ISSN 1346-602X

Full Research in Society, for Society

AIST TODAY

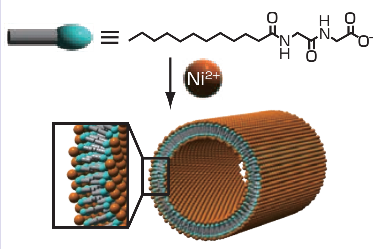
National Institute of Advanced Industrial Science and Technology

International Edition

2012

2012-1

No.43

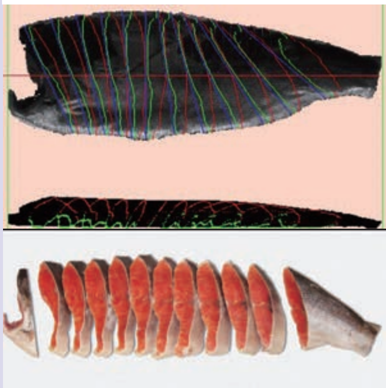


MESSAGE

President's Message
Thoughts for the New Year 2012

FEATURE

Tsukuba Innovation Arena for Nanotechnology (TIA-nano)
Taking on the Challenges of a Global Research Center



Research Hotline
UPDATE FROM THE CUTTING EDGE（October–December 2011）

In Brief

President's Message
Thoughts for the New Year 2012

Introduction

I greeted the arrival of the year 2012 with the wish that it would be a tranquil year free of any large disasters. I imagine that the readers of *AIST TODAY* feel the same way.

With the Great East Japan Earthquake of 3/11 at the top of the list, we faced natural disasters such as volcanic eruptions, torrential rains, and typhoons one after another last year. In addition to the damage done by the earthquake and the tsunami, long-term evacuation due to the nuclear accident, harmful rumors concerning radiation, and power shortages have had a tremendous impact on people's lives, the economy, and the industries of Japan, and we have to be prepared for the fact that restoration and recovery will take quite a long time. AIST Tsukuba and AIST Tohoku suffered significant damage from the earthquake, but we have resumed research activities and made progress since then.

The events of last year made me see the role of a public research organization in a new light, and taught me lessons for the future, especially through our responses to the earthquake disaster. I also strongly recognized the need to strengthen the hub functions of open innovation that we have been working on, in order to contribute to the preservation and expansion of Japanese companies' competitiveness in the world. These insights from last year are noteworthy enough to modify many of the long-held beliefs that we naturally inherited from the past. In order to contribute to the creation of a sustainable future society, we must face these issues with the utmost diligence.

In my message at the start of the year, I would like to express my thoughts about these issues without being too formal.

Overcoming the earthquake disaster

From immediately after the Great Earthquake of 3/11, many inquiries and requests for advice and support were sent to AIST from the outside. According to our Public Relations Department, there was a significant increase in the amount of traffic to the AIST website after March 11. Before the earthquake, in early March, the average number of visits per day was about 20,000. After the earthquake, the number increased to more than 100,000, with the record number being more than 200,000 in one day. The major reasons for this increase in traffic were the results of radiation dosimetry and earthquake-related information that we published on our website starting soon after the earthquake. We received many inquiries about the health effects of radiation and questions about the tsunami and aftershocks, and our staff responded to them attentively.

In the first six months after the earthquake, we conducted 25 geology-related research activities as well as supporting efforts such as urgent field investigations in relation to the earthquake. TV stations and newspapers reported that AIST researchers had long been advocating the need to take countermeasures against large-scale tsunamis in the national government's nuclear power plant-related council meetings. These researchers, who voiced their convictions even though they were dissenting opinions, showed that they were fulfilling their responsibility as scientists. Although it is regrettable that major damage was not prevented, their efforts in visiting the sites whenever possible and explaining the need to prepare for large tsunamis should be recognized.

There is a novel entitled Sanriku Kaigan Ōtsunami ("Great Tsunamis on the Sanriku Coast") by Akira Yoshimura. Soon after I took office as president, an AIST geologist's talk inspired me to read it. The central theme is the tsunamis that have repeatedly hit the area, in the Jogan (859-877), Edo (1603-1868), Meiji (1868-1912), and Showa (1926-1989) periods. The author describes in the postscript of the paperback edition that he wrote the novel in the hope that people would learn from the past in order to minimize damage in the future. Unfortunately, last year's catastrophe taught us that we are far from being able to fully use our knowledge of science and technology, as well as our experience, and more efforts have to be made in order to make such knowledge applicable to society. The reason why the Shinkansen had no accidents lies in the fact that the results of earthquake research were able to be used as practical knowledge for society. We must try to increase the number of examples of appropriate application such as this for our future society.

We conducted 55 support activities related to radiation dosimetry in six months. I mentioned earlier that we responded to inquiries sent by the general public through our website. We also carried out a variety of activities including making the results of radiation dose measurements at AIST Tsukuba available to the public, reporting the results to national and local governments, providing human resources to the City of Tsukuba's disaster response headquarters, supplying measuring instruments to Fukushima Prefecture, and sending staff there to assist in the measuring of radiation. With staff members in the Metrology and Measurement Science field, who planned the aid effort, heading the list, people from all six of AIST's research fields volunteered to participate, and more than 100 employees (researchers, administrative staff, and even former employees) visited the Iwaki Technical Support Centre of the Fukushima Technology Centre in a five-month period and engaged in measuring radioactive contamination.

Companies throughout Japan, especially in the Tohoku region, suffered from harmful rumors about radioactive contamination in their products; however, our support efforts made a significant contribution to preventing the dissemination of false rumors at an early stage. We received letters of appreciation from the governor of Fukushima Prefecture and the director of the Fukushima Technology Centre. We also provided training sessions on radiation measurement and information on radiation to many organizations including the Ministry of Education, Culture, Sports, Science and Technology; the Ministry of Economy, Trade and Industry; prefectural public research institutions; various industry organizations and associations; local institutions; and welfare organizations. We assisted them in accurately understanding the situation and in devising a plan for each of these organizations. We will continue to provide such support in the future.

The Council for Promotion of Industrial Technology Collaboration (CPITC) is an institutions with more than 100 public research institutions nationally as members. The president of AIST serves as the president of the organization, with the secretariat located at AIST. Support for the industry in disaster-affected areas using this organization's network had a powerful effect. From Hokkaido in the north to Kyushu in the south, institutions all over Japan offered support in response to email requests from the secretariat. This included testing requests, consultations regarding technological inquiries, and requests for equipment from companies in the disaster zone, and many collaborations took place between these public research institutions. The media reported that supply chains worldwide had been significantly affected by the damage especially to large companies. The effects of damages to small- and medium-sized companies that provide high-quality components and materials were equally great. Supply chains seem to be recovering faster than initially expected, and CPITC, which has been making strong efforts to support small and medium-sized companies, has made significant contributions to their recovery. The experience CPITC has gained through the supporting efforts can be utilized in future industrial support as well.

A new era for energy

The power outages over a wide area due to earthquake and tsunami damage made me keenly aware of the need to strengthen the power supply system. In addition, the accident at the Fukushima Daiichi Nuclear Power Plant is urging Japan to redefine its energy strategy. For a long time, Japan has the concept of an optimal energy mix, namely utilizing a variety of energy sources without placing too much emphasis on any one type in particular, based on the recognition that Japan is a country with few natural resources. I believe that this concept was spelled out in the mid-1970s, after the 1973 oil crisis, and was aimed at constructing a rational and efficient utilization structure by combining fossil fuel energy sources such as petroleum and coal; nuclear energy; and natural (renewable) energies such as hydroelectric power, wind power, photovoltaic power, solar thermal power, and geothermal power. Nuclear power was initially projected to account for about 20 % of total electric power demand; however, the figure increased over time, and discussions about raising the ratio to more than 40 % were taking place until recently. The nuclear power plant accident has forced us to reconsider this. It is certain that a major role will be played by renewable energies in the new energy policy. And as regards the electric power supply network, smart grids, which realize stable use of generated electric power, will be introduced based on the assumption that larger amounts of renewable energies must be generated compared with pre-earthquake figures.

Newspapers and other media have reported the national government's intention to establish a renewable energy research and development base in Fukushima Prefecture, and AIST will play an active role in this. AIST has been conducting *Full Research* for a long time in the areas of photovoltaic, wind, and geothermal power, and we have achieved many results that are currently being applied in society. Based on our achievements, we aim to attain innovative outcomes in terms of efficiency, reliability, stability, and pricing. The accomplishments we are attempting to achieve include not only physical items such as products and devices but also proposals for standardization and specifications to properly evaluate conscientious manufacturing by Japanese companies that put an emphasis on quality. Trials of evaluation and certification based on the standards and demonstration of highly acceptable systems are also included. Although energy-related research requires time and money, I would like to make AIST a leading research base, in collaboration with private companies, universities, and public organizations, where scientists and technical experts gather from inside and outside Japan.

Conservation and the effective use of electrical energy have been serious problems in Japan since the earthquake, but these are also very important concerns worldwide. AIST is currently engaged in a number of research initiatives that aim to create a power-conserving society in the future, in the fields of lithium-ion batteries, next-generation rechargeable batteries, SiC power devices, ultra-low-voltage-driven silicon devices, normally-off devices, and silicon photonics. By integrating these efforts with research and development at the new base, AIST will cultivate a new era for energy that is highly efficient and ecological.

A new era for industry, academia, and government collaboration

The AIST Open Lab 2011 held on October 13 and 14, 2011, had more than 4,200 visitors, which was a 20 % increase over the previous year. I spent those two days with a gratifying feeling that people are expecting a great deal from us year after year, and our way of engaging with them here at AIST has been improved. While interacting with visitors from private companies, universities, and local governments, I felt a thought that I had vaguely kept in my mind for several years turn into a conviction: we are now in a new era of industry-academia-government collaboration. In other words, we are in the open innovation era, in which various players cooperate synergistically and complementarily, as indicated by the arrows below.

