National Institute of Advanced Industrial Science and Technology ISSN 1346-602X

AIST Today

2002 Summer No.5

International Edition

Feature

Annual Plan of the National Institute of Advanced Industrial Science and Technology for FY2002

National Institute of Advanced Industrial Science and Technology

On Target for Success AIST 2002

President
Hiroyuki YOSHIKAWA

Our goal: The establishment of "Full Research" structure

A year has passed since the new AIST was inaugurated. As chairman in charge of the administration of AIST, I have promoted the following three pillars as our mission.

1. Promotion of advanced research projects through innovative attempts adopting a broader perspective, which leads to enforcement of Japanese industrial competitiveness in the world market and creation of new industries.
2. Pursuit of research projects which support long-term government policies based on both immediate and future requirements from the public administration.
3. Promotion of Fundamental Research for Science and Technology under AIST's responsibilities to meet national expectations to attain a high level of technological background which requires an integrated approach.

In order to fulfil these goals, I expect each research unit to possess:

1. International competitiveness to meet the global standards.
2. Initiative to pursue constant evolution of research themes based on the scenario leading to the ideal future society.
3. Dynamic organization which allows flexible and prompt action within the cooperative framework with outside research institutions both at home and abroad.

"Full Research" which I have emphasized refers to the research projects implemented by the research units with such qualities.

By creating coherent research phases from the basic studies to application based on a certain subject, "Full Research" enables seeking of the original basic knowledge and practical application of the outcomes, producing unique and unprecedented offspring in technologies and products development. Moreover full research framework opens up a whole range of new research possibilities. The scene of such research activities is also unique and unparalleled as they cannot be put into practice in any other settings.
The social situation does demand AIST to promote the full research projects.

As seen in the Secondary Basic Program for Science and Technology, the national expectation toward the development of science and technology which contributes Japan's industrial growth surges with a view of empowerment of the economic recovery and sustainable global development.

Practical Application of Science and Technology

It is not an easy task to develop the results of basic research projects into innovative industrial technologies. Such difficulty is not only associated with the recent R&D projects but inherent to the development of any applied technologies. Twenty years ago, I advocated the importance of fostering endeavors to discover the basic knowledge in immature fields for the creation of a new technology terrain,

which had been related merely as a dream.

CAD of the US MIT group, Engelberger's industrial robots and System 24 (FMS) by Williamson are the historical achievements that withstood hardships to reach the level of practical application.

Proposition of Type II Basic Research

Scientists tend to give primary importance to the investigation and elucidation of unknown phenomena, as it were, the traditional basic research. This attitude probably derives from the philosophy that basic researches, as they require greater ingenuity and inspiration, have superiority to any other research works. However, I also find academic value in the researches which aim at the development of the existing scientific knowledge into the practical application. Although this retrospective approach may run against the trend of conventional basic research activities, we should recognize originality and creativeness in such attempts as comparable or even superior to the quest for the new scientific knowledge. In this context, I would like to name a research of this kind as "Type II Basic Research". Translational research in life science belongs to this category.

In type II basic research, it is important not only to fabricate goods but to objectify the process of such production allowing us to pass down this intellectual property to the next generation.

Type II Basic Research and Industry-Academia-Government Collaboration

In order to pursue the "Type II Basic Research", it is insufficient to direct attention to the technological seeds created through the basic research. We must adopt the attitude of constantly focusing on the application of research findings regarding industrial technology in accordance with the social needs. Careful observation of the two domains of "technological seeds" and "social needs" groups leads us to search for the optimal parameter in the functional relation between the seeds and needs. This is the fundamental method of the Type II research projects that are to reflect industrial needs. The active promotion of industry-academia-government collaboration is a must for us to take an objective view over such needs.

In depth Knowledge and Powerful Leadership

The results of the industrial-academia-government collaborative projects at each AIST research center will be considered to form a major part of the career path of AIST researchers. In addition, I would like to place emphasis upon venture business as a new key component of the career progress of our staff.

New systems are considered to encourage entrepreneurs in AIST to spin off new businesses. Taking advantage of these systems, I expect each of AIST staff will have the strong motivation to launch new businesses and contribute to the national goal of the industrial development by incubating entrepreneurs. Currently, various attempts are in progress to create 1000 venture companies based on the academic researches. AIST also has been active in providing an environment to support venture businesses including the set-up of a venture factory and the venture support merit system, with a view to creation of 100 companies by AIST researchers.

Regarding cases overseas, leading researchers of any project tend to launch venture businesses as part of the process to the practical application of their accomplishments. The younger researchers including students who witness such entrepreneurial process have the privilege of various opportunities to learn about setting up new businesses. Consequently, the experiences are taken over from generation to generation. Following such examples, I would like to encourage our research managers including the directors of AIST research centers to spin off new businesses. Such challenges are to be recognized as "Venture for Matured Researcher" for which AIST are ready to provide various backups.

Lastly, seeking the establishment of a full research structure, we will place our primary goal for AIST marking its second anniversary at following three points: 1. Enhancement of our active involvement in the research projects through industry-academia-government collaboration, 2. Promotion of "Type II Basic Research", 3. Encouragement of entrepreneurship in "Venture for Matured Researchers".

CERC-ERATO 2002 International Workshop on "Phase Control of Correlated Electron Systems."

22 - 25 May, 2002
Waikoloa, Hawaii, US

● Dr. R.B.Laughlin, Nobel laureate

● Dr. T.M.Rice

● Dr. Y. Tokura

As I set out from Japan to attend the workshop in Hawaii, I felt as if I was leaving my heart behind. The excitement and the build-up to the FIFA World Cup was just about reaching "fever pitch" back home. The co-hosts of the conference, however, were also from Japan and were sufficiently far-sighted to conclude the conference before the start of the football festivities, and fortunately no extra time was deemed necessary by any of the fourth officials.

The 2002 CERC-ERATO International Workshop on "Phase Control of Correlated Electron Systems" kicked-off at 08:30 on May 22nd 2002 on the Big Island of Hawaii. The co-hosts of the conference were the Correlated Electron Research Center (CERC) of AIST, and the Tokura Spin Superstructure Project (SSS) of the Exploratory Research for Advanced Technology (ERATO) of the Japan Science and Technology Corporation (JST). The conference covered a broad spectrum of frontier science on correlated electron systems and included a great line-up of maestri backed up by a squad of up-and-coming talent.

Not so much a game of two halves, more a rich scientific program packed into three and half days that soon made me forgot what I was missing back home; it consisted of 21 invited talks by world-famous scientists, including two Nobel laureates (30 + 5 mins each), several oral presentations of contributed papers (10 or 15 + 5 mins each), and a poster session with a four-minute preview talk for each pre-

● Dr. J.G.Bednorz, Nobel laureate

sentation. In the main, the following subjects were discussed:

spin-charge-orbital order and its control in transition metal;
exploratory materials with correlated electrons;
charge order and valence fluctuation in organics;
photonic phenomena in correlated-electron system;
superlattices as the new tailored materials;
junctions and tunneling spectroscopy;
theory of correlated electron physics and technology;
approach toward correlated-electron technology.

The scale of the conference was, nevertheless, kept adequately small with only 45 contributed participants, among which there were 25 participants from CERC and 12 from ERATO-SSS. The compact nature of the conference turned out to be a positive element as people were able to talk freely and to spend quality time with each other. If this conference were to be evaluated from an administration angle by AIST and JST, the confabulatory atmosphere must be regarded as the best investment of the lot, especially since the young researchers and postdocs of CERC and ERATO-SSS, who work every day and night at the front-line of research, had invaluable opportunity at this conference to communicate with the path-breakers of each research field without too much hesitation. This type of communication is just as important today as it was back in the "pre-internet era". Although we are, of course, able to read most scientific papers these days anywhere on the planet on the day they are published, still the grapevine telegraph within the community, arising out of face-to-face interaction, is so important to allow these papers to be read and evaluated appropriately. In addition, the venue, Hilton Waikoloa Village, was absolutely fabulous and the weather provided an ideal playing surface. All in all, it turned out to be a totally cool conference in spite of the intense summer heat on the island and the desirable atmosphere of the resort hotel in Hawaii worked well to encourage discussion and interplay.

Research on correlated electron systems has been maturing rapidly in recent times and explorations towards applications are becoming fully activated as our understanding of the physics and chemistry deepens:

"I am increasingly hopeful that new kinds of memory and photonic control will grow out of this field. It is an extremely exciting field, both scientifically and technologically." (R. B. Laughlin, Nobel laureate),

"A (still) emerging field from which exciting physics and new application concepts can be expected to arise." (J. G. Bednorz, Nobel laureate)

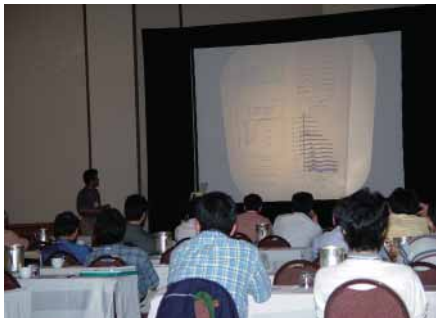
At the conference, praise as well as expectations were heaped on CERC and its activities:

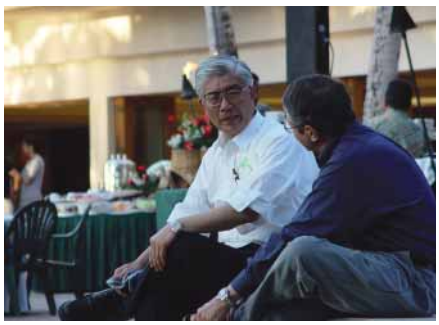
"I am extremely impressed by CERC and have made great efforts to encourage experimental collaboration between it and my university. Certain parts of CERC are the best in the world, and all of it is excellent." (Laughlin)

"High level work and group leaders with high international reputation, are important to enable continued creative approaches on the level of individual projects." (Bednorz)

"CERC is a wide-ranging program aimed at advancing the field of strongly correlated electrons over a wide front. It is

● Poster Session





achieving impressive results." (T M Rice)

A unique feature of this conference was the poster presentation from two members of the administrative department of AIST to introduce AIST activities to all the participants. Although I thought it was a difficult task to explain the concept of AIST in such a brief window of opportunity, subsequent comments proved favourable and complimentary:

"The AIST program will enhance and strengthen the leading role that Japanese science has in the field of condensed matter physics and strongly correlated electrons in particular." (Rice)

"As a general remark: Investing in research and technology is determining the future of our society. Secondly, a good balance should be sought between industry-sponsored and academic-funded research." (T T M Palstra)

"Every large and established organization must periodically reexamine and refresh itself to remain vital. Since the public scientific research community in Japan has just undergone this difficult process, they should look forward to a particularly productive and rewarding period." (H Y Hwang)

The trend towards more modern modes of presentation was clearly evident. Most of the presenters brought their own laptop PC's and used LCD projectors. Exquisite presentations, making good use of several computer software packages, effectively fascinated the audience with their flair and distribution of ideas. This seems to be appropriate for a conference at the forefront of science. Conference staff however were always mightily relieved whenever a speaker got up to use the OHP projector as each presentation had to be set up within a very short time period. In order to avoid unexpected troubles due to connection to PC's, two of our accustomed LCD projectors were brought all the way from Japan. Although there were a few inevitable "own goals", the conference overall was extremely well run:

"The organization was excellent, all aspects have been created in a most professional way. It will be most desirable to have more of this type of meetings. This has been a very successful meeting. THANK YOU VERY MUCH!"
(an invited speaker)

R.B.Laughlin (Stanford, USA)
Strong Correlation as a Critical Phenomenon.

S.Maekawa (IMR Sendai, Japan)
Nonlinear optical response and spin-charge separation in Mott insulators.

Y.Endoh (IMR Sendai, Japan)
Recent research on high Tc superconductivity - related on the electronic phase separation problem.

K.Yamada (Kyoto, Japan)
Melting of static charge stripes in La2-x(Sr,Ba)x(Cu,Ni)O4.

B.Raveau (ISMRA Caen, France)
Magnetic and transport transitions in manganites: the impact of Mn-sitedoping.

N.Furukawa (Aoyama-Gakuin Tokyo, Japan)
Randomness effects in manganites.

M.Imada (ISSP Kashiwa, Japan)
How do quantum meltings of charge order and spin order take place?

A.Barthelemy (Paris-Sud, France)
Tunnel junctions with manganite electrodes: interface structure and tunneling magnetoresistance.

T.M.Rice (ETH Zurich, Switzerland)
The transition between a small gap semiconductor and ferromagnetic metal in FeSi and FeGe.

E.Hanamura (Chitose, Japan)
Clampimg of the two order parameters, ferroelectric and antiferromagnetic, in hexagonalYMnO3.

D.S.Chemla (UC Berkeley, USA)
Macroscopic quantum coherence in degenerate excitons gases.

M.Kuwata-Gonokami (Tokyo, Japan)
Time-resolved magneto-optical and THz spectroscopy in strongly correlated electron systems

B.Keimer (MPI Sttutgart, Germany)
Spin Dynamics in Orbitally Degenerate Magnetic Insulators

T.T.M.Palstra (Groningen, The Netherland)
Orbital Order Induced Phase Transitions in Transition Metal Perovskites.

