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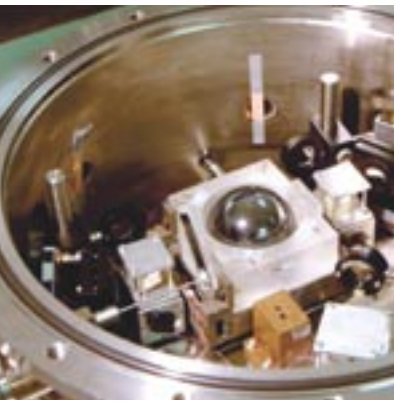

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New Agents of Action Addressing the Challenges to Humanity

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

Last year saw Mother Nature demonstrate her meaner side. Japan was battered by one massive typhoon after another. Moreover, the typhoons followed a different course than in years past, cutting through Shikoku and causing much of the country extensive damage from high winds and heavy rains. The Chuetsu Earthquake in Niigata was also extremely intense. The devastation suffered by people in the affected areas there was unimaginable. These were outcomes of the immense forces of nature, forces that humankind is powerless to change. Once again, we were compelled to acknowledge the vast power of nature, and the reality that human populations are only able to live under “mild” natural conditions. In that respect, the very notion of “environmentally friendly” technology conversely seems to reflect a certain human overconfidence.

Still, humanity cannot afford to sit on its hands and do nothing when confronted by the hazards of nature. Because humans are not the most physically resilient species on the planet, we have prevailed over our adversaries by applying our powers of knowledge and wisdom. We have tamed wild beasts that once preyed on us, conceived of medical technologies to counter microbial agents of disease, built homes and other structures that are more resistant to the devastating forces of typhoons and earthquakes, and developed water management and flood control technologies that protect us from the ravages of swollen rivers. Thanks to these technologies, human populations today have a much safer environment in which to live than would have been possible against the many dangers faced by their ancestors eons ago. However, as last year’s catastrophes served to remind us, we have not yet done enough. It is accordingly with strong resolve that we strive to forge ahead, developing even newer technologies, building even stronger homes and embankments, developing even more effective medicines. In the process, though, we find ourselves confronted by yet another reality: namely, in the form of new problems stemming from the contradictions that technological overkill represents in terms of the laws of nature and the core ethical values we as human beings embrace. Is there any path that leads away from that contradiction? The road ahead is not clear to us, even as we strive to engineer new technologies. Nonetheless, we do face the expectation that we frame that road in clear terms even though we ourselves cannot ignore the fact that our research strategies are driven by hypotheses and theories.

The Challenges for Humanity

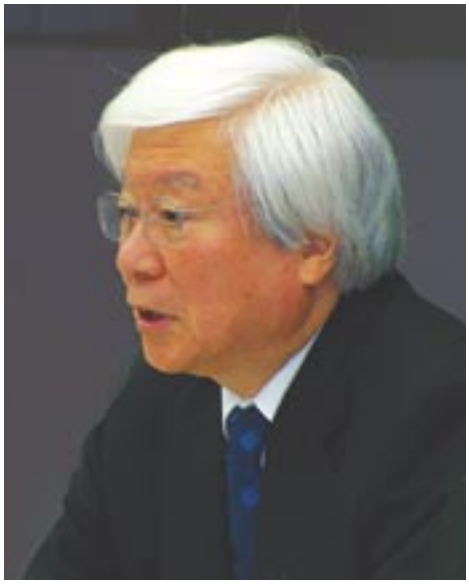
If there is any utterance that concisely exemplifies the broadly shared goals of humankind today, it is probably the phrase, "sustainable development." First and foremost, this expression comprises the challenge of finding solutions to the key problems currently burdening humanity: that is, by eradicating poverty, relieving people from the miseries of disease, reducing the impact of natural disasters, maintaining a climate of international order, preserving diverse human cultures, and closing the gap in access to information. This, moreover, is to be achieved while either preserving or improving the global environment, comprised as it is of the atmosphere, hydrosphere, lithosphere, and biosphere.

The challenge here is to find solutions simultaneously to two ostensibly separate sets of issues: the problems confronting humankind, and the task of protecting the natural environment. However, for our modern civilization, these seemingly disparate challenges have begun to display an interconnectedness. Indeed, there is a dark side to this mutual relationship that has confronted us with a new set of difficulties, in that any attempt to solve one set of problems could lead to an aggravation of the other.

Based on our current knowledge, at a minimum, finding solutions to the array of problems outlined above would presumably demand that we move forward with the application of available technologies, automation, the pursuit of increased affluence, and the assurance of security. In real terms, this means continued industrialization. However, it is already a known fact that industrialization without consideration for the environment is inconsistent with the need for environmental preservation. That said, the task of reducing carbon dioxide emissions into the atmosphere counts as a classic example of an environmental problem that will be difficult if not impossible to solve without adversely impacting industrial activities.

Humankind has no choice but to strive to simultaneously address both sides of this dichotomy. Not only that, but unless it begins that undertaking immediately, expectations are that grave dangers will loom ahead. As matters currently stand, the world has yet to agree even on a program of action. Many international treaties, economic policies, and frameworks have been hammered out and put into effect to address individual problems. These steps have revealed problems and charted the course that should be taken, but in reality they have demonstrated only limited effectiveness. The world has not yet reached a consensus on strategies that will ensure the potential for sustainable development as a whole.

Given this state of affairs, so far, consensus has emerged only to a minimal degree: namely, the recognition that our knowledge of science and technology will be essential to realizing the goal of tackling human and environmental issues simultaneously. Nonetheless, many unknowns surround the questions as to which forms of scientific knowledge are needed, and how they should be applied.



Research Strategy at AIST

AIST has just completed its first research phase and is preparing to enter the second. Currently it is putting together a research strategy that will serve as the foundation for the medium-range plan that will carry it through that second phase. This strategy is related to what we call "field strategy" which is the outgrowth of repeated reflection and debate, stretching back over the past two years, into the fundamental nature of AIST's mission and strategy. Thanks to the intensive efforts of our formulation group, we now have a strategy that is taking tangible form. With this foundation, we have launched a research strategy workshop as the fourth round of our workshop series on "Full Research," in which all AIST personnel take part. It seems worthwhile here to review and elaborate on some of the more noteworthy factors involved in the formulation of our research strategy.

In drawing up a new strategy, it is important that we aim first for a set of clear objectives. What is more, those objectives must be clear and understandable not only to us, but to all members of society at large. Second, it is imperative that we be certain about the specific resources we will be allowed to utilize in attaining those objectives. On this understanding, we then strive to identify and counter any factors that may pose obstacles to the attainment of our objectives.

AIST is a publicly funded institution. As such, it is a necessary condition that its research objectives be in the public interest and meet with societal expectations and approval. Assuming that society in general shares the expectation that science and technology be applied to the search for solutions to the difficult task of simultaneously addressing human problems and the need for environmental protection, it is natural for AIST to make that solution one of its objectives. In addition, given that poverty reduction and many other issues will hinge on industrialization-led improvements in standards of living, it seems evident that AIST should also adopt the goal of developing industrial technologies that will help humankind achieve a more harmonious balance between industrial progress and environmental protection.

Confronted with the challenges of sustainable development, industry can be expected to gradually evolve and adapt as it assimilates new technologies. That process will involve industry-specific adaptations as all industries strive for environmental balance, and may ultimately be compared with the industrial revolution that began some 200 years ago. If this is to be described as a new "industrial reform," then it follows that AIST should adopt the goal of generating, through research, the technologies and knowledge that will bring this new industrial revolution to life.

If we think along these lines, it begins to become clear how AIST's strategy should be developed. It should start with a detailed examination of current industrial conditions from the perspective of environmental balance mentioned earlier. Industry is creating wealth, but the issue is whether industry can respond as a whole to the ever-changing demands of environmental protection. Many companies have made independent strides toward this goal in recent years. Nonetheless, it remains to be seen whether industry as a whole, or at least at its core, will steadily adapt in the interest of achieving environmental balance. Gauging the level of industrial adaptation toward this goal, moreover, will provide us with information as to which technologies are needed or in short supply. That information in turn will help to define the technology-related challenges that should be addressed by new research.

Next, the research required to solve these technology-related challenges must be remolded into a strategy for the implementation of substantive AIST research projects. It is hoped that this will be a strategy framed in the creative language of science, and worthy of the effort by the many highly qualified scientists at this unique institution to devote their fullest abilities as aspiring researchers who share the same lofty goals.

Through this approach, AIST will acquire a harmoniously structured strategy that upholds goals reflective of the demands and expectations of society, and that on that basis enables AIST researchers to achieve those larger goals collectively through the research accomplishments they amass on the basis of individual research incentives.

Research Strategy and "Full Research"

Let me reiterate here that a balanced research strategy as described above will be conditioned on the implementation of "Full Research." This ties in with issues that were debated during our previous series of workshops. During those sessions, I explored the processes by which Type-I basic research themes may be shaped by Type-II basic research or product development-related research, and argued that the themes so derived may differ from the themes that arise from traditional disciplines, and that as a result, the potential to seed new and innovative scientific research is huge. In actuality, this same perspective or spin applies to the task of formulating the research strategy I touched on earlier. Consequently, the basis for balance or harmony here is that the research strategy for AIST as a whole overlaps with the research strategies pursued by each research unit or individual researcher.

At this point, I would like to devote attention to the relationship that AIST and its researchers have with society. AIST has a research strategy similar to the concept of "Full Research." In the eyes of society at large, researchers are usually not thought of as "agents of action." An agent of action in this context is a person who provides society with a direct impact or benefit of some kind. This person may be an educator, politician, administrator, entrepreneur, engineer, physician, reporter, artist, novelist, or someone else who is directly involved within a certain social sphere, elicits an impact of some kind, and assumes responsibility for that impact.

By contrast, scientists are engaged in the generation of knowledge. In itself, that knowledge does not have any impact on society. It is only when that knowledge is applied by someone that it has a societal impact of some kind. Accordingly, this step requires the presence of an intermediary — a user who is an agent of action. Moreover, it is expected that this user should assume responsibility for the resulting societal impact. Scientists are not in a position to be accountable for each and every effect or impact stemming from the utilization of the knowledge they generate. Hence, the social responsibility of a scientist is considered to be fulfilled by the pursuit of research and the provision of appropriate counsel to society. Appropriate counsel must be counsel that is neutral and conditioned on the consent of the scientist. This is a fairly stringent code of conduct that applies to the scientific community at large, and to be sure, counsel based on this code is something that society needs. Furthermore, the condition that scientists not be directly engaged in having a social impact is something that in return guarantees them social freedom to engage in the research they choose.

However, if there are any researchers at AIST who have doubts about this perspective on the scientist's role, I want to welcome and encourage you. Such is the nature of a researcher who has the courage to break out of the traditional mold or stereotype of the scientist and step into a new realm.

Actually, this idea is already integral to the concept of "Full Research" and the research strategy I mentioned earlier. When a scientist contemplates the objectives he or she shares with society in putting together a research strategy, and thinks about the perspectives within the scientific realm that derive from those objectives, he or she is beginning to assume a newfound sense of responsibility for the impact that his or her research accomplishments may someday have on society in the hands of a user, even if those accomplishments amount to nothing more than a set of purely scientific data. Furthermore, it is unlikely that researchers involved in "Full Research" will feel anything at all unnatural about the sense that they have a certain responsibility due to their involvement. Above all, they will have fully demonstrated this sense of responsibility if they decide to launch a new business venture based on the accomplishments of their own research.

As individuals who have chosen a social role that is rooted in the pursuit of "Full Research" by becoming new agents for action in society, we are putting into practice the now increasingly accepted modern understanding of science as an integral part of society.

Feature

Measurement Standards and How They

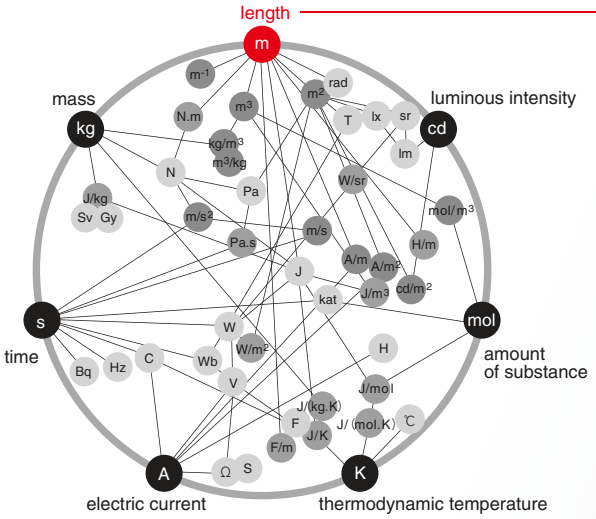
Akira ONO, Research Coordinator

Whenever we buy, sell or exchange any kind of item, we use a remarkably broad array of units. Each of these units is determined according to a standard gradation, or measurement standard. Thanks to the existence of these measurement standards, we can carry out an infinite array of activities and transactions with the confidence that we know exactly how much of each item we are dealing in.

For today's advanced technologies, such as nanotechnology and biotechnology, ever more precise measurement standards are required. The importance of such precise measurement is growing constantly.

How are these measurement standards defined? How are they established and propagated for general use?

The World of the International System of Units (SI)



All SI units are derived from of the seven basic units. These units are mutually interconnected. For example, the unit of time (s) is necessary to define length.

National Standards for Length
Iodine-stabilized He-Ne laser

Iodine-stabilized He-Ne lasers provide an extremely stable light source at a wavelength of 633 nm. These lasers can realize an accurate "ruler" with a scale division of half the wavelength, using an interferometer. They are also used as a secondary measurement standard.

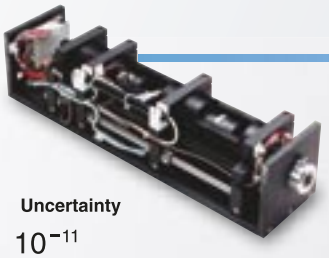
Practical Standards

Gauge blocks account for approximately 80% of the practical length standards presently in use. A gauge block is one of the end standards in a block shape. The distance between its two ends is used directly as a length standard. Because of that, there are over a hundred of them that are different in size. Their shapes are maintained by precision polishing and their absolute length can be realized with better than 0.05 μm precision.

Measuring devices for general use

Various kinds of measuring devices used for manufacturing, such as slide calipers, micrometers and dial gauges, are included in this category.

* nm (nanometer; 1 nm = 1/100 millionth of a meter)



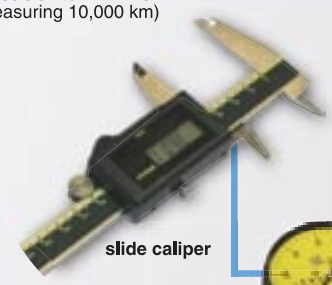
Uncertainty

10^{-11}

(precision to 0.1 mm when measuring 10,000 km)

10^{-7}

(precision to 1 m when measuring 10,000 km)



10^{-5}

(precision to 100 m when measuring 10,000 km)

The Role of Measurement Standards Units and Measures

Hirokazu MATSUMOTO,
Deputy Director, Metrology Institute of Japan

Units and Measures

The exchange of materials is an indispensable part of our everyday lives. Yet the greater the quantity and variety of material exchanged, the more difficult it becomes to exchange items directly. Precise information about those items is needed in order to exchange them. For this purpose, a wide range of units is employed.