Industry: Large-sized enterprises (manufacturers) → Large-, medium-, and small-sized enterprises (manufacturing, service, and financial businesses)

Academia: Universities (science and technology) → Universities (arts, science and technology) and technical colleges

Government: National government, national research institutes → National government, local governments, national research institutes, and prefectural research organizations

Goal: Production, technology, and personnel development → Production, technology, service, standardization, certification, and personnel development and utilization

Although it may not seem like a new concept to you, we are under a harsh set of conditions known popularly as the "six intense sufferings" (strong yen, high corporate taxes, increased labor costs, restrictions for environmental protection, delays in economic partnerships, and constraints on power supply—documented by the Industrial Structure Council), and efforts for innovation involving all of society are necessary in order to revitalize Japan, a country with few natural resources.

I would like to add a few explanations here, starting with the industrial sector. Destruction of the industrial supply chains by the Great East Japan Earthquake of 3/11 has become a major topic. The media reported that the earthquake damage to not only large companies but also small- and medium-sized technology-based companies had a large impact, bringing to light the important roles these small- and medium-sized companies in Japan play in the global economy. These companies are currently enduring a very severe management environment with the six sufferings. They need to be included in the collaboration circle of industry-academia-government more than ever, and we have to make sure that their environment is such that at least they can manage to maintain their technical bases. I believe that the weakening of small- and medium-sized technology companies will lead to the thinning of industries in Japan, more so than the shifting of large corporations overseas. The reason for including service and financial industries lies in the fact that their importance will increase along with the current trend toward softening economies. Additionally, there is room for them to be revitalized and optimized.

Secondly, I would like to explain the academia part. We are currently seeing that society is unable to follow the speed of technological advancement. For example, there are cases in which regulations must be eased first in order to promote the use of products or activities. Other cases involve concerns over harmful effects from certain products, or activities without early adoption of appropriate guidelines. The collaboration circle must include not only science and technology researchers but also humanities and arts researchers, so that research and development as well as investigations to allow the results obtained to be smoothly utilized in society are conducted in parallel. In addition, technical college graduates, whose capabilities are highly evaluated by industries, have a large potential and should be included as a part of academia.

As for "government," it is important to secure the participation of local governments and local public research institutes. AIST signed a partnership agreement with the City of Maniwa in Okayama Prefecture last year. The city has a plan for industrial development that utilizes forest resources in the area, and AIST plans to take part in their plan in the area of biomass technology. Pioneering innovations led by enthusiastic local governments in various places, as members of the industry-academia-government collaboration, can have a significant effect on the revitalization of Japan at the national level. Further, public research institutes, which I previously mentioned in regard to activities for and contributions to emergency recovery efforts from the earthquake damage, play a key role as supporters of local companies. AIST considers the strengthening of CPITC's activities to also be important.

Lastly, I would like to talk about the "goal." Setting the goal of collaboration as simply creating world-class products and developing technologies and human resources to support the realization of such products is no longer valid. We need to propose a framework for products and projects so that they can be used by customers with confidence over a long period of time. Proposals for international standards and specifications as well as the construction of certification systems are typical elements of such a framework. Japan has fallen behind Western countries in this area, and it is not too much to say that international standards are the only tools that ensure fair competition in an era when the number of countries and regions having a large impact on the global economy is rapidly increasing. In Germany, for example, which is often compared to Japan as another industrial state with manufacturing as the main industry, the production of consumer products is mostly limited to automobiles, and products often considered to be declining goods in Japan, such as televisions, mobile phones, and computers, are rarely produced there. Even then, Germany has a stronger presence in the global market than Japan, and one of the reasons for this involves its business climate, in which partnerships between industrial strategies and standards/certification strategies occur naturally. We need to learn from them. Further, it is important to create new services, develop human resources, and utilize them in order to improve people's quality of life and social activities. We often hear about development plans for young people. The nurturing of talented people who can play an active role on the global stage is essential, and they should be intensively trained. I mention the utilization of human resources here because I would like a larger number of retired scientists and engineers with rich experience to be more active on the scene. High utilization of these experts will not only improve innovation capability, but also make our society a better place to live.

Closing

It seems that I am running out of space here while offering my opinions. I have limited myself to three topics, but feel that I have not quite expressed enough in each of them. I intend to describe the research and development base for renewable energy in more detail in the future. With regard to the various open innovations in the new era of collaboration, I will continue to send out messages through the Tsukuba Innovation Arena (TIA) and various consortiums.

Let me conclude by offering my best wishes to you for the New Year.

Tamotsu NOMAKUCHI

President
National Institute of Advanced Industrial Science and Technology (AIST)

Tsukuba Innovation Arena for Nanotechnology (TIA-nano)

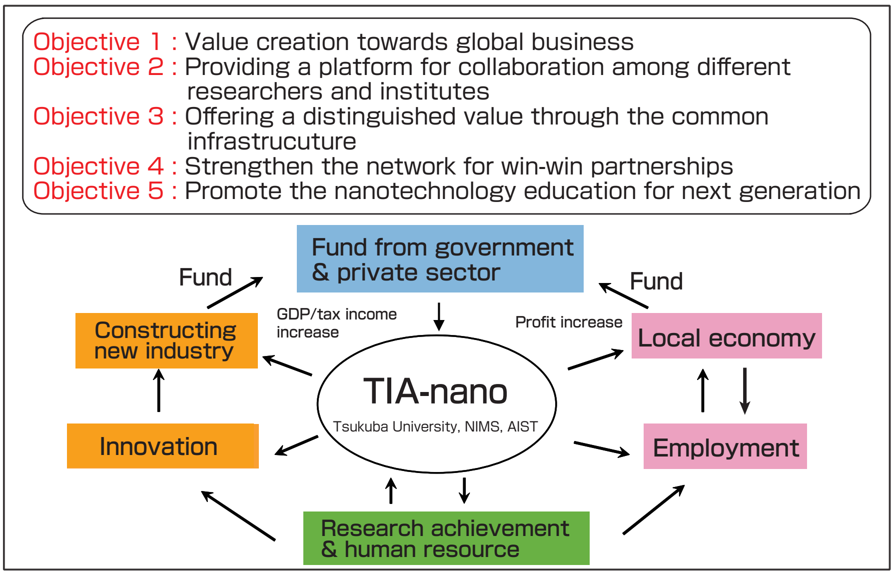
Taking on the Challenges of a Global Research Center

The Establishment of TIA-nano and its Fundamental Principles

Japan's economy and industry have been in a state of serious stagnation in recent years and in 2010, Japan was surpassed by China and fell to third place in the global GDP rankings. In the meantime, innovation models in recent years have been emphasizing fusion of various academic and technological fields, unification of research and education, and cooperation among industry, academia, and government. Moreover, to actualize these ideas, large-scale research and development centers are being established in Europe and the United States. In light of this general trend, it has become essential for Japan to also strengthen its nanotechnology strategy in order to propel growth, resulting in growing calls for the creation of a Japanese nanotechnology research center.

In response to these circumstances, in June 2009 a decision was made to create a global nanotechnology research center in Tsukuba, the home of world-class advanced nanotechnology research facilities and human resources. This center, known as the Tsukuba Innovation Arena for Nanotechnology, or TIA-nano for short, was consequently established with the National Institute of Advanced Industrial Science and Technology (AIST), the National Institute for Materials Science (NIMS), and the University of Tsukuba comprising the core, together with participation by the private sector.

Japan has strong technological traditions in the fields of nanotechnology and related material technologies and has achieved many pioneering research and development results, while giving birth to a number of world-leading businesses. In order to build a nanotechnology research center that makes the most of these Japanese strengths with the goals of contributing to the prosperity of Japan as an advanced manufacturing country and solving global issues, TIA-nano was established on the basis of the following five objectives.



Principles of TIA-nano and graphic representation

Objective 1: Value creation towards global business

By assembling the best of science and technology in industry, academia, and government and through practical demonstrations using common basic infrastructure, to rapidly create new global-scale businesses.

Objective 2: Under One Roof

By creating a place where researchers and research bodies from various industries as well as academia and government can join together and collaborate despite the differences in organizational culture, to construct a hub of co-creation under one roof that overcomes existing barriers.

Objective 3: Spiral-up benefits

By providing an internationally advantageous common basic infrastructure to research bodies throughout Japan and the world, to promote research and development, commercialization, and the creation of knowledge.

Objective 4: Networking for Win-Win

To construct a national network centering around Tsukuba that connects industry, academia, and government. In addition, to further enhance the international cooperation network generating win-win relationships with overseas research centers and institutions.

Objective 5: Education of the next generation

With the University of Tsukuba at the core and the cooperation of universities worldwide together with the joint forces of industry, academia, and government, the TIA Graduate Schools Alliance will be established to function as a center for graduate education and industrial human resources training.

Grounded upon these basic principles, TIA-nano is in the process of constructing a global collaboration center for industry, academia, and government on a platform of public research and educational institutions.