J.G.Bednorz (IBM Zurich, Switzerland)
Current induced Insulator - Metal transition in doped Perovskites.

H.Y.Hwang (Lucent, USA)
Electronic structure of perovskite titanate superlattices.

Z.V.Vardeny (Utah, USA)
Optical studies of singlet and triplet excitons in pi-conjugated polymers.

H.Kobayashi (IMS Okazaki, Japan)
Development of new types of molecular conductors - design and characterization of single component molecular metals and magnetic molecular superconductors.

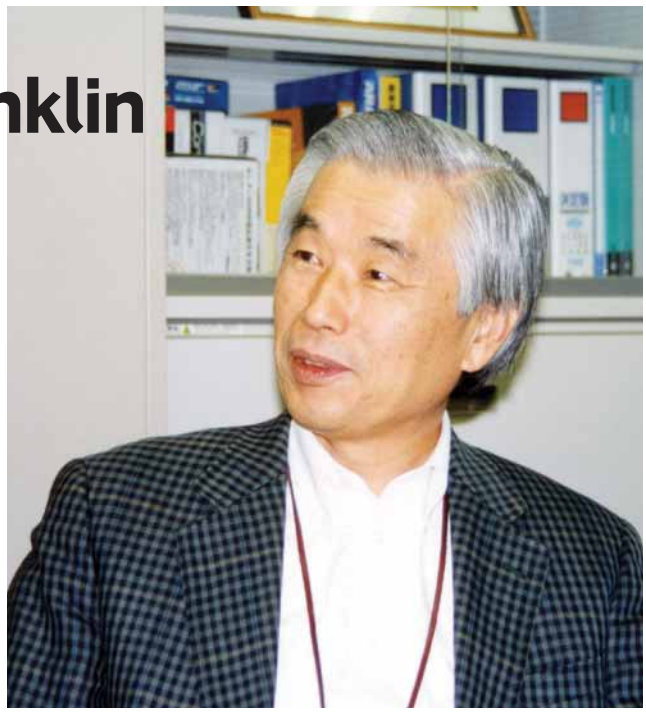
H.Rogalla (Twente, The Netherland)
Making use of the wave symmetry: a new chapter in high-Tc superconductor devices

K.Kanoda (Tokyo, Japan)
Pseudo-gap, quantum critical AF fluctuations, charge order/glass in organics; physics on 2D anisotropic triangular lattice.

B.Batlogg (ETH Zurich, Switzerland)
Charge dynamics in organic molecular crystals.

2002 Benjamin Franklin Medal Laureate

Dr. Sumio Iijima, Director of the Research Center for Advanced Carbon Materials, AIST



Dr. Sumio Iijima, Director of the Research Center for Advanced Carbon Materials of Institute of Advanced Industrial Science and Technology (AIST) received the 2002 Benjamin Franklin Medal in Physics from the Benjamin Franklin Institute(Pennsylvania, USA) on April 25th 2002.

The award is for "the discovery and elucidation of the atomic structure and helical character of multi-wall and single-wall carbon nanotubes, which have had an enormous impact on the rapidly growing condensed matter and materials science field of nanoscale science and electronics."

Major Achievements of Dr. Sumio Iijima

Taking advantage of electron microscopy techniques, Dr. Iijima discovered the carbon nanotube, a new material layer of carbon, in a carbon electrode subjected to arc discharge in 1991. The carbon nanotube has a tubular structure with a diameter in the order of nanometers, and is the fourth form of carbon after diamond (3-dimensional structure), graphite (2-dimensional structure) and carbon 60 (C60: spherical structure). Dr. Iijima proposed models for the mechanism behind nanotube growth and bending, through detailed structural analyses. He also discovered the capillary phenomenon, whereby foreign substances become incorporated into the nanotubes, and synthesized single-wall carbon nanotubes. These achievements created a global research boom in the field of carbon nanotechnology. In addition to such academic researches, the possibility of industrial applications has been explored since the discovery of the carbon nanotube which has a unique structure and physical properties. Research focus is placed on the potential for its usage as a hyper efficient electron source because of its microstructure and carbon composition, and various R&D projects of flat panel displays are in progress by exploiting such specifications. The carbon nanotube is also expected to be applied in such fields as ultra-high-strength materials, fuel cells, ultra-sensitive sensors, high-resolution STM prones, catalytic and absorbent materials, and pharmaceuticals for its crystal completeness and microstructure. Dr. Iijima is currently involved in research at NEC, Meijo University, JST and AIST, as an internationally recognized pioneer of this field. His efforts in the discovery of nanotube have opened up a new scientific field, which covers the basic material science research to practical application and have had a significant impact on both scientific and industrial communities.

Benjamin Franklin Medal

The Benjamin Franklin Medal was established in 1824 funded by Franklin's inheritance. Every year the most eminent scientists and technologists in the following six categories are selected to receive this award: Life Science, Engineering, Geoscience, Chemistry, Physics, Computer and Cognitive Science.

The Benjamin Franklin Institute is a non-profit organization founded in Philadelphia, USA, in commemoration of Benjamin Franklin, famous for his 1824 experiment on electrical discharge in which he flew a kite in a thunderstorm. The institute is actively involved in various projects with a view to the promotion and diffusion of science and technology.

Amongst the winners of Benjamin Franklin Medal in Physics are found Nobel Laureates for Physics such as Horst Stormer, Daniel C. Tsui, William Philips, Carl Wieman, Serge Haroche (Michelson award) and Herbert Walther (Michelson award), that indicates the award's venerable authority at a global level.

Past Japanese laureates include Dr. Akira Tonomura (Benjamin Franklin Medal in Physics in 1999), Dr. Reona Esaki (1961) and Dr. Akito Arima (1990).

Annual Plan of the National Institute of Advanced Industrial Science and Technology for FY2002

Planning Headquarters

1. Introduction

One year has passed since the inauguration of the National Institute of Advanced Industrial Science and Technology (AIST) as an independent administrative institution. Currently our research units are making steady progress in their work, and results are beginning to appear as much as we had anticipated from the outset. In addition, we have expanded our intellectual property program, launched a new venture assistance program, set in motion various AIST-initiated ventures, and begun other projects. We believe these efforts have put us on the path toward the New AIST. This document outlines the AIST annual research plan for FY2002.

2. Main Elements of Our 2002 Research Plan

A. Life Science and Technology (Table 1)

The Basic Biotechnology Research Program for Health Maintenance and Improvement includes bioinformatics research, analytical research on the structures and functions of proteins and genes, and research on glycogenes. The Green Biotechnology Program includes research on environmental biotechnology, and the Development Program of Medical and Welfare Apparatus for Healthy Life Extension comprises regenerative medical engineering as well as research and development of medical and welfare apparatus.

B. Information Technology (Table 2)

As part of the Program for Upgrading the Telecommunications Foundation of the Ministry of Economy, Trade and Industry (METI), AIST is slated in 2002 to participate in the research and development of technologies for network computing, organic semiconductors, nonvolatile magnetic memory devices, and high-frequency devices. Under this program, we will develop: technologies to make integrated use of large, distributed collections of data and sensor information; low-power-consumption semiconductor devices to use in highly convenient portable equipment; and next-generation wireless network devices operating at over 20 GHz.

● Table 1 Main Projects in Life Science and Technology

○ Basic Biotechnology Research Program for Health Maintenance and Improvement	
・Analysis of Dynamism of Intracellular Networks	(1)
・Comprehensive Study of Human Glycogenes	(2)
・Protein Function Analysis Project	(2)
・Genome Diversity Project for Model Diseases (GEM)	(2)
・Structural Genomics and Informatics	(2)
・Protein Expression and Interaction	(2)
・Development of Technological Infrastructure on Bioinformatics	(2)
○ Green Biotechnology Program	
・Development of Transgenic Plants for Production of Industrial Materials	(1)
・Development of Highly Sensitive Analytical Technologies for Environmental Hazardous Compounds Using a Biospecific Reaction	(2)
・Development of Monitoring Methods for Microorganisms in the Environment	(2)
○ Development Program of Medical and Welfare Apparatus for Healthy Life Extension	
・Medical Care Support System Using Cellular and Tissue Engineering	(2)
・Advanced Support System for Endoscopic and Other Minimally Invasive Surgery	(2)
・Graphical Analyzer for Human Chromosomes Using a Confocal Laser Scanning Microscope	(2)
・Development of Advanced Diagnostic and Treatment System for Early Diagnosis and Quick Recovery	(2)

(1) New (2) Continuing

Table 2 Main Projects in Information Technology

○Program for Upgrading the Telecommunications Foundation	
・Network Computing Development	(1)
・Organic Device	(1)
・Memory Device Technology	(1)
・High-Frequency Device Technology	(1)
・Next-Generation Software Development Project	(1)
・Next-Generation Ferroelectric Memory	(2)
・Femtosecond Technology	(2)
○Program of Next-Generation Semiconductor Device Process Technology	
・Development of Next-Generation Semiconductor Materials and Process Technology	(2)
・Advanced Design Technology for SoC (System on a Chip)	(2)
・Ultra-High-Density Electronics System Integration	(2)
○21st Century Robot Challenge Program	
・Human Friendly and Supportive Robot Systems	(2)
・Robot Component Technologies for New Application Fields	(1)

In the area of consumer-support interface technology, we are researching how to infer a user's intentions by using sound and images, nonverbal information such as nods and other responses, and user location. AIST is using software verification technologies and research on Web and mobile equipment security to create systems that are secure, worry-free, and highly reliable. We will also use open-source software methods, which are in the spotlight because of Linux, to develop a high-quality software base with the goal of business use. In the Program of Next-Generation Semiconductor Device Process Technology, launched in 2001, the completion of a super clean room will further the centralization of research and development, making this a year that promises great accomplishments leading to industrial application.

C. Environment and Energy (Table 3)

Our priority research areas will be: for global warming, technologies to reduce global warming agents, technologies to raise the efficiency of and to distribute energy systems, and environmentally friendly production process technologies; for pollution, chemical substance risk management and reduction technologies; and for a stable energy supply, cleaner and more diverse energy sources. Another priority research area that AIST will add is techniques for the integrated assessment of environmental and energy systems, of which life cycle analysis (LCA) is a representative example.

In 2002 AIST will participate in the Ministry of Economy, Trade and Industry's research and development program, which addresses the priority research areas mentioned previously. Development efforts will focus especially on chemicals risk assessment methods, ultra low loss power device technologies, hydrogen energy and fuel cells using various fuels, energy-conserving process technologies, superconducting technologies, and other areas, as well as development in areas including diesel exhaust control technologies, contaminated soil remediation technologies, development and assessment of substitutes of fluorine compounds, and LCA methods. From a medium- and long-term perspective, AIST will also start new research and development work on methane hydrates, biomass, and advanced energy network technologies. In performing this research, there are plans for positive crossover initiatives such as environmental information technology.

Table 3 Main Projects in Environment and Energy

○Program for Innovative Technologies to Mitigate Global Warming	
・Development of Energy-Conserving Innovative Production Process Technologies	
Development of Next-Generation Chemical Process Technology	(2)
Technology for Supercritical Fluid Utilization	(2)
・Development of Technologies for Innovative Energy-Use Systems	
Development of Ultra Low Loss Power Devices Technology	(2)
R&D on Advanced High-Temperature Air Combustion Control Technology	(2)
R&D of Fundamental Technologies for Superconducting AC Power Equipment	(2)
R&D of Fundamental Technologies of Superconducting Generators	(2)
R&D for Superconducting Bearing Technology for Flywheel Electric Energy Storage Technology	(2)
○Energy and Environment Program for Fixing and Effective Use of Carbon Dioxide	
Investigation of CO_2 Fixation and Utilization Technology	(2)
○Integrated Assessment and Management Program for Chemical Substances	
Risk Assessment of Chemicals and Development of Risk Assessment Methods	
○Reduce-Reuse-Recycle (3R) Program	
Development of Low-Cost and Downsizing Technology for Reusing and Isolating CFCs	(2)
○Program for Solid Polymer Fuel Cells and Hydrogen Energy	
Development of Solid Polymer Fuel Cell System Technologies	(2)