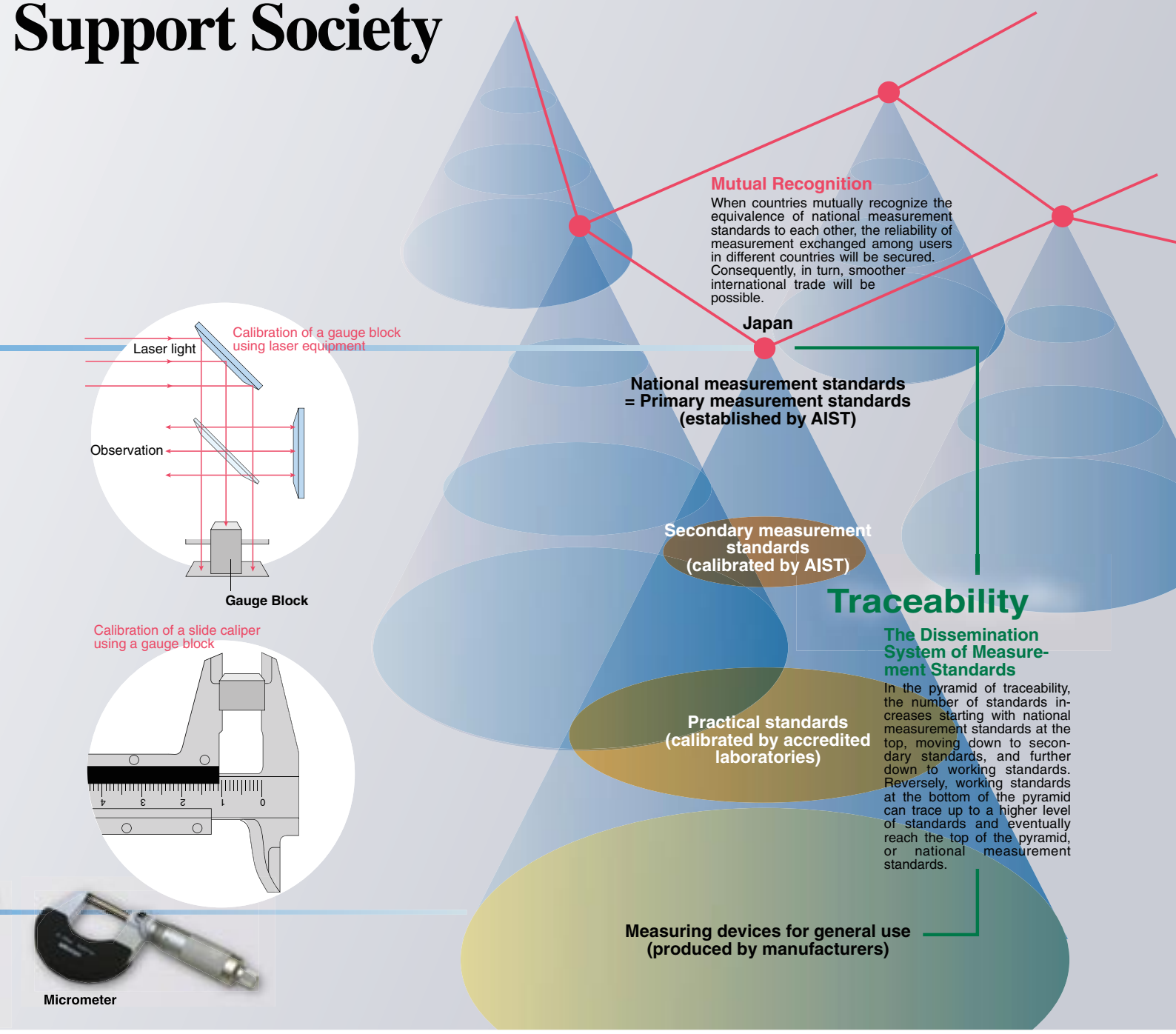
To use these units, a sufficiently large community of users must accept the use of a common set of measures in their everyday lives. If the gradations in these measures – the units – differ among the people conveying information about a given item or transaction and those receiving it, or if the people involved lack confidence in them, it becomes impossible to conduct transactions with confidence, For this reason, measures represent a keystone supporting our modern society.

Measurement Standards for Better Safety and Security

Allowing lab-test results to be used anywhere in the world

In lab tests, blood and urine samples are used to measure levels of cholesterol, gamma-GTP, urinary proteins and the like, to ensure that patients' levels of these substances are normal. These values must be identical (within a reasonable range) at any hospital in the world. If they are not, great confusion and danger may result. Incidentally, no measurement standards for cholesterol have yet been established. AIST is currently working to develop measurement standards for cholesterol and other key blood components.

Support Society



Toshihide IHARA, Manager, Metrology Planning Office, Metrology Management Center

Measuring Critical Water-Supply Flowrate in Nuclear Reactors

Nuclear power plants work by splitting atoms to heat water. The resultant steam drives a turbine, which turns an electrical generator. After passing through the turbine, the water vapor (which is uncontaminated by radiation) is cooled and returned to the water supply, where it is once more sent to the nuclear reactor. Because this flow volume is used to control the amount of heat generated by the nuclear reactor, obtaining an accurate assessment of the water flow is crucially important for the safety and generating efficiency of the power plant. At AIST, we are hard at work developing highly precise technologies for measuring water-supply flow volumes in nuclear reactors.

Monitoring Electromagnetic Environments

Mobile telephones generate redio waves. To prevent such emissions from interfering with pacemakers and other medical devices, mobile phone use is prohibited in hospitals and on trains. Production of electronic devices, such as PCs, is governed by international standards regarding unnecessary generation of radio waves. In Japan, such devices are thus requlated to ensure product safety. AIST prepares the measurement standards needed to monitor and control these high-frequency electromagnetic environments.

Traceability in Measurement Standards

Measurement standards are the means by which standard gradations are stipulated to establish various units. In Japan, the National Measurement Institute of Japan (NMIJ), a center within the National Institute of Advanced Industrial Science and Technology (AIST), determines the national standards upon which measurement standards are based. NMIJ develops and supplies standards that are trusted not only throughout Japan, but in many countries overseas as well.

To make national standards available throughout society, a system of *traceability* must be established. Traceability is provided by a verifiable system for assuring that the units of measurement applied in a given environment are identical with a higher national or international standard for that unit. This article examines how traceability works, using units of length as an example. The standard for length, the measure that stands at the apex of any traceability system, an elaborately constructed physical model representing one meter of length. For 70 years, this physical model of the meter served as the national standard for length in Japan. The problem with the use of physical models, of course, is that the loss of the physical model on which the system is based would result in chaos. For this reason, efforts were made to develop a scientific method of defining the meter. Eventually, in 1960, wavelengths of light came to be used to determine gradation, and "one meter" was defined as 1,650,763.73 times the wavelength of the light emitted by an atom of krypton.

This innovation allowed length to be established using contactless techniques. It reduced uncertainty regarding the accuracy of the measurement value by two orders of magnitude, thereby greatly improving the technological basis upon which modern industry is founded. ("Uncertainty" is a measure of precision; it is the range in which the true value is sure to be found.) A further advance occurred in 1983, when the speed of light was used to redefine "one meter" as the distance that light propagates in a vacuum in 1/299,792,548 of one second. The national standard for "one meter" is thus obtained from a stabilized wavelength produced by an iodine-stabilized helium-neon (He-Ne) laser.

However, the instruments we use on a daily basis were not produced with direct comparison with this national standard. Rather, the standard is transferred from a designated standard device representing the national standard to a secondary standard device. The gradations on the secondary standard device are compared with those on the designated standard device, to "calibrate" the device, or verify its precision. This check can only be performed by an accredited calibration laboratory. Using a technology called wavelength interference, laser wavelengths can be used to accurately calibrate the gradations on a wide range of standard devices. The wavelengths of He-Ne lasers are then used on the secondary standard device as well. By this process, capable private-sector calibration laboratories can calibrate a practical standard device (a gauge block or other simple device that can be used as a standard device by any end user). In the next phase, the gradations on this practical standard device are transferred to the calipers, micrometers, and other devices used by the end user. Here again, this work must be performed by an accredited laboratory.

Japan's private-sector calibration laboratories boast an exceptionally high level of technology. Today, some 35 accredited laboratories use the designated secondary standard devices in their possession to perform calibration. Standing at the top of the calibration pyramid, these certified operators play an extremely vital role in modern industry: the number of practical standard devices each laboratory has calibrated runs to the hundreds of thousands; and the number of types of general instruments to which the calibrations on those practical standard devices are transferred number in the tens of millions for each accredited laboratory. Because the traceability system forms a pyramid, calibration is remarkably cost-effective in Japan, conveying national standards to the nation's users with enviably low levels of uncertainty.

International Mutual Recognition

As industrial technology and business operations become increasingly global in nature, the importance of interaction with other countries is rising dramatically. These interactions depend on the ability to trust the measurement standards used by each country; one country's units must be interchangeable with all others'. For this reason, the international community has been grappling with the need to establish mechanisms to preserve the equivalence of various countries' measurement standards and provide society with measurement standards that each country can recognize, so that the inspection and test data of each country are interchangeable. This interchangeability is called the "international mutual recognition" of measurement standards. Today 57 signatory countries and regions are members of the International Bureau of Weights and Measures (BIPM), the international standards body established by the Meter Convention.

Countries signatory to the international mutual recognition process are required to prepare quality manuals, conduct

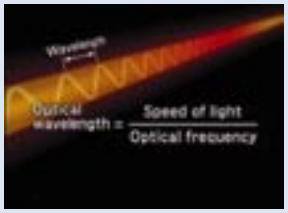
Optical Comb: A leading-edge technology for optical frequency measurement

Hajime INABA, Wavelength Standards Section, Time and Frequency Division, Metrology Institute of Japan

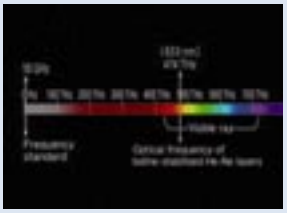
The unit of length, the meter, is determined using red light from an iodine-stabilized He-Ne laser (ISHN laser) as a ruler (1). A laser is a wave; its cycle length is called the wavelength. How do we determine the laser wavelength? An optical wavelength is calculated from the optical frequency (2). In the case of an ISHN laser, the optical frequency is approximately 474 THz (1THz =1 terahertz = 10^{12} Hz). Therefore, the wavelength is approximately 633 nm because the speed of light is defined as 299,792.458 km/s.

We now come to the question of how the optical frequency of the laser is measured. We must measure an optical frequency using the frequency standard, which is approximately 10 GHz microwave generated from a cesium atomic clock. However, the optical frequency of an iodine-stabilized He-Ne laser is approximately 474 THz, which is more than ten thousand times higher than the cesium frequency (3). Therefore, measuring an

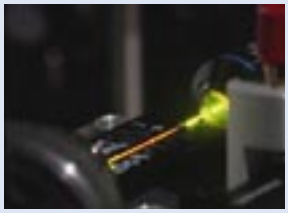
(1) Iodine stabilized He-Ne laser



(2) Relationship between optical wavelength and frequency



(3) Frequency gap between the frequency standard and the laser



(4) Photonic crystal fiber

fully transparent international comparisons, and submit to peer reviews by specialists from other countries. Standards that pass this rigorous process are registered in the BIPM database. Officially in operation from 2004 onward, this system will soon allow measurements gathered in other countries to be accepted "as is" in one's own country, contributing significantly to smooth trade operations and economic growth.

Legally Designated Measurements That Protect the Security of Our Everyday Lives

Takeshi ITO, Metrology Planning Office, Metrology Management Center

Measuring instruments for commercial transactions and certifications that have a remarkably pervasive influence on private consumers are under strict legal control. For instance, they must pass mandatory verification before they enter the market. They are called "specified measuring instruments".

Today, there are 25 categories of legal measuring instruments in Japan. Meters for water, gas and electricity, for example, are requisite in daily life. Aside from these, in the real world, weighing instruments to weigh foods in retail shops, alcohol hydrometers to determine the alcoholicity in liquors, fuel dispensers at gas stations, and taximeters in taxis are helping people without always being noticed. Sphygmomanometers and clinical thermometers used for health management at home are similarly required to pass verification.

For environmental measurement, sound level meters and vibration level meters are examples of specified measuring instruments. Concerning the contamination of air, soil and water, measuring instruments to determine minute quantities of pollutant such as dioxin, which have drawn public attention, are also subject to verification.

The period of validity of verification is limited. Specified measuring instruments must be subjected to regular inspections to guarantee their accuracy.

Conventional mechanical instruments have adopted more and more advanced electronics, such as CPUs. In this trend, new-generation measuring instruments have been introduced. They can be applied to, for example, centralized screening systems using LANs and the Internet, energy supply management and its distribution system with consolidated databases of measuring results. In addition, they are able to interact with mobile devices such as mobile phones and may allow the popularization of electronic money with IC chips. Those innovations have brought drastic changes in the practices of transactions and logistic systems. Specified measuring instruments are playing valuable roles in this society. They have become more and more important as they incorporate increasingly advanced technology.

On the other hand, these remarkable advances also pose a problem. To ensure the measurement accuracy, legal regulation has mainly dealt with hardware, which has been sufficient so far. However, it has been expanded to installed software today, because the development of information technology has increased the risk of illicit interference and falsification. To meet the emerging needs of software protection, AIST is engaged in the research of this field.

Taxi meter


Noise meter


Gas meter


Water meter


Commercial weighing scale

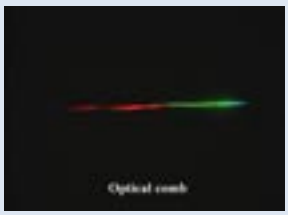
optical frequency using the cesium frequency as a standard was extremely difficult.

At AIST, the investigation of optical frequency measurement has proceeded. As a result, we have developed a special light optical frequency comb, which is a bridge between the microwave frequency region and the optical frequency region. An optical frequency comb can be generated using a femto-second mode-locked laser and a photonic crystal fiber (4).

As shown in the photo (5), this optical frequency comb involves various color components, similarly to a rainbow. However, its micro-structure is not continuous like a rainbow but discrete like a comb (6).

The frequency intervals of a comb are uniform. If the intervals are locked to an atomic clock, these comb frequencies are also determined accurately (7). A locked optical comb appears as though a million stabilized lasers form a line at uniform intervals (8).

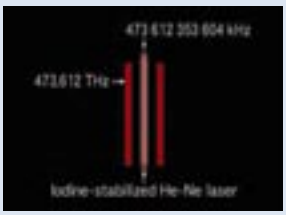
Various laser frequencies can be measured over 1000 times more accurately than conventional techniques by using an optical comb as an optical frequency ruler. These accurate lasers will improve semiconductor processing precision, for example. Furthermore, using this technique, contributions to the optical communications are expected.



(5) Optical comb

(6) Magnified optical comb
(Conceptual figure)


(7) Frequency counter



(8) Frequency measurement of a laser using an optical comb as a frequency ruler

Measurement Standards at Production Sites: Automobiles

Tomohiro MOCHIZUKI,
Measurement Engineering Department, Nissan Motor Co., Ltd.