Chairman,
Executive Board of the Tsukuba Innovation Arena for Nanotechnology
Teruo KISHI

For inquiries about this article : Tsukuba Innovation Arena http://tia-nano.jp/en/index.html

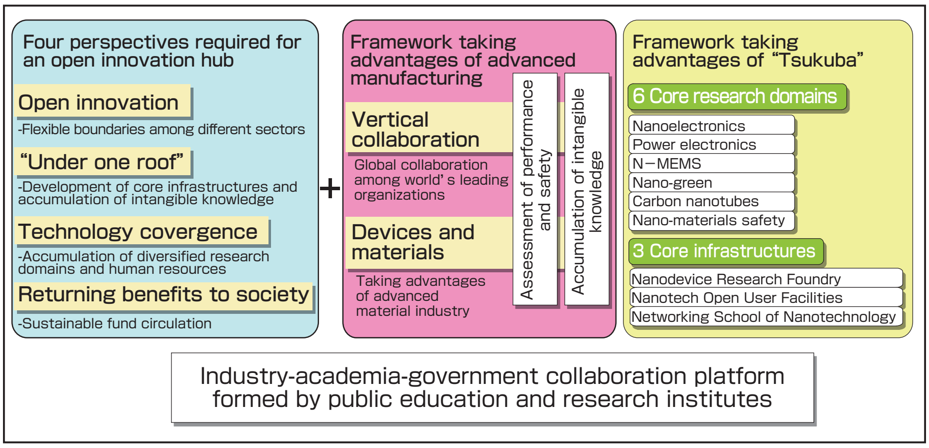
Establishment of a Medium-term Plan for TIA-nano and the TIA-nano Alliance Forum

Establishment of a medium-term plan for TIA-nano and the TIA-nano Model

At TIA-nano, we are striving to create "independent spiral-up benefits" that will contribute to the securing of strong international competitiveness brought about via nanotechnological innovation, which will, in turn, promote reinvestment in research and development supported by expansion of employment opportunities due to the birth of new industries and increased GDP, and which will then propel further innovation and creation of new industries. To realize this virtuous circle, TIA-nano has proposed the "TIA-nano Model" for the maximum use of the strengths of Japan, in its first medium-term plan (FY2010-2014).

As typified by the automobile industry, Japan's strength traditionally lies in vertical collaboration based on mutual adjustments that begins at the stage of raw materials, materials, and parts manufacturers and continues through to processing and assembling and all the way to sales. Moreover, the industrial sectors in each and every layer of this manufacturing process contribute to a variety of innovations.

Additionally, intellectual property accumulated in public research institutions in Tsukuba and an extensive research support system are also strengths of Japan. At TIA-nano, taking the human resources, research accomplishments, and highly advanced research facilities of AIST, NIMS, and the University of Tsukuba into consideration, we have decided to concentrate capital and human resources on six core research domains and to create three core infrastructures to support these research domains.



The TIA-nano Model

In Japan, public research institutions have been assuming responsibility for industrial technology development and have been acting as the focal point for national projects ever since the postwar period of rapid growth, and the existence of a platform composed of public research institutions has proven to be a strong point of Japan in creating industry, academia, and government collaboration. The goal of TIA-nano is to contribute to the prosperity of Japan as an advanced manufacturing country and to the solution of global issues through the realization of the TIA-nano Model that maximizes the use of Japan's strengths.

Collaborative structure of TIA-nano and the TIA-nano Alliance Forum

TIA-nano has created a new collaborative structure to support smooth implementation of the action plan prescribed in its first medium-term plan. In May 2011, the TIA-nano Alliance Forum was established and with TIA-nano and the Nanotechnology Business Creation Initiative, a collaborative structure between the TIA-nano management body and organizations intending to utilize TIA-nano such as technology research associations has been created, with concrete collaboration already being actively pursued. At the same time, the Tsukuba Innovation Arena Networking School Consortium was established to foster practical research personnel by making full use of TIA-nano's advanced infrastructures and intellectual property.

Presently, TIA-nano is vigorously advancing its plans for creation of the world's top-class nanotechnology research center based on the first medium-term plan and its corresponding action plan, on the foundation of these strong collaborative structures.

Secretary General,
Executive Board of the Tsukuba Innovation Arena for Nanotechnology
Fumihiko MATSUKAWA

Expectations for TIA-nano

In the Fourth Science and Technology Basic Plan, issue-driven science, technology and innovation are strongly promoted and hence the activities and operation of TIA-nano are being viewed with great attention. I am looking forward to TIA-nano developing as one of the world's top-notch innovation development centers that attracts leading corporations and researchers from around the globe through the creation of attractive programs based on coordination among different research domains and different fields in addition to TIA-nano’s six core research domains.

Director for Nanotechnology and Materials,
Bureau of Science, Technology and Innovation Policy,
Cabinet Office
Toshio BABA

I am greatly looking forward to the framework of TIA-nano attracting the best and the brightest of industry, academia, and government around cutting-edge research and development infrastructures and becoming a place for mutual inspiration that will generate world-leading knowledge and innovation.

Director, Office for Materials Science and Nanotechnology Development,
Basic and Generic Research Division,
Research Promotion Bureau,
Ministry of Education, Culture, Sports, Science and Technology
Shuichi SAKAMOTO

Japan today is faced with unprecedented difficulties. To overcome the problems in such areas as energy, the aging of society, and the deteriorating economy, the fusion of technology, human resources, and the social environment (leading-edge equipment) is indispensable. TIA-nano has the potential to become one such model. Industry, academia, and government are joining together in Tsukuba, and a great movement has already started. I anticipate that here we will witness the birth of the world’s best technologies, human resources, and industries.

Director, Research and Development Division,
Industrial Science and Technology Policy and Environment Bureau,
Ministry of Economy, Trade and Industry
Hiroshi FUKUSHIMA

Creation of New Industries and Employment from the Operation

It is said that about 16 % of Japan’s total labor force is employed by the manufacturing industry, but due to the recent extremely strong yen and comparatively high industrial costs, there are concerns that the overseas relocation of Japanese manufacturing industries may be accelerated. The mission of TIA-nano is to revive the Japanese manufacturing industry and secure new employment by reinforcing the transition between development and commercialization of nanotechnology and material technology, which are the foundations of manufacturing. Thus, the responsibilities of those involved in this project are very great.

At TIA-nano, we are tackling subjects that will contribute to the realization of a sustainable society such as nanoelectronics, power electronics, nano- and microelectromechanical systems (N-MEMS), carbon nanotubes (CNTs), new materials, and safety evaluation of nanomaterials. Although similar research centers already exist in the world, with the huge potential accumulated up to now by AIST, NIMS, and the University of Tsukuba, combined with enthusiastic private-sector participation, systemic ideas (namely, the development of nanosystems that are ahead of societal needs), and strong government support, we believe that we have a great chance of establishing ourselves in the world.

The goal of TIA-nano is to create new industries and employment. We hope that the participating researchers will join together under clearly defined objectives and tackle highly complex themes as a team. We are earnestly looking forward to the convergence of industries in Tsukuba and the subsequent creation of new employment opportunities throughout the country.

Chairman,
Board of the Tsukuba Innovation Arena for Nanotechnology
Michiharu NAKAMURA

For inquiries about this article : Tsukuba Innovation Arena http://tia-nano.jp/en/index.html

TIA-nano's Efforts in the Nanoelectronics Field

Creation of a nanoelectronics research center

In the nanoelectronics research domain, TIA-nano is working on a project to merge complementary metal-oxide-semiconductor (CMOS) technology and nanotechnology. The semiconductor processing lines (Fig. 1) with 100-mm and 300-mm wafer diameters, which are core infrastructures, have been set up inside the Super Clean Room (SCR) building of AIST Tsukuba West. Here, the circumstances that led to the creation of such a nanoelectronics research center and its significance are briefly explained.

As we entered the 2000s, activities using large-scale research centers such as Albany NanoTech in the State of New York, U.S.A., became common for semiconductor research and development. This was due to the worldwide consolidation of pilot manufacturing lines caused by soaring research and development costs.

With this as a background, many discussions were held among industry, academia, and government members involved in TIA-nano on creating the optimal research facilities for the nanoelectronics research center of TIA-nano. As a result, it was decided to build facilities that combine the CMOS technology that had long been refined in Tsukuba with nanotechnology. As a first step, a set of standard process equipment for CMOS and specialized equipments for nanomaterials have been installed. Since state-of-the-art CMOS lines normally reject dissimilar materials, CMOS lines that can be used for this type of pilot manufacturing are rare in the world and thus of great value.

Advancement of the research project

Five large research projects are currently underway in the nanoelectronics research domain. Three of them are being led by researchers (Naoki Yokoyama, Leader, Collaborative Research

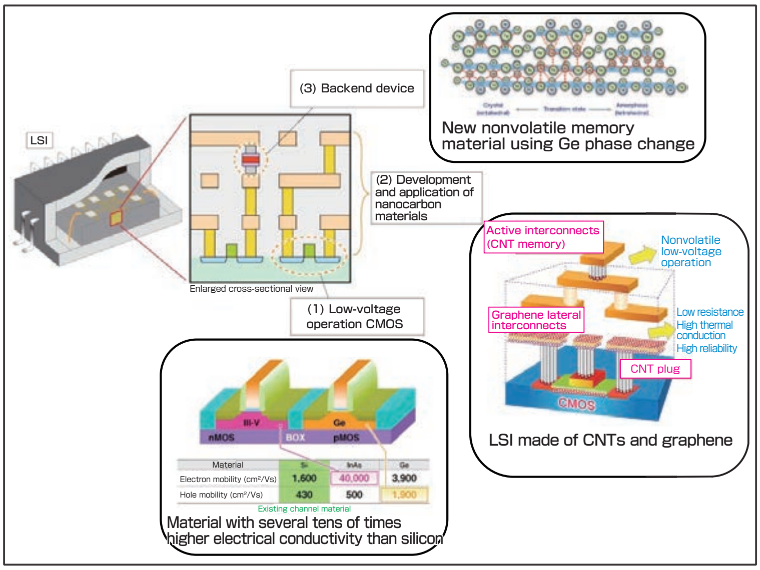


Fig. 2 Green nanoelectronics LSI of the Yokoyama Project

Fig. 1 Semiconductor processing lines in the SCR building

Team, AIST; Yasuhiko Arakawa, Professor, The University of Tokyo; and Hideo Ohno, Professor, Tohoku University) selected under the Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST Program) established by the Cabinet Office. The fourth is the Ultra Low Voltage Device Project for Low-Carbon Society being implemented by the Low Power Electronics Association & Project (LEAP), which is aimed at the realization of ultralow-power large-scale integrated circuits and network devices by combining CMOS with new materials, new devices, optical technology, etc. The fifth project, involving research and development of extreme ultraviolet lithography (EUVL) being implemented by EUVL Infrastructure Development Center, Inc., is focusing on the establishment of lithography techniques that can be applied to circuit lines with widths of less than 16 nm.