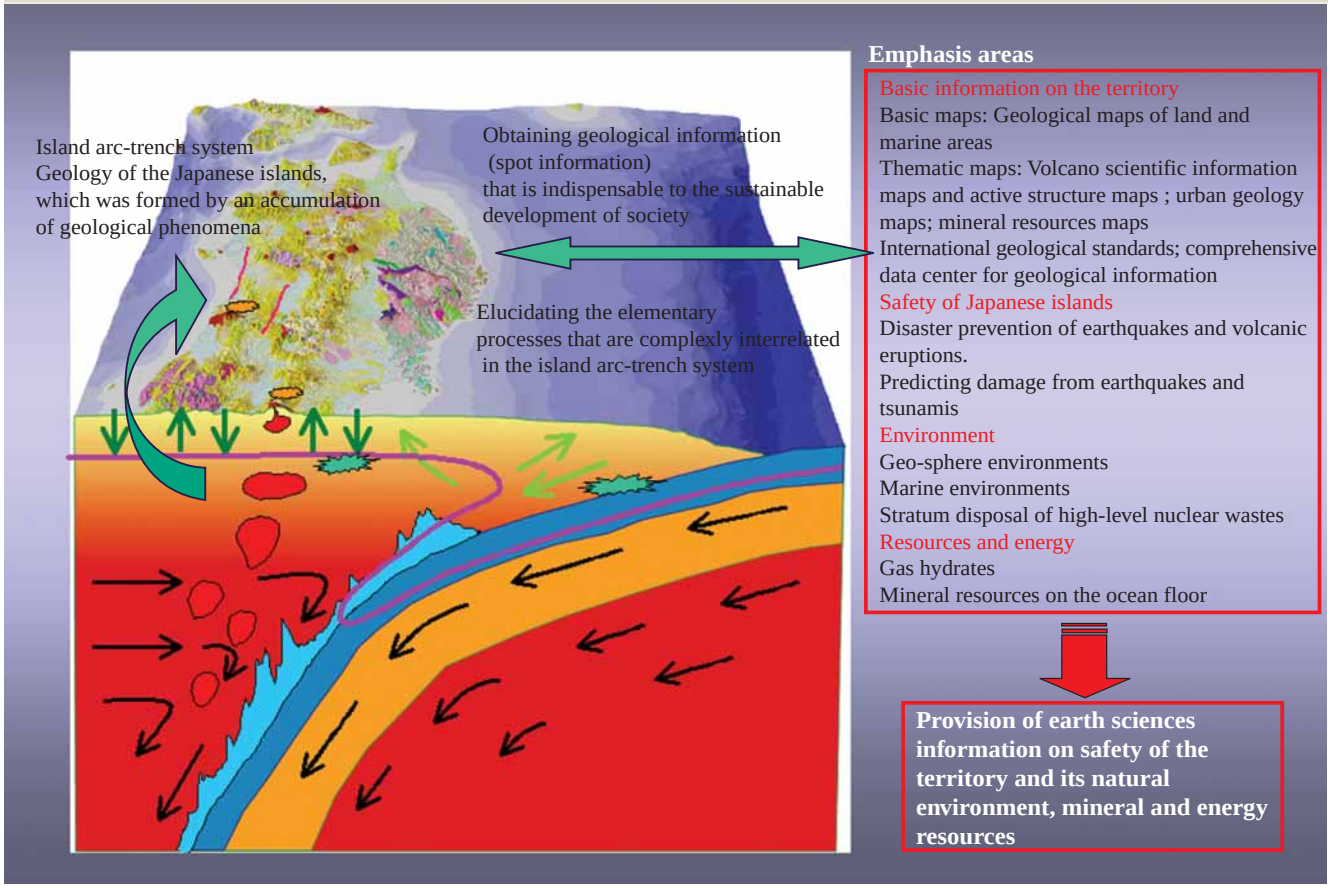
● Table 4 Main Projects in Nanotechnology, Materials, and Manufacturing

○ Nanotechnology Program	
・Nano-Materials and Processing	
Nanotechnology Carbon Project	(1)
Synthetic Nano-Function Materials Project	(2)
Nanostructure Polymer Project	(2)
Nanotechnology Glass Project	(2)
Nanotechnology Material Metrology Project	(2)
・Nano-Manufacturing and Measuring	
Nano Crystal Integration Ceramics Project	(1)
3D Nanoscale Certified Reference Material Project	(1)
○ Innovative Component Industry Program	
・Innovative Material Processing	
Materials Creation and Processing for Precision Components Project	(1)
High-Precision and Energy-Saving Molding Process for Functional Metallic Materials (Metallic Glass) Project	(1)
・Material Production Systems	
・Other (a related project)	
Synergy Ceramics Project	(2)
○ Reduce-Reuse-Recycle (3R) Program	
・3R Key Technologies	
Development of Recycling Technologies for Construction Wastes/Glass, Etc.	(2)

D. Nanotechnology, Materials and Manufacturing (Table 4)

In 2002 the Nanotechnology Program will include the Nanostructure Polymer Project, the Synthetic Nano-Function Materials Project, Nanotechnology Glass Project, and the Nanotechnology Material Metrology Project, and the program will work on developing the technologies for devices and materials operating on new principles, measurement and assessment methods that will underpin the advance of nonatechnology, simulation techniques, and material structures that display innovative physical properties. Other research includes synergy materials for the development of material production system technologies, and the Digital Meister Project, which is concerned with key technologies for manufacturing. We will also work on developing carbon nanotube technologies that hold promise for a wide variety of applications such as hydrogen storage for fuel cells and the materials for ultra-low-voltage wall-mounted displays. Through these and other initiatives, AIST aims to play a leading role in nanotechnology, which is currently in the world spotlight.

● Figure 1 AIST's Potentials in Geological Survey and Geoscience, Marine Science and Technology



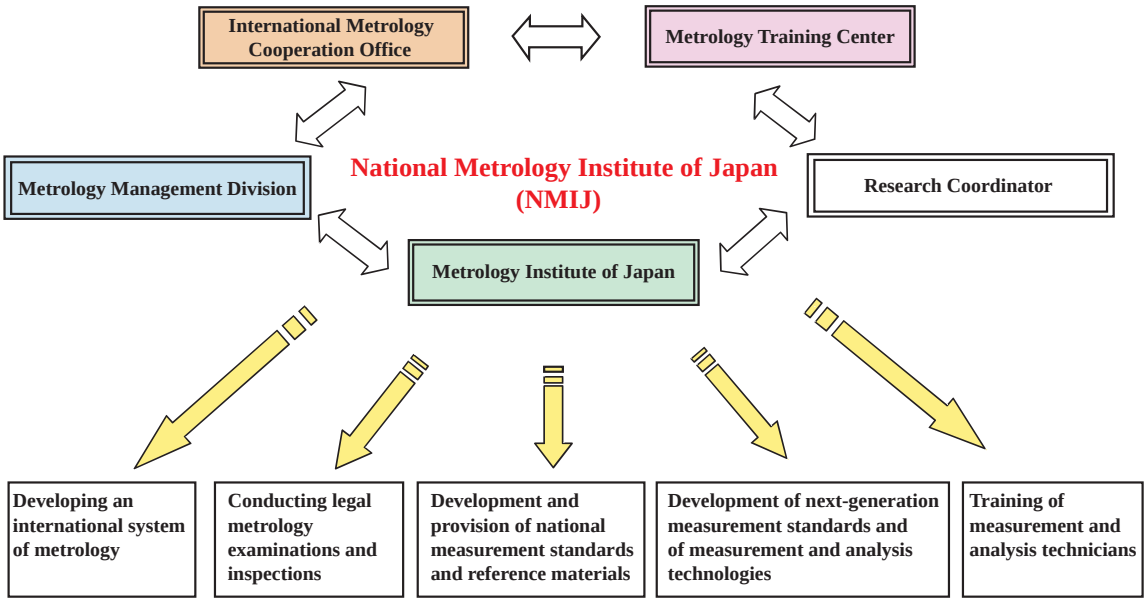
E. Geological Survey and Geoscience, Marine Science and Technology (Figure 1)

AIST will carry the activities over into 2002: (1) the preparation of comprehensive and systematic basic earth sciences-related maps, including 1:50,000-scale geological maps and 1:20,000-scale geological maps of land and marine areas; (2) the preparation of maps related to the earth sciences, including active structure maps and active fault strip maps, maps for predicting damage from earthquakes and tsunamis, geological maps of volcanoes, and volcanic scientific information maps; and (3) the preparation and provision of geological information. AIST will carry out surveys and research on earthquakes and active faults, volcanoes, and deep geological environments, and use the information for purposes such as predicting disasters. In addition, we will conduct exploration for, and the assessment and development of, geothermal energy and coal-seam gas, as well as minerals and methane hydrates in the earth's crust or on the deep sea floor, and other energy and mineral resources on the sea floor or in sea water, and we will develop technologies to extract them. The Coordinating Committee for Geoscience Programmes in East and Southeast Asia (CCOP) is striving toward sharing geological information throughout East and Southeast Asia, and AIST serves as the managing Asian body for the International Consortium of Geological Surveys (ICOGS), the Commission for the Geological Map of the World (CGMW), and other organizations.

F. Standards and Measurement Technology (Figure 2)

In 2002 AIST aims to begin providing a total of at least 30 new standards from among the 158 standards to be provided under our medium-term target. These include at least 10 physical standards and at least 20 reference materials. In this way, AIST will try to begin the early provision of reliable measurement standards based on the government's standards development plan. To build a sustainable and stable system to provide measurement standards, and to assure compliance with international standards, AIST also intends to obtain proof of compliance with ISO/IEC 17025, and in order to build a quality assurance system complying with ISO Guide 34, AIST plans to complete accreditation in over 60 reference materials. In the area of measurement standards and measurement and analysis technologies, AIST will also be using the Nanoscopic Measurement Technological Infrastructure Project to work on research and development for next-generation standards, and, by means of the Remote Calibration System Based on Information Technology Project, will attempt to become a world leader in research for developing a network-based standards provision method. Further, in addition to promoting international mutual approval for measurement standards and legal metrology, we will represent Japan in the international efforts for this purpose. AIST's international cooperation includes managing the Asia-Pacific Metrology Programme (APMP) and the Asia-Pacific Legal Metrology Forum (APLMF), and technical cooperation with Thailand.

● Figure 2 AIST's Potentials in Standards and Measurement Technology



Introduction of Newly established Research Centers and Laboratories

A year has passed since the new AIST was inaugurated.

During this one year, 6 research units have been launched in addition to the original 52 research institutes founded with the start of AIST. AIST today has given a profile of each of the 52 research units in the issues No.1 and 2. Special feature of the current issue is the brief overview of these 6 new research organizations.

Grid Technology Research Center

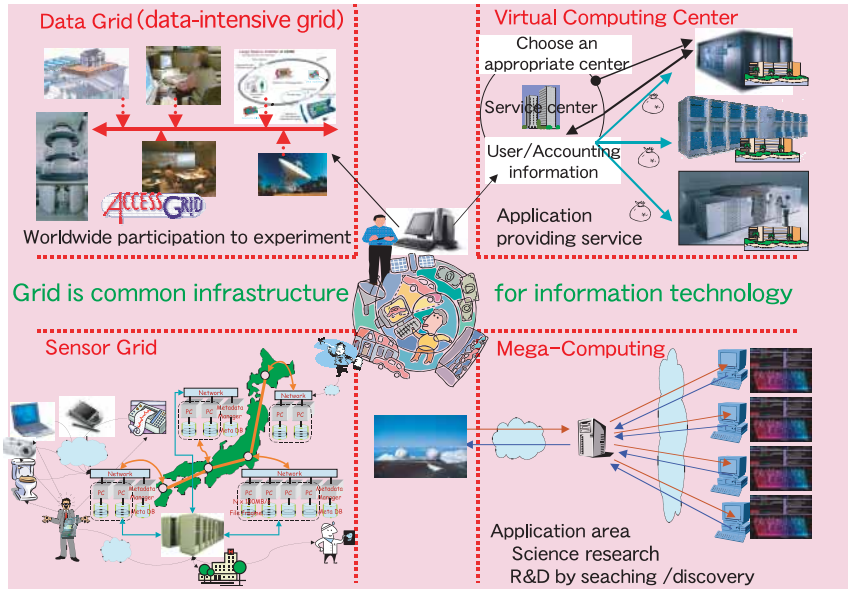
Director Satoshi SEKIGUCHI

"Grid" is an emerging technology to solve a particular problem in dynamic, multi-institutional virtual organizations coordinated by sharing resources such as high-performance computers, observation devices and databases over a high speed network.

Grid technology is infrastructural technology (software, network and hardware) for the integration of PDAs, PCs, high-performance computers, large volume data centers, visualization devices and observing devices. It applies a technique for utilizing them. This technology is a natural extension of the Internet represented by recent web technology and draws attention as a social infrastructural technique for industries and science, which might promote the rapid development of the Internet.

Grid Technology Research Center (GTRC) is a newly established center as a part of the National Institute of Advanced Industrial Science and Technology (AIST). The primary objective of GTRC is providing world class leadership in advanced computing science and technology as well as commercial technology through the development and application of the grid. The GTRC also aims to become the focal point of research and development in the grid communities in Japan and Asia-Pacific region.

We would accelerate the dramatic advancement and systematization of grid technology focusing on the development of the newest grid middleware, building of the testbed and development of a verifying system by utilizing a high-performance computing system and large-scale databases.

