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Feature

Exploration of Geothermal Resources for Remote Islands of Indonesia



National Institute of Advanced Industrial Science and Technology

New year's Greetings



Mechanism of generating wealth by knowledge

Stagnation, siege mentality and depression, these daunting words summed up the year 2002. In a general mood of society in which people tried to find someone or something to blame, specious logic and criticism prevailed. And now, we are facing the new year, 2003.

Our new year's resolution is to find way out from this cloud of criticism of the last year, that was almost weeping and wailing. There is no magic wand for confronting such a grave situation. All of us have no choice but to fulfil our own roles in society. It is almost pointless and will even worsen the situation if we shift the blame onto others and commentate on any issue as an outsider.

Now, what should we do as a member of AIST? The harsh realities that produced various hardships that we have experienced since last year still exist as imperative facts. In order to make a breakthrough there is little doubt in the necessity for us to be committed to take one of the numerous roles in the society. And it is essential to identify the primary task for each.

AIST is a research institute. A research institute assumes the role to produce knowledge. In this sense, our responsibility would be straightforward, that is to produce knowledge which serve as a resolution of the current issues. As our products (= knowledge) are related to industrial technology, they must benefit the industrial community.

It is essential to have a recognition that industry is the largest mechanism to generate wealth in the society. Accordingly, it can be said that we are the leading player of the activities characterizing mankind, that is "production of wealth based on knowledge".

The modern-day version of the nature of human characteristics; to yield wealth by use of knowledge is construed as a policy common to every nation, that is, state support provided to research activities of science and technology, and industrial application of their outcomes. Japan, a country advocating an emphasis on forging a framework to advance innovations in science and technology is heading such a trend. This is confirmed by the rapidly growing call for "Industry-Government-Academia" collaboration. This is a generally shared awareness. However, we, assuming the major responsibility of these activities for wealth creation, should have a deeper recognition of the contents of these doings. Apparently, the primary importance should be placed on a thorough understanding of the patterns specific to the knowledge in the modern world.

Return to indigenous knowledge

One of the remarkable fruits born out of discussions at international organizations such as ICSU is the viewpoint of cognizing the limits of modern scientific knowledge to solve environmental issues. Although it is possible to understand environmental problems based on the knowledge of natural science such as physics and chemistry, interdisciplinary knowledge including human science and sociology is required in order to prevent or restore the deteriorated environment. However, for that purpose, modern knowledge is extremely segmentalized and confined to each academic field. And yet, no "science" exists to integrate such fragments.

However, although it differs from modern science, our traditional wisdom teaches human beings how to coexist with the environment. Such wisdom is inherent to

each region and proves its real worth only in the natural and social environment unique to the region. It is often called "indigenous wisdom". Historically, the significance of indigenous wisdom has been unduly dismissed during the process of elimination of opposing elements against science such as superstitions, anti-scientism, spurious science and so on. However, the indigenous wisdom has been gradually re-evaluated and the method to differentiate its nature from anti-scientism is being established. In addition, we have started to pursue the possibility to utilize such wisdom.

The significant feature which marks the indigenous wisdom is in its constitution coupling knowledge as a factual information of an object and a subjective meaning for a person who has the knowledge. For instance, indigenous wisdom concerning a certain plant may be a combination of the objective information such as suitable conditions and the right season for its growth and the knowledge of possible application -medicinal use of the plant. Moreover, people make use of the knowledge. Hence, a factual knowledge and an understanding for application can be found simultaneously.

In contrast, facts and applications are separated in knowledge which is based on modern science. More precisely, modern science is a scheme of knowledge established by liberating the factual information from the concerns for the possibility of its practical application. As a result, this amount of information has been rapidly increased within the sphere of modern science.

Facing the vast amount of modern scientific knowledge which is continuously growing, the possible application of such factual knowledge, in other words, the potential practices to generate wealth have been emerging as a significant issue. This is a natural consequence of the separation of the factual knowledge from applications. Therefore, vigorous investment by the government to scientific researches in the expectation that they will serve as a breakthrough of the current severe state of affairs is

an inevitable corollary from the history of human knowledge. At the same time, such an endeavor is assuming a large scale project to challenge the structural problem interwoven in modern world knowledge.

Learning from indigenous wisdom and creating coherency of knowledge

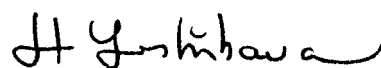
AIST is taking a pioneering role in such a project. It can be said that rebuilding the tie between the factual knowledge and application based on the scientific methods is the first trial ever made in the history of knowledge. At AIST, with penetrating insight, each director of a research unit takes responsibility for creating a coherency of knowledge within the unit where the researchers producing factual knowledge and those specialized in applications pursue their respective interests based on their self-motivation.

Researchers conduct studies into their own subjects under the supervision of the directors of each unit. Our challenge lies behind such daily activities at a research unit. In other words, we exert ourselves to overcome the structural problem associated the modern knowledge and consequently, to formularize the process to produce wealth from the proliferating knowledge.

A fulfilling year of full research

Defining the year 2003 as a year when the grief of last year will be reviewed objectively and all of us will play a role to solve the issues, our New Year's resolution is to begin a "full-scale" operation to pursue our full research centering on the type-II basic research that we have just launched.

President



Hiroyuki YOSHIKAWA

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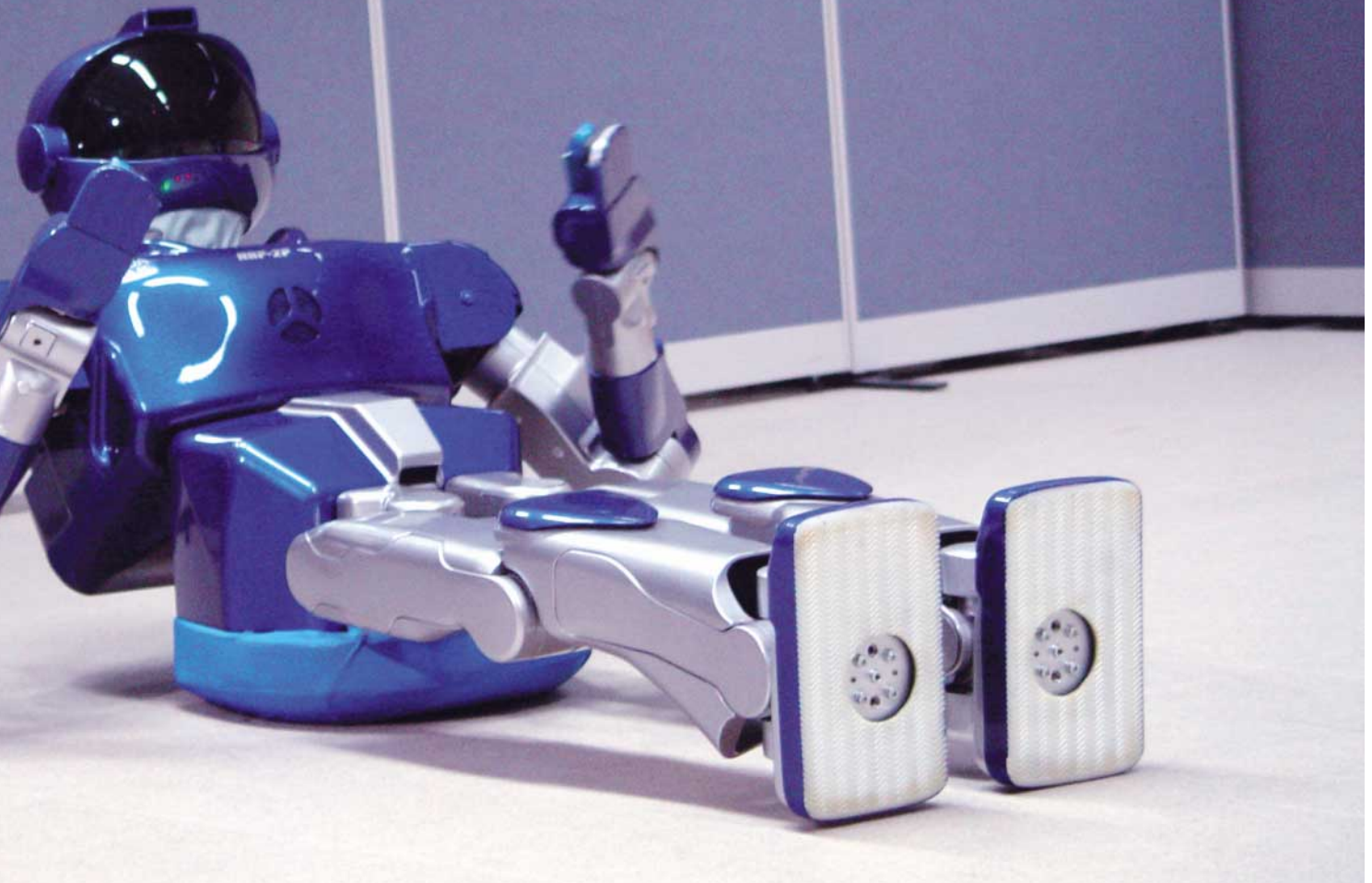


Life-sized Humanoid Robot Capable of Getting Up and Lying Down

— “P-chan”, One Step Closer towards the Practical Application of Humanoid Robot Workers —

TOPICS

Life-sized Humanoid Robot Capable of Getting Up and Lying Down



For the first time in the world, a life-sized humanoid robot with the ability to get up and lie down on its own has been successfully built by the collaboration of Intelligent Systems Institute, AIST and Kawada Industries Inc. These two movements were realized by the deft combination of hardware and software: Kawada Industries Inc. successfully designed the hardware "with a mechanism similar to that of a human body which does not carry a backpack and is equipped with flexible waist joints and high-powered arms", whilst AIST developed the software which "regulates the systemic movement by controlling its center of gravity to enable the shift of support. This achievement has marked an important step toward the practical use of humanoid robot workers.

Characteristics of the Humanoid Robot HRP-2 Prototype

This robot with the ability of these movements is the HRP-2 prototype (HRP-2P), and is called P-chan for short nick after the capital letter of "prototype" among the researchers engaged in this project. P-chan is 154cm tall; it weighs 58kg and its height for weight ratio is very similar to that of human. It is much more light-weighted compared to the previous humanoid robots. In order to realize the "standing-up" movement and "falling or tipping-over", it has the following characteristics:

1. high density electronics installation package to eliminate a bulky backpack which can be a hindrance of getting-up movement,
2. larger moving range of center of gravity as well as the distance of arm's reach thanks to the flexible hip-joint axes that allow a great deal of freedom of bending movement, and
3. increased power of the arms to the level of the legs, to have them enabled to support the upper body.