Measurement Standards Indispensable for Automobile Inspections

To retain a satisfied customer base, we, automobile manufacturers, must guarantee the quality of the vehicles we sell, and reduce production costs by reducing defects through quality control. For both of these tasks, measurement standards and measurement management occupy a position of vital importance.

Quality control in the automobile manufacturing process proceeds in a step-by-step manner. First, inspection occurs at the level of individual parts. Manufacturers must strictly guarantee that parts pass national regulations concerning the basic functions of parts (running, turning, stopping, etc.). Important security parts such as brakes and chassis are subjected to particularly stringent checks.

Finally, when the car is fully assembled and ready to be shipped to market, a final inspection of the vehicle's performance and various other factors is conducted. The list of items tested in this inspection is daunting, yet all items must be identical to the test items used by the Land Transportation Bureau. Once the vehicle is passed on to the inspection line, each inspection item is tested and adjusted in order.

The measurement standards used in production processes such as these are traceable to national standards. A collection of 93 in-house standard devices is used in common by all companies for precision management. At the level of secondary standard devices, about 400 such devices, which are calibrated using the at-house standard devices, are in use at all worksites. Because the items produced at each plant vary from auto bodies to engines and many other components, some 50–60 secondary standards are required to manage the instruments used in inspection.

The Increasing Importance of Traceability

As multifaceted and complex as the inspection of completed vehicles is, for all of the basic items inspected — brakes, wheel alignment, speedometer, exhaust and much more — traceability must be assured. No variance can be tolerated, even though the same engines may be produced at different plants or the same type of cars may be built in different countries.

Moreover, unlike the conventional practice in the industry, parts and device suppliers anywhere around the world can actually provide their products even if they are not part of our corporate group. For that reason too, the importance of traceability in measurement is rapidly rising to manage the quality of the parts and devices we use. For example, Nissan and Renault require their suppliers to conform to common quality requirements, including ISO/TS 16949 — a set of quality system requirements that applies to the automobile industry.

Under these exacting conditions, manufacturers need to maintain highly precise in-house measurement standards and conduct continuous training of calibration technicians, expecting them to improve their skills to sophisticated levels. Toward this end, we are working proactively to secure certifications in various measurement categories from the Japan Calibration Service System (JCSS), which is considered to be the Japanese version of ISO/IEC 17025. For instance, Nissan is already fully certified in two categories: length (end measures) and electricity (DC voltage).

The advance of economic globalization is driving a steady increase in the import and export of automobiles. Each importing country has its own set of laws governing these products. In many countries, the traceability requirements are stricter than those in Japan.

Ultimately, we would like to establish a one-stop testing process — a system in which, meeting common requirements, countries would accept one another's measurements based on mutual trust in the measurement standards of each country. Because no such system yet exists, the international trade of automobiles still involves complicated and time-consuming processes. We must write test reports that follow the legal requirements of each country. These requirements can be broadly divided between the North American and European type, with many countries outside these two regions choosing to adopt one or the other.

Responding to Advances in Technology

Today's automobiles are becoming more technologically sophisticated with each passing year. The rate of this advance is accelerating. Not surprisingly, the measurement standards required to build these products are changing in number and variety at a blistering pace. For example, as more automobiles are

Photo 1 Welding process on a production line
A battery of robots carries out the work with high precision. (Photo courtesy of Nissan Motor Co. Ltd.)

Photo 2 Installing an engine unit
Human skills and measurement standards play a vital role in ensuring the safety and trustworthiness of automobiles. (Photo courtesy of Nissan Motor Co. Ltd.)

Photo 3 Final inspection of a product fresh off the production line
A wide variety of measuring instruments are used. (Photo courtesy of Nissan Motor Co. Ltd.)

installed with fuel cells, standards for electrical power, hydrogen and chemical reactions must be devised and adopted. These new needs may arise full-blown within the space of a year, but responding as quickly with the standards they require is no easy matter.

At the same pace as the technology furnished to customers, we must rush to calibrate our products according to newly mandated standards. For all automakers, this process presents a formidable challenge in the coming years.

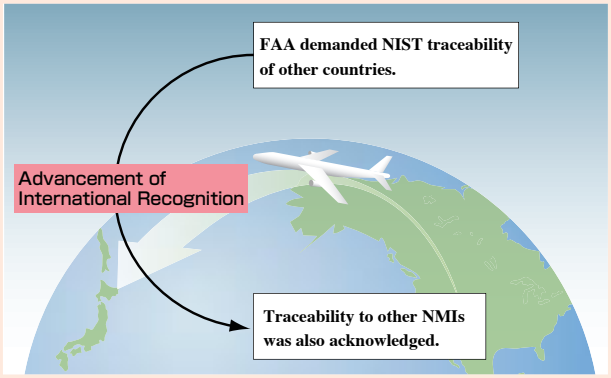
Measurement Standards in Aircraft Maintenance

Toshirou ITOU,
Quality Assurance Department, Japan Airlines

For airline companies, nothing is more decisive for the safety of passengers than aircraft maintenance. Following a tragic airplane crash in 1996, the United States Federal Aviation Administration (FAA) handed down a requirement that all instruments used in the maintenance of US-registered aircraft provide National Institute of Standards and Technology (NIST) traceability, whether the maintenance provider is based in the United States, Japan, or any other country.

Aircraft maintenance requires a dizzying variety of instruments micrometers, calipers, torque wrenches, thermometers, thermocouples, voltage meters, ammeters and others. Ensuring NIST traceability for each and every one of these instruments was grievously time-consuming and incurred enormous costs. Unable to square this circle alone, Japan's airlines turned to the then Agency of Industrial Science and Technology (AIST) for advice. This consultation produced an arrangement between AIST and NIST for cooperation in the field of measurement standards. In addition, the two agencies used the results of comparisons of individual measurement standards mutually to persuade the FAA that these measurement standards were equivalent.

In this way, Japan's airlines were able to win exemptions from the FAA's traceability requirements, allowing them to deploy instruments traceable to Japanese standards in the maintenance of US-registered aircraft and their parts. At about the same time, in 1999, a global Mutual Recognition Arrangement (MRA) was concluded with respect to the field of measurement standards. This framework lent impetus to the development of an organized system of international comparison and mutual recognition for measurement standards on a global scale.



As a result of these developments, in July 2003, the requirements contained in the FAA Advisory Circular, a notice of FAA inspection operation, were changed, clearly permitting the application of NIST or other national measurement institutes' traceability provisions.

Measuring Gene Quantities

Mamoru KAWAHARASAKI,
Bio-Medical Standards Section, Organic Analytical Chemistry Division, Metrology Institute of Japan

Deoxyribonucleic acid (DNA) consists of a characteristic double-helix formed by four nucleotides, called bases, which pair specifically with one of the other bases, in bonds called base pairs (Figure 1). The genes, blueprints of all organisms, are written by these four bases.

Measuring Genes by Amplifying Genes

How can we measure gene quantities? At present, for gene quantification, the fastest and most accurate method is a technique called "quantitative PCR". Quantitative PCR combines the polymerase chain reaction (PCR) method with measurement of genes using fluorescent dyes. The PCR method, which is a gene amplification method, amplifies a specific gene with a certain base sequence to twice its size by single reaction. Theoretically, by a continuous reaction (i.e. chain reaction), a single gene can be amplified infinitely (in practice, the reaction will be stopped by lack of available reagent, the heat degradation of enzyme activity, and so on). This technique allows even small quantities of genes, which had originally been impossible to measure, to be quantified with reasonable accuracy.

To measure the amplified gene, several fluorescent dyes are used. Usually, the time needed to reach the threshold fluorescence intensity in the PCR gene amplification is measured. If the original gene quantity before the amplification is small, this interval will be longer; if the original quantity is large, the threshold will be reached more quickly. By creating a graph showing the relationship between the predetermined standard gene quantities and the times to reach the threshold fluorescence intensity, and by measuring the time taken for an unknown quantity of a sample, it is possible to measure the gene quantity in the original sample (Figure 2). The special equipment needed to carry out quantitative PCR is commercially available (see photo).

This measurement technology is used to quantify the amount of genetically modified organisms (soybeans, corn, etc.) in foodstuffs. Future uses may include such medical applications as predicting the time for the onset of AIDS.

Photo
The left black device is a LightCycler®(Roche Diagnostics, GmbH, Germany) ; the right square one is a PRISM®-7900 (Applied Biosystems, USA).

At present, AIST is participating in the development of international protocols to support the reliability of genetic measurement using quantitative PCR, in cooperation with Consultative Committee of Amount of Substances (CCQM) under the Meter Convention.

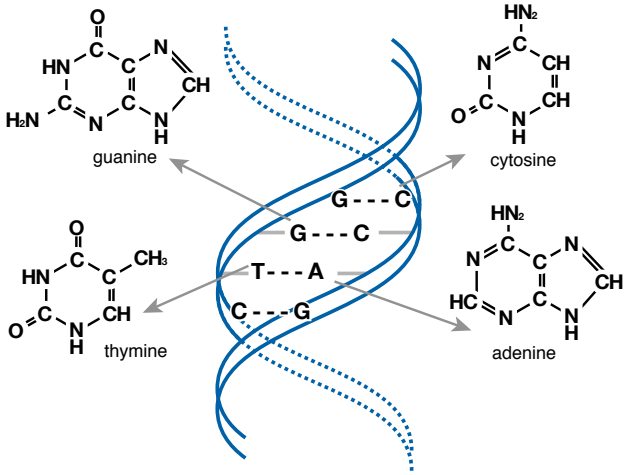


Figure 1 The structure of DNA
Genetic information is written by four bases: adenine, thymine, cytosine and guanine.

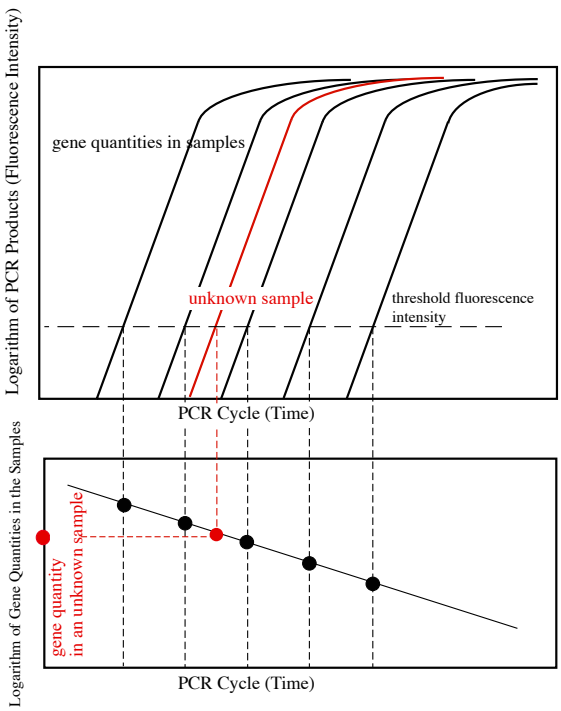


Figure 2 Principle of quantitative PCR
Using a genetic sample whose quantity is already known, the time to reach a threshold level of fluorescence is measured and plotted on a graph. This graph is then used to measure the quantity of the gene in the sample whose genetic quantity was previously unknown.

The Development and Spread of Nanotechnology and Related Measurement Standards

Toshiyuki FUJIMOTO,
Surface and Thin Film Standards Section, Materials Characterization Division, Metrology Institute of Japan

Research and development in nanotechnology is making impressive strides. Surprisingly, the roots of this discipline are ancient, even prehistoric. It is known, for example, that the civilizations of Mesopotamia created colored glass such as eye beads, which they fashioned into jewelry and the like. Much later, around 500 AD, stained-glass techniques that had been developed in the Byzantine Empire began to find currency through much of the ancient world.

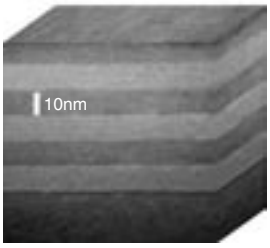
Nanotechnology Blooms in the Age of Advanced Measurement Technology

Recent advances in measurement technology have opened an exciting new chapter in nanotechnology. Ancient "nanotechnologies" guided by rough experience are taking on new life, thanks to measurement technology. Developers can now manipulate the colors in stained glass with high precision, based on a clearer understanding of the relationship between color and the oxides and metal particles embedded in the stained glass. Today these particles are being manipulated at the nanoscale level to develop new functional materials, requiring measurement technologies with unprecedented resolution and quantitative sensitivity.

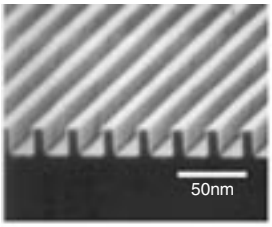
Nanotechnology makes use of unique functions discovered in individual structures and configurations thereof on a nanometer (billionth of a meter) scale, yielding new and unprecedented applications that transcend conventional scientific disciplines. To maximize the benefit from these unique properties, these tiny individual structures and the functions discovered for them must be evaluated in terms of universal values. The most effective route to achieving this ability is to introduce measurement standards that offer a universality transcending the differences among disciplines. AIST's NMIJ is at the forefront of activities to prove the equivalence of Japan's national measurement standards with international standards. Among the many benefits of this research is its effectiveness in protecting intellectual property rights.

NMIJ is working proactively to develop a battery of valuable measurement standards. For example, NMIJ is working on certified reference materials for scales that are useful as measures for the evaluation of various nanoscale three-dimensional structures, which form the building-blocks of nanotechnology. Evaluation methods and certified reference materials for the sizes of nanoparticles and nanopores are also under development. To serve the need for design and evaluation of optical recording media, the demand for which is growing exponentially, NMIJ is devising methods of evaluating the thermal properties of nanoscale fields and interfaces. This Institute is also working on methods of evaluating the density and hardness of ultrathin films. AIST expects that these new measurement standards will not only find application in certain specialized fields, but will also serve as the foundation on which the fusion and integration of nanotechnology with other fields is maximized.

The World's Finest Scales with Minimum Measurements of Several Nanometers



Schematic representation of a nanoscale for depth direction



Schematic representation of a nanoscale for in-plane direction

A Young Researcher Offers Her Views

Yukiko SHIMIZU,
The editor interviews a young scientist, Dr. Yukiko Shimizu, Radiation Thermometry Section, Temperature and Humidity Division, Metrology Institute of Japan

—What is your research activity?

I'm constructing a dissemination system of the radiation temperature standard in the middle temperature range from 100°C to 500°C. Radiation thermometers are widely used in the fields of industry and science. Non contact and fast determination of the temperature of even nano scale material can be achieved using radiation thermometers. We have already constructed a fast detection system with an infrared radiation thermometer and a laser source modulated at very high frequency. We succeeded in measuring the temperature and thermal conductivity of a 10μm thick metal thin film with a time constant of 300 nanoseconds. This technology should lead to the development of the next-generation measurement standards such as nano-scale temperature standards.

—What interests you in this line of research?