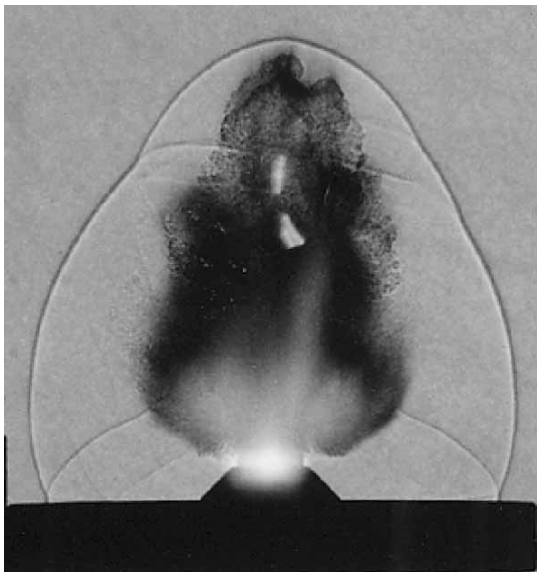


Research Center for Explosion Safety

Director Shuzo FUJIWARA

The Research Center for Explosion Safety, which was established on April 15, 2002, aims to be one of the leading comprehensive research bases in the world for fundamental and applied studies on explosions and general phenomena concerning explosions (spontaneous combustion, runaway reactions, pressure release, high-speed combustion, impact rupture and environmental impacts by explosion). The center will set up a network of domestic and overseas explosive experts to allow them to use the center's safety information, facilities, and equipment. The center also aims to create systems that can promptly and continuously respond to society and international needs concerning the safety of combustion and explosion of chemical substances.

The Research Center for Explosion Safety started with four research teams, namely, 1) The Explosion and Shock Waves Team which investigates the explosion phenomena and shock wave propagation, 2) The Energetic Materials Team which investigates chemistry of energetic materials, 3) The Gas Phase Explosion Team which researches the explosion of gas and dust, and 4) The Application and Environmental Protection Team which studies the effective utilization of explosive substances and assesses their environmental impact. At the center, there are approximately 40 permanent and temporary researchers including researchers working on collaborative projects. Important areas include basic studies to determine the phenomena of explosions and develop methods for preventing explosion disasters, prepare safety technical standards for explosives and gases (dimethyl ether, hydrogen, etc.), and respond to global harmonization by contributing to recycling, safety treatment measures and explosive safety of pyrotechnics.



Photograph Showing the Shock Waves in the Air

A micro-explosion technique was developed as a means of efficiently evaluating the effect of explosions. This technique, which uses less than one gram of explosive in small containers, enables experiments to be performed safely in an ordinary laboratory. This is a Schlieren photograph of an air blast during an explosion of an approximately 1-cm explosive magazine. This technique allows us to monitor and measure the propagation of an air blast and interference of structures in a more simple and easy way with a high degree of accuracy.

Laboratory for Membrane Chemistry

Director Fujio MIZUKAMI

Since the chemical industry is assumed to be a typical energy-consuming industry, technological innovation in the industrial processes has been required to minimize energy consumption and environmental risks. The Laboratory for

Research Base of the Laboratory for Membrane Chemistry (AIST Tohoku)

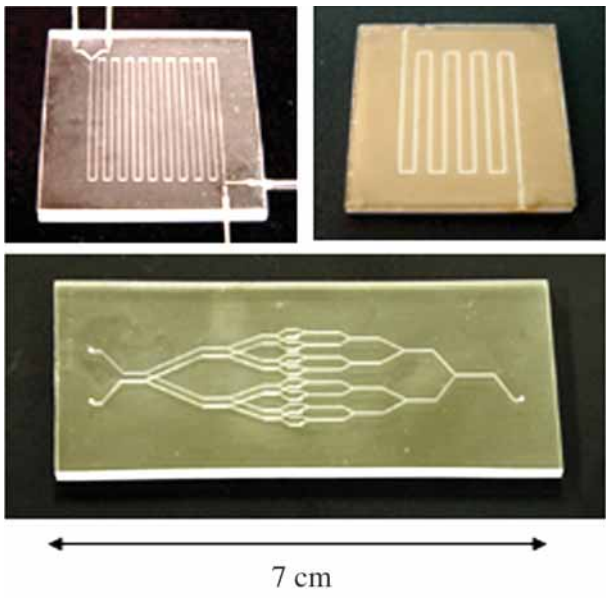
Membrane Chemistry aims to propose new chemical processes, which would meet the above criteria by membrane and related materials and process technologies. One of the targets is to establish a simple and efficient chemical process by using catalytic membrane reactors, which can integrate catalytic reactions and separation processes. Preparation of nano-particle catalytic materials, structurally controlled porous materials, inorganic-organic hybrids and their precise structural analysis form important research bases for designing membrane materials with desired properties. The separation process of gases and vapors is studied by inorganic membranes based on selective permeation due to the difference of molecular size and chemical affinity. Recognition and sensing of hazardous molecules and ions are also attempted for on-site monitoring of pollutants in the environment and industry by a simple procedure.

Micro-Space Chemistry Laboratory

Director Hajime SHIMIZU

In recent years, the conditions in the "chemical industries" are severe. A big promotion; for higher efficiency and quality is being made in production such as a shift to a large-item-small-scale production as the diversification of consumer needs, strengthening of competitiveness in the world market and contribution to the realization of a sustainable society by resource and energy conservation, and lessening the environmental impact. Here, micro-space chemistry technology, which utilizes minute space to control the fluid at high speed and accuracy has been recognized as a novel and special reaction field. It is also an innovative technology which enables the increase of efficiency and acceleration of the reaction, analysis and measurement. In addition to chemical industries, the medical, pharmaceutical, biotechnology and food industries have high expectations of micro-space chemistry technology. The Micro-Space Chemistry Laboratory is researching on technology for various useful analyses and chemical reactions using microreactors which have fine fluid channels whose widths are from several to several hundreds of micrometers like a human hair.

This laboratory aims to establish micro-space technology and apply it to innovative practices with the following three themes, i) micro-fluid analysis chip technology, ii) nano-material processing technology, and iii) biological organic chemistry system technology. The goal is to contribute to the chemical, medical, pharmaceutical, biotechnological and food industries by developing the collaboration with business, universities and government with the opening of AIST facilities to the public such as the clean room for fine chemical experiments in Kyushu.

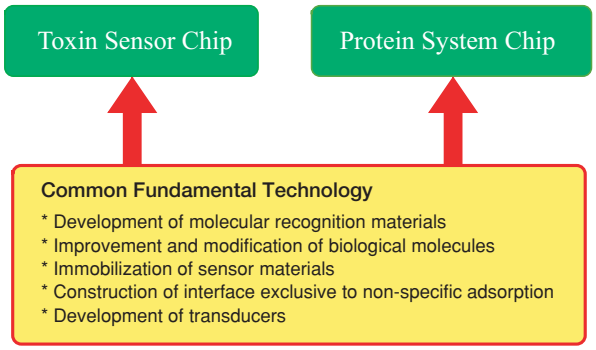


A Variety of Microreactors

Laboratory of Advanced Bioelectronics

Director Isao KARUBE

A highly sensitive system measuring ultra trace chemical and biological compounds is strongly required for medical welfare, environment, food industry and security. However, the present system needs a complicated pretreatment process, expensive instruments and a long measurement time. Ultra sensitive measuring systems especially for toxic chemical compounds are required, e.g. organic chloride, polyaromatic hydrocarbon, biological toxin produced by pathogenic microorganisms. High-throughput system chips for analyzing DNA and protein, which are essential tools in the post-genomic and proteomics era, are also desired.



Laboratory of Advanced Bioelectronics Research Areas

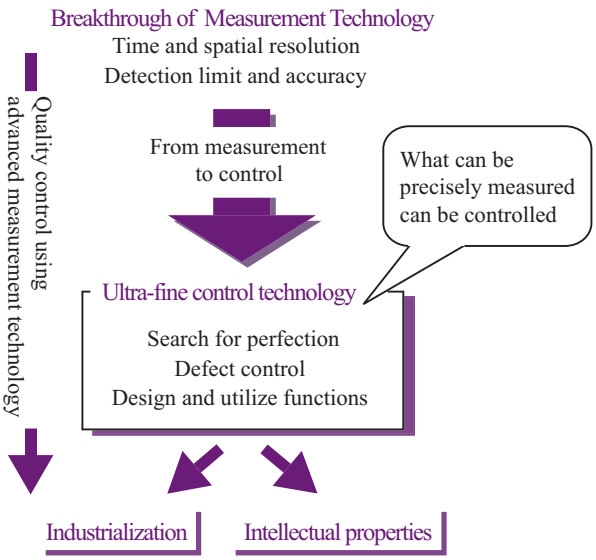
The Laboratory of Advanced Bioelectronics aims at developing a bio-system chip for rapid simple detection and functional analysis of biological components, which include ultra trace toxic compounds, DNA and protein.

Ultra-Fine Profiling Technology Laboratory

Director Shingo ICHIMURA

A big trend has been emerging for adding novel functions to materials by controlling “ultrafine” structures at the atomic and molecular levels to create new industries. Based on a fundamental concept described as “only what can be measured can be controlled”, Ultra-Fine Profiling Technology Laboratory (hereafter Uptech lab) aims to develop and utilize the measurement technology for the world of ultrafine structures as well as the controlling technology derived from ultrafine measurement.

The requirements for “observing smaller things” and “detecting tiny amounts of materials” are common in various fields including life science, information and communication technology and environmental and energy technology. Therefore, if we continue developing the basic technology elements for common purposes in many fields by simply adding an appropriate interface for applications to technology elements in a specific field, we will always be able to provide measurement technology that matches the demands from the most advanced industries. The strategy of R&D in the Uptech lab is to focus our research work on two important topics: 1) technology for measuring materials in an ultra-tiny space, 2) technology to measure ultra-tiny amounts of materials. We are focusing on the spatial and temporal change of the measuring objects to investigate the distribution of these factors related to the objects, namely, the profiles. We also carry out our research with a view for the practical application as well as dissemination of the newly developed technology.



The Strategy of R&D at the Uptech Lab

Special Feature Article for Time Day (June 10)

Is your clock accurate?

— Universal Coordinated Time and Primary Frequency Standards —

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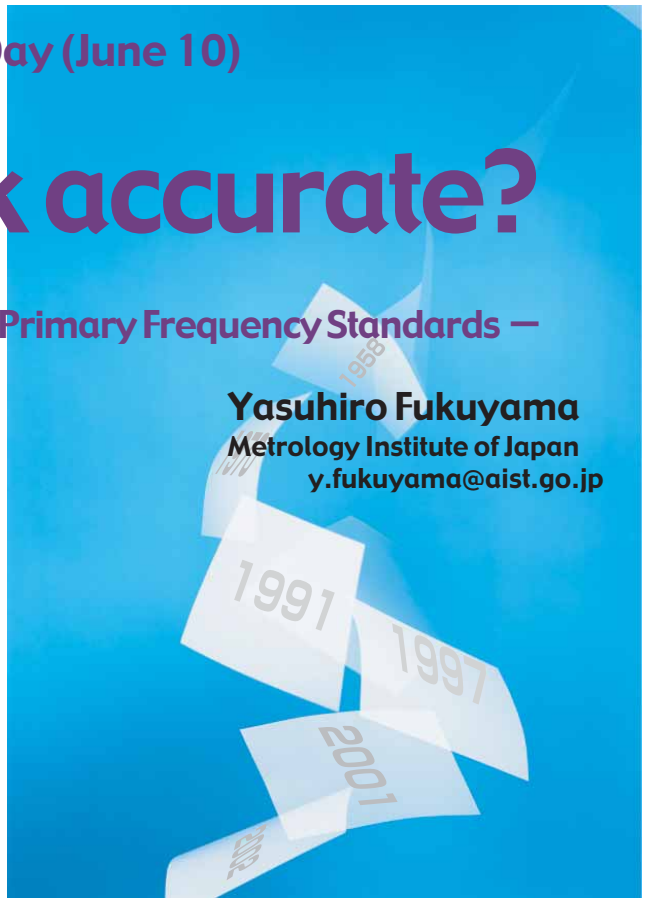

Accurate clock

"Is your clock accurate?"

This may not be as strange as it sounds. If we ask whether the time shown on your clock is accurate, then perhaps you could answer straight away. However, this question is actually asking whether the clock, once adjusted, ticks accurately for ever. To answer this question, you should have an understanding of at least two characteristics of the clock to prove this kind of "accuracy". Basically, you must be sure that the frequency of the oscillations -"ticking movement"- is constant and the frequency is faithful to a certain standard.

June 10 is designated as "Time Day" in Japan. Taking this opportunity, now we are taking a look at both ancient and contemporary efforts to "create an accurate clock" in Japan.

Time Day and Water Clock - Attempt to create an accurate clock in ancient Japan

According to *Chronicles of Japan*, on April 25th (June 10th under the current solar calendar) of 671A.D. a water clock called "Rokoku" was used for the first time in Japan to announce the time at the palace. "Time Day" was created based on this episode.

The water clock used at the palace regulated time at certain frequencies which were determined by water flow-in at a constant rate. And the intervals were calibrated to a standard, i.e. scale marks interlocking with the solar movement. In other words, the said two key factors to make an accurate clock were already pursued in Japan over 1300 years ago.

Establishment of Universal Coordination Time (UTC) - Contemporary approach to an accurate clock

Regarding the endeavors of the modern age. Currently, the time scale employed as an international standard is UTC, Universal Coordination Time. It is rather perplexing but this time scale has no function to indicate the current time nor to send out an electric signal. All we can define is the difference between the UTC at a past moment and the clock in hand. Even so, UTC possesses its own raison d' etre because it is the most "accurate time scale" in the world.