Weakness Resolved through Getting-up Movement

For the practical application of humanoid robots, one of the most significant issues has been the fact that humanoid robots are relatively susceptible to falling over. When a humanoid robot stands on two legs, what supports the body weight is an extremely restricted area of the bottoms of its

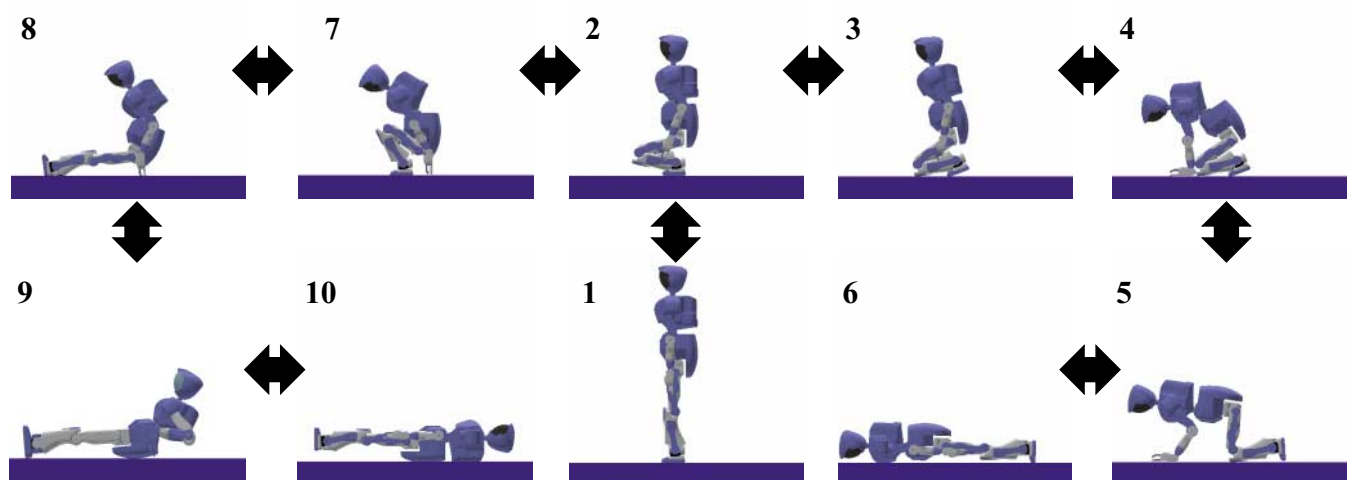
feet whereas the gravity center is located at relatively high position, that is around the waist. Therefore, a biped robot is considerably unstable compared to the wheel-type robot or the robots with four or six legs.

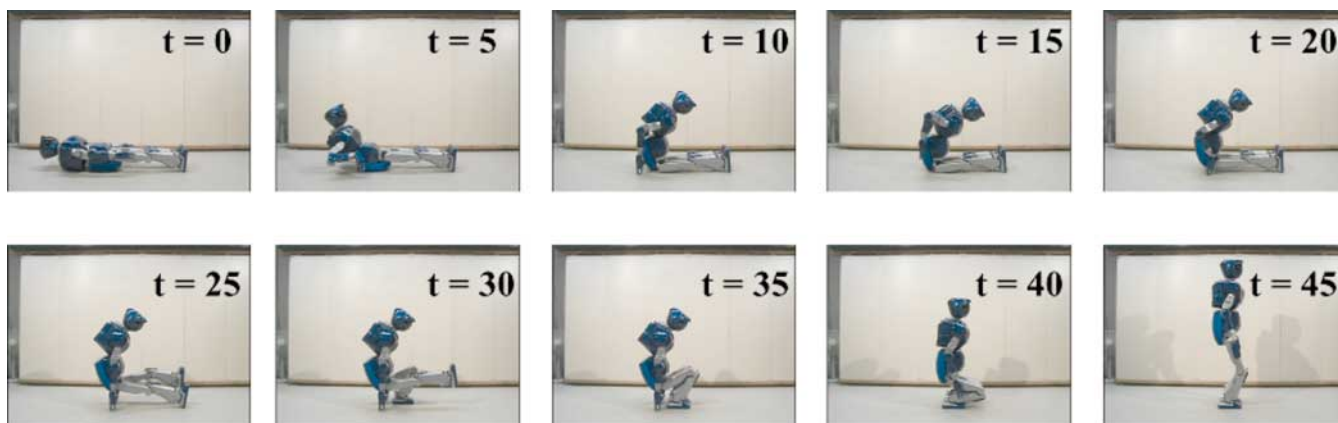
In order to overcome this weakness, a great deal of effort has been made to create a robust gait control system and improve its adaptability, focusing on "prevention from falling" of the robot. However, so long as it functions in an environment with unexpected factors arising from co-existence with human beings, it is almost impossible to liberate the robot from possibility of falling. Consequently, a different approach to the weakness has been adopted: developing a robot which has an ability to get up on its own from fallen positions. Based on this idea, the weakness can be resolved by coordination of the following three motor controls.

1. Prevention from falling or tipping-over as far as possible (stabilization),
2. Taking a passive attitude in order to protect itself and surrounding objects from damage when it falls (falling or tipping-over control), and
3. Raising oneself from the ground to a standing position (recovery of the position).

The robot with an ability of getting up on its own to continue the work will make a great contribution to the realization of humanoid robot workers. The achievement of this time was produced by adding the ability of recovering the position as above 3 to the long pursued research goal: prevention of falling.

This kind of "getting-up" movement was possible





● Getting up motion from Lying on the back state

before with a small sized humanoid robots 60 cm tall or less. However, P-chan is the first humanoid robot ever with a height of 120cm or over that can raise oneself. There has been no success with the development of such system because for the body of larger size, the influence of inertia force becomes intensified in the movement of getting up and lying down, making it difficult to keep a balance while controlling the movement.

"Lying Down Movement" May Open the Doors to the Wider Applications of a Robot

The fact that the robot is able to safely go down on all four limbs and lie down will lead to an increase in the types of jobs that can be performed by robots. For example, lying facing up and down is an indispensable movement when it passes through under obstacles, checks the lower part of a car. If a humanoid robot keeps standing like humans at all times, a great deal of energy is consumed in order to maintain the balance. Considering that, it would be energy saving if it can lie down on its own just like humans.

Key Factors for the Realization of Getting-up, lying-down Movements

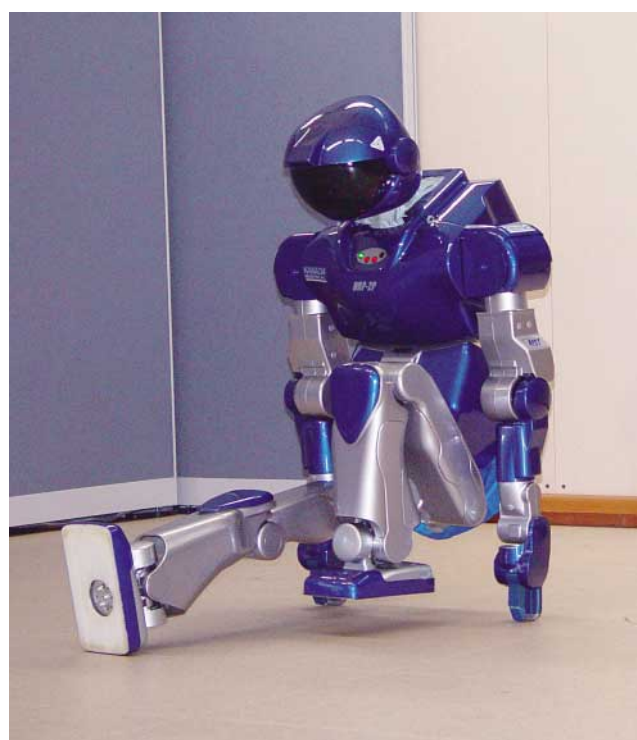
For the purpose of realizing the movements of raising oneself and lying down, it is necessary to control the position of its center of gravity and smoothly shift its stance (getting down on all fours, standing on two legs and so on).

The control of the arms of conventional robots means handling objects with fingers whilst keeping the rest of the module away from the surroundings. Similarly, the leg

control is merely for supporting the body weight on the bottoms of the feet to prevent the robot falling over. In contrast, the movements of getting-up and lying- down of the newly developed robot greatly differ as they need contacts between the various body parts and the surrounding objects. Such movements were realized by incorporation of the hardware of human-type robot HRP-2P and the software that enables the control of systemic movement.

The Software that Controls the Entire Body Movement

The software controls the shift of the stance of the robot body by regulating the position of the center of gravity. Firstly, the movements of getting-up and lying-down were



resolved into their component elements in accordance with the stance as they determine the way of controlling the gravity center. The results are shown in the figure as below. The smooth shift between stances were obtained by allocating a suitable position of the center of gravity to each of the component movements in each of the ten different stances.

Further Progress of the Research & Development of the Humanoid Robot

The current robot can raise itself only when it lies down (either facing up or down) on its own. The technology of falling control will be integrated so that the robot can get up in case it falls accidentally.

Furthermore, HRP-2, considered to be the final version at this stage, will be completed by the end of 2002 and it is considered to make it commercially available for research and development purposes. In addition, the internal API (Application Programming Interface) of HRP-2 will be open to the public, allowing the users to develop software.

A venture software company established in October 2002 will take charge of the operation and maintenance of the current control software including the position recovery function. New software development will also be continued.

Humanoid Worker Robot

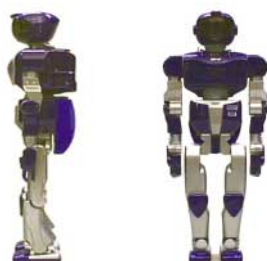
So far industrial robots have been working in the environment suitable for them such as factories. Even though Japan is the world's biggest market for industrial robots, the market size has remained flat at approximately 500 to 600 billion yen since the 1980's. The main reason for



this is that the variety of tasks which can be handled by a robot has been limited, and it is essential to develop a robot which can work alongside the humans in a less-controlled environment. For human-interactive operations, humanoid robots are the best suited to such purposes. A robot which has a shape very similar to that of human beings is capable of operating in the environment adjusted for human use, utilizing existing tools without modification and working in collaboration with human workers.

Since Honda Motor Co., Ltd. introduced the humanoid robot P2 in 1996, a number of humanoid robots have been developed, and the humanoid robot has entered into a new era of technical epoch. Honda Motor Co., Ltd. released a robot called ASIMO and Sony Corporation unveiled its SDR-4X. ASIMO can be even rented for events. However, the applications of these robots has been specialized in the area of entertainment, and they are not intended for work.

This research is a part of a five-year program launched by Ministry of Economy, Trade and Industry in 1998, "Humanoid Robotics Projects (HRP)" under the project leader, Mr. Hirochika Inoue, Professor of Tokyo University. The project aims at presenting the possibility of realization of humanoid worker robot through the researches on application examples of humanoid robots.



Specifications	
Height	154 cm
Weight	58 kg (inc. batteries)
D.O.F.	Total 30D.O.F.
Waist	2D.O.F.
Arm	6D.O.F. × 2
Leg	6D.O.F. × 2
(Hip joints have cantilever type structure)	

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What Causes Earthquake Swarm?

**Published in Nature:
Stress Fluctuations
as the Most Illuminated Mechanism
of Swarm Earthquakes**



● Cover of the Nature, 5 September 2002 issue (courtesy of the Nature Japan)

Seismic activities can be classified into either a major quake followed by aftershocks or an earthquake swarm. In general, within major earthquakes a maximum-scale quake is followed by a number of minor aftershocks. Meanwhile, the swarm earthquake is a series of the quakes of a similar scale to the mainshock. The pace of subsidence in such earthquake occurring is gradual relative to aftershocks in normal earthquakes, and the seismic activities are protracted.

The AD 2000 Izu islands earthquake that struck the northern Izu islands showed one of the most energetic swarms ever recorded. We analysed the seismicity data as well as the land survey of this swarm to demonstrate that the sustained crustal deformation and increase in stressing rate largely contribute to the occurrence of earthquake swarms.

Earthquake Swarms Produced by the Change in Stressing Rate

Earthquake swarm has been considered to be "an exceptional phenomena" which differs from the normal earthquakes. Dominant hypotheses that explain the occurrence of the swarm include the immediate influence of magma and ground water (ex. intrusion to the fault), peculiar inhomogeneity of crustal structure and so on. As shown below, in the AD 2000 Izu islands earthquake swarm, we found that the seismic activities were produced by stress transfers due to crustal deformation, that was incited by magma intrusions and extrusions. Although the mechanism of each earthquake is the same as that of normal earthquake, an extraordinarily high stress generated for a relatively short period rapidly elevates the rate of earthquake occurrence, resulting in distinctive seismological behaviour. The research result was published in Nature, the issue of September 5th, 2002 (co-authored with Dr. Takeshi Sagiya, Geographical Survey, Japan and Dr. Ross Stein, US Geographical Survey).