Many national institutes of standards are now competing in the construction of radiation temperature standards in the middle temperature range. It is challenging to develop a more accurate standard in an original way. It may have enormous impacts in the fields of science and technology. Research on temperature standards in the nanoscale domain necessarily goes hand-in-hand with the development of leading-edge measurement technologies.

—What are your future prospects?

Although the principle of thermal-radiation thermometry is based on the Planck radiation formula and the quantum devices such as semiconductor detectors, but the actual measurement processes are being developed on the classical physics technologies such as design and fabrication of blackbody furnaces and set up of geometrical optics. By introducing techniques of micro-optics and quantum optics, we hope to develop a new thermal radiation measurement standard which is more accurate, faster, and easier to use. Specific techniques we are working on include high-resolution measurement of wavelength dependence of Planck radiation by using those of quantum optics and molecular spectroscopy.

Using the Avogadro Constant as a New Standard for Mass

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

Most people who have studied chemistry will probably remember an eccentric portrait of Italian physicist Amedeo Avogadro (1776—1856) that crops up in many textbooks. Avogadro hypothesized that equal volumes of gases at the same temperature and pressure contain equal numbers of molecules. This principle, now known as Avogadro's law, is today one of the most fundamental laws for physics and chemistry.

Improving the Accuracy of the Avogadro Constant

How many molecules are contained in 1 mole of gas? Avogradro does not offer a specific number for this quantity. At the time, no proof of the existence of atoms and molecules existed, and the theory on which these entities are based had not yet been validated experimentally. Today the internationally accepted value for the Avogadro constant is $6.022\ 1415 \times 10^{23}\ mol^{-1}$ (recommended in 2002 by the Committee on Data for Science and Technology (CODATA)). The constant is defined as the number of atoms or molecules in a single mole, which in turn is defined as 0.012 kg of ^{12}C. Since the beginning of the 20th century, numerous researchers have engaged in an interminable series of tests and measurements, striving to find an accurate value for the Avogadro constant. Since the 1920s, when X-ray diffraction was deployed for the first time, the accuracy of these measurements has steadily increased. The most startling progress of all has come the past decade, thanks to the emergence of the X-ray crystal density method and growth technologies for silicon crystals.

Because the Avogadro constant is such a fundamental constant in physics and chemistry, the discovery of more accurate values for this number is of monumental importance for basic chemistry. The implications are likely to be felt not just in laboratories, but in broad areas of everyday life as well, because of one radical outcome: the redefinition of the basic unit of mass, the kilogram.

Redefining the Kilogram

Of all the weights and measures that form the basis of the International System of Units, only the kilogram, the unit of mass, continues to be based on a material artifact. As discussed above, all of the other base units have already been redefined using physical principles. For example, the unit of time, the second, is based on the radiation period of the cesium atom; the meter, the basis of length, is defined in terms of the distance light travels in a vacuum within a defined period of time.

In its premises in the suburbs of Paris, the International Bureau of Weights and Measures (BIPM) houses the artifact that serves as the standard for the kilogram. Each country signatory to the Metre Convention holds a copy of this artifact. Every 30 years or so, these copies are shipped to Paris for recalibration. Meanwhile, the mass of the artifact itself fluctuates over time, rising as ambient gases are adsorbed on its surface and shrinking whenever it is cleaned. Naturally, these fluctuations compromise the stability upon which the present definition depends. The international community has therefore reached an agreement in principle to redefine the kilogram according to a defined number of atoms, using as accurate a value for the Avogadro constant as possible.

Toward an Atomic Mass Standard

The National Metrology Institute of Japan (NMIJ) is striving to find the most accurate value for the Avogradro constant, using a silicon single-crystal sphere precisely ground to 1 kg. First, the diameter of the high-purity silicon sphere is measured using laser interferometry to obtain a highly precise measure of volume. The density of the sphere is then measured in vacuum, and its lattice constant (the gap between the atoms) and molar mass (average atomic weight based on the three stable isotopes of silicon existing in nature) are determined.

Drawing on these data, in 2002 NMIJ succeeded in determining the Avogadro constant with an uncertainty of 10^{-7} level. This breakthrough contributed significantly to finding the most reliable value for the Avogadro constant as listed above. Based on our value as one of the fundamental input data, CODATA has conducted a comprehensive revision of no fewer than 200 fundamental physical constants.

Future efforts are intended to further reduce isotopic impurities and improve the measurement accuracy to a few parts in 10^8, thereby realizing a new standard for mass based on the Avogadro constant. Through joint research on the international level, the current definition of the kilogram should be obsolete within 10 to 20 years, ushering in a much more readily verifiable and universally reproducible standard for mass.

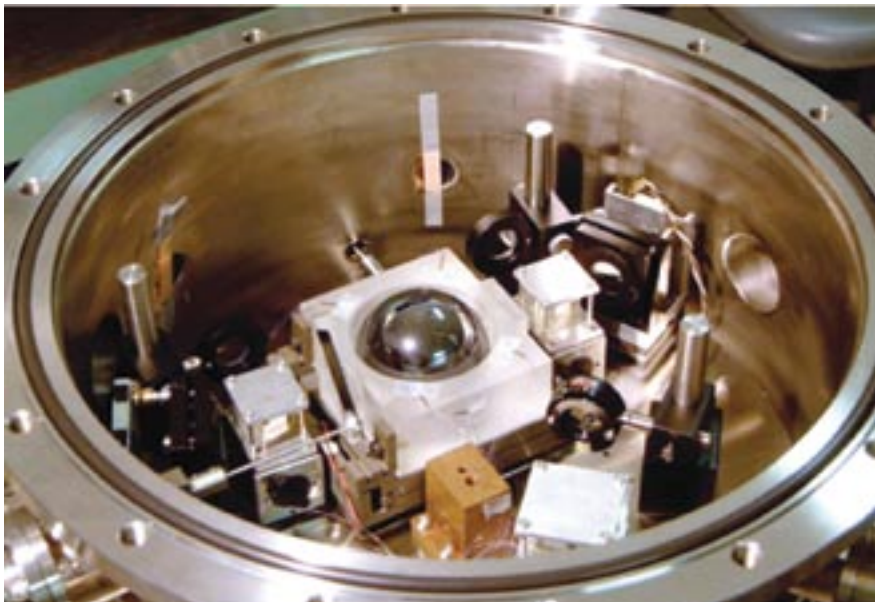


Photo Using laser interferometry to measure the diameter of the silicon sphere

Next-Generation Standards for High Temperatures

Yoshiro YAMADA,
Radiation Thermometry Section, Temperature and Humidity Division, Metrology Institute of Japan

A Novel Idea for a High-Temperature Fixed Point

Establishing standards for temperature, a physical quantity that is not easy to grasp, depends widely on repeatability of the temperature under which phase transitions occur in a substance. Formerly, temperature was defined on the centigrade scale, using a scale of 100 gradations from the boiling point of water to its freezing point. Today scientists use the Kelvin scale, in which the triple point of water is used to define the unit kelvin of the thermodynamic temperature. Additionally, a wide range of other fixed points, including the freezing points of pure metals, are used to realize and to disseminate the temperature scale.

Creating a fixed point, however, poses many difficulties at temperatures above 1000˚C, where matter reacts violently with other matter; the highest fixed point that can currently be used is approximately 1085˚C — the freezing point of high-purity copper. Attempts to use metals with higher melting points have failed because the graphite crucible used to contain the molten reference metal reacts with it, rendering the results unusable.

At NMIJ, we devised a new method that substitutes a metal-carbon alloy in place of a pure metal, thereby eliminating the graphite-metal reaction. By including carbon in the metal alloy at the composition known as a eutectic, the graphite-metal reaction can be prevented from proceeding further. As a result, highly reproducible melting and freezing points are obtained. NMIJ has succeeded in establishing nine distinct fixed points, from 1153˚C to 2474˚C, using carbon eutectics of a wide variety of metals. We have also demonstrated that fixed points can be obtained at temperatures above 3000˚C, using eutectics of carbon and metal carbides.

How Made-in-Japan Technologies Are Becoming World Standards

For these “made-in-Japan” standards technologies to win acceptance as true global standards, it is necessary to demonstrate temperature reproducibility and determine temperature values with high precision. These tasks cannot be achieved in Japan alone; it must be demonstrated that the temperatures can be reproduced by anyone, anywhere in the world. Worldwide agreement depends on independent verification of temperature values by the world’s leading research institutes. Many of these national metrology institutes are now involved in their research activities in this field. NMIJ is actively transferring knowledge and experience to many national metrology institutes, promoting information exchange and collaborative investigation, while working to maintain its global lead.

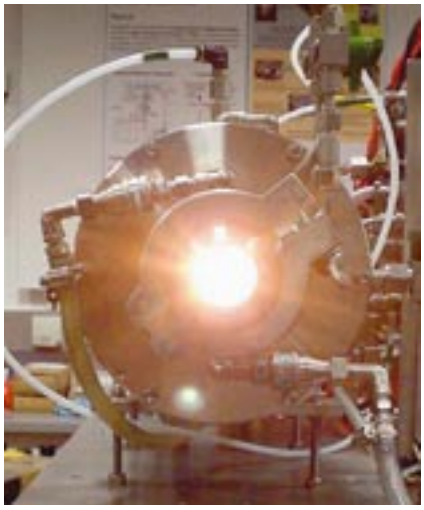


Photo High-temperature fixed-point furnace for radiation thermometer calibration (Ru-C eutectic point)

The International Temperature Scale, the international convention on temperature standards that is revised approximately every 20 years, comes up for revision within a few years. When the International Temperature Scale is next redefined, significant changes can be expected in the upper temperature ranges, where greater precision is an urgent necessity for industries such as materials and energy.

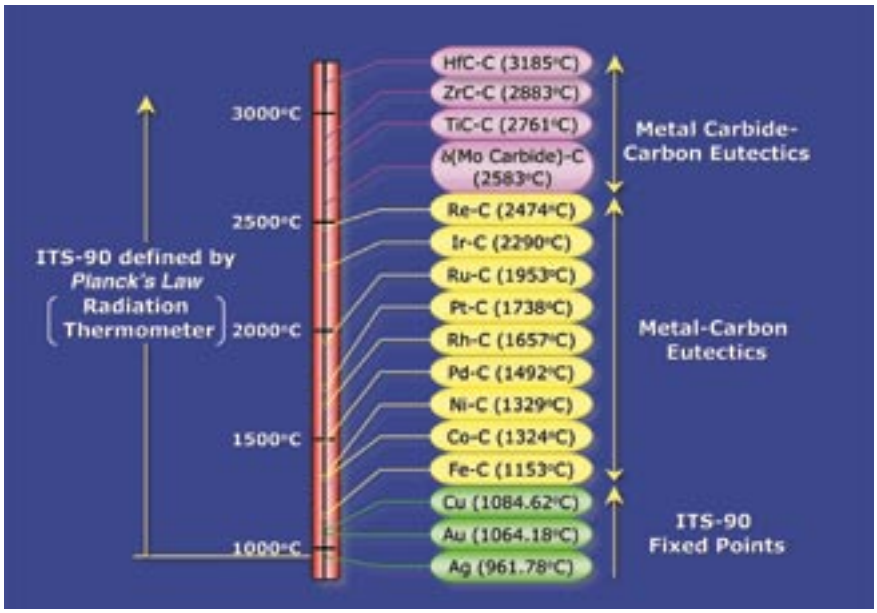


Figure High-temperature fixed points using metal (carbide)-carbon eutectics

Current Status of International Mutual Recognition and Future Directions

Mitsuru TANAKA,
Director, Metrology Institute of Japan

Measurement Standards in Everyday Life: Development and Maintenance

As our modern world grows more complex and advanced, the measurement standards on which it depends continue to expand both in the types of standard measures established and the purposes to which they are applied. The requirements upon which various quarters of society insist for these standards are demanding and complex: Technological development depends on uncompromising precision; manufacturers must find the standards easy to use for quality-control purposes; the array of available reference materials must be wide-ranging and comprehensive, to be an effective tool in environmental regulation, and so on.

Moreover, each country must underwrite the reliability of these measurement standards. The role of NMIJ/AIST is to create and support national standards and disseminate the measurement standards introduced. Thereby, it can provide a guarantee of reliability to people everywhere who use and depend on measurement results. The people who receive these measurement results from NMIJ use them to supply measurement standards at the next level, which in turn informs the next level of standards, until the work of NMIJ pervades every facet of modern Japanese society.

Of course, the chain is no stronger than its weakest link: reliability must be vouchsafed in every part of this process of supplying measurement standards. This is why traceability, the series of links that join these various measurement standards together to ensure their reliability, is extremely important. NMIJ is the organization that creates the framework that guarantees the traceability of measurement standards to Japan's national standards.

The Deployment of International Mutual Recognition and Japan's Response

With the relentless advance of globalization, imported products are bought and sold and technologies exchanged with ever-increasing frequency. When this happens, if the mutual traceability of the measures — the measurement standards — on which they are based cannot be guaranteed, evaluating the product or technology correctly becomes impossible. Because it is impracticable to verify this traceability every time a product is sold or a technology is transferred, the international community has struck upon the idea of guaranteeing the inter-reliability of each measurement standard in advance, so that mutual traceability can be guaranteed whenever the occasion demands. This system of measurement standards is known as International Mutual Recognition.

In Japan, the institution that is responsible for International Mutual Recognition is NMIJ. To fulfill its responsibilities, NMIJ continuously conducts international comparisons of national measurement standards and peer reviews by measurement standard experts. Under the Meter Convention, for example, in 1999 the national metrology institutes of numerous countries signed a mutual recognition arrangement. Preparations are being made to put this agreement in force from 2004 forward. As an enthusiastic participant in this arrangement, NMIJ has published an impressive body of outstanding results in international comparisons and enjoys a sterling reputation on the international stage.

NMIJ's brief differs from region to region. In the Asia-Pacific region, with whose countries and regions Japan has long enjoyed especially close ties of business and technological development, NMIJ has taken a leadership role in improving the region's measurement standards technologies. In the markets of North America and Europe, assuring quantitative and qualitative accuracy in measurement standards is an important issue in supporting the competitiveness of Japanese products and technologies.