In fact, the complicated procedures to define UTC are intended to meet the two requirements of an "accurate clock" as previously mentioned.

Firstly, the frequency of oscillations must be maintained constant. This is achieved by taking the average of measurements at reference atomic clocks all over the world. More specifically, the differences between UTC and measurements submitted by any timing center in the world by satellite are calculated at BIPM (the Bureau International des Poids et Mesures) for analysis. Based on this analysis, BIPM computes EAL (free atomic time), which is the most dependable time scale to keep the second constant.

Secondly, there is a "standard". Time shifting, once based on length of a day is now defined using quantum resonance of a cesium atom as a yardstick. In order to comply with this standard, it is necessary to use a special atomic clock called "primary frequency standards". This reference clock is designed and developed at timing

standard centers with the utmost care to determine a second precisely. The result of frequency corrections to EAL based on calibration by primary frequency standards is TAI (International Atomic Time) which achieves consistence of the definition of a second.

TAI is adjusted by adding leap seconds to produce the universal time scale, UTC.

Cesium Atomic Fountain Primary Frequency Standard

AIST, as a national metrology institute, is contributing to the establishment of UTC in the following two ways. Firstly, we maintain and control multiple atomic clocks at all times to provide BIPM with data to define EAL. Moreover, we develop our own primary frequency standards with a view to the establishment of TAI.

Unfortunately, there are few institutions to provide constantly their clock measurements from primary frequency standards for TAI. Therefore the current UTC lacks an important factor to maintain accurate time scale.

AIST is presently pursuing a research project to build atomic fountain frequency standards, next generation frequency standards. Measurement data which serves as a reference for TAI establishment will be acquired shortly. It is expected that with this atomic clock, there is a potential for a tenfold increase over the accuracy of the conventional method, to reach order-of-magnitude improvements equivalent to accuracy of 10^{-15}. Accuracy has been a long held challenge in our history of clockmaking since June 10th 1331. In 2002, we will mark a next step toward the lure of hyper-accurate time.

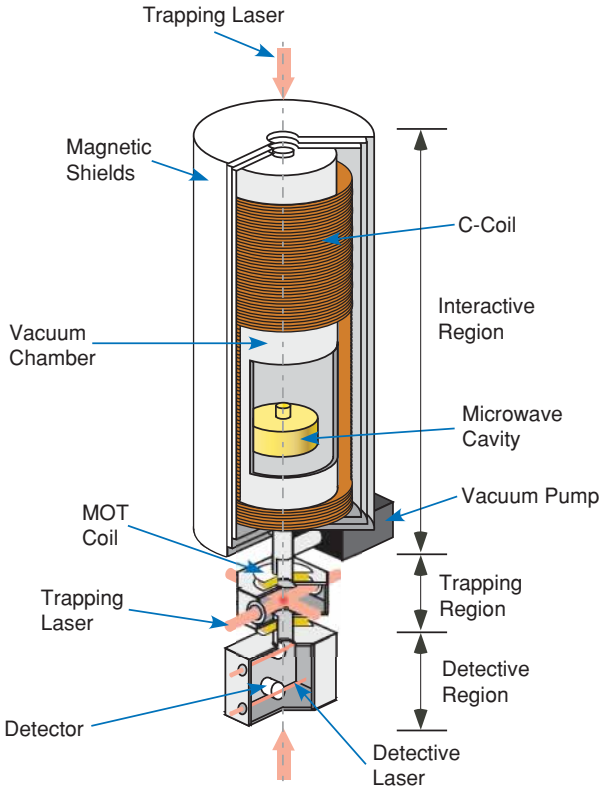

Fig. Cesium Atomic Fountain Primary Frequency Standard

Tanabata (The Star Festival)

Tanabata is the Weaver Star Festival, which occurs on July 7. The Chinese legend, which has it that Altair(the Cowherd Star) and Vega(the Weaver Star) were split apart by the two banks of the River of Heaven(the Milky Way) and come together once a year on this night, has aligned with Japanese belief. Originally a festival carried out among the Court nobility, it has since the Edo Period(1603-1867) become established among the people at large.

On the night of the 6th, people write their wishes or poems on strips of poetry paper in various color. And hung them on leafy bamboo; then on the night of the 7th, they are put out in the garden. These are attractive enough to be called summer Christmas trees.

Photo : K.Nakajima

Abstracts

(April - June 2002)

The abstracts of the recent research information appeared on the Vol.2 No.4-No.6 of "AIST Today" are introduced and classified by research area. For inquiry about the full article, please contact the author directly.

Life Science & Technology

Regulation of Neuronal Activities by Muscles

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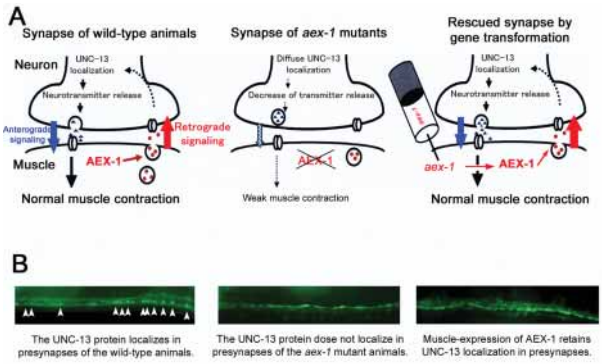
AIST Today Vol. 2, No. 4 (2002) 19

Retrograde signaling from postsynaptic cells to presynaptic neurons is important for regulation of neuronal activities such as efficacy of synaptic transmission. We have identified the novel protein AEX-1 that controls retrograde signaling at neuromuscular junctions in the Nematode *C. elegans*. *aex-1* mutants show neural defects including reduced presynaptic activity and abnormal localization of the synaptic vesicle fusion protein UNC-13. We found that AEX-1 protein has similarities with UNC-13 and only muscle-specific AEX-1 expression rescues neural defects. This suggests that AEX-1 acts for a peptide release form muscles. Our finding sheds a light on understanding the molecular mechanism of retrograde signaling in vertebrates including human beings.



Regulation of retrograde signaling by AEX-1. (A) Schematic model of the AEX-1 dependent signaling mechanism at synapses. (B) Localization patterns of the UNC-13 protein at corresponding synapses of (A)

Non-invasive Measurements of Olfactory Perception and Cognition in Human

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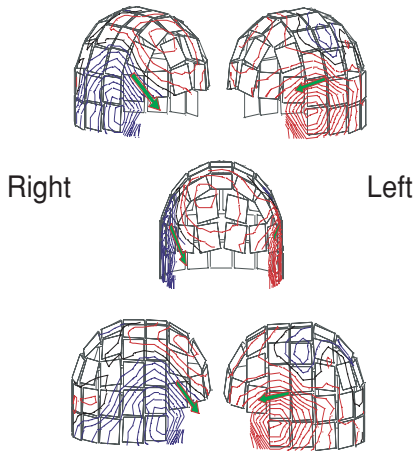
AIST Today Vol. 2, No. 4
(2002) 20

Perception and cognition of our senses are in general interpreted as a dispersive processing in human brain. However, an information processing of olfaction is unknown until now. Recently we have measured human olfaction non-invasively using magnetoencephalography(MEG). From these MEG experiments we found the olfactory nervous centers estimated in orbito-frontal cortex using odorant stimulation synchronized with respirations. Another olfactory experiment of MEG odd-ball paradigm was tested by using two odorants (a pleasant odor and an unpleasant one). This response of P300m revealed an olfactory cognitive component different from perception. These results suggest a new television transmitting odors in future.



Two equivalent current dipoles estimated as olfactory centers with MEG mapping on the brain

Elucidating the Bacterial Metabolism

- Cellular Activities Visualized at the Atomic Scale -

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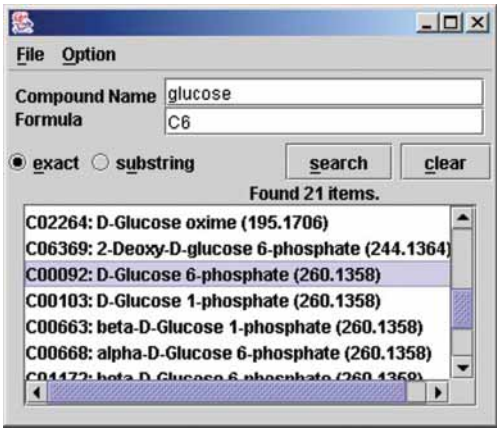
(2002) 21

For an understanding of complex cellular activities, insight into the synthesis and degradation of organic compounds within a cell, its metabolism, is of primary importance. I have devoted my efforts to the digitization of the cellular metabolism by building databases for compound structures, enzymatic reactions, and metabolic pathways. In these databases, biological activities are described at the atomic scale. Using graph algorithms, tracer experiments can be performed on a computer. At present, metabolic data for E.coli and B.subtilis are available.
http://www.metabolome.jp



Snapshot of COMPOUND Browser

Tissue Engineered Bone

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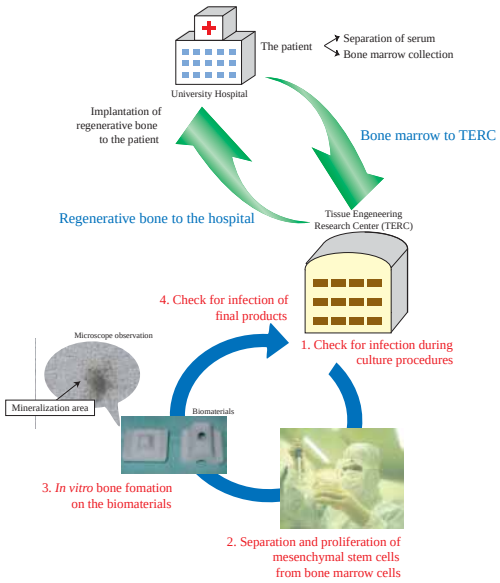
AIST Today Vol. 2, No. 4
(2002) 22

We have succeeded in fabricating "bones" by cultivating bone marrow collected from patients and transplanting the "bone" back to the patients as artificial joints. This is the first such feat in the world. When joints are badly damaged, one of the treatments would be total joint replacement. However, there have been reports of cases in which artificial joints became loose around implanted bone tissues, and had to be removed. In order to solve such problems, we have come up with an original idea of coating joint prostheses with osteogenic cells or their precursors from the patient. Bone marrow was collected from patients at Nara Medical University and Tissue Engineering Research Center (TERC; Ikeda City) isolated the mesenchymal stem cells (MSCs) and increased their number in culture. After the culture expansion, the cultured stem cells have differentiated into osteoblasts together with bone matrix formation on the surface of the prostheses under osteogenic culture conditions. Then, the cultured bone was transplanted back to the patients. The development could lead to possible applications in treating various bone and joint diseases, including rheumatoid arthritis and bone tumors, as well as for tissue regeneration medicine to treat various diseases of organs. Hopes are pinned on the new technology to develop into new treatments that will not require organ transplants.



Regenerative cultured bone on prosthesis

GUPPY: A Sequence Information Viewer Program

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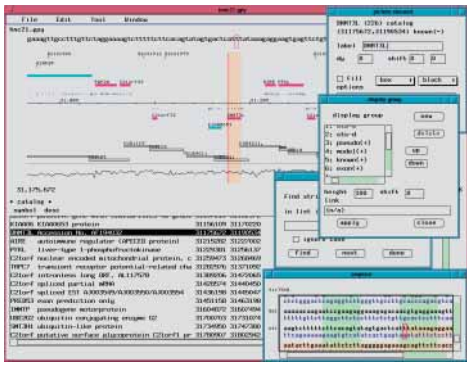
AIST Today Vol. 2, No. 5
(2002) 14

GUPPY (Genetic Understanding Perspective Preview System) is a viewer program for genetic sequence annotations with graphical layout. It is a highly interactive program which allows smooth zooming of focused sequence regions from a whole genomic view. The program also equips scripting facilities to maximize flexible adaptation to various kind of databases and analysys programs in molecular biology. The program is available for academic use from our homepage (http://staff.aist.go.jp/yutaka.ueno/guppy/).



A screen shot of GUPPY program with the sequence map of human chromosome 21. The annotation data were obtained from DDBJ/CIB Human Genomics Studio (http://studio.nig.ac.jp/)

Preparation Method of an Enzyme-Immobilized Membrane

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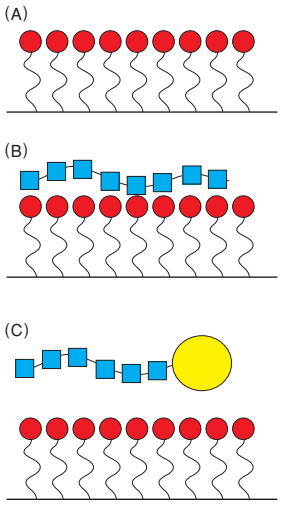
AIST Today Vol. 2, No. 5 (2002) 13

We have found a quite easy preparation method for immobilizing enzymes for several years ago, method by using polyion complex membrane. For improving thickness of the polyion complex membrane, a new immobilizing method was found; polyglutamate-enzyme complex was prepared and the complex was immobilized on a cysteamine-modified gold electrode by means of the electrostatic attraction. Comparing the oxidation current responses to glucose with the two electrodes which used the complex or unmodified enzyme, it was found that the complex was fully immobilized on the modified gold surface. The immobilization method could be used for the biochip such as biosensors with high-integration.