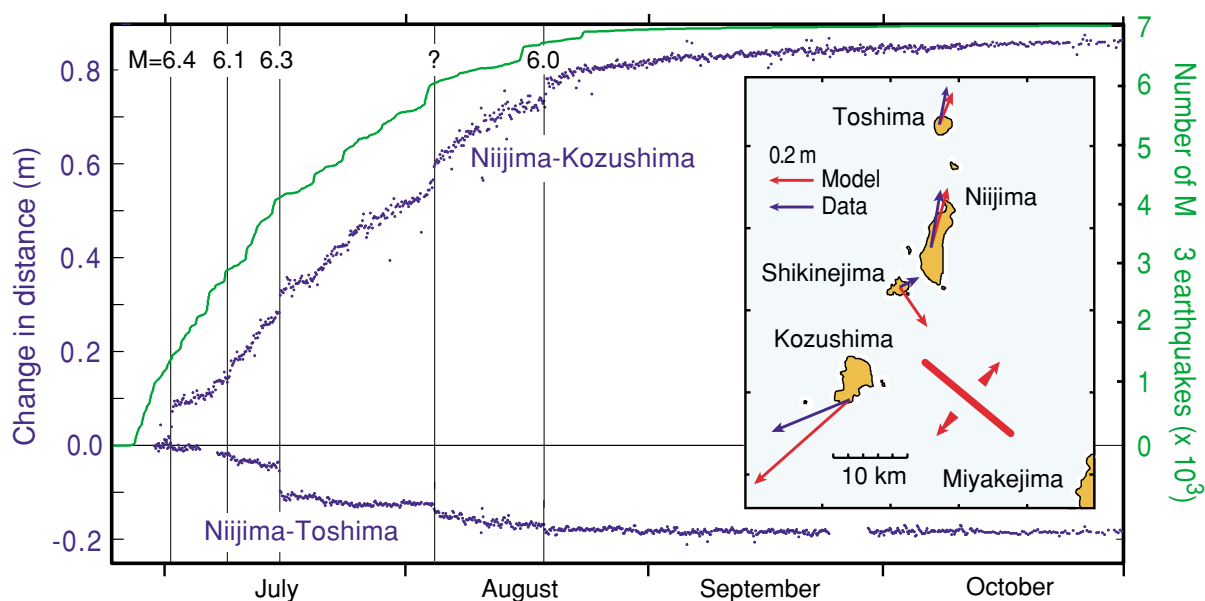
Analysis of the AD 2000 Izu Islands Earthquake Swarm

The swarm that struck the northern Izu islands from June to August 2000 was one of the largest earthquakes ever recorded in the land territory and surrounding areas, producing 7,000 shocks with magnitude ≥ 3 including five magnitude ≥ 6 shocks. In addition to its enormous scale, a

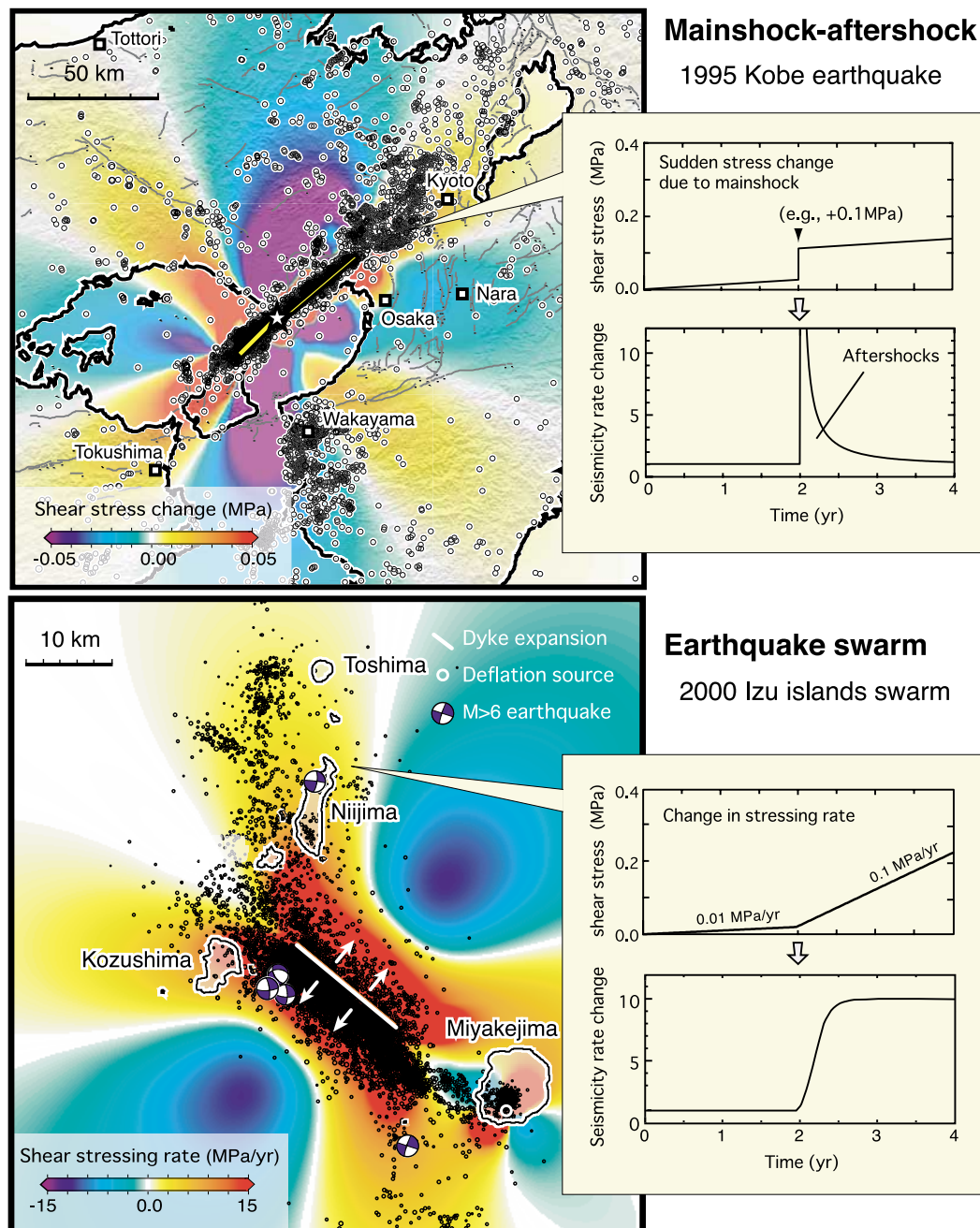
great deal of attention was attracted to the detailed data of the seismic activities obtained through thorough observations conducted by the researchers of Japan Meteorological Agency and Tokyo University, as well as the continuous GPS (Global Positioning System) observation by Geographical Survey Institute. The displacement of the ground surface in relation to the seismicity was monitored in almost real time (see Fig.1).

Swarm Moved the Islands - Laboratory-based Observation Using the Growth Model of Magma -

As a result of GPS observation, it was calculated that the distance between Niijima and Kozushima islands was extended by approximately 80cm whilst that between Niijima and Toshima islands was drawn closer by 20cm during the 2 months from June 26 to August 23, when the seismicity was active. From longitudinal data analysis of displacement, although abrupt changes of about several centimeters were produced by shocks over magnitude 6, it was made clear that the distance between the two islands were gradually extended for the two months. In order to give an explanation to such crustal deformation, we assumed that a vertical dyke spread 15 km long by 5 km wide in the waters off Miyakejima continuously propagated for 2 months (dyke model hereinafter). The dyke eventually opened by 20m. Based on this dyke model, the shear stressing rate of the surrounding earth's crust was calculated as



● Fig.1 GPS line-length changes and cumulative earthquakes during the swarm.



● Fig.2 Two types of seismicity produced by a stress step or an increase of stress rate.

a strike-slip fault that is common in the most earthquakes. Consequently, the area was divided into two in accordance with the resulting variation of stressing rate (Fig.2 bottom). The warm and cold colors indicate the increase and decrease of the stressing rate, respectively. We estimated that the stressing rate in the offshore of Miyakejima, close to the dyke was 10 MPa/year or over and it reached several MPa a year even on Nijima island, away from the dyke. Based on the GPS observational data for the several years before the seismic activities, the normal stressing rate is estimated at 0.01 MPa/year. That means, more than a

1000-fold increase in stressing rate occurred in the area of north west offshore of Miyakejima whilst a several hundred fold increase occurred in the surrounding area of Nijima. The sustained stressing rate was higher than normal. Meanwhile, most of the observed shocks occurred in the area of increased stressing rate (Fig. 2 bottom). Comparing the occurrence rate to that of the normal earthquakes, it was observed that the change of the seismicity rate is more proportional to the stressing rate variation. This finding conforms to a theory obtained from the fault friction experiment. This theory, although being quite straightforward, was veri-

fied for the first time by our study, suggesting the possibility to apply it to prediction of an earthquake. Through the observation of the swarm of this time, it was revealed that:

1. The area of seismic activities expanded over time;
2. The duration of aftershocks of earthquakes magnitude ≥ 6 was extremely short.

These results also confirmed our laboratory-based fault friction theory.

Increase in Stressing-rate and Seismicity

As shown in the study of the Izu islands earthquake swarm, it has become easier to calculate the shift of crustal stress by means of the computer assisted numerical analysis, in spite of the difficulty in calculation/estimation of the absolute stress value. Another major clustering element of seismic activities, that is "majorshock and aftershocks" can also be explained by the similar analysis.

Conventionally, the academic attention has been drawn to the aftershocks provoked on the source fault. However, recent findings indicate the influence of majorshock to the seismic activity away from the earthquake source. The shift of seismic activities in the areas away from the epicenter that was developed before-and-after the mainshock is not necessarily consistent. We observed both increase and decrease in seismic rate, depending on the area. In case of the Izu islands swarm, where the deformation was produced by dyke intrusion, the remote triggering of the seismic center can be explained by the calculation of static stressing rate changes. In the example of the Kobe earthquake in 1995, the stressing rate changes extended to the latent shear faults in the surrounding crust that were triggered by the mainshock were calculated as shown in Fig. 2, top. The earthquakes that occurred during the following 18 months (aftershocks in a broad sense) were also plotted.

Although there are exceptions, an earthquake is likely to occur frequently in the area where the stressing rate increased. In contrast, the area where the stressing rate decreased, reduced earthquake activity is observed. It should be noted that even the slightest variation in stressing rate (less than atmospheric pressure) can cause a significant

change in seismic activities. This suggests the sensitivity of constitutive balance of the crust that may be hovering around the critical level. The achievements of the similar researches upon the other major earthquakes around the world have manifested the correlation between the abrupt change of stressing rate produced by the mainshock and seismic activities.

Possibility of Earthquake Prediction

As indicated above, the chain earthquake can be categorised into two groups depending on the type of stressing rate change (Fig.2) .

1. Mainshock-aftershocks type: The sudden increase in stressing rate triggers temporal bursts of seismic activities, i.e. aftershocks which decay over time.
2. Earthquake swarm type: The seismic activities increase in proportion to the gradual and sustained increase in stressing rate.

These properties of stressing rate and seismic behaviors can be applied to the probabilistic prediction of sequencing seismic activities such as aftershocks and swarms. The experimental attempt of aftershock prediction has already started. Earthquake prediction/forecast has still a long way to go for contemporary geoscience. However, we are approaching the perception any earthquake occurrences are not individual phenomenon acting in isolation but rather being interrelated to one another within the crust. In that sense, there is plenty of scope for anticipating the realization of earthquake prediction in the future.

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Exploration of Geothermal Resources for Remote Islands of Indonesia

— For Supplying Clean Energy to Fulfill the Growing Demands for Energy in Asia —

Institute for Geo-Resources and Environment Hirofumi MURAOKA

Background of the Project

This program, officially named “Research Cooperation Project on the Exploration of Small-scale Geothermal Resources in the Eastern Part of Indonesia” started in April 1997 and ended in March 2002. Firstly, we would like to overview the background information of the project.