The number of participating corporations has reached 20, and more than 120 corporate researchers have joined together in Tsukuba to participate in the projects. To support these research activities, Nanoelectronics Consortium has been set up based on the rules and regulations of AIST and is discussing a medium-term research facility management strategy.

The framework for nanoelectronics research has finally been completed. Future tasks include promoting the attractiveness of this research center, increasing corporate participation, and establishing a system of collaboration with universities. Headed by the TIA Nanoelectronics Working Group, we are tackling these tasks and are making our best efforts to realize a unique Japanese-style nanoelectronics research center.

Councillor,
Tsukuba Innovation Arena Promotion Division, AIST
Hiroshi IWATA

Open Innovation at the Power Electronics Research Complex

Open innovation

Open innovation is often referred to as a paradigm shift in innovation. The majority of great inventions that have significantly changed our society and the way we live in the postwar era have been the fruit of closed corporate innovations. However, with the increasing complexity and sophistication of technologies required for products, single-handed development of all the technologies necessary for business has become unaffordable for most companies in terms of both cost and speed. This is because a product's life cycle will end without sufficient time to recover the costs of research and development. At the same time, an enormous market has emerged with the progress of globalization. In addition, the advances made in information technology now allow anyone to instantaneously acquire the results of various studies that are progressing simultaneously all over the globe. In the era of open innovation, even possessing the most superior technology does not guarantee success in itself. The winners are those who immediately understand the needs of the market and have the wisdom to use technology most appropriately.

A clean room of AIST power electronics research complex (1,500 m^2)

When I have discussions with people in the industrial sector, I get the impression that they are feeling somewhat uncomfortable about open innovation. Open innovation is, when rephrased, a strategy that aims to win in business without competing in technology development. It does not go hand-in-hand with the traditional Japanese-style model up to now; namely, that to succeed in technology development is to succeed in business. Japan is considered to be most skilled at material technologies and coordinating technologies. Thus, we have selected products that require both superior material technology and coordinating technology as the next exit strategy and are currently planning a system that will propel relevant corporations with skilled material technology and/or coordinating technology to participate in joint innovation carried out openly at the power electronics research complex. By joining together in the same research center and establishing collaboration based on strong mutual trust under one roof, it will become possible to develop new technologies at a speed unthinkable overseas. In addition, when seeking applications for the results, the extended global collaboration will assist in their worldwide dissemination.

The power electronics research complex

Although we see tremendous advancements by emerging nations in the semiconductor electronics industry, Japan is still maintaining its superiority in the power electronics field. The reason behind this is said to be that unlike information electronics products, power electronics products embody technologies that cannot be easily copied; for example, in the areas of manufacturing technology and embedded software technology. The maintenance and further development of this superiority is the main mission of the power electronics research complex. On top of this, the environment surrounding power electronics has been undergoing tremendous changes due to the rapid expansion of demand for highly efficient utilization of energy, as can be seen in the increased global efforts toward creation of a low-carbon society and the shift toward utilization of renewable energy.

The power electronics research complex was completed in October 2010 and has celebrated its first anniversary. More than a hundred researchers have joined together from industries, universities, and public research institutions, and the activity base of a technology research association has already been established. Research and development of the next-generation power semiconductor material with an emphasis on silicon carbide (SiC) is being conducted here. Japan has been the world leader in research and development of SiC for about 40 years, with Kyoto University and AIST leading the way. This is a perfect example of putting the new innovation model founded on Japan's high-level material and coordinating technologies into practice, and we firmly believe in our ability to develop strong industries from this research center that will be able to effectively compete with the progress being made in emerging nations.

It is extremely difficult to make a clear prediction of what lies in the future. Yet, we are all aware that the world is changing and we have to change as well. We have no time to lose in establishing a new innovation model that can replace the postwar success model.

Councillor,
Tsukuba Innovation Arena
Promotion Division, AIST
Michiya OKADA

TIA-nano's Approach to N-MEMS

Overview

Despite the high quality of scientific research activities, Japan is now decreasing its global market share of microelectromechanical systems (MEMS) devices. Especially, Japan lags behind in mass production of integrated MEMS products such as accelerometers, microphones, and mirror arrays for video projectors. Looking at the manufacturing infrastructure, the majority of MEMS production lines in Japan are still of the 6-inch type and only a very limited number of companies employing the old generation semiconductor production lines have 8-inch lines. Considering the situation, we have to be aware of our disadvantage in large volume mass production.

In order to recharge Japan's international competitiveness in the MEMS field, AIST has been preparing advanced MEMS facilities for industry, and at the same time is conducting the research and development of MEMS mass production and green sensor network systems.

Fig. 1 State-of-the-art MEMS lines (8 and 12 inches)

Preparation of mass-production facilities for the industrial sector and technology development for MEMS mass production

In FY2010, pilot mass production was carried out by collaboration with universities and industries under the national project on 8-inch lines (and partially a 12-inch line), and the process conditions for all device fabrication were established. In FY2011, a new project on Green Sensor Networks was launched. At the same time, a consortium, MicroNano Open Innovation Center, was founded with the private sector to promote widespread utilization by private businesses. Along with these efforts, the Esashi Project was also launched under the scheme of the Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST Program), established by the Cabinet Office. This project is dedicated for the development of heterogeneous integration of MEMS in collaboration with Tohoku University.

MEMS mass-production technology and green sensor network technology

In the course of this facility improvement work, we have installed wireless networked sensors, such as for electrical power consumption, process and utility gas consumption, temperature, particle concentration, humidity etc. This sensor network system is dedicated to visualize and control the whole energy and mass consumption in all machines in the clean room. This trial was regarded as a pioneering work to solve the energy issues in our future society. However, after the Great East Japan Earthquake, the situation has greatly changed. We are now facing serious energy shortage caused by the nuclear power plant accident. It is not the future, but today that we should establish a smart society through green sensor network.

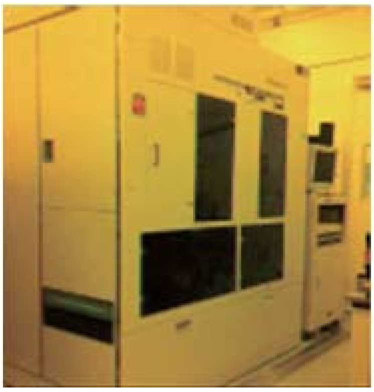


Fig. 2 i-line stepper (8 inches)

Fig. 3 X-ray computed tomography three-dimensional structure observation device (8 and 12 inches)

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Ryutaro MAEDA

Current Situation and Prospects of Research and Collaboration Activities in the Carbon Nanotubes and Nano-material Safety Research Domains

In the carbon nanotubes and nano-material safety research domains, we are engaged in technology development that will make it possible to control the shape of single-wall carbon nanotubes (CNTs) (Fig. 1) in various ways so as to take advantage of the superior characteristics of this new carbon material. In addition, we are developing high-quality single-wall CNTs and components made from them for various industrial applications, and are conducting fundamental research toward the creation of a single-wall CNT industry with the aim of realizing a low-energy society.

Specifically, we are engaged in (1) the development of industrial mass-production technology for single-wall CNTs at a demonstration plant, and the provision of samples; (2) the development of new applications that utilize the superior characteristics of single-wall CNTs; and (3) the establishment of methods that can be utilized by businesses to verify the safety of various nanomaterials and the actual implementation of such assessments.

Development of industrial mass-production technology for single-wall CNTs and provision of samples

We are engaged in the construction of a demonstration plant for mass production of single-wall CNTs (a project funded by the FY2009 supplementary budget) using the super-growth method developed by AIST and in large-scale joint research involving AIST and individual corporations.

Innovative Carbon Nanotubes and Their Application Project for the realization of a low-carbon society

Under the open innovation policy, backed by the strengths arising from shared accomplishments in each of the research and development items (Fig. 2) and enhanced efficiency in the development cycle achieved through close collaboration, we are developing new applications that utilize the superior

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characteristics of single-wall CNTs in every aspect from upstream industry to downstream one, extending from materials and parts through to application.

Establishment of methods that could be utilized by businesses to verify the safety of various nanomaterials

We are not only striving to establish research and assessment methods necessary for ensuring the safety of nanomaterials such as single-wall CNTs, but are also aiming to develop methods that have the potential to become the simpler, faster, and the more inexpensive industrial technology while paying attention to the movement toward global standardization. In addition, we are practicing procedures that will be required by individual businesses when the safety throughout the life cycle of their nanomaterials and the products produced using such materials needs to be explained to the general public in plain words, taking the case of CNTs as an example.