Schematic illustrations of method for immobilizing polyglutamate-enzyme complex. (A) Cysteamine modified gold electrode is prepared easily. (B) Polyglutamate could be attached on the modified electrode, since the electrostatic attraction was occurred between amino groups (red circles) at cysteamine and carboxyl groups (blue rectangles) at glutamate. (C) Polyglutamate-enzyme complex could also be immobilized on the modified gold

PDB-REPRDB: A Database of Representative Protein Chains from the Protein Data Bank (PDB)

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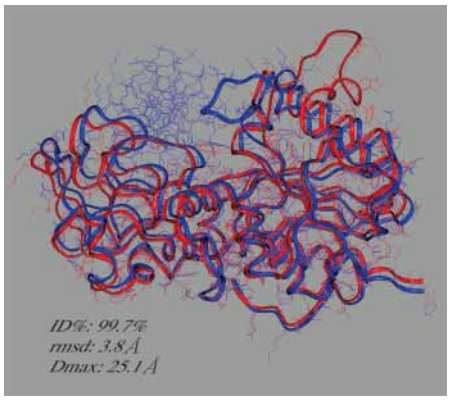
AIST Today Vol. 2, No.6 (2002) 15

The criteria used to select the representative protein chains are: a) quality of atomic coordinate data, b) sequence uniqueness, and c) conformation uniqueness. The system of PDB-REPRDB is designed so that the user may obtain a quick selection of the representatives according to the priorities specified oneself.

The structural library for protein secondary structure prediction and the data for our PAPIA (Parallel Protein Information Analysis) system were chosen from PDB using the system. And this will be useful for detecting local structure diversity between homologous proteins.

The system is available at the PAPIA WWW server (http://www.cbrc.jp/papia/).



An example of a protein structure change by DNA binding. The superimposed a monomer (1HMY) and a complex of HhaI DNA Methyltransferase (6MHTA) and DNA are shown as a red and blue ribbon, respectively

Imaging Detection of Cognitive Memory

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AIST Today Vol. 2, No. 6 (2002) 16

The time-limited role of medial temporal lobe (MTL) in human long-term memory was revealed by fMRI. In this study, 9 subjects were scanned while asked to recall the places they visited more than 7 years ago (remote memories); and the places they visited recently (recent memories). We observed robust and dominant left parahippocampal activation when recent memories were contrasted with remote memories.

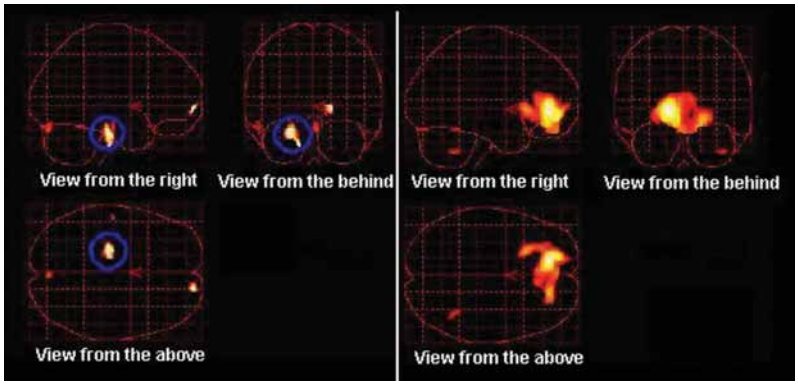

Figure Statistical parametric map (SPM) of regions showing a significant greater BOLD response. Results are presented as a maximum intensity projection or "Glass brain" in the contrast of Recent minus Remote memories (in left picture) and Remote minus Recent memories (in right picture)

Information and Communication Technology

Escape from Collision using Whole Arm Tactile Sensor

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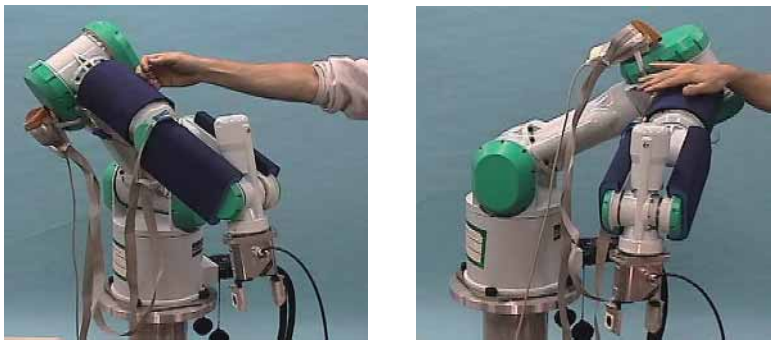
AIST Today Vol. 2, No. 5 (2002) 15

Whole arm tictile sensing is very important for a robot which makes unexpected collision with its environment or human. We have developed a prototype of a whole arm tactile sensor system. It is attached to a forearm of a robot arm and has 72 sensing points. A new control method realizes task motion and escape motion simultaneously.



While the hands are positioned at same position, the robot arms escape from collision with human hand

Laboring Humanoid Robot

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AIST Today Vol. 2, No. 6 (2002) 17

Humanoid Robotics Group of Intelligent Systems Institute has developed a humanoid robot HRP-2P and a software platform for humanoid robots in the cooperation with Kawada Industries Inc., Yaskawa Electric Corp. Shimiz Corp. and the University of Tokyo. The research and development are supported by Humanoid Robotics Project (HRP for short) of METI. HRP-2P has 150cm height, 58kg weight and 30 degrees of the freedom including two waist joints. The distinguished feature of HRP-2P is its light weight and the removal of a backpack which the conventional humanoid robots have. The software platform, called OpenHRP, is a collection of software for humanoid robots including a dynamics simulator and controllers. HRP-2P and OpenHRP are expected to be a research platform for humanoid robotics.

Humanoid robot HRP-2P

Environmental Science & Technology

Synthesis of Floating Spherical Titanium Dioxide Catalyst for Water Purification

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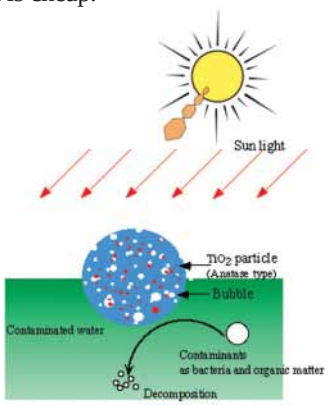
AIST Today Vol. 2, No. 5 (2002) 9

We have developed porous glass spherical catalyst containing Anatase type titanium oxide. These catalysts a float on a water and decompose contaminants such as anmonia in a water under UV and/or sunshine radiation. Usually, a water treatment is carried out by suspension of powder catalysts in a contaminated water. Many procedures are necessary for purification of contaminated water by powder catalysts. For example, pumping of water, mixing water and catalyst, exposure the mixture of water and catalyst for air, irradiation of UV to the mixture of water and catalyst, and etc. These procedures are not suitable for the purification of large amount of contaminated water such as pond, lake, and river. However, the floating porous glass catalysts containing titanium oxide, which we had develoved, are very usefull for water treatment of large amount of contaminated water. Furthermore the floating catalysts need not any maintenance and the production cost is cheap.



Picture of porous glass catalysts floating on the water

Mechanism of Multibubble Sonoluminescence

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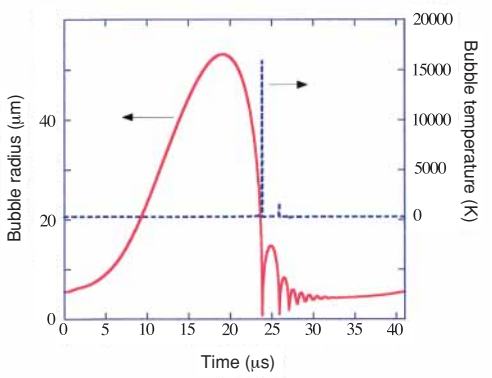
AIST Today Vol. 2, No. 5 (2002) 10

When a liquid is irradiated by strong ultrasound, many tiny gas bubbles appear. The bubbles repeat expansion and collapse according to the pressure oscillation of ultrasound. When ultrasound is strong enough, the light is emitted from collapsing bubbles, which is called multibubble sonoluminescence(MBSL). We have performed computer simulation of the bubble collapse under conditions of MBSL. We showed that the bubble temperature at the collapse is highest when the pressure amplitude of ultrasound is moderately low because at higher acoustic amplitudes the bubble content is mostly vapor. The light emission of MBSL is a combination of chemiluminescence and plasma emissions.



The bubble radius and the temperature inside the bubble as functions of time for one acoustic cycle

Development of a Multi-Functional Ceramic Catalyst for Reduction of Nosocomial Infectious Agents and Water Purification

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AIST Today Vol. 2, No. 6 (2002) 14

We have developed a composite ceramic catalyst bactericidally effective against organisms such as E. coli and MRSA (methicillin-resistant Staphylococcus aureus). The ceramic catalyst is a composite of an apatite coating and a titanium dioxide photocatalyst base which is capable of killing bacteria and adsorbing and decomposing organic materials. The surface treatment of the titanium dioxide and the adsorption of bacteria by the apatite makes even the weak light of a household fluorescent lamp sufficient to kill E. coli or MRSA.

In water treatment, the ceramic is effective at concentrations on the order of 5-30ppm and also acts to decompose bleach and other toxic organic materials. Safety and non-toxicity allow use in bathing areas or pools, in hospitals to prevent nosocomial infection, or for sterilizing or cleaning instruments and clothing. Chlorine-based chemical agents are generally used to purify bath water, which is problematic in terms of human safety and

Composite ceramic catalyst

environmental effects such as trihalomethane generation. In addition to greatly reducing the amount of such chlorine-based agents used and killing E. coli, use of the newly developed ceramic catalyst also dissolves organic material in bath water and breaks down bathtub scum. Other advantages include full bactericidal effectiveness at hot springs (alkaline water), absence of unpleasant odor, human safety, and low biofilm formation in pipes.

Separation of Metal and Polymer in Composite Material for Recycling

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AIST Today Vol. 2, No. 6 (2002) 13

Numerous composite products such as hoses, tires and cables, in which are used in a polymer matrix for reinforcement, are widely used in different aspects of technology and daily life. However, so far there has not been any method for recycling these products, being buried in landfills. In the AIST Chubu-Center a new process has been developed in which the metal surface is heated by induction heating, separating it from the polymer matrix. By introducing this method, metals of any complicated shape can be separated from the matrix with little consumption energy and at a high speed, regardless of the material being processed.

Separation of components in a car-window-seal composite by induction heating

Energy Science & Technology

Micro-Tubular Fuel Cell

A New Model of Fuel Cell for Mobile Applications

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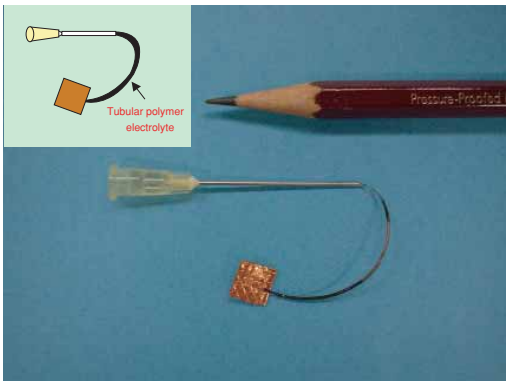
AIST Today Vol. 2, No. 6 (2002) 11

A new model of fuel cell comprising micro-tubular polymer electrolyte membrane and catalyst layers attached inside and outside of this tube is proposed. This enables a compact fuel cell, of high active surface to volume ratio design with leakage-proof fuel supply as well as flexible system configuration. The anode catalyst is Pt-Ru alloy loaded on carbon fibers, and the cathode catalyst is Pt chemically deposited on the surface of micro-tubular perfluorinated ionomer membrane. Using methanol with sulfuric acid in the anode compartment and air in the cathode compartment, the micro-tubular cell attained 0.9 mW cm^{-2} power, operating at ambient temperature and pressure.



Experimental model of a micro-tubular fuel cell

Nucleation Mechanism of Microcrystalline Si from Amorphous Phase

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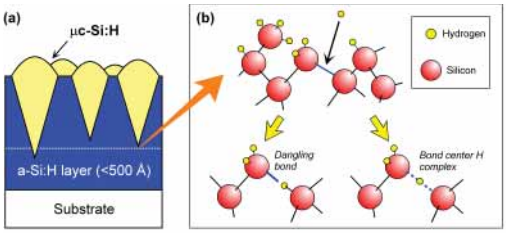
AIST Today Vol. 2, No. 4 (2002) 15

We have characterized surface structures of hydrogenated amorphous silicon (a-Si:H) by applying infrared spectroscopy, in order to investigate the phase transition from a-Si:H to microcrystalline silicon (μc-Si:H). At the onset of μc-Si:H nucleation from the a-Si:H phase, an infrared absorption peak at 1937±5 cm^{-1} assigned to the SiH_n (n=1~2) complex is detected. The SiH_n complex concentration within the a-Si:H surface region showed a clear relationship with the μc-Si:H nucleation. We confirmed that the SiH_n complex, formed by insertion of H into a strained Si-Si bond, contributes to the reactions that result in μc-Si:H nucleus formation.