The Republic of Indonesia has approximately 17,000 islands scattered in its vast territory stretching for 5,100km east to west (Fig. 1). The remarkable economic development of the country in recent years is restricted to a very few regions; Java, the most populous island that numbers 60% of the entire population (200 million), Sumatra with abundant resources and Bali, the base for tourism. The areas left behind by the economic development are the remote islands including Nusa Tenggara of eastern Indonesia.

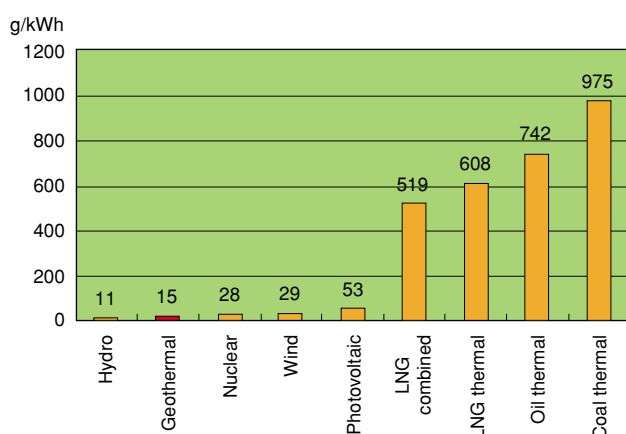
The major reason for this is attributable to the poor infrastructure of the remote islands, especially undeveloped energy supply system. With this in mind, the Indonesian government initiated the 2nd Rural Electrification Program with the aim of drastically upgrading local infrastructure as a base of industrial development in the eastern part of In-



● Fig.1 Map of the Republic of Indonesia as an archipelago

donesia as part of the 6th five-year plan starting from 1994. As it is unrealistic to lay a submarine cable which connects these vast many islands, various sources of natural energy has been explored as dispersive power sources. However, due to the rainy and dry seasons inherent to the tropical region, there is a slim possibility for these energy sources to ensure a stable power supply throughout the year.

Meanwhile, as most of these remote islands are volcanic ones, geothermal resources are abundant. Geothermal power generation has relatively a high operating rate regardless of the seasonal weather variation, and geothermal power is one of the cleanest energies from the viewpoint of emissions of carbon dioxide (Fig. 2¹⁾). For this reason, the Indonesian government placed a higher priority on the small-scale geothermal power plant in the Rural Electrification Program, and the exploration of small-scale geothermal resources at 217 sites. This required the technologies to explore geothermal resources in a short period in the areas with insufficient geoscientific data, and the Japanese participation in technical assistance co-operation has been provided.



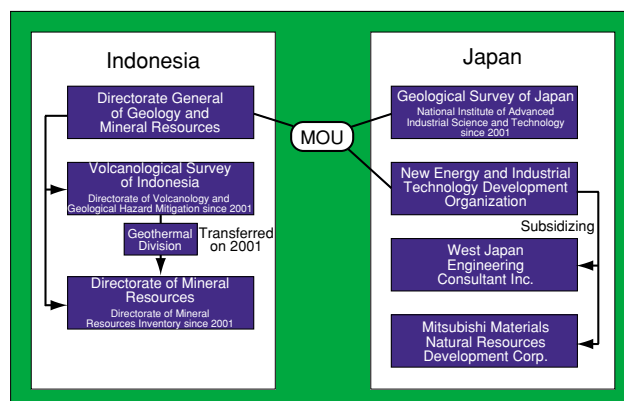
● Fig.2 Life cycle CO₂ emissions in various power generations¹⁾

Outline of This Project

The objective of this project is to develop a geothermal exploration system that is suitable for geothermal resources of tropical remote islands in the eastern part of Indonesia and to be utilized in the development of geothermal energy in Indonesia, and consequently, to contribute to the Rural Electrification Program, one of the major projects conducted by the Indonesian government.

This project is one of the ODA major projects supported by the budget of Official Development Assistance (ODA) under jurisdiction of the International Trade Policy Bureau of the former Ministry of International Trade and Industry (MITI). The budget of Japanese participating organizations is approximately 500 million yen for the five years. 80% of the budget was allotted to New Energy and Industrial Technology Development Organization (NEDO) in charge of the actual on-site project and 20% to Geological Survey of Japan (current AIST) for "logistics", that is laboratory researches to provide scientific research background.

Figure 3 shows a cooperation regime of this project. The Memorandum of Understanding was signed by the Directorate General of Geology and Mineral Resources, NEDO and Geological Survey of Japan in Jakarta on March 26th, 1998. NEDO made an entrustment contract with West Japan Engineering Company Inc. and Mitsubishi Materials Natural Resources Development Corp. (MRC) for investigations and later, the framework was continued based on a subsidizing contract. The assigned tasks of NEDO were geothermal exploration in relatively small areas which have geothermal potential (Fig. 4), drilling of wells for survey and construction of the Indonesian Geothermal Expert Modeling System (iGEMS). AIST was responsible for the es-

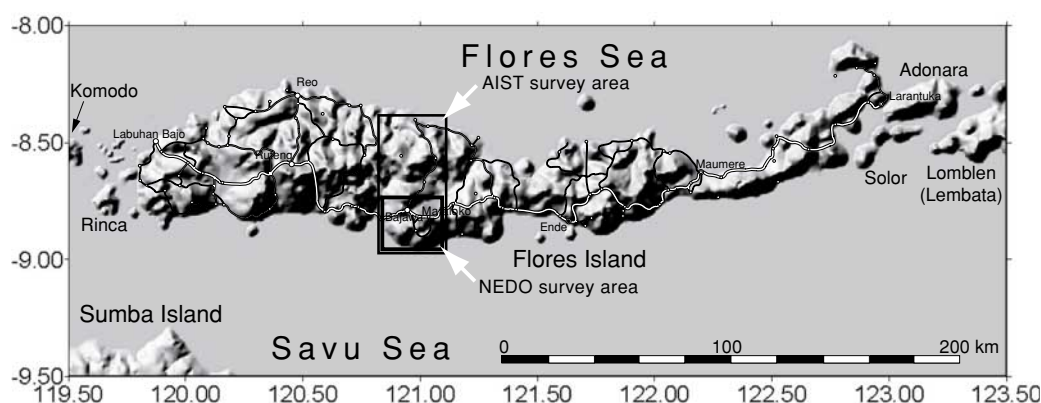


● Fig.3 Co-operation regime of the project

tablishment of geothermal exploration systems, including satellite remote sensing, geological survey, geochemical survey, gravity survey, resistivity profiling and self-potential survey in more extensive areas (Fig. 4).

Although the Directorate of Mineral Resources Inventory signed the Memorandum on behalf of the Indonesian government, the organization that played the main role in the technical investigations was Volcanological Survey of Indonesia. However, as a result of the organizational reform of 2001, Volcanological Survey of Indonesia was reorganized into Volcanology and Geological Hazard Mitigation, and its Geothermal Division was transferred to the Directorate of Mineral Resources Inventory completely. The Indonesian research institutes proceeded with their own investigations and also as the host country, extended its devoted cooperation in exploration activities by Japanese organizations.

In order to develop the exploration survey system suitable for remote islands, it is necessary to select model areas. Mataloko geothermal field, located in the central Flores, was selected based on the 1997 reconnaissance survey by Geological Survey of Japan.



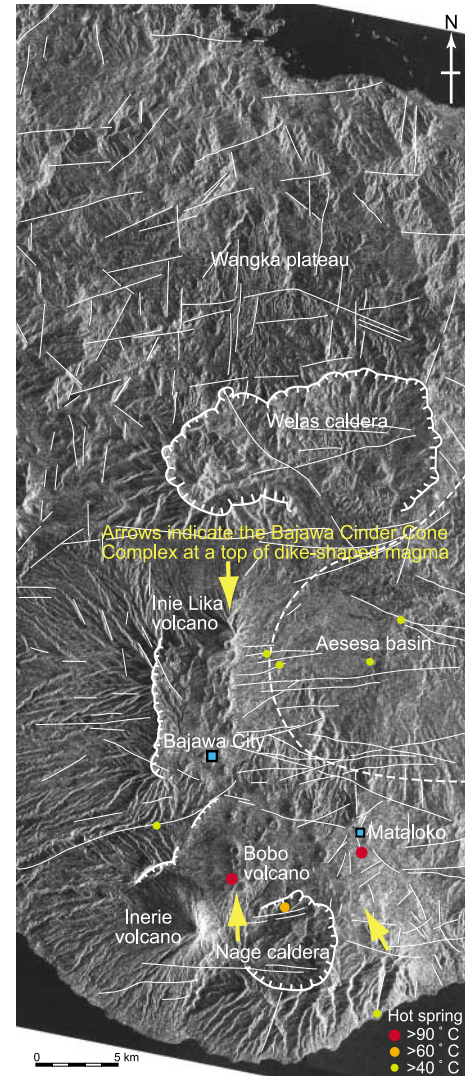
● Fig.4 Shaded-relief map of Flores Island and the survey area

Achievements in the Project

The technical details of the results of this project were compiled and released as a 348-page special number of “Bulletin of the Geological Survey of Japan²⁾” published in English by AIST. The issue features 31 articles presented by 6 organizations of the two countries. The inside stories are disclosed in the Chisitu (geological) News³⁾. More details can be obtained from these two reports. However a few key elements of the project can be represented as below.

Firstly, in reviewing the method of geothermal exploration by AIST, satellite remote sensing was utilized to the fullest extent in the areas that lack sufficient geoscientific data. In this project, the night-time infrared imagery of ASTER of Terra Satellite enabled us to directly extract the prospective geothermal areas. In addition, in cloudy tropical areas, SAR imagery of JERS-1 satellite utilizing microwave band that can penetrate the clouds provided a valuable base map (Fig. 5). This was also useful for analysis of geological conditions of the geothermal field, and the dike-shaped magma beneath Bajawa Cinder Cone Complex was identified as the important geothermal heat source of this area (Fig. 6). The key of gravity survey lies in position measurement, and the introduction of GPS (Global Positioning System) interference technique largely increased the efficiency of the survey. In the resistivity profiling, the three-dimensional inversion analysis was attempted for the first time in the geothermal field. The self-potential measurement can detect up-flow zones of a hot aquifer, so it provided useful data to select the optimum localities for drilling of exploration wells. In brief, an economical method of geothermal exploration was established under the condition of less accessible remote islands in view of the necessity of rapid exploration.

The highlight of this project was the drilling of an exploration well performed by NEDO. The drilling point was selected by piecing together all the exploration results. This means that the exploration system was to be clearly verified if the well emits steam. The flow test was performed on Jan., 20th, 2001 in the presence of several guests including two Diet members of Indonesia who flew by helicopter after the important conference in Kupang, the Governor of East Nusa Tenggara Province, the Director General of the Directorate General of Geology and Mineral Resources, the Vice-President of the Indonesian State Electricity Company, and several hundreds of local residents from neighboring villages. Due to the restricted equipment



● Fig.5 JERS-1 SAR imagery of the survey area (Copyright METI/NASDA) and geothermal features

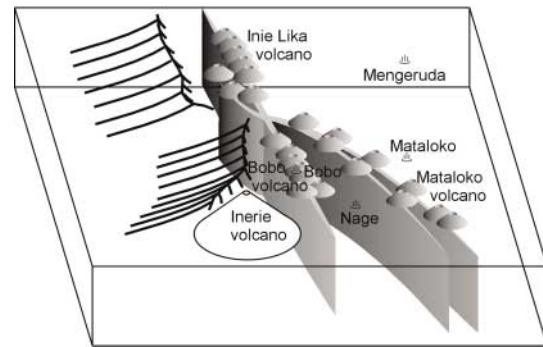
on the remote island, it was not possible to drill the exploration well deeper than 162.35m, that is extremely shallow compared to the normal level. Although the Japanese team became bewildered by the presence of these unexpected spectators, the test was quite successful (Photograph 1). About 15 tons per hour of dry steam was discharged constantly with the valve of pit mouth fully opened. This is a remarkable volume for that drilling depth of the well, equivalent to 2.5MW by condenser-type power generation and 1.2MW by back pressure-type one. In fact, this one well could supply 2MW of electricity currently generated by small diesel power plant for Bajawa city. Furthermore, as the well produces dry steam without hot water, if back-pressure power generation method is adopted, a reduction well is not required. This drilling well has guaranteed extremely economical geothermal development in this area.