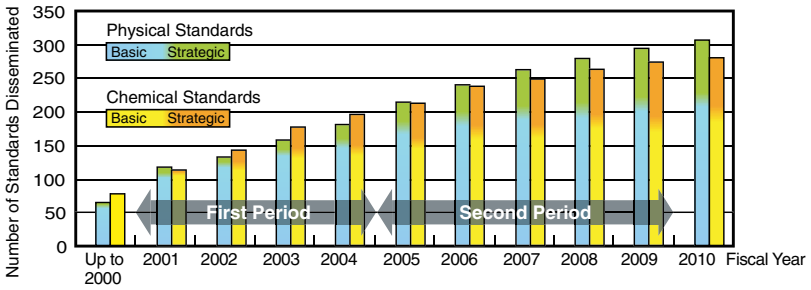


Figure 1: NMIJ's plan of measurement standards

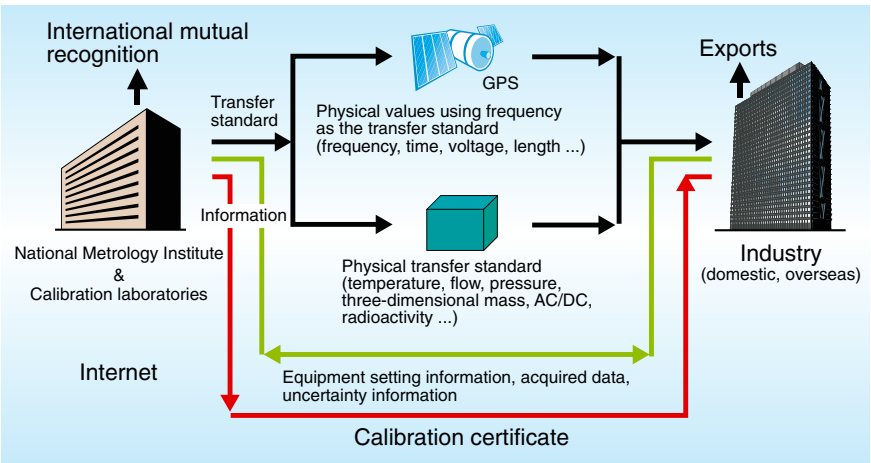


Figure 2: New format for dissemination of standards (remote calibration: e-trace)

The Next Five Years: Targets and Challenges

NMIJ follows a road map (Figure 1) that calls for the creation and dissemination of some 500 national standards, over the 10-year period from the beginning of its first four-year plan (2001–2004). In scope and ambition, this road map is the equal of that pursued by the United States. The basic component of this road map involves the preparation of some

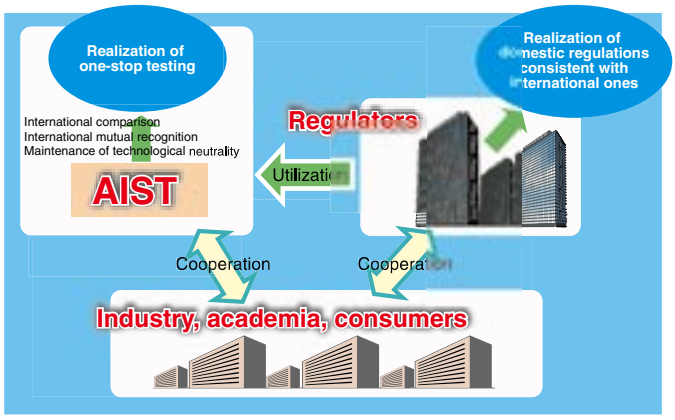


Figure 3: System for reliability and international consistency in measurement

Figure 4: Japan's response to the emerging tri-polar leadership structure in the world

300 standards. NMIJ is steadily pressing forward in the execution of this plan. In the second four-year plan, beginning fiscal 2005, NMIJ will augment this basic corpus of standards, aiming to establish and extend measurement standards in certain strategic fields, in view of Japan's global position in the world of industrial technology.

Unlike the national metrology institutes of other advanced countries, AIST incorporates not only National Metrology Institute of Japan (NMIJ), but a host of other agencies as well, devoted to the fields of biotechnology, the environment, energy and IT. It also conducts vigorous programs of exchange in each category. As such, NMIJ can be expected to create national standards that will lead the world in reference materials for biotechnology, clinical pathology, medicine, the environment and nanotechnology, and in technologies for evaluating the reliability of instrumentation software.

Today's industries require flexibility in the dissemination of measurement standards. Users must be able to choose the level of reliability that is appropriate for them, according to the time and cost required to obtain the standards. Accordingly, NMIJ will be hard at work technically optimizing the formats by which measurement standards are delivered. We are developing remote calibration technologies, using electronic communications and IT to deliver highly reliable measurement standards to users in remote locations (Figure 2). These efforts include ongoing research to speed up the supply of time and voltage standards and to develop new formats for the supply of radioactivity and temperature standards.

Another issue of vital importance at NMIJ is the development of greater reliability in national and international standards. As described above, NMIJ is participating in joint international research on the Avogadro constant to develop a new generation of highly accurate standards for mass that do not depend on artificial physical models for the kilogram. It is using alloys to establish standards for high temperatures. In all of these critically important efforts, NMIJ plays a world-leading role.

Emerging Needs in Measurement Standards

As those fields in which measurement standards are used continue to expand, it is of paramount importance to ensure that measurements conducted in Japan can be reliably traced to international measurement standards. This process of traceability forms part of the technological bedrock underpinning the sustainability of economic activity and R&D in Japan. To execute this process smoothly, a nationwide system must be designed for the creation and dissemination of national standards, to ensure traceability in the standards used to materials and technologies and in the regulations that govern society. Industry, government and academia must work closely to introduce a level of sophistication beyond that of conventional physical and chemical standards (Figure 3).

The call to action is no less urgent on the international front, where the contours of the process are often shaped by conflicting national agendas. The United States continues to insist strongly on its own national measurement standards, while the European Union is busily unifying measurement standards as it knits itself into a cohesive economic bloc. Moreover, the Asian-Pacific region is emerging as factory to the world and an immense market in its own right. Consequently, these three different powers form a tri-polar configuration strengthening internal ties within themselves (Figure 4). Under these circumstances, expectations are high both at home and abroad for Japan to continue to play a leadership role in the Asian-Pacific region. To serve such expectations, surrounded by a unique jumble of advanced industrial powerhouses and developing nations, Japan should keep making suggestions as to what direction the region should take with regard to measurement standards. At the same time, Japan should show her presence on the world stage by maintaining a high global profile for Japan's measurement standards.

AIST RESEARCH HOT LINE

UPDATES FROM THE CUTTING EDGE

(Oct.—Dec. 2004)

The abstracts of the recent research information appeared on the Vol.4 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

Venomous Protease of Aphid Soldier for Attacking Predators

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e-mail: m-kutsukake@aist.go.jp
AIST Today Vol. 4, No.10 (2004) 19

We identified venomous protease from unexplored and unique insect, soldier aphid. In social aphid, soldiers and normal nymphs are, although genetically identical due to parthenogenesis, remarkably different in their morphology, behavior, and reproductive physiology. To understand the molecular basis of soldier aphids, soldier-specific expressed genes in eusocial aphid, *Tuberaphis styraci*, were isolated by a cDNA subtraction. As a result, cathepsin B protease gene was obtained as a major soldier-specific gene. From molecular analyses, it was concluded that the cathepsin B protein was a major component of the aphid venom produced by soldiers.

Aphid soldiers attacking to a predatory lacewing

The Novel Gene Silencing Technology: CRES-T

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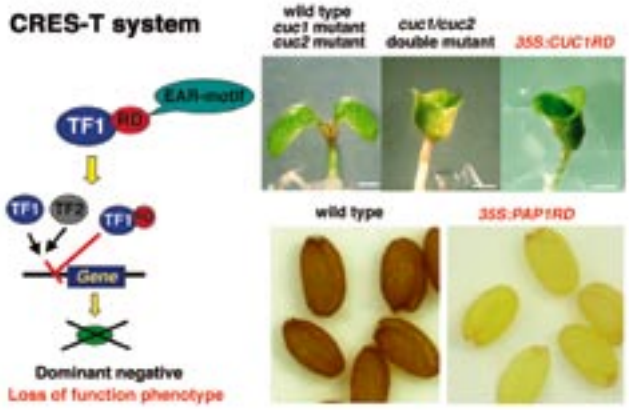
AIST Today Vol. 4, No.10 (2004) 20

The redundancy of genes for plant transcription factors often interferes with efforts to identify the biological functions. To overcome such redundancy we have developed a novel gene silencing system by using a dominant repressor, which was designated as CRES-T. We demonstrated feasibility and efficiency of the CRES-T system in several plant transcription factors of different families in transgenic plants. This CRES-T system is simple and effective compared existing gene silencing system and can overcome genetic redundancy. This system would be useful not only for the rapid analysis of the functions of transcription factors but also for the manipulation of plant traits.



The novel gene silencing technology (CRES-T; left) ant its dominant negative phenotypes: cup-shaped cotyledon (right upper) and suppression of tannin accumulation on seeds (right lower).

A Novel Microfluidic Analysis Method for Simple Sequence-Selective DNA Detection

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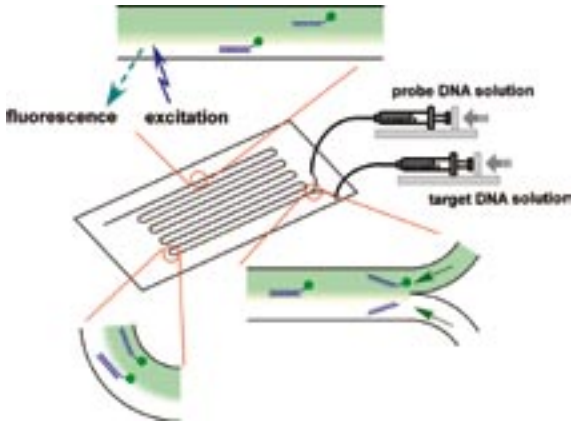
AIST Today Vol. 4, No.10 (2004) 26

On-site detection methods for DNA have been demanded in the pathophysiology field. Such analysis requires a simple and accurate method, rather than high-throughput. This report describes a novel microfluidic analysis method and its application for simple sequence-selective DNA detection with high accuracy. A microchannel offers superior controllability of fluids. The method uses a microchannel device with a serpentine structure. This method does not require immobilization of probe or target DNA: solutions are merely injected into the microchannel and all reactions occur in the liquid phase. Such features might lower the experimental error and difference in data by operators.



Schematic procedure of the sequence-specific DNA detection in microfluidic device

Is This a Protein?
Design of a Foldable 10-Residue Peptide
- Pursuing minimal elements of a protein -

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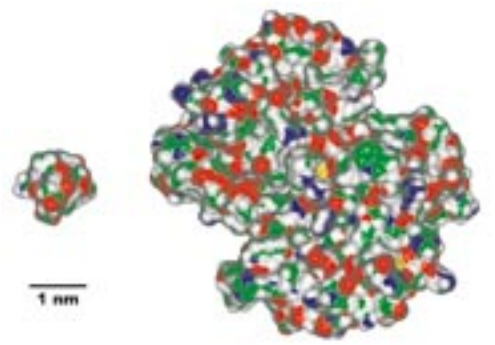
AIST Today Vol. 4, No.11 (2004) 19

We have designed a peptide termed chignolin, consisting of only 10 amino acid residues, on the basis of statistics derived from more than 10,000 protein segments. The peptide folds into a unique structure in water and shows a cooperative thermal transition, both of which may be hallmarks of a protein. Also, the experimentally determined β-hairpin structure was very close to what we had targeted. The performance of the short peptide not only implies that the methodology employed here can contribute toward development of novel techniques for protein design, but it also yields insights into the raison d'etre of an autonomous element involved in a natural protein. This is of interest for the pursuit of folding mechanisms and evolutionary processes of proteins.



Comparison of molecular size between chignolin (left, with 10 amino acid residues) and human hemoglobin, one of representative protein (right, with 574 residues).

Color Perception is not Innate But Acquired After Birth

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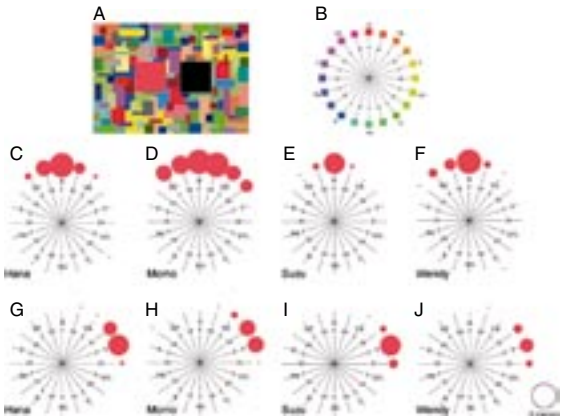
AIST Today Vol. 4, No.11 (2004) 20

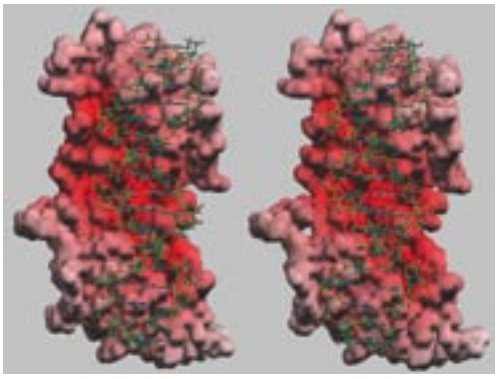
It was tested whether or not early experience is necessary for color perception. Infant monkeys were reared for nearly a year in a separate room where the illumination came from only monochromatic lights. After extensive training, they were able to perform color matching. But, their judgment of color similarity was quite different from that of normal animals. Furthermore, they had severe deficits in color constancy; their color vision was very much wavelength-dominated, so they could not compensate for the changes in wavelength composition. These results indicate that early visual experience is also indispensable for normal color perception.



Color identification. A, Schematic illustration of stimuli. B, 20 Munsell chips as stimuli. C-F, Normal monkeys' responses under the illumination where the x- and y values of a white chip (N9.5) were 0.331 and 0.331. G-J, Color deprived monkeys' responses under the same illumination as c-f. K-N, Normal monkeys' responses under the illumination where the x- and y values of a yellow chip (5Y) were equivalent to those of a red chip (5R) in c-j. O-R, Color deprived monkeys' responses under the same illumination as k-n. Responses to each chip were represented as a diameter of a circle and plotted at the position that corresponds to the Munsell Color Order System.

Ab initio Molecular Orbital Calculation of Biomolecule

Many biomolecules have metal atoms playing important role in the biological activity. To reveal the mechanism of the biological activity at molecular level, the classical mechanical treatment is insufficient because of the flexible electronic states of metal atoms, and the quantum mechanical treatment is indispensable. The fragment molecular orbital (FMO) method treats the electronic wave-function of biomolecule explicitly, and carries out a massive molecular orbital calculation with convenient computational cost. We carried out the FMO calculation of the DNA and estrogen receptor (ER) complex, and reveal the detail interaction and the change of the ER electronic state induced by DNA binding.



Electrostatic potentials (ESP) of the estrogen receptor: DNA binds to the largely plus ESP region (the deep red region) of the estrogen receptor. (stereovision)

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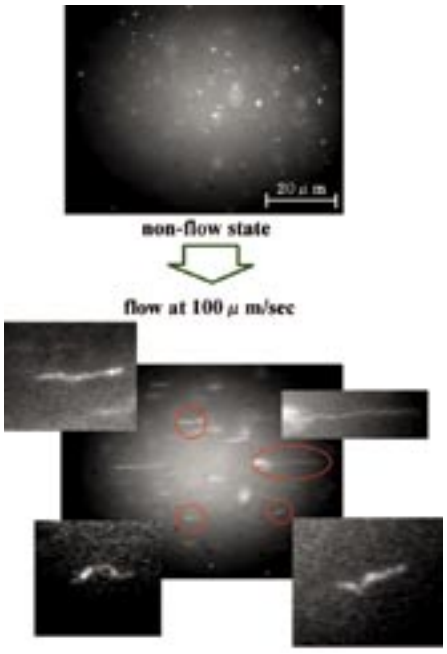
AIST Today Vol. 4, No.11 (2004) 21

Microfluidic Conformational Changing of Macromolecule and Efficient Chemical Reaction

Conformational control of macromolecules is useful for efficient chemical and biochemical reactions. This paper reports a conformational control method for macromolecules, such as long-strand DNA, in microchannel flow, along with a simple method to stretch DNA strands by microfluidics. Stretching and orientation of DNA molecules by control of flow within a microchannel was directly observed by optical microscopy. This technique is useful to create chemical reactions with macromolecules; it offers high selectivity and efficiency that are impossible to achieve in bulk solution. We also demonstrated that our microfluidic stretching method can accomplish efficient hybridization of long-strand DNA.