(a) Cross-sectional structure of μc-Si:H thin film and (b) precursor formation reaction for μc-Si:H nucleation

New Theory for Photoinduced Phase Transitions in Nanostructures

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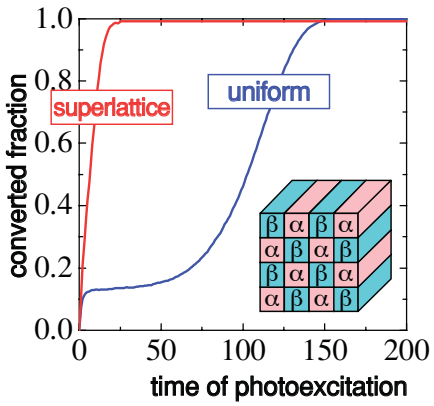
AIST Today Vol. 2, No. 5 (2002) 11

By means of Monte Carlo simulations on a kinetic model, we demonstrate that the efficiency of a photoinduced phase change can in general be enhanced drastically by using a superstructure of an appropriate combination of two components. This is due to the accelerated nucleation of converted domains in the structural blocks relatively close to local instability. The present mechanism provides a general guideline on the design of photocontrollable materials with potential applications for memory and storage devices.



Acceleration of photoinduced phase transition in a superlattice

Study the Origin of High Performance of Thermoelectric Property in Skutterudite

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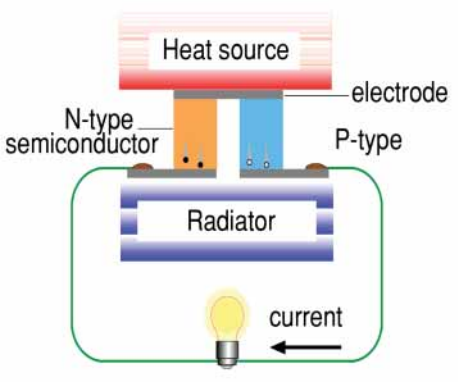
AIST Today Vol. 2, No. 4 (2002) 16

We studied on skutterudite to clarify the origin of the high performance of thermoelectric property. Ce L_3-edge XANES measurements suggested that f electrons hybridize strongly with conduction electrons. Large density of states around Fermi energy can be expected, which may work positive to the thermoelectric property. Electron diffraction measurements elucidated that crystal structure of PrRu4P12 transfers from body center cubic to simple cubic at T ~ 60 K. Nesting of the Fermi surface can be responsible for the transition. Relationship between the anomalous electronic states and the thermoelectric properties should be studied in the future. We also performed crystal growth of skutterudites under a pressure of 3.5 GPa using a wedge-type cubic-anvil high-pressure apparatus. We found that CoP_3 which melts incongruently at ambient pressure transforms to a congruent melting compound under high pressure.



Principle of thermoelectric power generation

Enzymatic Synthesis of L-Lactic Acid from Carbon Dioxide

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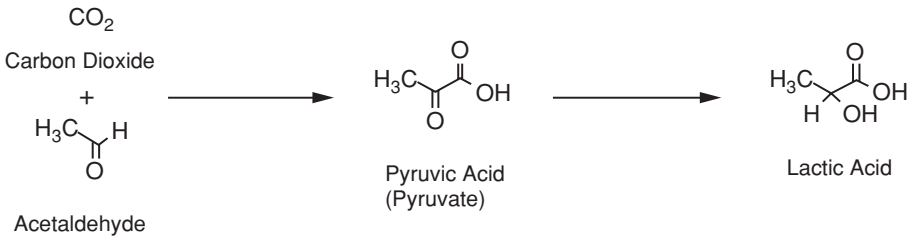
AIST Today Vol. 2, No. 5 (2002) 12

We have developed a novel enzymatic process to synthesize L-lactic acid for use in the biodegradable plastics. The process consists from two step enzymatic reaction: reverse reaction of pyruvate decarboxylase and asymmetric hydrogenation of pyruvic acid by L-lactic dehydrogenase. First, we have turned the decarboxylation of pyruvate on its head. The reaction proceeded at higher pH in bicarbonate buffer. Then we tried two step reactions to produce L-lactic acid. We could obtain L-lactic acid in satisfactory yield with higher optical purity. This method can be useful for utilization carbon dioxide as a chemical source.



Synthetic Process of L-Lactic Acid from Carbon Dioxide

Low-Drive-Voltage Printable Organic Field Effect Transistor

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AIST Today Vol. 2, No. 6
(2002) 8

Photonics Research Institute (PRI) has been engaged in the development of organic semiconductor devices, such as an organic thin film transistor (TFT), which is expected to be a post-silicon technology. Recently PRI has developed a field effect transistor (FET) using a conducting polymer, which is prepared by a simple stacking process that requires no micromachining or related photolithography procedures. The organic FET has a very short channel length (ca. 0.5 μm), and demonstrated excellent performance at a low driving voltage (under 1 V). This new transistor is expected to act as a breakthrough for the development of plastic electronics.

Organic thin film transistors prepared on a plastic substrate

A Novel Low-k Material for an Interlayer Insulator Film

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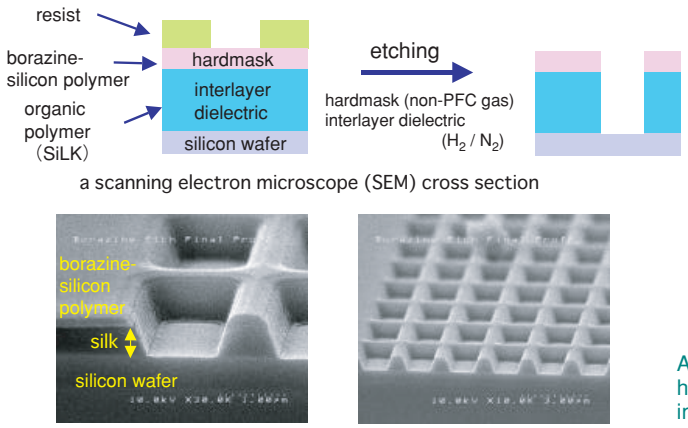
AIST Today Vol. 2, No. 6
(2002) 9

We have developed a novel low-k material, borazine-silicon polymer and its application as an interlayer insulator film for ULSI semiconductor circuits has been carried out in collaboration with the Association of Super-Advanced Electronics Technologies. Dielectric constant of the spin-coated thin films of the polymer was evaluated as lower than 2.1, the required value for next-next generation semiconductor standards. This material also presents superb thermal resistance as well as excellent mechanical properties. As etching process of this material does not use any PFC gases which cause global warming, an environmentally friendly semiconductor process will be realized.

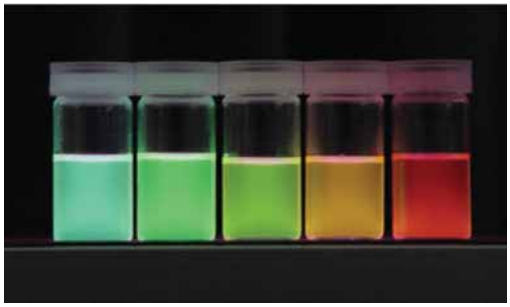


A borazine-silicon polymer as the hardmask of integrated circuit interconnect

CdSe Nanoparticles Prepared in a Microspace

- A Controlled and Continuous Preparation of Monodispersed CdSe Nanoparticles -

Micro-space was utilized toward an industrial production of nano-particles. A microreactor, which is a reactor utilizing micro-space, can control reaction condition exactly and reproductively. CdSe was prepared by utilizing a microreactor, and good controllability and excellent reproducibility of particle diameter distribution was demonstrated. We are now trying to establish a method for narrower diameter distribution and also an industrial production of nanoparticles.



Fluorescence from nanoparticles of various diameters

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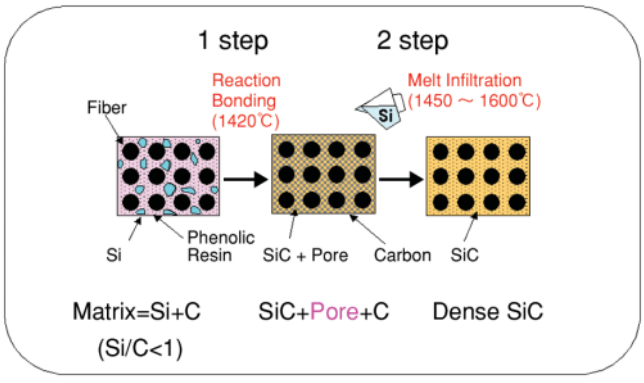
AIST Today Vol. 2, No. 6 (2002) 10

Mechanical Engineering and Manufacturing Technology

Ceramic Matrix Composites by Two-Step Reaction Bonding

Fiber reinforced SiC composites could be fabricated at 1420°C by reaction-bonding with carbon from silicon powder and phenolic resin as matrix precursor. However, this reaction caused ~38% volume reduction. On the other hand, liquid silicon infiltration into porous carbon matrix was generally used for SiC matrix composites. This reaction between carbon in the preform and liquid Si from outside of the preform increases the volume of ~ 56%. Therefore, this preform needs appropriate porosity to complete this reaction. So we combined these reaction-bonding method and liquid silicon infiltration method to obtain dense SiC/SiC composites.



Schematic illustration of 2-step reaction bonding method for SiC/SiC composites

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AIST Today Vol. 2, No. 4 (2002) 17

Precision Machining of Brittle Materials

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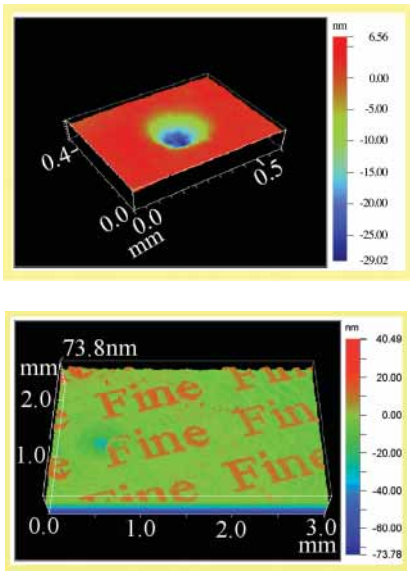
AIST Today Vol. 2, No. 5
(2002) 16

Ductile mode machining of brittle materials, such as optical glasses, enables high-precision optical devices without the use of a mold. This study presents experimental results on machining of optical glasses by using ultra-precision lathe. Machining experiments on glasses were conducted in several different atmospheres. Damage-free cutting mark can be obtained over 0.3-micrometer tool infeed in linoleic acid atmosphere. A profile generation experiment on brittle materials was performed. The micro-pit array and some characters were cut on the surface profiles without brittle damages. The maximum depth of the profile is almost 30 nm. A deeper form without brittle cracks will be obtained by carrying out repetitive cutting.



Typical cutting pattern over soda lime glass

New Polishing Method for CVD Diamond Film

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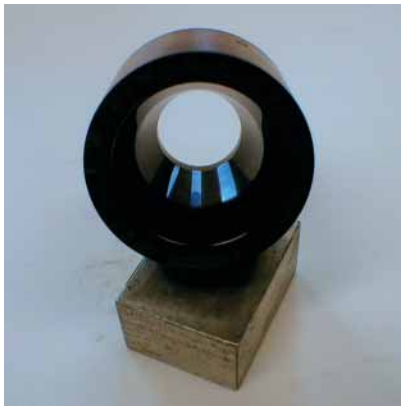
AIST Today Vol. 2, No. 5
(2002) 17

New polishing method for CVD diamond film by using a sintered intermetallic TiAlX wheel is developed. This method is utilizing a strong chemical reaction between titanium and carbon, chemical component of diamond. A tungsten carbide die of 45mm outer diameter, whose inside is coated by 10 micrometer thick CVD diamond film, can be mirror polished within 30 minutes in air and at room temperature using the TiAlX wheel rotating at 3000rpm. This polishing time is less than one tenth of the traditional polishing method.



Inside of this tungsten carbide die is coated by mirror polished CVD diamond film of about 10 micrometer thick

Fabrication of Transparent Titanium Oxide Thin Film using Organic Solution

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AIST Today Vol. 2, No. 6 (2002) 12

New process to fabricate a TiO_2 thin film using an organic titanium solution is developed at AIST-Tohoku center. The coating solution can be synthesized in air within ten minutes at room temperature. Coating process is also performed in air. Dip coated or spin coated specimen, glass or metal, is dried then heated at 400 to 500ºC for several minutes in air. During the heating, anatase type TiO_2 thin film of well bonded to the substrate is synthesized. This thin film is expected to use as a photocatalyst as well as a high temperature corrosion protect coating of metal.