The 10-minute demonstration of a flow test was over amidst the applause of all the attendees. It can be certainly said that Japanese researchers were amongst those most relieved.

In the last fiscal year of the given ODA budget scheme, it is obligatory to hold seminars in the aid-receiving countries for the purpose of dissemination of the results. Following this rule, on February 20th, 2002, the final open seminar of this project was held at the auditorium of the Directorate General of Geology and Mineral Resources, in Bandung, Indonesia (Photograph 2). It was fortunate that the seminar was jointly held with the 4th Asian Geothermal Symposium sponsored by NEDO from February 20th to 21st and we had an audience of over 100, including ten geothermal specialists invited from other Asian countries. AIST largely contributed to this symposium, not only in terms of administration work to run the conference. In addition to the keynote speech made by the director of Geological Survey of Japan, 8 AIST researchers lectured on the technological achievements, and three chairpersons were from AIST. The outcomes of the project were introduced to not only Indonesia but also other Asian countries.

Future issues

The lofty cause of this project led a concerted effort of all the participating parties toward the realization of the goal. The successful achievements were made available to the public in a swift and comprehensive manner²⁾. These results were delivered through close co-operations with the excellent partner. The irreplaceable asset of this project is



● Fig. 6 Subsurface dike model of the Bajawa Cinder Cone Complex

firm friendship and unfailing trust deepened with Indonesian fellow workers. In this respect, we have a great sense of accomplishment and success.

As a matter of course, from the viewpoint of establishing infrastructure to supply clean energy, it would be ideal that Japan will take part in building a small-scale power plant in Mataloko area. Regrettably though, Indonesian State Electricity Company should not be able to construct a geothermal plant in this area without relying on outside support due to financial difficulties starting from the Asian currency crisis of 1997. The earnest wish common to the project participants is that the ultimate end of this project will be accomplished within a new project framework as represented by Clean Development Mechanism provided in the Kyoto Protocol. The project is completed, but we have a feeling that our challenge has not ended yet.



● Photo.1 (LEFT)
Flow test of the NEDO geothermal exploration well
on January 20, 2001



● Photo.2 Participants at the final open seminar in Bandung on February 20, 2002

Relational Information

- 1) Hondo, Yuki: CRIEPI News, No. 338, 4p (2002).
- 2) Geological Survey of Japan: Bull. Geol. Surv. Japan, 53, No. 2/3, 61-408 (2002).
- 3) Geological Survey of Japan: Chishitsu (Geological) News, No.577, 1-45 (2002).

The abstracts of the recent research information appeared on the Vol.2 No.10-No.12 of "AIST Today" are introduced and classified by research area.
For inquiry about the full article, please contact the author directly.

Life Science & Technology

HIV-1 Protease-Inhibiting Substances

Two peptides that inhibit HIV-1 (human immunodeficiency virus type 1) protease were isolated from the hydrolysate of oyster proteins prepared with thermolysin. These peptides behaved as competitive inhibitors for HIV-1 protease, and were more potent as an HIV-1 protease inhibitor than pepstatin A.

And furthermore, a water-soluble lignin-like substance inhibiting HIV-1 protease was isolated from boiling water extracts of sclerotium of bunashimeji (*Hypsizigus marmoreus*). Dehydrogenation polymers which are thought to be model compounds of lignin were then synthesized and fractionated into four ranges of molecular mass by ultra-filtration, i.e. over 30kDa, 30k-10kDa, 10k-1kDa and 1k-500Da. These fractions had the HIV-1 protease inhibitory activity. The smallest mass fractions of dehydrogenation polymers (1k-500Da) also inhibited cytopathicity of MT-4 cells induced by HIV-1.

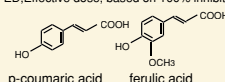
HIV-1 Protease Inhibitory Activity of Peptides from Oyster

	IC ₅₀ (nM)	K _i (nM)
Leu-Leu-Glu-Tyr-Ser-Ile	20	13
Leu-Leu-Glu-Tyr-Ser-Leu	15	10
Pepstatin A	1,800	

Anti-HIV Effect of Lignin-like Substances

	ED(μ g/ml) ^{a)}
Bunashimeji (<i>Hypsizigus marmoreus</i>) lignin	7.8
Oligomer of p-coumaric acid (Mr 500~1,000)	15.6
Oligomer of ferulic acid (Mr 500~1,000)	15.6

^{a)} ED, Effective dose, based on 100% inhibition of HIV-1-induced cytopathicity in MT-4 cells



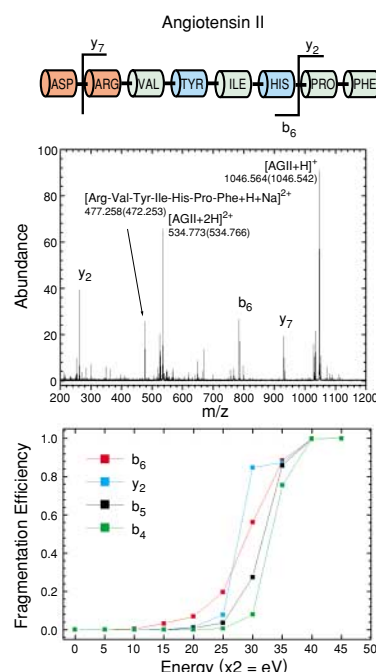
HIV-1 protease-inhibiting peptides and lignin-like substances

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No.10 (2002) 11

Fragmentation Studies for Peptides Using Mass Spectrometry: Experiment and Simulation

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No. 10 (2002) 12

In recent years there has been significant interest in fragmentation analysis of peptides and proteins using mass spectrometry (MS) combined with infrared multiphoton dissociation (IRMPD) and collision induced dissociation (CID) technique. We investigate the cleavage of polypeptides induced at the backbone amine bonds by using the CO₂ laser peptide cleavage IRMPD technique. MS experiments are performed in electrospray ionization fourier-transform ion cyclotron resonance (FTICR) MS, and the results are compared with those of CID experiment. In addition, we theoretically model the fragmentation of the peptides under vacuum conditions using molecular dynamics. The dissociation energy and proton affinity for the peptide bonds (C'-N bond) are also obtained using *ab initio* calculations.

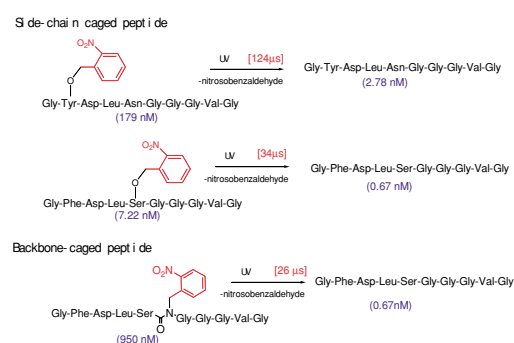


ESI-FTICR Spectrum and product efficiency curves obtained from CID experiment

Caged Peptide: Imprisonment of Biologically Active Peptides in a Photocleavable “Cage”

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Caged peptides, whose activities are masked by the introduction of photocleavable groups, have recently been recognized as a useful tool to elucidate various biological phenomena with a high spatial and temporal resolution, even in living cells. AIST has developed two types of caged peptides; side-chain caged peptides and backbone-caged peptides. The technique was applied to sperm activating peptide (speract). The backbone-caged speract showed superior features to those of the side-chain caged speract: greater caging ability and faster photolysis rate. The caging strategy described can be used as a general procedure to cage any biologically active peptide.



Caged sperm activating peptides. Nitrobenzyl groups shown in red are photo-cleaved and intact peptides are produced by UV-irradiation. The value under each peptide is the IC₅₀, and the value above each arrow is the half-life of the intermediate during photolysis.

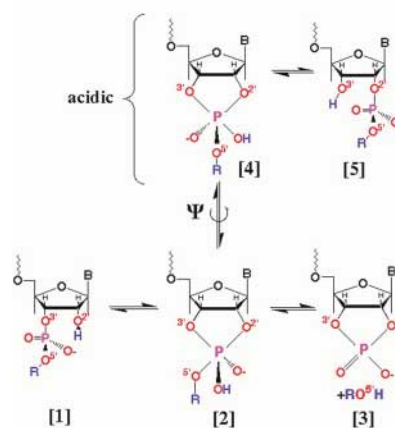
Virtual Laboratory : First Principles Simulation of the Catalytic Reaction of Ribozyme

Since their discovery in the early 1980s, catalytic RNA molecules have been at the center of great attention in molecular biology and medical science. Their figure of merit is the fact that RNA enzymes (ribozymes) can be engineered to cleave other target RNA molecules. Hence, ribozymes are very promising therapeutic agents able to inhibit gene expression and suitable for gene therapy of cancer. Yet, the mechanism of the cleavage reaction escapes experimental probes.

By using a first principles molecular dynamics approach, we have been able to simulate the cleavage process of the ribozyme. The simulation shows that a divalent metal cation Mg^{2+} is essential both in selecting the right reaction path between two possible competing channels and in lowering the activation barrier of the reaction (Fig.).

Another important factor is the role of water, present in all the experiments either *in vitro* or *in vivo*. Water molecules form a continuous hydrogen bond network connected to all the hydrophilic part of the ribozyme. On one hand, this network stabilizes the structure, on the other hand, it provides a path along which a proton can travel, jumping from molecule to molecule, and start the reaction.

On a second instance, we found that the Mg^{2+} cation can make the proton abstraction (the initial stage of the reaction) easier, but can prevent the proton transfer from one site of the ribozyme to another one. In this case, the lost proton is dispersed in the solvent in form of hydronium OH_3^+ . This kind of detailed simulation was made possible by the recent advances both in the computational power of the last generation of parallel supercomputers and in the software algorithms. [details in M. Boero, K. Terakura and M. Tateno, *J. Am. Chem. Soc.* **124**, p. 8949 (2002)]



Panel (a) shows the schematic reaction of the cleavage of the RNA molecule (sequence from [1] to [3]) and the competing reaction path ([4] and [5]). Our computer experiment shows that the initial system (i) is driven by Mg^{2+} (blue ball) toward a transition state (ii) and eventually to the cleaved ribozyme (iii).

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A Fluorescence Imaging Technology for Accurate Diagnosis of Cancer

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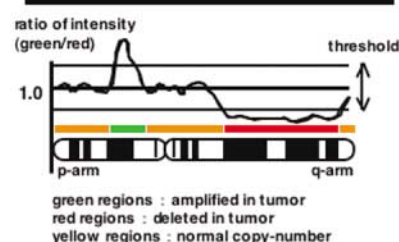
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In these post-genomic era, the mechanism of various diseases, especially cancer, have been understood at molecular level. As cancer is established to be caused by genetic alterations, it is expected to achieve the accurate diagnosis for each cancer based on the genetic information. Recently, the comparative genomic hybridization method (CGH) was developed, which can detect the chromosomal abnormalities by an imaging technique. CGH has the remarkable advantages that the chromosomal gains and losses in whole genome can be detected by only one hybridization process without probes of known DNA sequences. Therefore, we are focusing on developing the methods for cancer diagnosis by CGH technology.



Genome-wide analysis of chromosomal abnormalities in cancer by an imaging technology, comparative genomic hybridization (CGH)

Differently labeled tumor (green) and reference (red) DNA are co-hybridized to a normal metaphase spread. After the microscopic observation and imaging, DNA copy-number changes in the tumor genome can be detected as the imbalance of fluorescence intensity in the acquired image and be located on the chromosome map. Green regions indicate the chromosomal amplifications in the tumor cells and red regions indicate the losses. This figure shows a typical CGH analysis of hepatocellular carcinoma.