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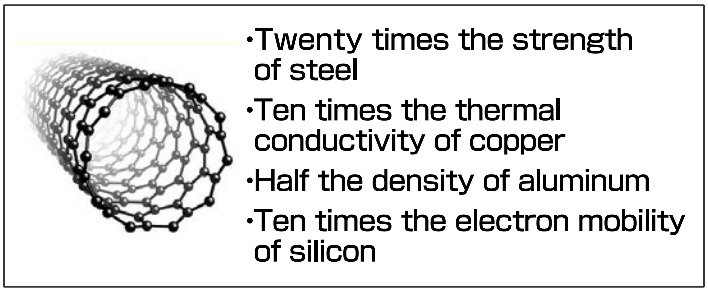

Fig. 1 Typical characteristics of single-wall CNTs

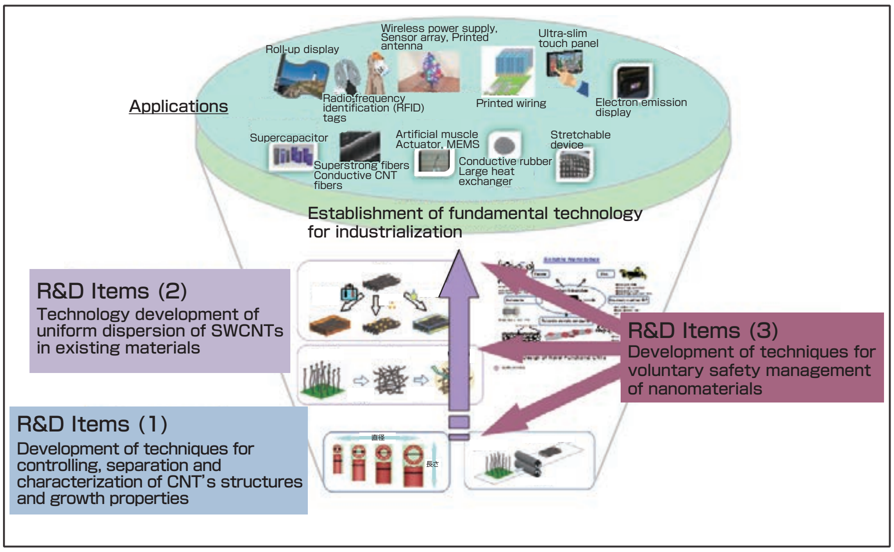

Fig. 2 Innovative Carbon Nanotube Composite Materials Development Project for the realization of a low-carbon society

Efforts of the Nano-green Research Domain at TIA-nano

Open innovation platform for environment and energy technologies

The hurdle for a single corporation or a single institution to create innovation becomes higher every year, and thus the current world trend is global open innovation in which wisdom is summoned from all over the globe to solve issues. Led by the National Institute for Materials Science (NIMS), TIA Nano-Green sets a goal to develop innovative technologies for environment and energy with basic and fundamental material technologies accumulated up to the present as a core technology.

In putting this into practice, TIA Nano-Green will be opening up a platform for various collaborations that can be used by the participants as their needs, in accordance with our basic concept of global open innovation. This platform will be created primarily in the new environmental research building that is expected to be completed by the end of FY2011 at the Namiki-Site of NIMS.

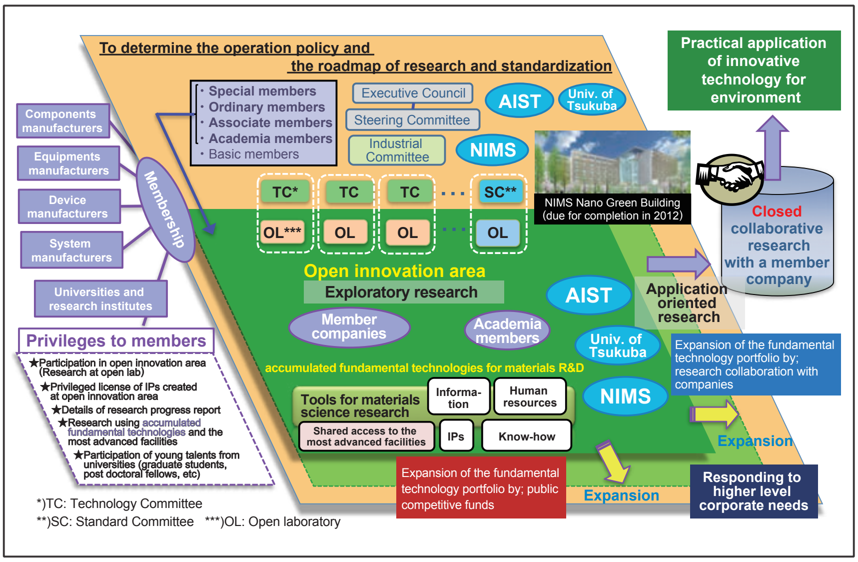

Fig. 1 TIA nano-green research platform

Four elements necessary for open innovation to function successfully

TIA Nano-Green possesses four elements that are necessary for successful open innovation.

(1) A place for interaction (between different industries; between industries, academia, and public institutions; and across interdisciplinary areas)

Different businesses and industries, academia, and public institutions will mingle together and make the development of ground-breaking technologies possible through the gathering of vast knowledge in advanced science, various technologies, and world-class talents.

(2) State-of-the-art equipment and skilled experts to assist in their use

Large-scale improvements and expansion of state-of-the-art equipment have been carried out to reflect our position as the central research institution in the field of material research, and experts are employed to assist in their use.

(3) Strategic investment by the government

Based on an inter-ministry collaboration program being implemented by the Ministry of Economy, Trade and Industry and the Ministry of Education, Culture, Sports, Science and Technology, investments have been made in TIA Nano-Green such as the new environment research building and state-of-the-art equipment.

(4) Nurturing of talented personnel who can become next-generation leaders

Through human resource development, a continuous cycle of science leading to technology, leading in turn to industry, and leading in turn back to science will be created in the materials field which is one of Japan's strong areas.

Expected outcomes

At TIA Nano-Green, advancement, heightened reliability, and lower costs of environment and energy technologies will be achieved through the collaboration of

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industry, academia, and public institutions under the open innovation method, while research investments by individual companies will be minimized. As a result, the industrialization of new technologies will be promoted.

Chief,
TIA Promotion Office,
NIMS
Kazuo NAKAMURA

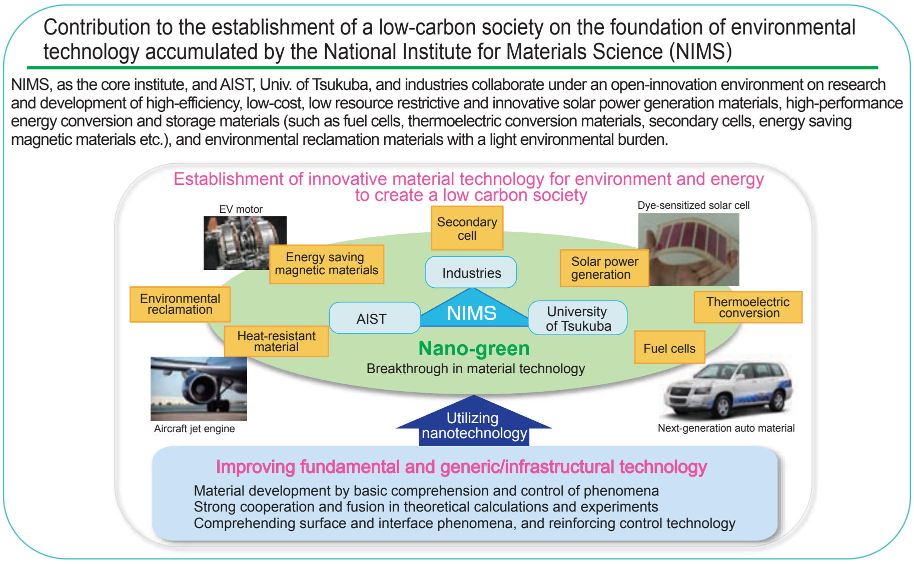

Fig. 2 Goal of TIA nano-green

Graduate School Collaboration Activities at TIA-nano

Concept

Recent leaders in various sectors of Japan seem to be behind, when compared with the leaders of yesterday and European and American leaders, in terms of their sheer number, depth of understanding, ability to make prompt decisions, and ability to take the appropriate actions. Therefore, in a world where everything is changing so rapidly and nobody can predict what lies ahead, it is crucial that we now ask the following questions, seek out answers, and act accordingly: (1) What qualities are we going to value when we develop human resources? (2) What will be the most advantageous education system for the next 100 years that can meet this objective?

As for the first question, since the aim of each person’s life is self-development, our responsibility will be to nurture people who can continue to develop themselves over a long period of time to attain such a goal. To be more precise, we need to nurture “T-shaped” personnel who not only dig deep into their own expertise but also have a bird's-eye view of subjects related to that expertise. In addition to this, each individual must constantly devote their best efforts to expanding this bird's-eye view of various subjects and strive to cultivate themselves so as to become fully and truly developed. This is the bottom line. Without such effort, we might simply be creating “specialists without spirit, sensualists without heart.” This development into wholeness as a human being is indispensable for becoming a leader.

For the answer to the second question, we can obtain insights from history and experience. We all know that it is important to listen to those who have walked before us and to give answers and sometimes guidance to those who come after us. Even a somewhat undependable student who has joined a university lab to perform graduation research may grow tremendously, after completing the research, by enrolling in a graduate school and beginning to teach newly enrolled graduation research students. However, to nurture students as candidates for future leaders, additional training with a certain amount of ingenuity and interaction with respected predecessors during this period is essential. We might find some ideas in this regard in the high school education under the pre-1950 system that produced many leaders with a broad perspective, and in the education at gymnasia in Hungary in the early 20th century where many talented scientists were nurtured. For these reasons, as can be seen in the honors program described below, it is especially meaningful to today’s universities to have collaboration coordinators who not only have rich experience in life but also research achievements, and are sufficiently well-rounded to participate in human resource development and in the hub of co-creation of cutting-edge research by industry, academia, and independent administrative institutions.

The Nanoelectronics Human Resource Development Program including an honor's program and the TIA Networking School of Nanotechnology, which is currently under discussion, may be considered as such an attempt.

Practical implementation

The following two important questions have been raised as issues that must be solved in relation to nanotechnology in Tsukuba: (1) What are some concrete measures that could be adopted to induce synergistic effects and accumulation effects in Tsukuba? (2) To achieve this, how are we to proceed with the creation of a place of co-creation for research and human resource development? The Nanoelectronics Human Resource Development Program under the Tsukuba research and education cooperation system was launched in April 2010 under a five-year plan with an honors program (http://www.tsukuba-honorspg.jp/) at its core. We are planning to enrich the program and pass it on to the TIA Networking School of Nanotechnology. The following is a description of the key points of the honors program.