Direct observation of long-strand DNA structures in microchannel flow

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AIST Today Vol. 4, No.10 (2004) 26

Molecular Basis for Template-Independent RNA Polymerization

- Collaboration between protein and RNA for determination of nucleotide specificity -

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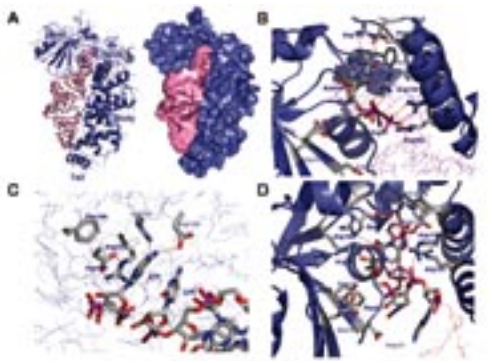
AIST Today Vol. 4, No.12 (2004) 23

The CCA-adding enzyme is the smartest enzyme among a large number of template-independent RNA polymerases. It adds and/or synthesizes the defined sequence CCA onto the 3' end of tRNA without aid of nucleic acid template. The ternary structure of the enzyme complexed with tRNA primer lacking terminal A and incoming ATP analog has been determined. The structure shows the base moiety of ATP stacks with base moiety of the 3' end of tRNA primer and is recognized by complement amino acid residues through "Watson-Crick" like base pairing. These results suggest that the complex of RNA and protein together compose the template for the incoming ATP and the collaboration of RNA and protein determines the nucleotide specificity of the enzyme.



A. Overall structure of ternary complex: The enzyme and tRNA are colored in blue and pink, respectively. B. Recognition of incoming ATP analog by complementary amino acids. C. Stacking ark formed by RNA primer and amino acids. D. Recognition of C74C75 of tRNA primer by complementary amino acids pocket.

New Technology to Identify Environmental Chemicals Causing Mental Disorders

- Assessment of psychotropic chemicals with experimental animals -

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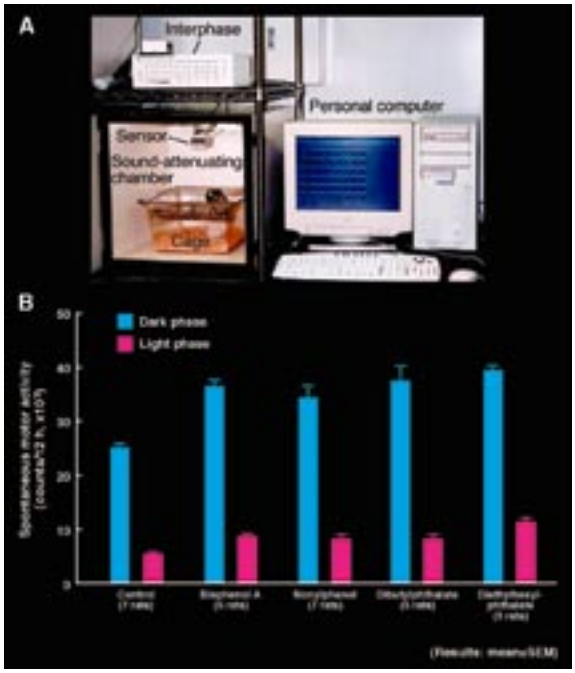
AIST Today Vol. 4, No.12 (2004) 24

We have developed screening technology to identify environmental chemicals affecting the brain. Environmental chemical was administered into the rat brain at 5 days of age, and spontaneous motor activity was measured at 4-5 weeks of age. Some of phenols and phthalates caused hyperactivities similarly to a neurotoxin, 6-hydroxydopamine [Fig.]. The histological analysis revealed that some phenols, such as bisphenol A, blocked the development of dopaminergic neurons. This technique is expected not only to draft the regulation for chemicals but also to contribute to the creation of better chemical substitutes and new drugs for prevention or treatment of mental disorders.



Spontaneous motor activity in the rat
A: Motor activity monitoring system
B: Environmental chemicals caused motor hyperactivities not only during the dark phase, but also during the light phase.

Transcriptional Gene Silencing by Small RNAs in Human Cells

This article was removed, since it included the information reported to be inadequate by the surveillance committee.

(4/3/2006)

Development of a Real-time Communication Method using Ethernet

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AIST Today Vol. 4, No.10 (2004) 22

Real-time communications typically have either guaranteed bandwidth or relied on specialized operating systems and device drivers. The former is not suitable for robot control and the latter makes it difficult to reuse software. Using an open source operating system (Linux), standard middleware (CORBA) on top of a global standard communications media (Ethernet) we developed a cost effective real-time communications system for use in a wide variety of embedded systems such as robotics, consumer electronics and vehicles.

Developed embedded boards(55[mm]×95[mm]) (SH-4 CPU board(left) and stackable peripheral boards)

Two-Way Communications by using Light-Controlled Photo-Switch

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AIST Today Vol. 4, No.11 (2004) 22

A wavelength-divided multiplex interactive light communication paths for 1.31μm and 1.55μm bands simultaneously switched by use of control light (660nm) have been developed using a novel palmtop-size photo-switch based on light-controlled switching of light path. The study will provide a key device for implementing the commercialization of "light-tagged photo packet communication system".

Combined N units of light-controlled photo-switch, is to build up an interactive optical communication system of (N+1:1) configuration, and simultaneous illumination with signal light and control light used as a light tag enables to realize an interactive optical packet communications for target destinations through light control only, which will be open the way to provide a low cost key device for the development of next generation optical communications system.

A prototype of all-optical photo-switch; an outward show
Width: 120mm, Length: 80mm, Height: 27mm／Volume: ～260ml

Color Liquid Crystal Display Driven by Organic TFT

A joint research group of AIST-Photonics Research Institute (AIST-PRI), Hitachi Ltd. and OITDA has developed a printed protective layer that keeps the transistor from damage during pixel formation with liquid crystals and source and drain electrodes which reduce the contact resistance for organic thin film transistors (OTFT). They have also succeeded in producing a 1.4-inch color liquid-crystal display with a resolution of 80 pixels/inch driven by the OTFT prepared by using the developed techniques. These techniques are expected to act as a breakthrough for the development of a low-cost flexible display such as an e-paper.

Color liquid crystal display driven by Organic TFT

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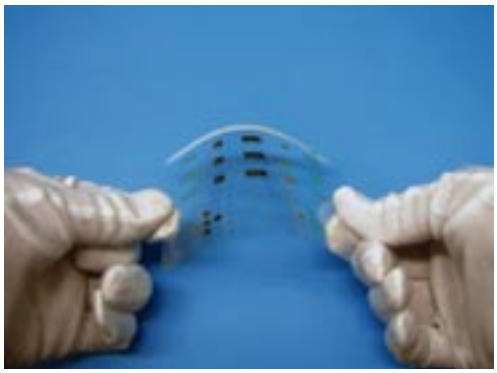
AIST Today Vol. 4, No.11 (2004) 23

Fabrication of SiO_2 Thin Film by Printing Technique

We were succeeded to prepare SiO_2 thin film from the silazane by low temperature solution process. This process enables to fabricate the SiO_2 thin film with good quality at low temperature below 100 ℃. So it is easily prepared on a flexible plastic sheet with no thermal damage (picture). The organic thin film transistor (OTFT) using the solution processed SiO_2 thin film as a gate insulator was comparable to that using thermally oxidized SiO_2 thin film, indicating that the solution processed SiO_2 thin film was such useful for the gate insulator of OTFT as the thermally oxidized SiO_2 thin film.



The solution processed SiO_2 thin film fabricated on a plastic sheet

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AIST Today Vol. 4, No.12 (2004) 26

P2P-Based Middleware Enabling Transfer and Aggregation of Computational Resources

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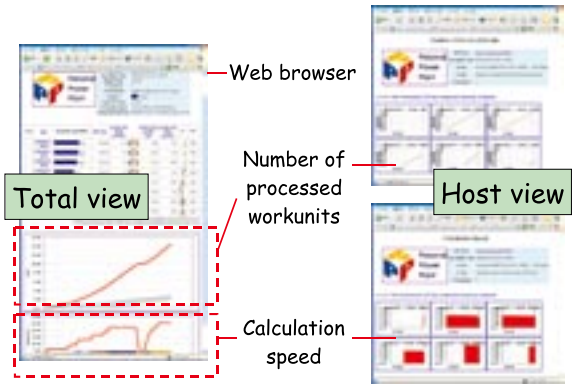
AIST Today Vol. 4, No.12 (2004) 27

P3 is middleware used for distributed computing that makes effective use of existing PCs. It enables engineers and scientists to harvest PC's compute power of existing computers in their organization. It also enables outside contributors to participate in research projects that are too massive for a single organization to handle. Unlike Conventional distributed computing projects, in P3 a "participant" means not only a "resource provider" but also a "resource user" because the participant both provides and uses the power.

http://p-three.sf.net/
http://www.jxta.org/universities/aist.html



Job monitor showing condition of PCs and a job
Acknowledgment : Development of P3 is party supported by the Information-Technology Promotion Agency (IPA) “Next Generbarion Software Development” project.

What are the Real Structures of Materials for Optical Disc ?

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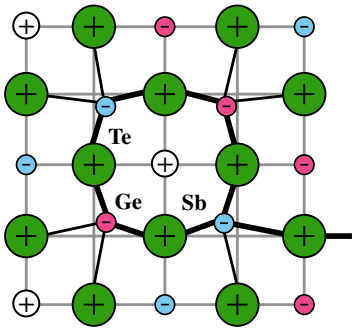
AIST Today Vol. 4, No.12 (2004) 20-22

Rewritable optical phase-change discs, such as CD-RW and DVD-RW are now available to store movies, musics and business files. However, the high-speed switching mechanism due to the phase transition has not well been understood. In CAN-FOR, we recently cleared the mechanism by use of a synchrotron radiation beam line in Spring-8. The phase transition in writing and erasing happens due to a small shift of Ge atom in between an off-central position and a tetrahedral bonding position surrounded by neighbor Te atoms.



A distorted rock salt structure of Ge2Sb2Te5 crystal. The unit is constracted by a ring of a network: [-Te-Ge-Te-Sb-Te-Ge-Sb-]-Sb. In the ring, there exists a positive charged hole for stabilizing the system.

Construction of a Deep Ultraviolet Raman Microprobe System

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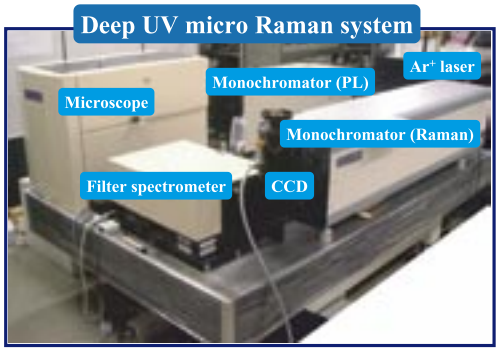
AIST Today Vol. 4, No.10 (2004) 27

A Raman microscope system using deep UV(DUV) laser excitation has been developed to characterize nano- scaled surface layer of wide gap semiconductors.

This system consists of DUV laser operating at 244 nm, microscope, dispersive spectrometer combined with a filter spectrometer and a CCD detector.

We have constructed this high through-put system using highly reflective dielectric mirrors instead of metal mirrors, and a Cassegrain reflection type objective. This DUV Raman system has enabled us to examine nano-scaled epitaxial films of wide gap semiconductors such as SiC and AlGaN. We have characterized ion-implanted surface layer and polished surface layer of SiC. We expect that our DUV Raman systems will be a versatile tool for characterizing thin surface layers of wide gap semiconductors.



Photograph of developed DUV microscope

Eye-Detection of ppb Level Pb(II) by the Ce(IV) Phosphate Membrane Filter Coupled with Color Signaling

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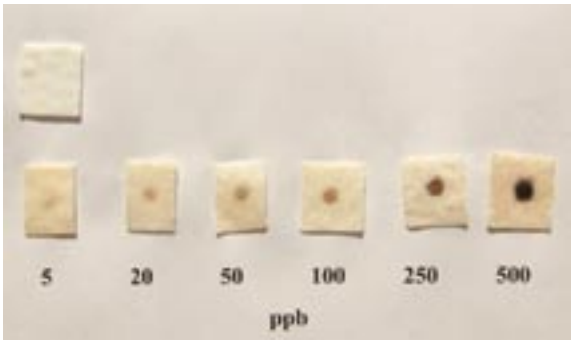
AIST Today Vol. 4, No.12 (2004) 29

Lead is harmful heavy metal giving fatal damages to brain and nerve, and therefore, strict allowance standard has been adopted to industrial waste water(100 ppb), and to environmental and drink waters (10 ppb). A Pb(II) selective membrane filter was fabricated from the fibrous $Ce(HPO_4)_2\ H_2O$ (Cerium phosphate) crystal. Trace Pb(II) of ppb level was selectively captured on the membrane surface simply by filter the sample solution. Visual detection of ppb level of Pb(II) was realized by coupled with color development as PbS. The simple detecting technique can provide an on-site and low cost means of monitoring trace lead ion in environmental water and industrial waste water.



Detection of ppb level of Pb(II) by color development on the cerium phosphate membrane filter

Development of Flexible Heat-Resist Gas Barrier Film

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AIST Today Vol. 4, No.12 (2004) 30

A novel gas barrier film is developed by optimizing composition of clay materials and additives, as well as preparation process. A flexible and translucent gas barrier film can be prepared through the compact lamination of clay crystal platelets of thickness around 1 nm each. The gas permeability of the film at room temperatures to hydrogen, oxygen, nitrogen and other inorganic gases is lower than the detection limit: comparable to that of aluminum foil. Besides, the gas barrier performance of the film remains unchanged up to temperatures as high as 1000 °C.

Outlook of the translucent clay film, 0.04mm thick

Energy Science & Technology

Biogas Plant to Recover Hydrogen and Methane Quickly

- A semi-pilot biogas plant based on two-stage fermentation process -

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AIST Today Vol. 4, No.10 (2004) 16-18

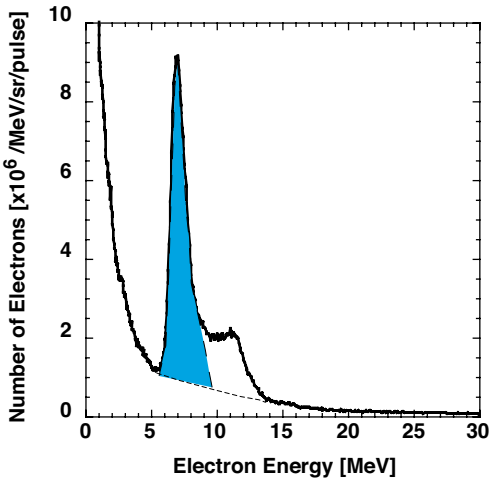
AIST has established a high efficiency hydrogen/methane fermentation semi-pilot plant to decompose kitchen refuse, paper waste and food waste with anaerobic microbes and to recover hydrogen and methane at the AIST Tsukuba West, in collaboration with Nishihara Environment Technology, Co., Ltd , Ebara Corp., Kajima Corp. and Japan Bioindustry Association. (See Photo.) This plant is a world first semi-pilot plant to recover hydrogen and methane separately from kitchen refuge, paper waste and food waste through the two-stage fermentation process. Percent energy recovery could be extensively improved from 40~46 % to 55 %. This work is supported by NEDO, Japan.