Information and Communication Technology

Isosurfaces in Three-Dimensional Ray-Tracing Software POV-Ray

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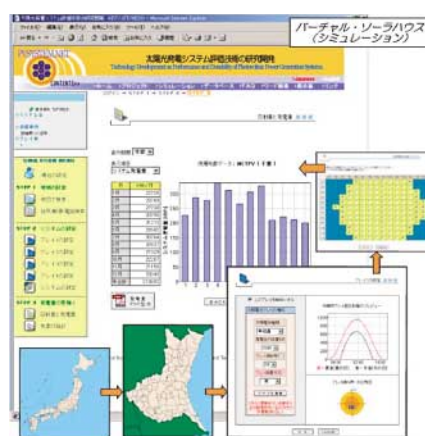
Recently, a new version (version 3.5) of POV-Ray (<http://www.povray.org>), which is an open-source software for three-dimensional ray-tracing computer graphics, has been released. In this software, isosurface algorithm developed by the authors has been officially implemented. The users can easily create complex objects with the isosurface feature combining various mathematical functions, noise functions, and external data. Since the POV-Ray with isosurface objects is extremely flexible, it will be useful not only for scientific visualization but also for business presentation, arts, education, hobby, etc.



Example of isosurface objects

The Launch of a New Web-Site “PVSYSYSTEM.NET”

The Energy Electronics Institute of the AIST has opened its new web site PVSYSYSTEM.NET (<http://www.pvsystem.net/>) to present the up-to-date results of the ongoing development of the “Total Support Technology for Photovoltaic Power Generation Systems”. This web site offers, in particular, a “Virtual Solar House on the Net” and a “Database with Example Data of Photovoltaic Power Generation Systems”. With the benefit of the simulation techniques developed by AIST, the Virtual Solar House allows the user to predict the electric power output and to calculate the generating costs for his own photovoltaic power generation system.



The Virtual Solar House allows users to predict the electric power output and to calculate the generating costs of their own photovoltaic power generation system

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No. 11 (2002) 13

GridRPC System Ninf-G Ver.1 is Now Available!

Grid computing is regarded as a viable next-generation computing infrastructure. GridRPC, an RPC mechanism tailored for the Grid, is one of the most attractive and easiest programming models on the Grid. Ninf-G version 1 is a GridRPC system developed by AIST Grid Technology Research Center, and released on 19th, November 2002, as an open source software. Ninf-G provides library functions and system commands which can be used for development and execution of application programs on the Grid. We will continue the R&D of Ninf-G as a reference implementation of proposed standard GridRPC API at the Global Grid Forum.

GridRPC: A Programming Model based on Remote Procedure Call (RPC) on the Grid



GridRPC: A Programming Model on the Grid

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Development of BIO-REMOTE

- Toward Aids for Daily Life of the Handicapped -

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We propose and develop a new human interface system for the handicapped. The operator can control various home electrical devices using this interface system. This system composes of a transmitter unit and a receiver unit of bioelectric signals, and the receiver unit includes an infrared remote controller and an interface port connected with a personal computer. Bioelectric signals are preprocessed and discriminated using a statistical neural network, which is described as software in the personal computer, and the operator's intended command is executed through an infrared remote controller.



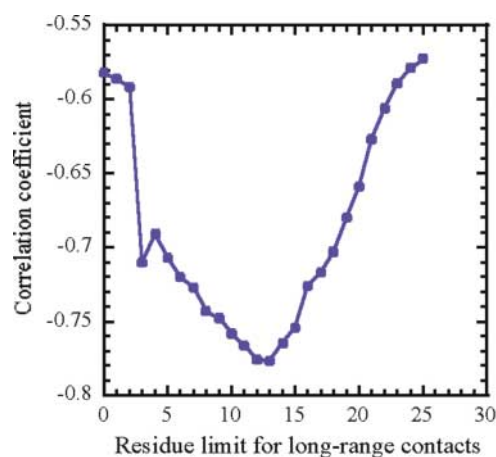
Bio-Remote: The operator can control various home electrical devices based on extracted information from his/her body. The system can adapt itself to the operator's characteristics through adaptive learning using a neural network

Medium and Long-range Interactions in Protein Folding

- Inter-residue Interactions in Protein Folding -

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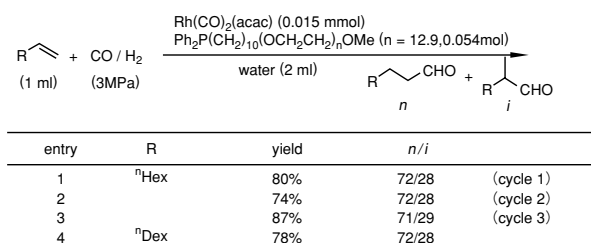
Elucidating the mechanism of protein folding is an intriguing and challenging task. We have proposed a novel parameter, long-range order (LRO) for a protein from the knowledge of long-range contacts (contacts between two residues that are close in space and far in the sequence) in protein structure. A simple statistical method has been developed for predicting the folding rate of two-state proteins using LRO and we found an excellent agreement between the predicted and experimental protein folding rates. Further, we found that the conformational properties, short and medium-range energy and long-range contacts are the major determinants for transition state structures of two-state proteins.



Plot connecting the correlation coefficient obtained between long-range contacts and folding rate of proteins, and the minimum limit to define long-range contacts.

Hydroformylation Reaction of Higher Olefin in the Aqueous Solution

Organic synthesis in the aqueous solution is a very active field. We synthesized amphiphilic ligands, which had phosphino alkyl group as a hydrophilic part and PEG as a lipophilic part. In the presence of the ligand and rhodium catalysts, hydroformylation of higher olefins in the aqueous solution proceeded to giving the corresponding aldehydes in good yields. The catalyst could be easily separated from products and recycled efficiently.

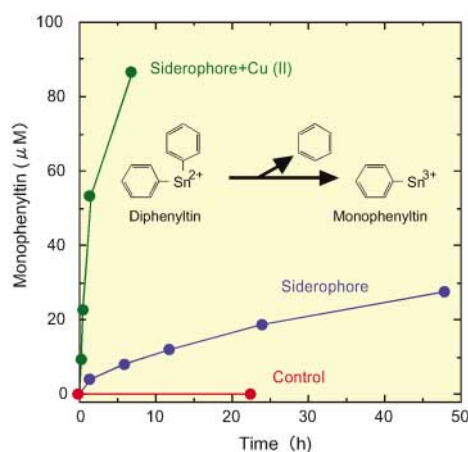


Hydroformylation in the Aqueous Solution

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AIST Today Vol. 2,
No. 10 (2002) 9

Degradation of Organotin Compounds by Peptide Siderophore

Organotin contamination caused by antifouling paints and agrochemicals has been considered to be one of important ecotoxicological problems. We discovered that a bacterial peptide siderophore (pyoverdine), which is a powerful Fe^{3+} chelator and an efficient Fe^{3+} transporter, possesses a catalytic function for organotin degradation. The reaction leads to the dephenylation of tri- and diphenyltin under mild conditions. Furthermore, the activity for diphenyltin is increased by addition of Cu^{2+} , suggesting that the siderophore also behaves as a metal-complexation catalyst. The new function found in peptide siderophore should be available for the design of a functional chelator to degrade trace organometallic compounds.



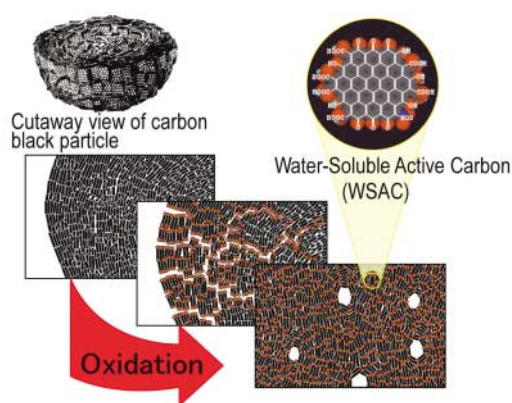
Degradation of diphenyltin by siderophore and siderophore-Cu (II) complex

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Water-Soluble Active Carbon

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Water-soluble Active Carbons (WSACs) were yielded by oxidative degradation of carbon black particles. WSACs consist of hydrophobic polynuclear aromatic planes and many hydrophilic functional groups. They dissolve in neutral and alkaline aqueous solutions and capture organic compound molecules on their hydrophobic planes. The amounts of the organic compounds captured by the WSACs are roughly equal to those of activated carbons. Moreover, it was found that WSACs reduce the toxicity of the pesticide, TPN, by capturing the pesticide molecules. This material would be a promising candidate for an environment restorative material.



Schematic representation of formation of Water-Soluble Active Carbon from carbon black

Energy Science & Technology

Chemical Hydrogen Carrier

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AIST Today Vol. 2,
No. 11 (2002) 14

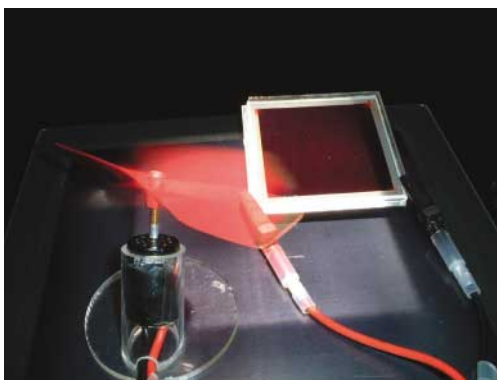
There has been a great concern on hydrogen as a clean secondary energy for fuel-cell driven cars etc. To the gas station, hydrogen should be transported in safety. For this purpose, liquid chemical carriers such as cyclohexane, dekalin, methyl cyclohexane, methanol etc. are promising candidates for hydrogen storage & transmission because those are liquid at an ordinary temperature and have higher hydrogen content (ca. 7 wt%). We have demonstrated that a highly efficient hydrogen production is possible using a palladium membrane reactor, where a hydrogen recovery exceeding 90% is obtained.



Recovery of pure hydrogen from chemical hydrogen carrier using a membrane reactor

Efficient Dye-Sensitized Solar Cell based on Novel Coumarin-Dyes

We have developed efficient coumarin-dye-sensitized nanocrystalline TiO_2 solar cells (DSSCs). We have attained a 7.5% solar energy-to-electricity conversion efficiency, the highest performance among DSSCs based on organic-dye photosensitizers, under AM 1.5 irradiation (100 mW cm^{-2}) with a DSSC based on a novel coumarin-dye photosensitizer and nanocrystalline TiO_2 photoelectrode. Our result strongly indicates that the molecular design of organic-dye photosensitizers for DSSCs can be successful and that the prospects for application of these photosensitizers in DSSCs are promising.



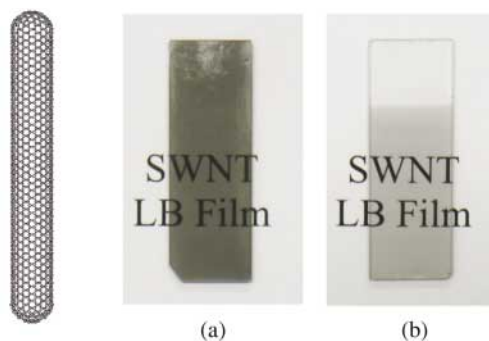
A dye-sensitized solar cell based on novel coumarin dye

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Nanotechnology and Materials Science & Technology

Thin Films of Highly Oriented Single-Wall Carbon Nanotubes

Optically homogeneous thin films of chemically solubilized single-wall carbon nanotubes (SWNTs) have been realized by the Langmuir-Blodgett technique. Deposition can be performed in a layer-by-layer fashion either by horizontal or vertical deposition, allowing to precisely control the film thickness. Absorption spectra of these LB films preserving the spectral features characteristic of semiconducting and metallic SWNTs prove that no serious alteration of their electronic structures occurred throughout the solubilization and film deposition. Polarized absorption spectroscopy and AFM observation demonstrate that the tubes are highly oriented in the vertical dipping direction. These results provide important basis for the future development of the scientific understanding and technological applications of this new and exciting form of carbon.