1. Seven collaboration coordinators, as mentioned earlier, are appointed to induce a flow of technology, knowledge, and people in Tsukuba. Needless to say, these collaboration coordinators are fully aware of the research skills of the research groups that will be participating and also thoroughly familiar with important corporate needs.

2. For those selected as honors graduate students, we have implemented a system where the collaboration coordinators will, jointly with the tutor of each honors student and a competent advisor from industry, academia, and/or an independent administrative institution, form a so-called “resonance field” of co-creation in which all players act in resonance to stimulate each other and to assist in the activities of each honors student. We are making efforts to construct a global “resonance field” of co-creation by having world-class researchers from overseas and distinguished faculty members from Japanese universities participate in this human resource development system.

3. In greater detail, intensive courses for credit in English by the world’s top faculty members will be offered for two weeks at the end of July each year, the Tsukuba Nanotechnology Symposium will be held for three days during the last week of July each year, honors students will be sent overseas for three to four months to attend lectures and to participate in research, and in March each year they will have the opportunity to make a presentation to invited corporate researchers and others in order to receive their advice, etc.

To expand on this endeavor, we are making efforts to create a long-lasting hub of co-creation for nanotechnology collaboration in Tsukuba with ongoing participation of the members of the Japanese universities confederation that are conducting research in Tsukuba and researchers of the industrial sector, in addition to the members of the TIA Networking School Consortium founded in April 2011 consisting of AIST, NIMS, the University of Tsukuba, Tokyo University of Science, and Shibaura Institute of Technology. To realize this idea, we are also newly applying to participate in the Leading Programs in Doctoral Education. Through this and with the organizational participation of other universities, we are planning to extend our current program to the establishment of the TIA Networking School of Nanotechnology. The TIA Networking School Working Group and the Graduate School of Pure and Applied Sciences of the University of Tsukuba are making every effort for the realization of these plans.

Professor,
Graduate School of Pure and Applied Sciences, University of Tsukuba
Kouichi MURAKAMI

Open-user Facilities of TIA-nano

Tsukuba City is a unique advanced user-facility conglomerate, which cannot be seen elsewhere in the world, packed not only with shared state-of-the-art equipment and facilities that encompass a wide range of technologies, but also with collaboration networks constructed among facilities. With a small investment, users of these shared facilities can reinforce their research and development capacity so as to be able to deal with various new research topics. Moreover, if the users choose to make their technological objectives known to others, they will be able to efficiently acquire both partners and technologies for their purposes. These open-user facilities are, without doubt, a tool for the full utilization of Tsukuba’s resources. In this article, the open-user facilities relevant to TIA-nano are introduced from the following three

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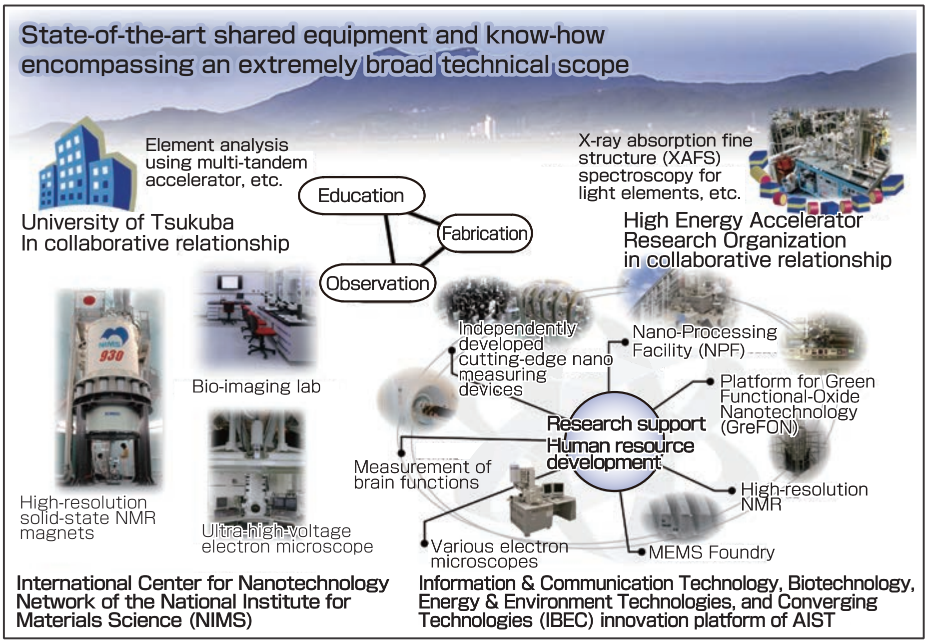
perspectives: fabrication, observation, and education.

Fabrication

The Nano-Fabrication and Characterization Facility and the Nano-Bio and Chemistry Facility of the Nanotechnology Innovation Station of NIMS; the Nano-Processing Facility (NPF), MEMS Foundry, and Platform for Green Functional-Oxide Nanotechnology (GreFON) of AIST, etc. are providing the fabrication function on the basis of fine processing technologies. These are facilities with the know-how to handle diverse materials and the structure to support research through the assistance of researchers and technicians with rich experience. Moreover, in the Super Clean Room of AIST, which is a representative industry, academia, and government collaborative research and development foundry of TIA-nano, in addition to the demonstration of new integrated devices, process technology for new materials is being prepared and work is now proceeding to consolidate this with the existing open-user facilities.

Observation

In the field of cutting-edge research and development, technology for observation is absolutely vital. At TIA-nano, research is supported through the provision of various nano characterization equipment such as an ultra-high-voltage electron microscope, high-resolution nuclear magnetic resonance (NMR) apparatuses, a positron probe microanalyzer, which is an independently developed evaluation method unique in the world, and others. Additionally, new measures are also being adopted as exemplified by an AIST-developed station for the fluorescence yield X-ray absorption fine structure spectroscopy of light elements, which is being set up and fine-tuned for its unveiling at the Photon Factory of the High Energy Accelerator Research Organization.



Collaboratively networked open-user facilities of NIMS and AIST and examples of accessible equipment

Education

A variety of human resource development curricula are being initiated at TIA-nano beginning with a component technology school that aims to improve handling of cutting-edge equipment, to schools that aim to train personnel who not only have advanced equipment handling techniques and know-how but can also supervise manufacturing scenes. These curricula are composed of both classroom learning and practical training and are constructed for the development of human resources with practicality. Along with detailed information on fabrication and observation, as well as announcements on how to use open-user facilities, recruitment announcements for these schools are posted on the following websites. Please feel free to browse through this information.

NIMS International Center for Nanotechnology Network:
http://www.nims.go.jp/nsnet/

AIST Information & Communication Technology, Biotechnology, Energy & Environment Technologies, and Converging Technologies (IBEC) Innovation Platform:
http://www.open-innovation.jp/ibec/

AIST Innovation Center for Advanced Nanodevices:
http://unit.aist.go.jp/ican/

Director,
Innovation Center for Advanced
Nanodevices (ICAN), AIST
Hiroyuki AKINAGA

Research Hotline

UPDATE FROM THE CUTTING EDGE

Oct.-Dec. 2011

The abstracts of the recent research information appearing in Vol.11 No.10-12 of "AIST TODAY" are introduced here, classified by research areas.
For inquiry about the full article, please contact the author via e-mail.

Environment and Energy

A method to separate each rare earth phosphor from the mixture of phosphors

A continuous and low-cost separation by using a high field gradient separation method

We have developed a method to separate phosphor waste which is a mixture of several kinds of phosphors into each species of phosphor by using a high magnetic field gradient separation method. Measurement of magnetic susceptibility of phosphors revealed that each phosphor has different magnetic susceptibility. Green phosphor, $LaPO_4$: Ce,Tb (LAP), shows one order of magnitude higher magnetic susceptibility than other phosphors. By choosing an appropriate dispersant and optimizing operation procedure, the efficiency for the separation was increased. As a result, LAP was recovered as a magnetic product in the separation column with above 80 % of the concentration by one step separation. It was also confirmed that separation of other phosphors having smaller difference in magnetic susceptibility could be achieved.

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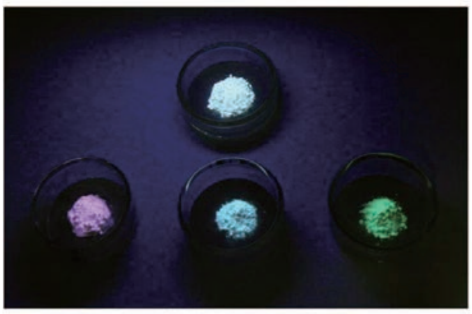
Phosphors of different color luminescence separated (red, blue, green from the left of bottom row) from tri-color phosphor mixture exhibiting white luminescence (upper row)

High-efficiency monolithically integrated CIGS submodules on metal foils

Demonstration of over 15 %-efficiency CIGS submodules

We have developed monolithically integrated CIGS submodules with efficiencies of as high as 15.0 % on stainless steel substrates. The surface of the stainless steel substrate was coated with an anodized Al_2O_3 layer which makes the monolithic integration possible. The demonstration of high-efficiency flexible submodules on low-cost substrates can lead to a wide variety of applications such as car, space, and power applications, in addition to exsisting niche and mobile applications.