An outer view of the semi-pilot plant

Monoenergetic Electron Beam Generation in Laser-driven Plasma Acceleration

- A step toward a compact accelerator -

The realization of a compact accelerator based on laser-driven plasma acceleration is expected owing to the high acceleration field which is 1000 times higher than that of conventional accelerators. So far, a monoenergetic electron beam has not been obtained in laser-driven plasma acceleration. We generated a monoenergetic electron beam for the first time. A dense gas jet was irradiated by a 100-mJ, 50-fs laser pulse with the wavelength of 800 nm. The monoenergetic electron beam with the energy of 7 MeV has been obtained in the acceleration length of 0.5 mm from the plasma with the electron density of 10^{20} cm^{-3}. (Figure) The monoenergetic electron beam generation is a breakthrough in realizing a compact laser-driven plasma accelerator.



An energy spectrum of a monoenergetic electron beam obtained in laser driven-plasma acceleration

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AIST Today Vol. 4, No.11 (2004) 28

Nanotechnology and Materials Science & Technology

Elemental Mapping with Atomic Sensitivity

- the Ultimate Analysis -

Advances in nanotechnology increasingly rely on characterization tools with atomic resolution. Chemical information on hetero-geneous nanostructures in particular is more and more crucial for diagnosing and predicting properties of novel functional nanodevices. We have developed an analytical electron microscope enabling elemental analysis at the sub-nanometer region which is a powerful tool to determine the atomic structures in nano-materials. Single-atom identification has been demonstrated by this apparatus for the chemically decorated carbon nanostructures with the highest confidence level.

A dedicated scanning transmission electron microscope with atomic sensitivity

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AIST Today Vol. 4, No.10 (2004) 24

Interface Engineering in Strongly Correlated Electron Oxides

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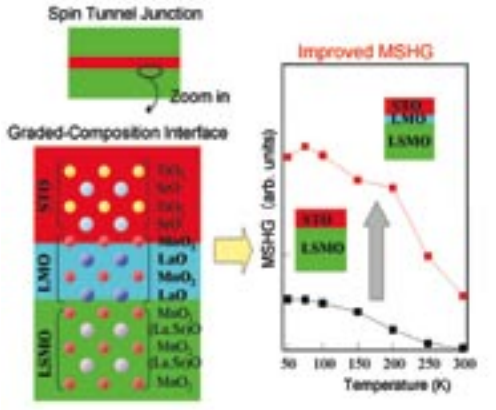
AIST Today Vol. 4, No.11 (2004) 24

The spin tunnel junction with perfectly spin-polarized ferromagnet $La_{1-x}Sr_xMnO_3$ (LSMO) can be one of the best candidates for magnetic random access memory. However, in the actual junctions, e.g. LSMO/$SrTiO_3$ (STO)/LSMO, only an inferior tunnel magnetoresistance has been observed. We have succeeded in probing the local magnetic properties at the magnetic heterointerface by Magnetization-induced Second Harmonic Generation (MSHG), and we confirmed that the interface ferromagnetism is deteriorated at the LSMO/STO interface. We have shown that by grading the doping profile on an atomic scale at the interface, robust ferromagntism can be realized even around room temperature, which leads to the improvement of the performance of spin tunnel junctions.



Atomic structure of graded-composition interface and its gigantic MSHG

Observation of Fermi Surfaces in a Single-Component Molecular Metal

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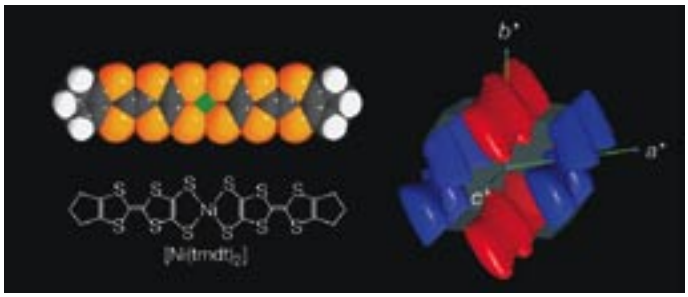
AIST Today Vol. 4, No.11 (2004) 25

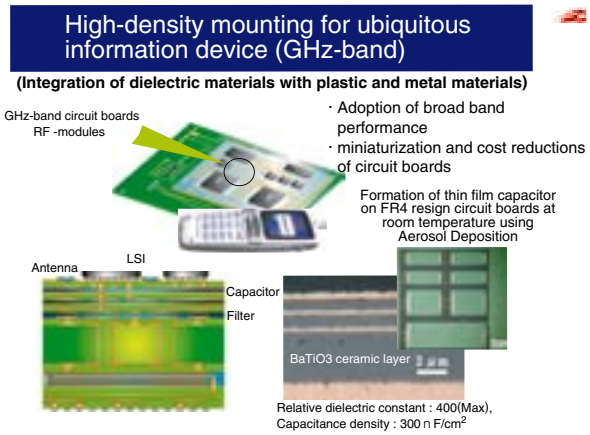
The realization of a molecular metal based on the crystallization of single-component, neutral molecules is a long standing quest. We report direct experimental evidence for the Fermi surface in [Ni(tmdt)$_2$], by detecting the quantum oscillations in magnetization. Torque magnetometry measurements of single crystals of [Ni(tmdt)$_2$], using a sensitive microcantilever at low temperatures in high magnetic fields to 45 T revealed dHvA oscillatory signals, for all directions of magnetic field, indicating the presence of electron and hole Fermi surfaces. These findings are consistent with band structure calculations, leaving no doubt that [Ni(tmdt)$_2$] is a single-component molecular metal in the most rigorous sense.



Molecular structure of [Ni(tmdt)$_2$] and calculated Fermi surfaces

World's First Technologies Embedded Capacitors on Resin Circuit Boards

The National Institute of Advanced Industrial Science and Technology (AIST) in collaboration with Fujitsu Limited and Fujitsu Laboratories Ltd., have developed the world's first technologies that enable the formation and multi-layering at room temperature of ceramic film with dielectric constant of 400, on resin circuit boards. The new technologies, named as Aerosol Deposition, makes it possible to embed passive components such as condensers into printed circuit boards, such as FR4 resin circuit boards, thereby achieving miniaturization and cost reductions of circuit boards.



Electric passive components embedded on resin circuit boards using Aerosol Deposition

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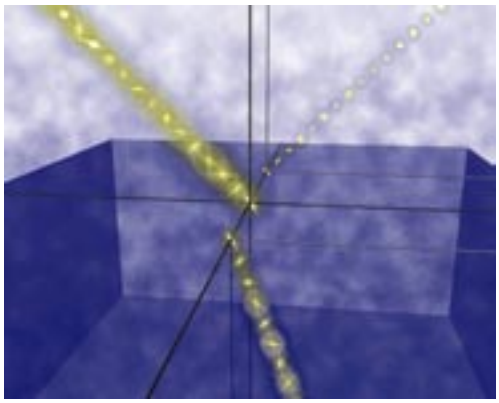
AIST Today Vol. 4, No.12 (2004) 28

Optical Hall Effect Fully Clarified

AIST has derived a new basic equations of geometrical optics taking into consideration the effect of polarization to the propagation of light wave packet, in collaboration with University of Tokyo. These equations predict "optical Hall effect" in which the polarization affects the trajectory of light beam and causes a shift in the direction perpendicular to change of refractive index. The effect, not predicted from the conventional geometrical optics, is closely linked with the conservation of total angular momentum of photon. The research group has proposed to amplify the effect extensively by use of photonic crystal. This study is supported by JST.



Reflection and refraction at an interface. When the incident light is circularly polarized, the mid-axes of reflected and refracted light beams pass through planes different from the trajectory of incident light.

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A Reference Material for Electron Spin Resonance

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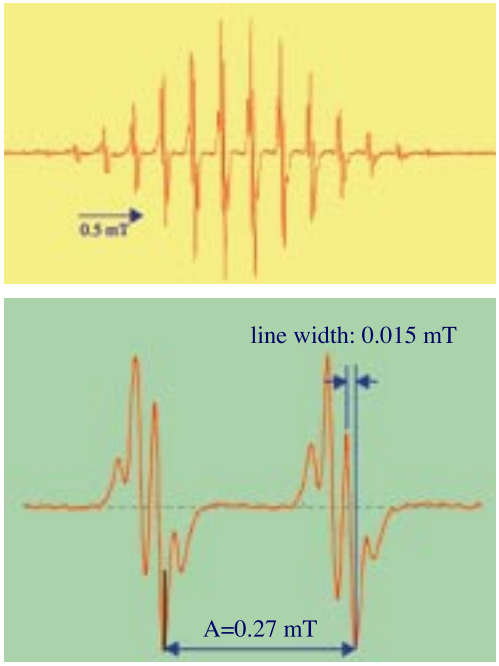
AIST Today Vol. 4, No.11 (2004) 30

Perfluoro-2,4-dimethyl-3-isopropyl-3-pentyl is an extremely stable free radical due to six bulky CF_3 substituents protruding above and below the radical center like 'picket fences'. Two 'picket fences', each comprising three trifluoromethyl groups, protect the radical center against various active molecules. Due to inert nature of the radical it could be used as an internal standard for the electron spin resonance (ESR) measurement. The highly congested 'picket fence' geometry hinders the three C_3F_7 groups from rotating around the three bonds next to the radical center. As a result, the ESR spectrum has a beautiful hyperfine structure (Fig. 1). Since this hyperfine structure is significantly influenced by magnetic field homogeneity and/or modulation amplitude, we propose this radical as the indicator testing for both spectral resolution and sensitivity of the ESR spectrometer.



Structure and ESR Spectrum of Persistent Perfluoroalkyl Radical

Mechanical Engineering and Manufacturing Technology

A Robot Spray Painting Simulation System on a Component-Based Software Framework

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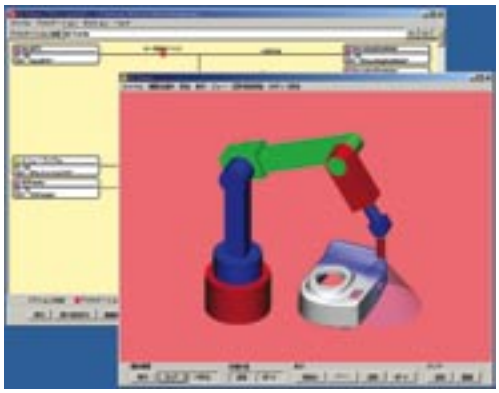
AIST Today Vol. 4, No.10 (2004) 23

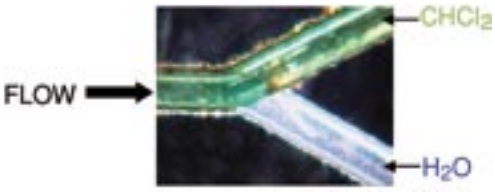
We have developed a new robot spray painting simulation system with easy-to-customize capability. In order to make it easy to customize the system according to each robot's characteristics, the main algorithms for calculation of motion were developed as a component with specific functions on the component-based software development and operation framework, called MZ Platform, which was developed by the Digital Manufacturing Research Center. As the simulation system was constructed by combining the different components, a function of the simulation can be easily changed by replacing the components. The cooperative use with other applications on MZ Platform is also possible.



Robot Spray Painting Simulation System On MZ Platform

Efficient Enzyme Reaction in Microchannel Reactor

Microchannel reactors have been attracting attention as a novel reaction apparatus in chemical industry. We have developed enzyme-immobilized microreactor, which can perform multistep enzyme reactions. We also developed partial surface modification method of microchannel surface for separation of aqueous and organic solution within microchannel. Using this method, we have developed efficient enzyme microreactor for optical resolution of chiral compounds. Further development of micro-bioreactor are in progress.



Separation of aqueous and organic solution in surface-modified microreactor

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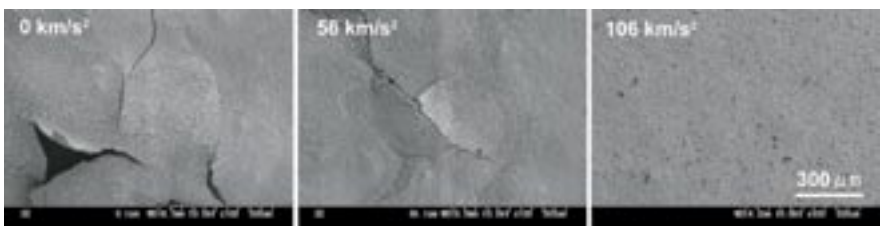
AIST Today Vol. 4, No.10 (2004) 25

Crack-Free Thick Film via Centrifugal Sintering

Centrifugal sintering is an advanced technology that is specifically designed to sinter structures under constrained conditions, such as films on substrates and layered ceramics. This technology consists of loading high centrifugal acceleration more than 100 km/s^2 onto specimens and heating. Owing to the distinctive pressing measure, pressing without molds and anisotropic shrinkage during sintering are achieved. This process has been found to be a successful strategy for eliminating shrinkage mismatches in multi-layered ceramics, leading to a crack-free homogeneous microstructure. This distinctive feature of centrifugal sintering arises from anisotropic shrinkage that is caused by chief densification progress along the radius of rotation.



Suppression of cracks in thick film by centrifugal sintering. The number indicates centrifugal acceleration

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AIST Today Vol. 4, No.11 (2004) 26

Development of a Thermal Diffusivity Reference Material for the Laser Flash Method

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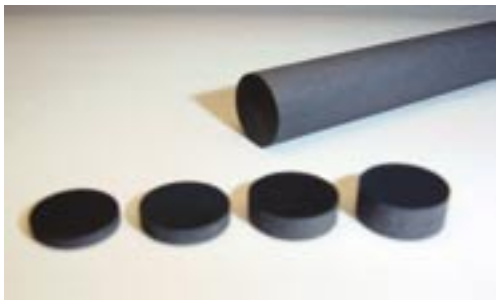
AIST Today Vol. 4, No.10 (2004) 28

The laser flash method is generally acknowledged as a standard and most popular method to measure thermal diffusivity of solid materials above room temperature. Since surface of optically nontransparent and dark materials can be directly heated by the laser pulse and measured without black coating, we selected a grade of isotropic graphite and characterized homogeneity and stability as a candidate reference material. We proposed a new calibration procedure of the laser flash instruments using a set of specimens of same thermal diffusivity with different thicknesses. The specimen sets with SI traceable thermal diffusivity value will be supplied soon.