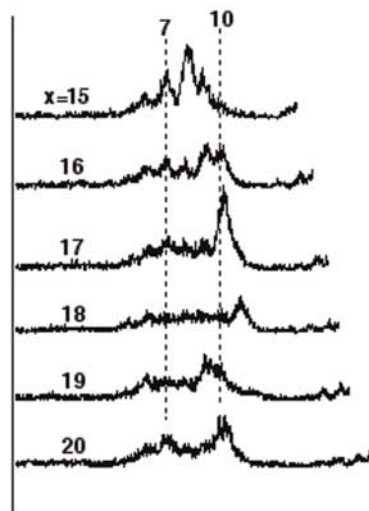
Langmuir-Blodgett films of single-wall carbon nanotubes by (a) horizontal lifting (140 layers) and (b) vertical dipping (58 layers).

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Experimental and Theoretical Approaches on the Stability of Nanoclusters

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 No. 10 (2002) 8

The article introduces the readers a joint research between AIST Chubu and IMR Tohoku University on the structure and size-dependent stability of group-14 clusters by means of surface induced dissociation (SID) experiments and theoretical calculations. So far, we have investigated on tin clusters and found that the fragmentation patterns and predicted structures are similar to those of Si and Ge clusters than those of Pb clusters, which is in contrast to similarities and differences in the bulk crystal structures of these elements.



Fragment ions generated in the collision of Sn_x^+ ($x=15-20$) with a graphite surface

Natural Ordering Superlattice of $\text{ZnO}_{1-x}\text{Se}_x$

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The $\text{ZnO}_{1-x}\text{Se}_x$ compound semiconductor has been grown by radical source MBE for the first time and we succeeded in obtaining its large bandgap bowing parameter of 12.7 eV. During this research, some SIMS depth profile of Se concentration occurred to show the formation of compositional ordering $\text{ZnO}_{1-x}\text{Se}_x$ layers. (Fig.1a) The period of $\text{ZnO}_{1-x}\text{Se}_x$ natural compositional ordering decreases with increasing Se concentration. The relationship between the period of the ordered layers and the Se concentration is consistent with Ferguson's theory. (Fig.1b) The dynamics of the two-dimensional nature of the compositional alternations of $\text{ZnO}_{1-x}\text{Se}_x$ can be explained by taking the surface dynamic process of growth kinetics into consideration.

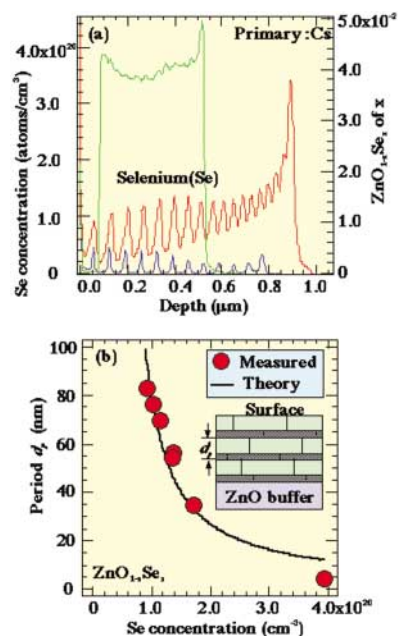
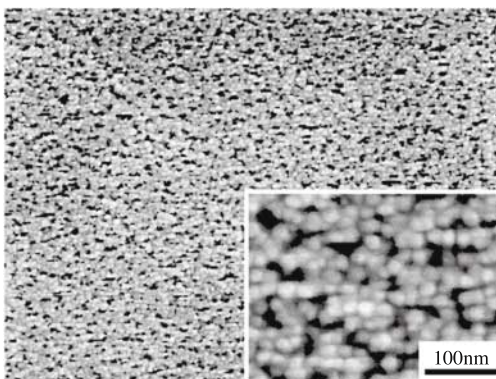


Fig.1 (a) Depth profiles of Se concentration in $\text{ZnO}_{1-x}\text{Se}_x$ thin films measured by SIMS and (b) the dependence of the natural compositional ordered period on the Se incorporation.

Fabrication of 3-Dimensional Silver Nanoparticles and Nanowires on CD Disk

Novel metal nanoparticles or nanowires have attracted an attention in physics and chemistry because of their unique characteristics on electrical conductivity and electrical field enhancement by localized surface plasmons. However, the simple and cheap fabrication methods have not been available so far. At LAOTECH in AIST, an easy but very valuable method was developed by the chemical decomposition of silver oxide thin film in a gas mixture of hydrogen and oxygen. By controlling the gas mixture ratio and pre-treatment of a vacuum chamber, we can convert the silver oxide film into 3-dimensionally deposited silver nanoparticles (each diameter~20 nm) or nanowires.



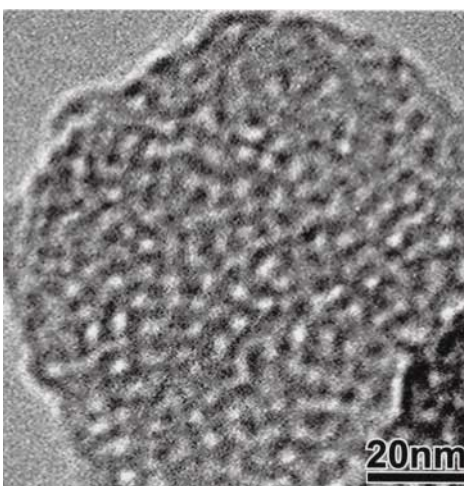
Silver nanoparticles generated by deoxidation of silver oxide layer under a gas mixture of hydrogen and oxygen (3:1) for 5 min. Inset is the expanded image

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Preparations of Hexagonal Tin- or Niobium Phosphate

- A Novel Anion-Exchangeable Nano Material -

Tin- and niobium phosphates were prepared from phosphoric acid with the corresponding metal chloride in the presence of suitable surfactants. The pore structures of these phosphates were hexagonal. These metal phosphates possess excellent anion exchange capacities. Especially in the case of niobium phosphate, 6.3 mmol-eq/g of capacity was observed, which is higher than common anion exchangeable resins. This is due to the charge balance of cations both on phosphorus and niobium. This unique property of these phosphates is expected to create some novel application of nanotechnology.



TEM images of calcined niobium phosphate

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No. 12 (2002) 13

Production of Fine-Grained Metals by Rotary-Die Equal-Channel Angular Pressing (RD-ECAP)

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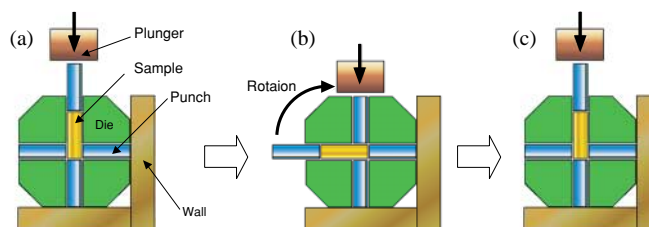
We have developed the new ECAP (Equal-channel angular pressing) process termed RD(Rotary-Die) ECAP. In current ECAP, a billet is repeatedly passed through two channels of equal cross-section intersecting at an angle. Then, intense plastic strain is introduced in a material without changing the cross-sectional area. RD-ECAP is differentiated from current ECAP by the following characteristics.

- Billet removal and re-insertion between passes are not required.

- The ECAP time is reduced by more than 75% compared to ordinary ECAP.

- The ECAP temperature can be precisely controlled and altered for different passes.

RD-ECAP is being applied to produce nano-structure metallic materials.



RD-ECAP process sequence. (a) initial state, (b) after one pass, and (c) after 90° rotation.

Development of Flexible Thin Film Piezoelectric Sensor

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(2002) 10

A foil type flexible pressure sensor based on piezoelectric of highly C-axis oriented aluminum nitride (AlN) thin film deposited on an aluminum foil substrate was developed. The sensor is composed of two AlN thin films and three aluminum foils as electrodes which detect the electric charge generated by pressure acting on the AlN film. The developed sensor having excellent flexibility can fit any curved surface like skin of human beings. Directly or indirectly, pulse wave of human beings can be detected precisely by using the developed sensor.

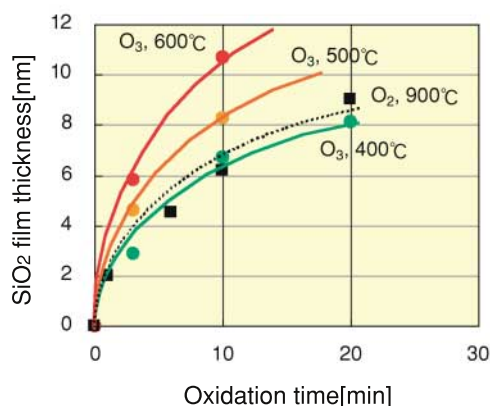


Developed sensor

Low Temperature Device-Quality SiO₂ Film Fabrication Process

- Development of 400°C Fabrication Process using Highly-Concentrated Ozone -

100 % ozone oxidation process has been applied for the first time to low-temperature oxidation of silicon to fabricate device quality SiO₂ films. A new quartz cold wall-type furnace equipped with a halogen lamp heater was built for efficient oxidation by 100 % ozone gas supplied from the lab-developed highly-concentrated ozone generator. As shown in the figure, the ozone-oxidized SiO₂ film growth rate at 400 °C was as large as that of the conventional thermal oxidation at 900°C. The electrical properties of the ozone-oxidized SiO₂ films show that the films are of the device grade.



Comparison of the oxide film growth rates between ozone oxidation and thermal oxidation: The ozone oxidation at 400°C shows a nearly equal growth rate to the thermal oxidation at 900°C. (the value from a literature)

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(2002) 11

Design of Smart Structure

- Stable Control of Tower Structure Using Distributed Sensor/Actuator -

When some stimulus exist, nerve of living things catches them as information and muscle responds immediately to lead living things in security. Our research has an object to make structure as simulated living things; in other terms, make a smart structure which includes sensor and actuator corresponding to nerve and muscle, respectively.

Until today, vibration information had been taken by a sensor which can collect only from specific point. Control by using point information sensor has problems, such as problem on distinguish vibration modes or problem on amount of information, so that there remind some difficulties on construction of control system.

The subject here is to realize a stable control system by using smart sensor and actuator (actuation system). First, let a sensor itself sort out factors which harm structures, using 2D sensor made of PVDF film. Second, at the same time, generate distributed actuation system without causing in-

stable phenomenon of structure. Smart structure with higher safeness for structure is on development by realizing the series of movements above-mentioned.



Experimental set up of smart tower structure

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Discovery of Friction-Generated Micro-Plasma

- With a Comet-like Propagation Pattern Around the Contact Point -

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No. 10 (2002) 13

We discovered a microplasma generated in a gap of sliding contact and achieved a world-first success in total micro-plasma imaging. We proposed its existence previously (Fig.1) and proved finally the hypothesis. It had a comet like shape with a tail and a horseshoe pattern on it (Fig.2). It was generated even under such extremely low load as 3g and low friction speed as 2 cm/s. It is generated for almost all materials of insulators, semiconductors and metal oxide films. This means that we are always with the microplasma in our daily life and in industry.