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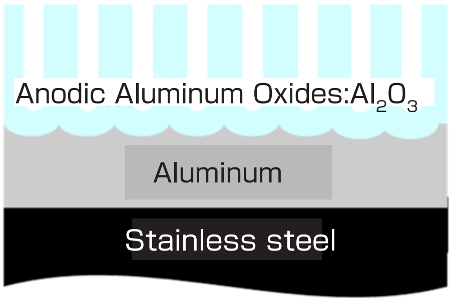
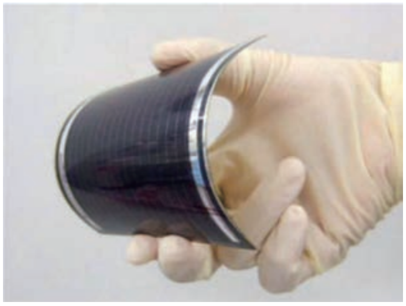


Cross-sectional image of the stainless steel substrate used in this work



Overall appearance of a monolithically integrated CIGS submodule on stainless steel substrate

Mechanism of template-independent RNA polymerization

A tale of a polyA tail – how to get all As

PolyA polymerase (PAP) adds a polyA tail onto the 3'-end of RNAs without a nucleic acid template, using ATP as a substrate. The mechanism for the selection of substrates by eubacterial PAP remains obscure. Structural and structure-based biochemical studies of *Escherichia coli* PAP (EcPAP) revealed that both the shape and size of the nucleobase-interacting pocket of EcPAP are maintained by a rigid intra-molecular hydrogen-bonding-network. It makes the pocket suitable for the accommodation of only ATP using a single amino acid residue in the pocket. The rigidity of the pocket structure of EcPAP is sustained by interactions between the catalytic core domain and the RNA-binding domain. EcPAP has a flexible, unstructured, basic C-terminal region that functions as an RNA translocator for processive RNA polymerization. A comparison of the EcPAP structure with those of other template-independent RNA polymerases suggests that structural changes of domain(s) outside the conserved catalytic core domain altered the substrate specificities and processivities of the template-independent RNA polymerases.

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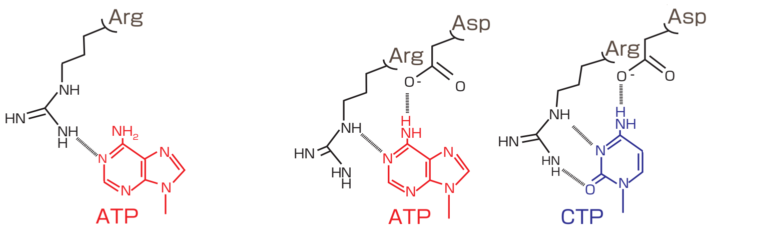
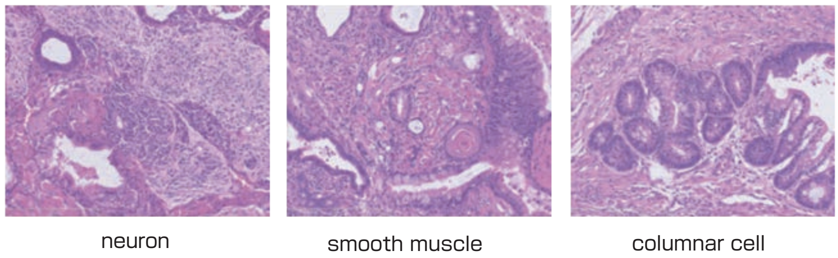


Nucleobase recognitions by polyA polymerase (left) and CCA-adding enzyme (right)

Development of an efficient method for the induction of safe iPS cells

Improvement of the efficiency of iPS cell induction by new factor Glis1

We have developed a new method for iPS cell induction to increase the safety by using novel factor Glis1. We screened more than 1,400 human transcription factors for the ability to replace Klf4 and discovered a novel transcription factor Glis1. Glis1 has the synergistic effect of Glis1 and Yamanaka 3 factors (Oct3/4, Sox2, Klf4) for iPS cell induction. Moreover this factor, enriched in unfertilized and recently fertilized eggs, could replace c-Myc to produce iPS cells from somatic cells with higher efficiency and decreased tumorigenicity. Glis1 promotes iPS cell generation effectively and specifically by activating multiple pro-reprogramming pathways. Glis1 also suppresses the proliferation of defective partially reprogrammed cells. We conclude that the improved safety and efficiency of iPS cell production using Glis1 would be beneficial for future applications of iPS cell technology.



Teratoma formation (mouse) from Oct3/4, Sox2, Klf4 and Glis1-iPS cell

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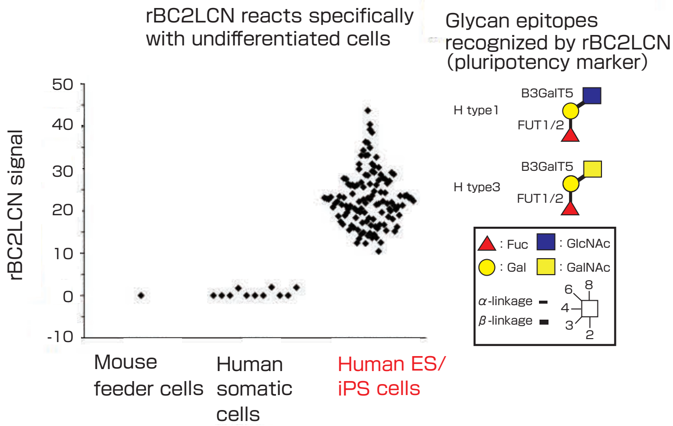
Life Science and Biotechnology

Facile diagnosis of iPS cells using glycan profiling technology

Identification of a novel pluripotency marker by high-density lectin microarray

We have developed a high-density lectin microarray and performed a comprehensive and facile glycan analysis of 114 types of human iPS cells generated from five different somatic cells, and compared their glycomes with those of ES cells (9 cell types). We found that somatic cells with originally distinct glycan profiles acquire those similar to ES cells upon induction of pluripotency. The increased expression of α2-6sialylation, α1-2fucosylation, and type1 LacNAc was found to be the characteristic glycan structural features common to human ES/iPS cells. Finally, we found that rBC2LCN with specificity to the glycans containing the above two characteristics (H type1/3: Fucα1-2Galβ1-3GlcNAc/GalNAc) reacts specifically with undifferentiated cells, which should be a useful probe to discriminate pluripotency.



rBC2LCN is a novel probe to detect undifferentiated cells.

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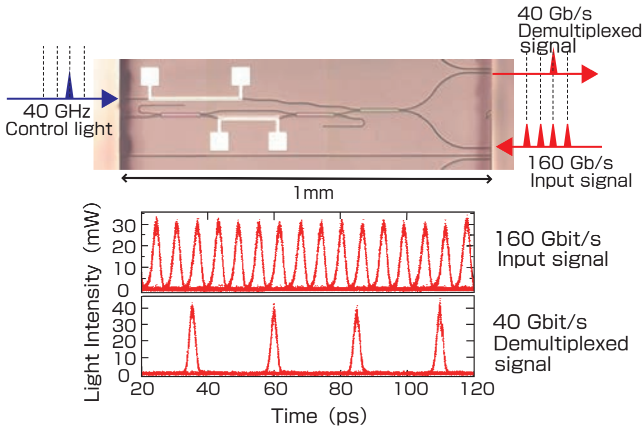
Integrated all-semiconductor ultra-high-speed optical gate switch

Simultaneous transmission and reception of ultra high-definition images at 160 Gbit/s data rate

We have developed a compact all-optical gate switch with a footprint less than 1 mm^2, in which an optical nonlinear waveguide using all-optical phase-modulation associated with intersubband transition in InGaAs/AlGaAs/AlAsSb coupled double quantum wells and a Michelson interferometer (MI) are monolithically integrated on an InP chip. The MI configuration allows a transverse magnetic pump light direct access to an MI arm for phase modulation while passive photonic integrated circuits serve a transverse electric signal light. We also demonstrate all-optical demultiplexing of a 160-Gb/s signal to a 40-Gb/s signal. The device is expected to be used in ultra-high-speed optical transceivers able to simultaneously send and receive ultra high-definition images.



Experimental result of demultiplexing a 40 Gbit/s optical signal from a 160 Gbit/s optical input signal

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AIST TODAY Vol.11 No.10 p.17 (2011)

A three-dimensional whole shape measurement system for processing of marine and agricultural products

High-accuracy shape measurement of marine and agricultural products paving the way to automated processing

We have developed a three-dimensional whole shape measurement system for automatic processing of marine and agricultural products in collaboration with Nikko Co., Ltd. This system is capable of measuring the three-dimensional whole shape of products of various forms, as they are carried on belt conveyors. Based on the measured shape data, the system can generate automatic processing data for cutting each product into equal-sized pieces. It can also handle various kinds of marine and agricultural products including defrosted and hence softened or frozen/distorted fish fillets with scales and pork ribs, which used to be difficult to measure with sufficient accuracy. It is expected that this system will contribute to the improvement of yield and productivity for processing marine and agricultural products.

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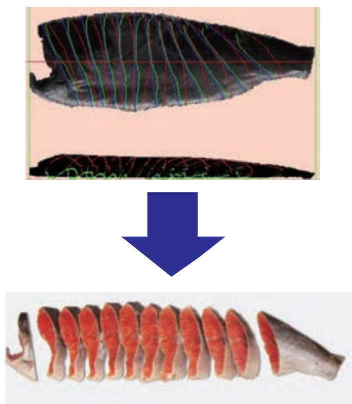
AIST TODAY Vol.11 No.11 p.14 (2011)

Three-dimensional whole shape measurement system

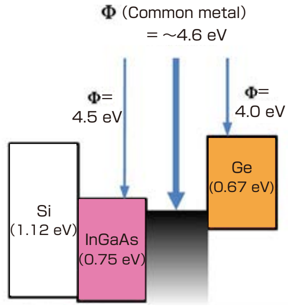


Example of measurement and cut pieces for salmon fillets

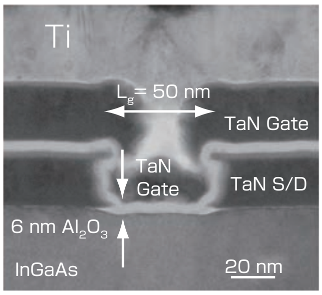
First demonstration of ultra-small III-V/Ge CMOS transistors

A breakthrough technology for next generation high-performance CMOS transistors of different alternative channel materials

We have proposed the alternative channel materials and a new engineering process in order to realize next generation high-performance CMOS transistors for 16 nm generation. We have developed a scalable III-V/Ge CMOS technology with common metal source/drain and gate electrodes, and III-V/Ge CMOS operation with gate length of less than 100 nm has been verified for the first time.