The surface of iron pipe with(left) and without(right) titanium oxide thin film after 3 week corrosion test in water

Standards and Measurement Technology

Observation of the Protonic Diffusion in Ice

- Breakthrough for the Research on Protonics -

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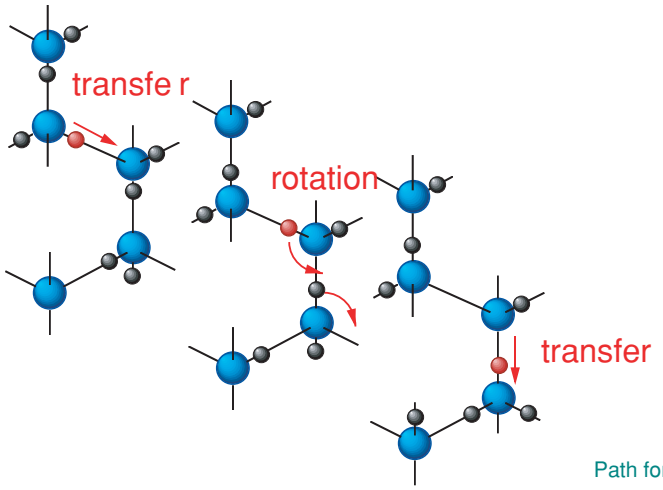
AIST Today Vol. 2, No. 4 (2002) 11

The protonic diffusion in ice was measured for the first time using a spectroscopic technique newly developed. The diffusion coefficient at 127 ºC and 10 GPa was determined to be $10^{-15}m^2/s$ larger by a factor of 10^5 than the value estimated for ambient pressure ice. Protons can move around in ice at a rate of 30 nm per second on average. In other words, the proton jumps successively into the neighboring water molecules every 10 ms.



Path for the protonic diffusion in ice

Realization of Iodine-Stabilized Nd:YAG Lasers

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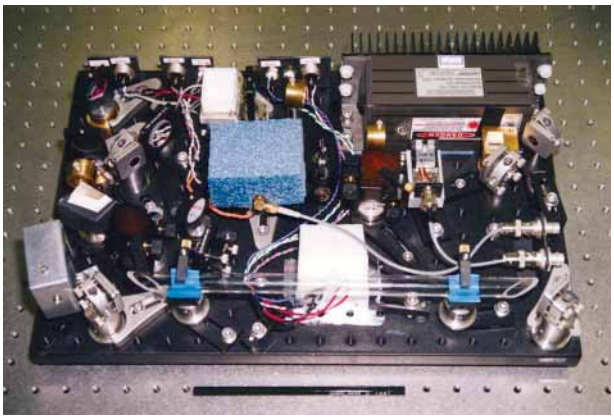
AIST Today Vol. 2, No. 4
(2002) 13

We have established four iodine-stabilized Nd:YAG lasers to verify the frequency stability and reproducibility of the lasers. One of them is the only transportable laser in the world, which has been tranported to several metrological institutes for international frequency comparison. We have also established an optical fiber network to transfer the realized optical frequency standard.



A transportable iodine-stabilized Nd:YAG laser realized at AIST

Fluorescent Quenching-Based Quantitative Detection of Specific DNA/RNA

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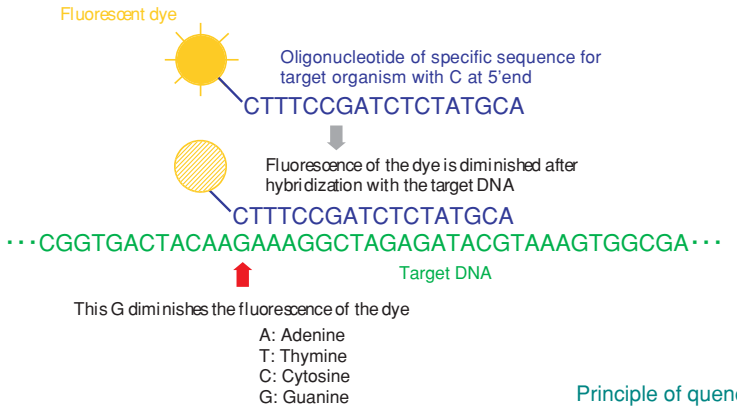
AIST Today Vol. 2, No. 4
(2002) 14

We have developed a simple method for the quantitative detection of specific DNA or RNA molecules based on the finding that BODIPY FL fluorescence was quenched by a guanine. When an oligonucleotide probe or primer containing a BODIPY FL-modified cytosine at its 5'-end was hybridized with a target DNA, its fluorescence was quenched and the quench rate was proportional to the amount of target DNA. This widely applicable technique will be used directly with larger samples or in conjunction with polymerase chain reaction to quantify small DNA samples.



Principle of quenching probe/primer (QP) method

Geological Survey and Geoscience

A 3-D Imaging of the Seismogenic Zone, Off Tokai

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AIST Today Vol. 2, No. 4 (2002) 12

The most of large earthquakes (magnitude 8 or more) are occurred in plate subduction zones in the world. Recent our acoustic imaging technology of deep interior of the earth can image even the depth of seismogenic plate boundary in 3-D. Japan – France cooperated investigation on the Tokai seismogenic zone was conducted in 2000. We had a 45 × 5 km 3-D reflection seismic data and processed the data by using the AIST's super computer facility. Our preliminary geological interpretation suggests that the up-dip limit of seismogenic zone was clearly imaged. It is characterized by out-of-sequence thrusts that show a splay-like structure. Our interpretation is concordant with the result of geodetic inversion study of on-land GPS network data.

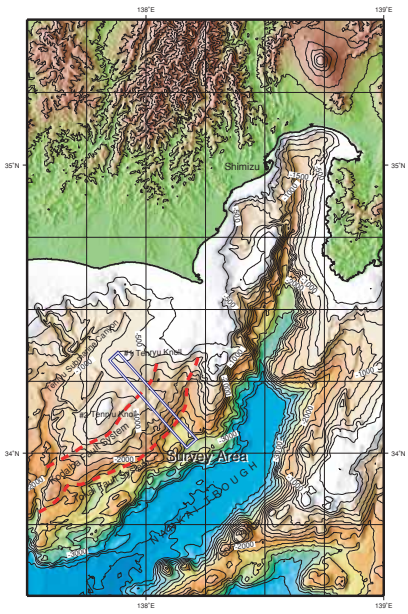

Figure shows the 3-D seismic survey area off Tokai, approximately 50 km far from Omaesaki in SW direction. The size of survey area is 45 × 5 km

Monitoring System of Coastal Environment using Blimp and Underwater Robot

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AIST Today Vol. 2, No. 5 (2002) 19

We built the underwater robot to collect the accurate data on seagrass beds distribution. It is equipped with a GPS which enables the robot to operate on programmed sites. With an installed CCD camera, which is wired to the mother vessel, we can monitor real-time robotic operation, and also take digital pictures including quadrat frame with a four million pixels. Other data, such as depth and longitude/latitude of the robot are simultaneously taken and stored in a personal computer in the mother vessel. Since pictures that are taken constitute digital data, they can be shown with fixed algorithms semi-automatically.

Underwater robot taking the picture of seagrasses within the quadrat frame

100,000-Year Periodicity in Earth's Magnetic Field Variations

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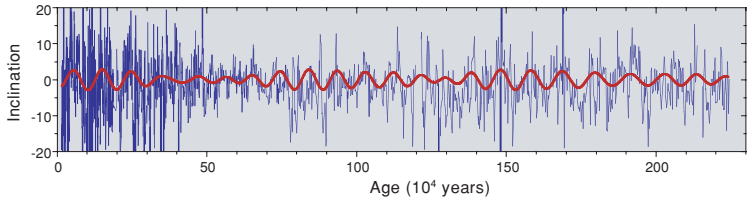
AIST Today Vol. 2, No. 6 (2002) 18

A continuous record of inclination and intensity of the Earth's magnetic field during the last 2250 kyrs was obtained from a marine sediment core of 42m long. This record reveals the presence of 100-kyr periodicity in inclination as well as intensity. Geomagnetic field is produced by fluid flows within the Earth's outer core, which is called the geodynamo. The geodynamo was thought to be a self-sustained system within the core, but the discovery of the 100-kyr periodicity, which is longer than the electrical diffusion time of the core, indicates the presence of external energy sources: orbital eccentricity and paleoclimatic changes.



Long-term secular variation in inclination of the geomagnetic field. The 100,000-year variation component was extracted using a band-pass filter (red curve)

Electromagnetic Exploration to Detect Fluids in Seismogenic Regions

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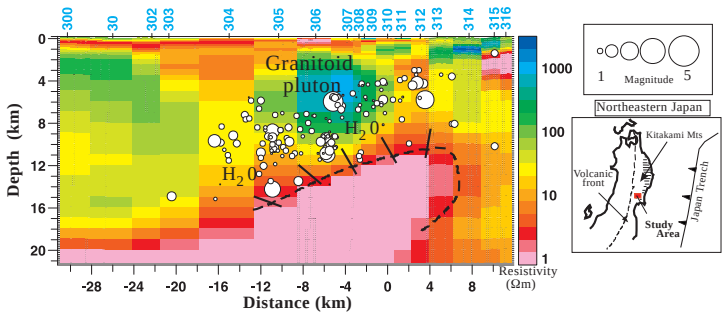
AIST Today Vol. 2, No. 6 (2002) 19

Geophysical prospecting methods have been used for explorations of oil, mineral and geothermal energy resources, and recently are applied to civil engineering and environmental problems. We carried out magnetotelluric surveys, which is a kind of electromagnetic explorations, to investigate the electrical resistivity structure of the seismogenic region of the 1962 Northern Miyagi Earthquake (M.6.5) in Miyagi Prefecture, northeastern Japan. As a result, a deep conductor was found and is interpreted as a fluid-filled zone. We suggest that the seepage of the fluid from the fluid-filled zone to the resistive granitoid pulton can become a trigger of the earthquakes.



Two-dimensional resistivity model obtained by an inversion of the MT data. The microearthquakes (circles) occur as though they cover the deep conductive zone (around 1Ω-m).

Winning the International Biosensor Award

Mr. Isao Karube, Director of Laboratory of Advanced Bioelectronics received International Biosensor Award for his outstanding achievements in the field of biosensor and bioelectronics. The awarding ceremony was held during the 7th World Congress of Biosensors from 15th to 18th May, 2002.

Dr. Karube has engaged in the research of biosensors for over 30 years and invented microbial biosensors. Their application to environmental monitoring is the world first achievement. With his flexible, creative mind-set, he has successfully developed a number of novel biosensors and translated them into practical applications.

Out of his inventions the followings stand out: the sensors for fish freshness, human tiredness, E-coli, toxic agents, blood sugar level, dioxin and so on. Some are directly linked to our everyday life including a toilet sensor for health check, biotips for human DNA and protein materials.

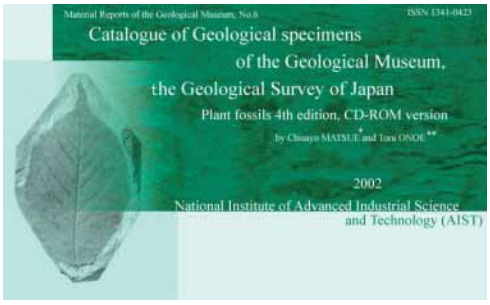
Welcoming Vice Premier of Vietnam at AIST

Mr. Phan Giakhiem, Vice Premier of Vietnam visited AIST Tsukuba center on 22nd May 2002. The Vice Premier received a presentation made by Mr. Hiraishi, vice-president of AIST on an outline of the organization and activities of AIST, followed by the tour of three research units.

Firstly, at the Gene Discovery Research Center, Mr. Taira, deputy director lectured on "Ribozime and Gene Discovery" and then there was an explanation on Mule, "Multilingual Data Processing and Information on Security" at Information Technology Research Institute by Mr. Handa, senior research scientist. Lastly, Mr. Haruta, Director of Research Institute for Green Technology presented on the recent research of exhaust gas from diesel engine.

The Vice Premier was very attentive and eagerly asked a number of questions.

The plant fossil catalogue was Published from AIST



The plant fossil catalogue registering about 3,600 specimens of 4th ed. was published from the Geological Museum of the Geological Survey of Japan, AIST as CD-ROM (Matsue and Onoe, 2002).

The contents of the 4th ed. is composed of a list of plant taxonomy, a list classified by the locality of registered specimens, an index of plant taxonomy, an index of genus name of species names, an index of geologic age, maps of locality, photographs of samples, and references.

As the files in the CD-ROM are changed into PDF, these are accessible with both Windows and Macintosh.

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AIST Today International Edition
2002 Summer
No.5

Edit and Publication :
Publication Office, Information & Publication Division, Public Relations Department
National Institute of Advanced Industrial Science and Technology (AIST)
Independent Administrative Institution (IAI), Ministry of Economy, Trade and Industry (METI)
AIST Tsukuba Central 3, 1-1-1 Umezono, Tsukuba, Ibaraki 305-8563, Japan
TEL: +81-298-61-4128 FAX: +81-298-61-4129 URL: http://www.aist.go.jp/