after Dr. Joseph F. Engelberger, the award is the world's most prestigious honor in the robotics field.

Dr. Tanie specializes in sensory control for industrial robotics and is internationally known for his distinguished achievements in the development of tactile sensor, power sensor and the application of such sensors in robot controllers. He has produced outstanding achievements as a leading researcher of the robotic applications in externally powered prosthetic hand and sensory substitution. He has recently embarked on the research into the application of virtual reality in remote control systems.

Admitted to Fellow of the American Ceramic Society

Dr. Shuzo Kanzaki

Director, Synergy Materials Research Center

The American Ceramic Society conferred the title of Fellow of the Society on Dr. Shuzo Kanzaki, Director of Synergy Materials Research Center at the American Society's 103rd Annual Meeting and Exposition (April 22nd - 25th 2001, Indianapolis, USA). The title is given to an individual who has greatly contributed to growth in academic and scientific researches in ceramic materials and is one of the world's most prestigious honor in the international ceramics community.

Introduction of AIST Logo and Symbol

Message from the designer

AIST Logo

Designed by

Ms. Mayumi Hayashi

AIST is an abbreviation of the National Institute of Advanced Industrial Science and Technology. The Logo symbolises the AIST as a hub of research network promoting various research projects of strategic importance.

AIST Symbol

Designed by

Mr. Yukio Kawamura

The ellipse in the center represents Earth and the bright future of united mankind whilst the arch embracing the ellipse shows the AIST's resoluteness towards down-to-earth researches beneficial to society with surging academic passion. The outline of the entire mark models the letter "A", both the initial letter of AIST and the alphabets, that represents with the AIST's commitment to become a pioneer of new academic ground.

AIST Today - International Edtion - 2001 - No. 2

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