Band lineup of InGaAs and Ge



Cross-sectional TEM image of InGaAs nMOSFET with the gate length of 50 nm

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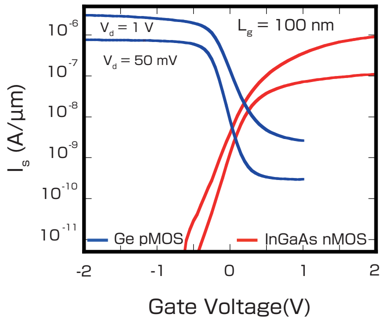

Electrical transport properties of InGaAs/Ge n/pMOSFET (Lg=100 nm)

New recyclable green catalyst

Efficient catalyst for oxidation reaction using metal-complex-type organic nanotubes

We have discovered that nickel-complex-type organic nanotubes (Ni-ONTs) function as the catalyst for oxidation reactions of various organic compounds, indispensable for industries, in water at room temperature. Ni-ONTs were synthesized by the mass production method developed by AIST. Ni-ONT can be synthesized by the simple operation of mixing inexpensive an amphiphilic molecule, glycylglycine connected with a fatty acid, and nickel salt in solvents. Because all nickel ions are exposed on the inside and the outside surfaces of the nanotube, Ni-ONT is expected to provide excellent catalytic sites. Since Ni-ONT is solid in water, it can be easily recovered through filtration after catalytic reactions and is also recyclable. Therefore, Ni-ONT is expected to contribute to green innovation.

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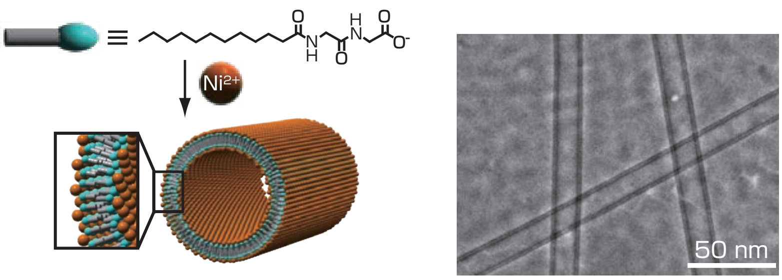
AIST TODAY Vol.11 No.10 p.18 (2011)

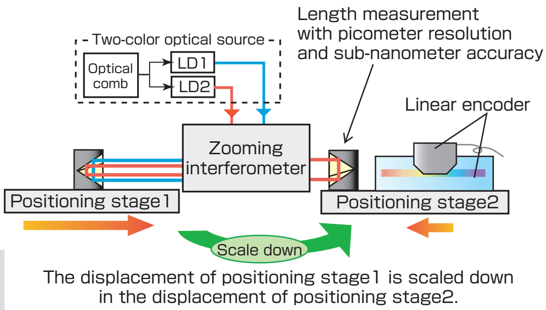


Schematic illustration and electron microscope image of Ni-ONT

A calibrator for precision linear encoders

A length measuring system with sub-nanometer uncertainty was developed

To respond to the demand for the calibration of precision linear encoders, we have developed a new length calibrator with sub-nanometer uncertainty. It is capable of calibrating the non-linearity errors of the precision linear encoders with the best measurement uncertainty of 0.6 nm (k=2). The system consists of an optical zooming interferometer, which can realize a several picometer resolution and sub-nanometer accuracy of positioning. Two tunable diode lasers, the optical sources of this interferometer, are stabilized by using an optical frequency comb. The calibration services for the precision linear encoders have been started.



Scheme of linear encoder calibration

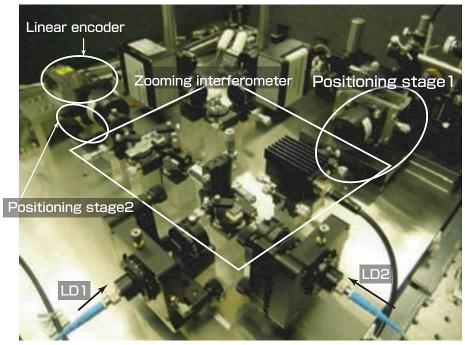


Photo of the calibrator

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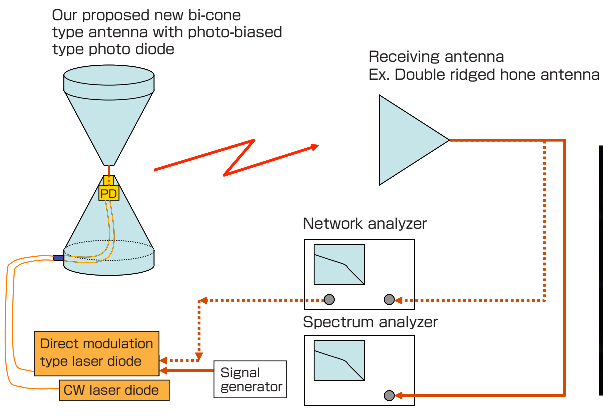
AIST TODAY Vol.11 No.10 p.19 (2011)

New evaluation method for EMI anechoic chamber over 1 GHz

New proficiency test method for radiated electromagnetic interference measurement over 1 GHz

We propose a bi-cone type antenna with a photo-biased type photo diode and an optical fiber link electromagnetic interference evaluation measurement system over 1 GHz that consists of a transmitting optical fiber link system and a vector network analyzer. The proposed system can measure $S_{21}(\omega)$ and $S_{21}(t)$ with the radiated electromagnetic interference measurement.



Proposed optical fiber link system and new bi-cone type antenna

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AIST TODAY Vol.11 No.12 p.15 (2011)

President Nomakuchi Visits France and Germany

President Nomakuchi along with Vice-President Seto and 3 other AIST members visited Europe from September 18 to 23, 2011, and had talks with President Alain Fuchs of the Centre National de la Recherche Scientifique (CNRS) and President Jürgen Mlynek of the Helmholtz Association. In addition, they visited several research institutes.

The talk with President Fuchs was held at the CNRS headquarters in Paris on September 20. President Fuchs explained the issues and the current situation of CNRS. Vice-President Seto explained the concept of open innovation and gave an overview of the Advisory Board meeting held in February, 2011, as well as what was expected at the next meeting scheduled in February, 2012. Furthermore, the presidents signed the extension of the General Agreement which was to expire in November, 2011.

CNRS President Fuchs, and AIST President Nomakuchi

The talk with President Mlynek was held at the Helmholtz Association office in Berlin on September 23. President Mlynek explained the current situation of research and development and the mission of the Helmholtz Association in Germany. Vice-President Seto described open innovation as well as expressed gratitude for President Mlynek's participation in the last Advisory Board meeting in February 2011.

In addition, President Nomakuchi and his party visited the Laboratory of Analysis and Architecture of Systems, CNRS, in Toulouse, Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences, Max-Delbrück-Center for Molecular Medicine and Helmholtz-Zentrum Berlin für Materialien und Energie (HZB), the last three being member research centers of the Helmholtz Association.

Since AIST had already concluded General Agreement with CNRS and MOU with the Helmholtz Association, the visits were very meaningful for the continued development of collaborative research with these institutes.

At Helmholtz Association (from 4th from left, AIST President Nomakuchi, President Mlynek and AIST Vice-President Seto)

MOU Concluded between Geological Survey of Japan and Institute of Geological and Nuclear Sciences Ltd. of New Zealand

The signing ceremony of the comprehensive memorandum of understanding (MOU) between Director Tsukuda of the Geological Survey of Japan (GSJ) and Dr. Alex Malahoff, Chief Executive Officer of the Institute of Geological and Nuclear Sciences Ltd. (GNS Science) of New Zealand was held at the International House of Japan in Roppongi, Tokyo on September 27, 2011. The signing of MOU was carried out at this time because Dr. Malahoff was attending the 4th One Geology Steering Group Meeting held at the same facility from September 27 to 28.

Director Tsukuda (left) and Dr. Malahoff (right) after signing MOU

GSJ has been collaborating and associating with GNS Science of New Zealand in the fields of geothermal energy, marine geosciences, mineral resources and geological survey since the days of former AIST. An MOU was first concluded between both sides in 1990, and after being extended in 1993, it expired in 1996. Later, an MOU was again concluded in December 2002 which expired in December 2007. For this reason, GSJ and GNS Science discussed future research collaboration, and agreed on concluding a new MOU.

Having been seen with the earthquake in Christ Church in February and off the Pacific coast of Tohoku Earthquake in March of 2011, Japan and New Zealand are located in the earthquake-prone zones, and measures against geological disasters including volcanic eruptions are becoming important issues. In addition, as a result of the accident of the nuclear power plant caused by the 2011 off the Pacific coast of Tohoku Earthquake, the importance of natural energy including geothermal energy is being reconsidered. Collaborative research on earthquake and volcanic disaster prevention and geothermal energy are the pillars of the MOU concluded this time, and future outcomes are expected.

Cover Photos
Above: Schematic illustration of Ni-ONT (p. 22)
Below: Example of measurement and cut pieces for salmon fillets (p. 21)

AIST TODAY
International Edition
2012-1 No.43
Published in March, 2012

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AIST11-E00003-3