Specimens of a candidate reference material for the laser flash measurement

Development of Highly Sensitive Visible-Near IR Transient Absorption Spectroscopy

- Observation of conducting electrons in photo-chemical devices -

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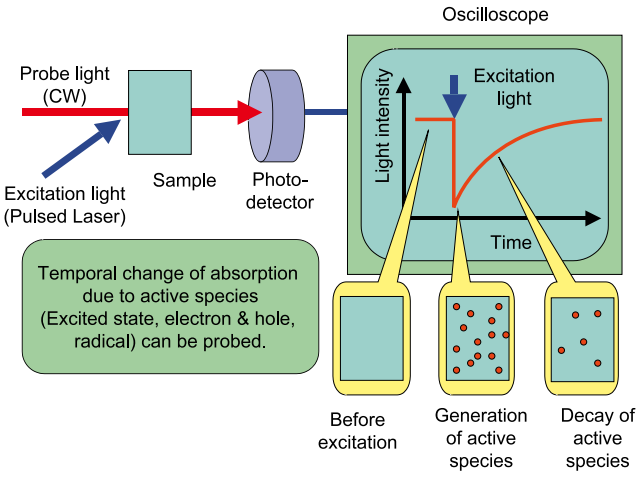
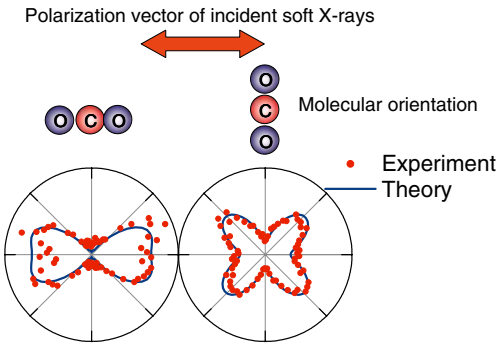
Transient absorption spectroscopy was developed to observe active species produced by light excitation (see figure). Application fields of this technique have been limited because of low sensitivity. Thus, we developed highly sensitive transient absorption spectrometer. In our system, very small absorbance change ($< 10^{-5}$) in wide-wavelength-range (400-3000 nm) can be detected with 50 ns time resolution, while 10^{-3} absorbance can barely be detected by conventional system. Using the spectrometer, we have studied primary processes of various photo-functional devices, such as dye-sensitized solar cells and photocatalysts. This spectrometer can be also used for trace analysis of molecules in solution.



Principle of transient absorption spectroscopy

Development of 3-D Momentum Imaging Spectroscopy for a Molecule

We have been developing multiple coincidence momentum imaging spectroscopy, which consists of electron and ion time-of-flight analyzers with multi-hit two-dimensional position sensitive detectors, a supersonic jet, and a fast TDC system. Figure shows an example of C 1s photoelectron angular distributions (PADs) of CO_2 in a molecular frame measured at a photon energy of 320 eV. CO_2 molecules are oriented parallel or perpendicular to the polarization vector of the incident photon beam. The photoelectrons are ejected from the molecule after scattering by the intra-molecular field and thus the PADs reflect the molecular field, geometry, etc.



C 1s photoelectron angular distributions (PADs) of CO_2 in a molecular frame measured at a photon energy of 320 eV

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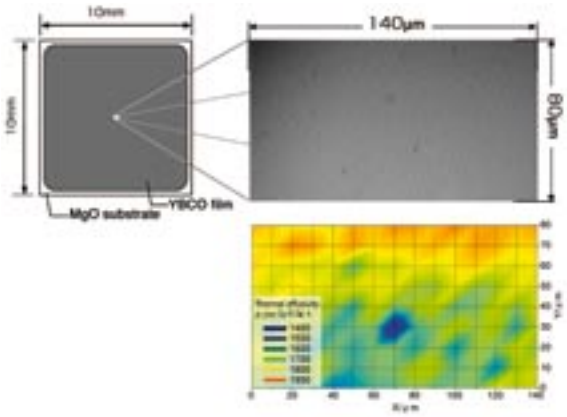
Thermoreflectance Measurement Technique for the Evaluation of Thermophysical Properties of Oxide Superconducting Thin Films

Fault current limiter (FCL) device is one of the most promising applications of oxide superconducting thin films. In this type of device, the SN transition of superconducting films is utilized for the limitation of the accidental overcurrent. Therefore, the initial consideration in its thermal and mechanical design is inevitably needed for preventing it from breaking due to large thermal stress. We have developed a non-contact thermoreflectance technique to remotely measure thermal effusivity of thin films and applied the technique for the evaluation of YBCO thin films (0.8μm in thickness) on MgO substrate. The absolute value of thermal effusivity of the YBCO films is clearly confirmed to be comparable with those of bulk YBCO. This evaluation technique is also expected to be available for detection of defect points of large thin films by scanning probe laser beams.



YBCO thin film specimen (upper left), its optical image (upper right) and the distribution image of its thermal effusivity (lower right) in the center rectangular area of 80×140μm

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The Mid Niigata Prefecture Earthquake in 2004

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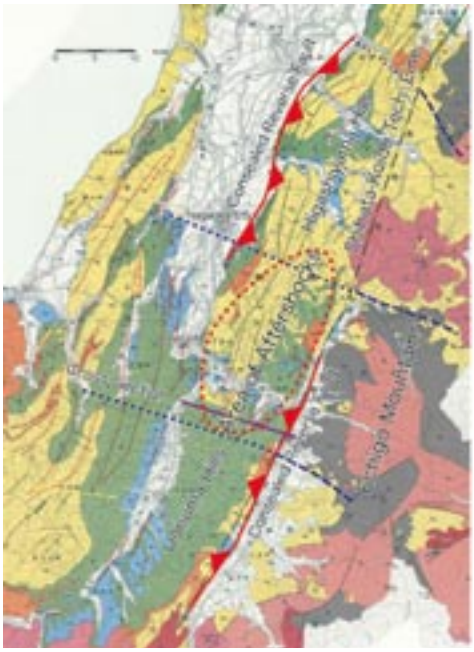
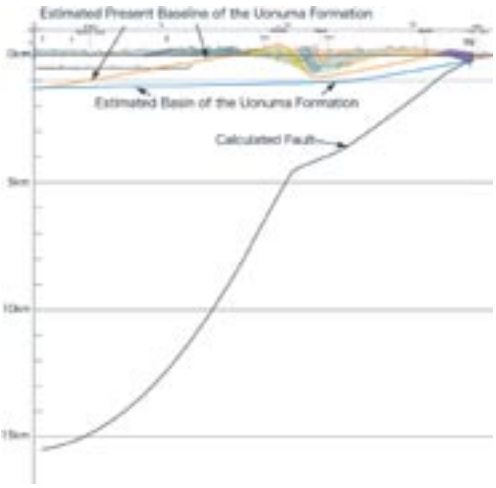
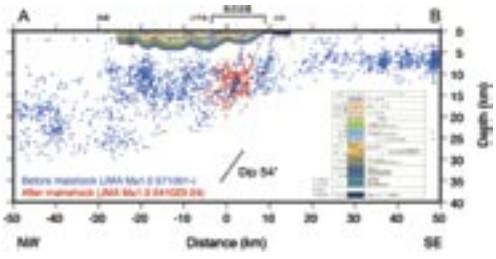
AIST Today Vol. 4, No.12
(2004) 16-19

At 5:56 PM JST on October 23, 2004, J_{MA} 6.8 earthquakes struck Mid Niigata Prefecture, Central Japan. The hypocenter of the main shock is located at 37.3 N; 138.8E with depth of 13 km. The intensity is registered 7 on the 7-grade Japanese intensity scale. Many aftershocks including some M6 class events have been following. The victims of this earthquake are 40. At peak time, over 100,000 refugee have stayed in schools, tents and cars. Geological Survey of Japan, AIST sent the teams of researchers for surveying the earthquake related fault system and disasters, providing geological maps and data of this area.







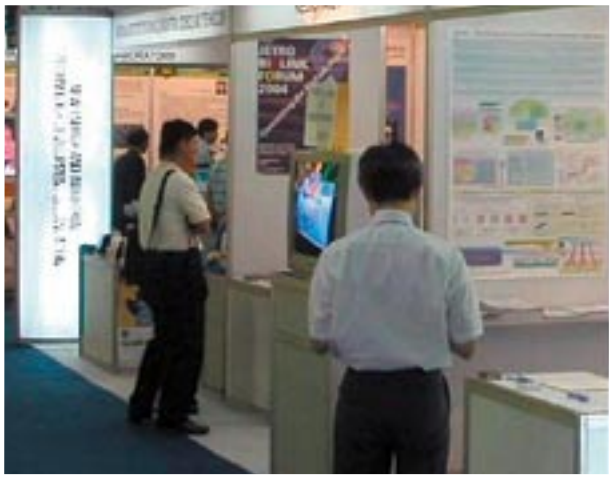
Geological structure and estimated cross section of the Mid Niigata Prefecture earthquake in 2004.

AIST Has Booth Presence at Nano Korea 2004 in Seoul

Nano Korea 2004 convened for four days, from August 24 through 27, 2004, at an exhibition hall within the COEX Mall, a popular venue for the younger crowd in the commercial development district (Gangnam) on the south side of the Hangang River that runs through central Seoul. Cosponsored by South Korea's Ministry of Science and Technology and Ministry of Commerce, Industry, and Energy, the event comprised a symposium and business show focused on nano technologies (nano materials, nano devices, and product applications).

A speaker from South Korea gave a presentation entitled “Nano Particular Materials Technology in Japan” which focused on AIST’s accomplishments in nanotechnology research.

Numerous countries were represented at the business show, including Japan, South Korea, the United States, Germany, the Netherlands, Sweden, and Estonia. Around 6,200 people visited the show during its four-day span. Many visitors showed up to see the AIST exhibit, which was located in a section of the NEDO booth and comprised a display of technologies for photocatalytic environmental filtration (photocatalytic filters). Some of the visitors were former AIST-associate Korean researchers who came away deeply impressed by the AIST technology exhibit.

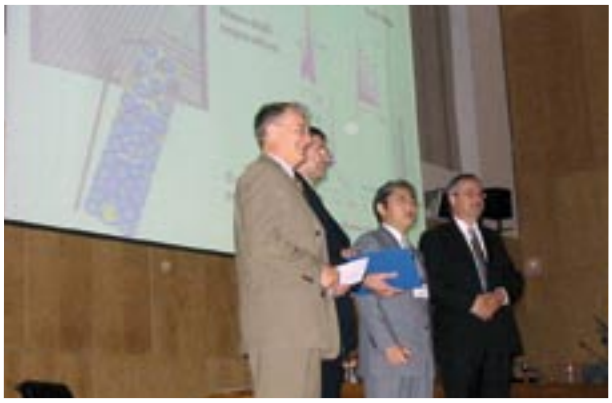


Single-Molecule Bio-analysis Laboratory Director Yoshinobu Baba Wins Merck Award

The Euroanalysis XIII Conference, which convened September 6, 2004 in Salamanca, Spain, included an awards ceremony for conferral of the 2004 Heinrich Emanuel Merck Award, which is sponsored by Germany.

The recipient was Yoshinobu Baba, director of the AIST Single-Molecule Bio-analysis Laboratory, for his paper, "Nanospheres for DNA Separation Chips," which was published in Nature Biotechnology, 2004.

The Merck Award was set up by Merck KGaA to encourage research advances in the life sciences, materials chemistry, and analytical chemistry in the environmental field. It is awarded once every two years to researchers under the age of 45 who spearhead world-leading research on the development and implementation of new methods of chemical analysis. Since its establishment, the award has been granted to 10 individuals (two Americans, two Canadians, one Austrian, one German, one Israeli, one Briton, one Swiss, and one Japanese). Baba's award is the second to a Japanese national, coming 16 years after the first. The panel of judges comprised seven individuals (two Germans, two Americans, one Briton, one Japanese, and one Spaniard) renowned worldwide for their work in the field. The panel's task is to select from an international field of candidates one or two awardees who have recently demonstrated stunning research accomplishments.



Report on the Japan-Australia Coal Research Workshop

The Fourth Japan-Australia Coal Research Workshop gathered on September 17, 2004 at the Grand Cube Osaka International Convention Center. The venue for this annual event alternates between Australia and Japan. Workshops are sponsored in Australia by government-affiliated Australian research institutes (CCSD, CSIRO), and in Japan by AIST, NEDO, the Center for Coal Utilization (CCUJ), and the Central Research Institute of Electric Power Industry (CRIEPI). The AIST-affiliated Energy Technology Research Institute (ETRI) serves as the organizing secretariat for workshops held in Japan. Following a welcoming address by ETRI Deputy Director Jun Hama, keynote speeches by Australian Ambassador John McCarthy (read by Embassy Counselor John Kjar) and Michiaki Harada (CCUJ), and a presentation delivered by Kyoto University Professor Koh-ichi Miura concerning joint Japanese-Australian research, workshop participants split into three groups on coal ash management, gasification, and emissions control, respectively, held roundtable discussions, and engaged in active dialogue on future prospects for technical cooperation and collaborative research.

AIST Tokyo Waterfront, *Nippon Kagaku Miraikan* (National Museum of Emerging Science and Innovation) Forge Cooperative Alliance

On October 14, 2004, representatives for AIST Tokyo Waterfront and Nippon Kagaku Miraikan took part in a ceremony held at Nippon Kagaku Miraikan offices to formally sign an agreement for cooperation aimed at promoting academic research and personnel exchange. After the signing ceremony, a desktop single-crystal growth apparatus researched and developed by AIST was installed in Nippon Kagaku Miraikan's Experiment Workshop in commemoration of the agreement and put on display.

The two institutions have adjacent facilities located within Tokyo Academic Park. Under their new cooperation agreement, they will coordinate their research and museum functions and strive to heighten their contributions to society in an effort to foster activities and exchange aimed at boosting public awareness and understanding of science and technology through specific exhibition-type events.

In the future, Miraikan will cooperate in the planning and operation of exhibitions held by AIST Tokyo Waterfront, and AIST Tokyo Waterfront researchers will collaborate in the planning of new Miraikan exhibitions. The heightened levels of exchange and interaction

by academic research and exhibition staff for both institutions will hopefully afford society with enhanced benefits from cutting-edge technology.

Report on Intelligent Systems Research Institute's Open House 2004 and Exhibit of Research Accomplishments

On October 13, 2004, AIST Tsukuba Central 2 and AIST Tsukuba East provided the venues for presentation exhibits detailing the accomplishments of 25 research projects. This was the fourth in a series of annual events designed to allow corporate and university researchers an opportunity to directly observe the accomplishments of AIST research in a research setting and foster consideration for future cooperative ties with the institute. Although a recent typhoon had left rainy skies in its wake on the day of the event, many delegates were on hand from as far away as Kyushu, representing companies and universities as well as government-affiliated institutions for science and research and facilities for public welfare.

In addition to providing details on the research exhibits themselves, the AIST website also contains the text of interviews with exhibitors, highlights of the presentations and exhibits, pages devoted to interesting aspects of research, and a listing of research fields in which AIST has been involved to date. Many of the exhibits comprised actual demonstrations or video presentations. The opportunity to experience this many research demonstrations in one location comes only once each year. Persons interested in obtaining information on the next Open House are urged to utilize the following contacts. (Materials are in Japanese)

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