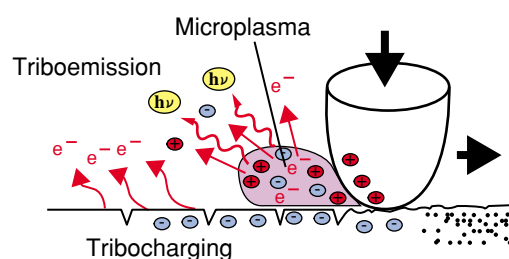


Fig.1 Gas-discharge plasma model

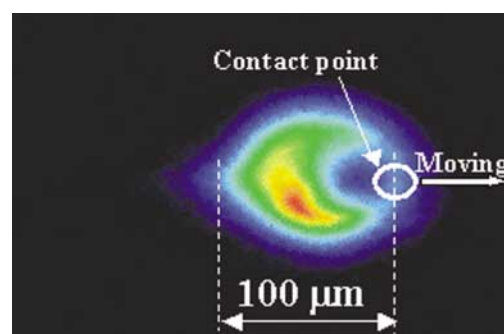


Fig.2 UV Plane image of plasma

Development of a Novel Determination Method for Dioxin Concentration

- Enables More Accurate and Rapid Dioxin Determination than Using the JIS Method -

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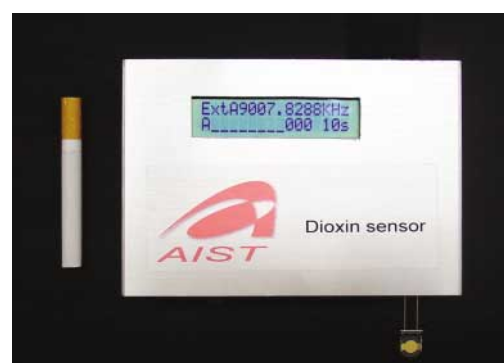
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The Institute for Environmental Management Technology and Human Stress Signal Research Center of the National Institute of Advanced Industrial Science and Technology (AIST) succeeded in rapid and accurate determination of dioxin concentration in actual environmental samples (fly ash from waste incinerators extracted and cleaned up with an accelerated solvent extractor) using QCM sensors. This development enables highly accurate and rapid dioxin determination in proportion to the GC/MS method in the JIS standard. It is hoped that it will make on-site determination of dioxins possible.



Photograph of the dioxin sensor using QCM method

Development of a Low-Cost, Wide-Range Hydrogen Gas Sensor

The Environmental Sensors Team of the Synergy Materials Research Center, AIST, has developed a low cost, wide range hydrogen sensor. The sensor is based on the novel gas sensor device combining a thermoelectric conversion material with a platinum catalyst which was presented last year by the same team. At operating temperature of 60 to 100 °C, the platinum catalyst selectively reacts with hydrogen gas, so the sensor has high selectivity to hydrogen gas. This new sensor is uniquely able to sense hydrogen concentrations from 250 ppm to 10 % in air, and is suitable for integration into silicon substrates.

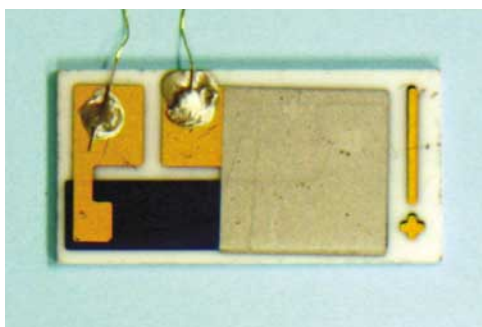


Photo of thermoelectric hydrogen sensor.

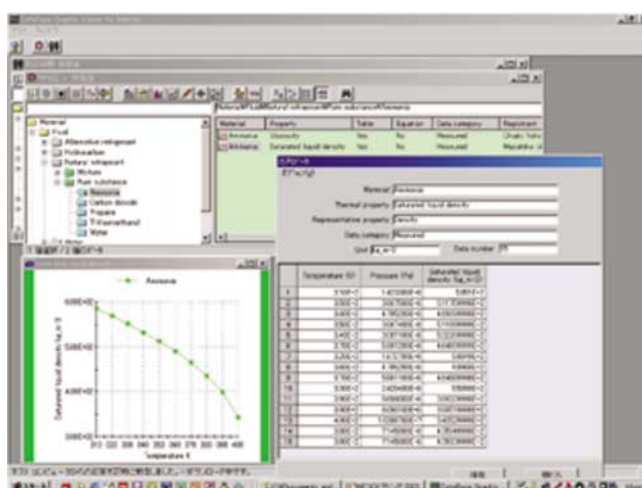
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AIST Today Vol. 2, No. 10 (2002) 15

A Network Database System for Thermophysical Property Data

We are developing a thermophysical property database by collaboration of scientists, researchers, and engineers who produce data by measurement and/or evaluation [1]. The independent databases in personal computers of collaborators are merged to a master database file stored in the database server operated at the key station and opened to worldwide access via the Internet.

This system will encourage data registrants to construct their own databases and accumulate thermophysical property data for huge variety of materials. A user friendly graphical user interface has been developed to register and access thermophysical property data the internet efficiently as shown in Fig. 1.

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For thermophysical property data

Purity Determination with Adiabatic Calorimeter

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No.11 (2002) 19

Most of the analytical instruments require reliable calibration standards for the accurate quantitative determination. The raw materials of these calibration standards are mainly high purity materials whose purities are determined by the SI traceable primary method. Freezing point depression method is one of the primary methods for the determination of the purity traceable to the SI without any reference materials. We introduced an adiabatic calorimeter for this freezing point depression method. We have determined the purity of some high purity organic compounds with this adiabatic calorimeter, and supplied as CRMs with certified value of purity.



Adiabatic Calorimeter

EGA-MS Instrument with Skimmer Interface

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No. 12 (2002) 20

EGA-MS (Evolved Gas Analysis-Mass Spectrometry) instrument has been constructed with skimmer interface that is effective to measure adsorptive gaseous species and useful to infrared image furnace. The skimmer interface is based on the principle of a jet separator. Thus objective gaseous species with higher mass have been enriched because of the difference of diffusion velocity from helium with light mass. The apparatus has successfully analyzed carbon substances in materials by sol-gel processing.



Scheme of skimmer interface

A Fast-Reversed DC Measurement with a Josephson Voltage Source

Ac-dc transfer difference due to thermoelectric effects in a thermal converter was evaluated using a NbN/TiN/NbN Josephson junction array as an ultra-stable Fast-Reversed DC (FRDC) source. The Josephson junction array was connected in parallel with a conventional semiconductor FRDC current source, as an "add-on" voltage-stabilizer for the input of the thermal converter. The ac-dc difference due to thermoelectric effects was evaluated with standard measurement (type-A) uncertainty of the order of $0.01 \mu\text{V}/\text{V}$, four-times better than that for the conventional semiconductor FRDC source.



Measurement set-up for a Josephson-based Fast-Reversed DC

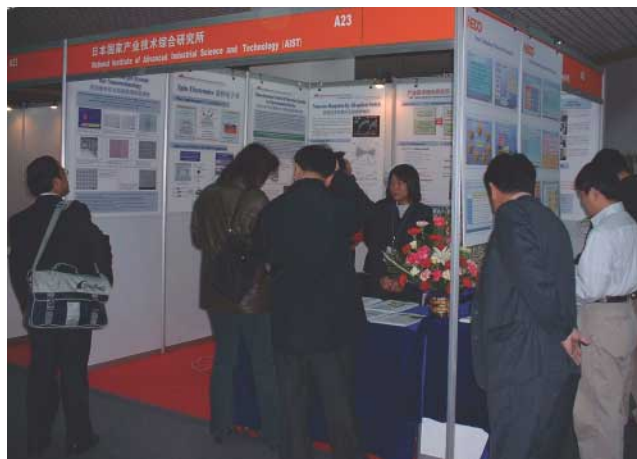
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12 (2002) 21

China International Nanotechnology and New Materials Exhibition — the First Nanotechnology Forum in China, "the Factory of the World" —

On November 3—5, 2002, China International Nanotechnology and New Materials Exhibition (China Nanomat 2002), organized by nABACUS Ltd., was held in Beijing, People's Republic of China, under the auspices of Ministry of Science & Technology (MOST) and Chinese Academy of Sciences (CAS). It attracted a great amount of attention as the first forum on nanotechnology in China, "the Factory of the World", which has established its national strategy prioritizing nanotechnology.

At the Exhibition, lectures were given on nanotechnology strategy of various research organizations in the world, investment strategies for nanotechnology by venture capital firms, and other topics. There were exhibits of the research results by about 50 nanotechnology-related institutes such as universities and companies (all were from China, except AIST and National Institute for Materials Science (NIMS)). At AIST's exhibition booth, panels were displayed by Nanotechnology Research Institute (R.I.), Photonics R.I., Nanoelectronics R.I. and Synergy Materials Research Center, which were written both in English and in Chinese. In addition, there were panels and videos that describe the outline of AIST. Our booth, with these panels and Chinese-speaking staff, was highly appreciated by the visitors, and the 100 brochures that we had prepared were completely given away in the morning of the first day. Moreover, we had received some offers for commercialization by Chinese corporations.

The laboratory tours were organized as a part of the Exhibition, and we had a chance to visit nanotechnology-



related institutes, including CAS, Tsinghua University and Peking University. We deeply felt that the Chinese government is realizing its high priority on nanotechnology.

http://www.aist.go.jp/aist_j/event/ev2002/ev20021103/20021103.html

Korea/China/Japan High-Tech Business Forum 2002



"Korea/China/Japan High-Tech Business Forum" was held at the COEX and ASEM Convention Center in, Seoul on Wednesday October 16, 2002. This forum focused on the high technology such as life science, information communication technology and environmental technology among Korea, China and Japan. It had about 150 participants from the three countries. The forum was presented by the Korea Industrial Technology Foundation with the co-operation of AIST and China Association for Science and Technology. On behalf of AIST, six researchers headed by Dr. Hiroshi Miyamoto, Director of International Affairs Department, joined the forum as invited speakers. Furthermore, about 20 attendees were sent by Japanese high-tech related enterprises and universities. Following the opening remarks made by representatives of each country including Mr. Koon-Hwan Shin, the Korean Minister



of Commerce, Industry and Energy, simultaneous sessions took place on three subjects: IT, life science and environment technology for information exchange of the specialists of each field. It was also decided that the next forum in 2003 would be held in China. Exhibitions of high-tech products presented by about 100 companies mainly from Korea were held on the following day.

The AIST Innovation Center for Start-ups has Inaugurated Its Marunouchi Office



The AIST Innovation Center for Start-ups has inaugurated its Marunouchi office on October 28th (Mon). The 300-square-meter office is located on the second floor of the Marunouchi Mitsui Building, 5 minutes walk from Tokyo Station, facing the greenery of the Imperial Palace. The office features are a research laboratory and meeting rooms.

The Innovation Center for Start-ups headquarters are in Tsukuba and Marunouchi, Tokyo. They engage in researches regarding Japanese public institutes methods and systems, which will bring new business is not a verb. To make a successful conclusion, as part of Encouraging development of strategic research centers, Special Coordination Funds for Promoting Science and Technology of the Ministry of Education, Culture, Sports, Science and Technology are given. For this purpose, the center may be able to solve the problems of venture business by promoting creativity and technical activity. We will carry out for a new formulation of research development to extend achievements of research to industry by AIST, universities, and other public research institutions through this entrepreneurial venture.

http://www.aist.go.jp/aist_j/topics/to2002/to20021029/to20021029.html

Conclusion of the Research Co-operation Agreement with the Mongolian Geological Investigation Center (GIC)



The Institute of Geoscience of AIST (Director: Hirokazu Kato) concluded the research co-operation agreement with the Mongolian geological research institute, Geological Investigation Center (Director: Mr. ShBaasandorj) in Ulan Bator, Mongolia on July 18, 2002.

The Geological Investigation Center (GIC) is one of the research institutes of geological survey affiliated with the Mineral Resources Authority of Mongolia.

AIST has been involved in a number of joint research projects with GIC through ITIT (Institute for Transfer of Industrial Technology) programs and JICA Technical Cooperation Projects from the former Agency of Industrial Science and Technology.

Based on this agreement, various programs will be conducted including the technological transfer of geological mapping by means of geological remote sensing, exchange of geological data and technological information, active interaction among researchers and graduate students, and preparation and implementation of joint research and development projects. It is hoped that these efforts will enhance the co-operative relations between the two institutions in research activities.



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