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FEATURE

The World of Metrology is Expanding

The 10-year historical locus of the National Metrology Institute of Japan (NMIJ)

Research Hotline

UPDATE FROM THE CUTTING EDGE（July−September 2010）

In Brief

The World of Metrology is Expanding

～The 10-year historical locus of the National Metrology Institute of Japan (NMIJ)～

Preface - Innovation and Metrology -

Technical innovation and measurement

The invention of the airplane is called a representation of 20th century technical innovation. It took many long years for mankind to observe the shape of birds, then to imagine how to fly for the first time, and finally to invent the airplane. In 1903 the Wright Brothers risked their lives to fly like a bird and began to follow the first step towards the practical use of the airplane. For that purpose, they needed reliable data. Otto Lilienthal gathered data of a glider and the Brothers applied the data to design the Flyer, a propeller-driven aircraft. But, the lift of Flyer was too small to be practical. The Brothers faced this hurdle for a long time. Then, the Brothers calibrated an instrument to measure the lift, gathered reliable data, designed their aircraft based on the data, and succeeded in the flight experimentation at last. Thus, measurement is required in order to establish science as a technology and to connect it with an innovation.

In order for nanotechnology to shift from the stage of imagination based on observation to the stage of technical innovation that guarantees reliable manufacture, it is necessary to connect nano-observation with nano-measurement. Moreover, unless it is shown based on measurement that the nanomaterial is safe for mankind, a product will not be accepted in society.

It is measurement that is the foundation where people who are social players share data, cooperate, and create innovation. Therefore, if the necessary measurement means and the resultant reliable data are not provided for the players, such a situation is called "Metrological Barrier to Technological Innovation". AIST removes this barrier and carries out activity as a technical source for national measurement system in order to promote the technical innovation in our country.

The measurement system mentioned herein is measurement standards and reference materials which give the measure of measurement, technical standards and database needed to calibrate the measuring instruments, the measuring instruments/analyzers, and the talented persons who are engaged in measurement. AIST offers service for measurement standards and reference materials. These tools support measurement that is required for use to cooperate or compete with foreign countries in technical innovation. Therefore, these tools must be approved internationally. Only in this way, the technical innovation originating from our country will have a global spread.

Social innovation and measurement

Measurement is the basis of trade, taxation and regulation, and is a technology as old as human society. The demand for national or international unification promoted a measurement institutional reform in the advanced nations early in the 20th century. This brought about conclusion of The Meter Convention and revision of the domestic measurement laws.

In order to connect technical innovation with social innovation and to change social activity from the system, it is necessary to further fix a technology to society. Measurement is the technology that plays an active part also in this field. These technologies secure the safety and reassurance of the life of the people, guarantee the stability of the important productive activity of our country, and also preserve land/resources. Measurement evaluates, from a viewpoint of human life, the safety of everyday medical care, food, and air/water/soil. Measurement also evaluates the capital involved in "life innovation", productive activity, or land/resource preservation. Measurement becomes an acceleration means to "green innovation". AIST is working also as the fountainhead of such measurement. For example, productive activity and trade/taxation activity is supported in such cases as energy transactions with a wattmeter, commercial transactions with a "balance" and a gasoline meter and service transactions with a taximeter. In these transactions, measurement is the fountainhead of the technical source where consumers and enterprises share data mutually. In recent years especially, in order to avoid the risk of a product, chemical analysis of hazardous substances and analysis necessary for medical diagnosis are required. For that purpose, expansion of the reference material service to ensure reliability is demanded. AIST is meeting such a demand exactly.

Aiming at measurement that is united with the industrial community and society

When we connect a measurement technology even to an extensive social innovation, we need to broaden measurement technologies and to extract the measurement issues that might become a barrier to social innovation. Furthermore, it is important to strengthen and optimize the domestic measurement system corresponding to our industries/society and its advance. In the 1st medium term (FY 2001–2004) or the 2nd medium term (FY 2005–2009) of AIST, we always expanded standard supply service based via publicly announced plans. This is because NMIJ intended to urge industries to newly create calibration business based on the domestic measurement system. Moreover, NMIJ endeavored to spread a global technical trend about metrology domestically, and to survey measurement technical needs from end users of standards, such as consumers and manufacturers' inspection departments.

This special feature looks back upon the 10-year historical locus of NMIJ, which performs AIST's metrological activity, and presents the prospect of the 3rd medium term to be followed in the future.

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National Measurement Standards Establishment Plan – Milestone in 2010 –

Standards and an intellectual infrastructure

When we shifted in April 2001, from the Agency of Industrial Science and Technology to AIST, we consolidated three laboratories related to metrology into a single organization in order to centralize management. Moreover, the government extracted six important areas to form intellectual infrastructure: measurement standards, geological information, chemical substance safety control, life/safety, biological genetic resource information, and material. They planed to set numerical targets of the six areas in 2010 and to implement respective activity.

This is because our country had then three challenging issues as follows. (1) We had to shift to areas of high productivity. We aimed to realize an innovative economic society that promotes creativity or innovativeness. (2) Companies should address the problems of environment and safety. They should be capable of voluntary control of safety. They should develop and disseminate products and services rapidly that smoothen the life of people including elderly or disabled persons. (3) Economic activity should globalize so that trade, capitalization, procurement, etc. are performed on an international scale. In this situation, objective reliability should be presented for technical evaluation and quality control of products. In consideration of these three issues, we recognized strongly the necessity to systemize and accumulate the result of science and technology, and to form intellectual assets (intellectual infrastructure) that is in common with society.

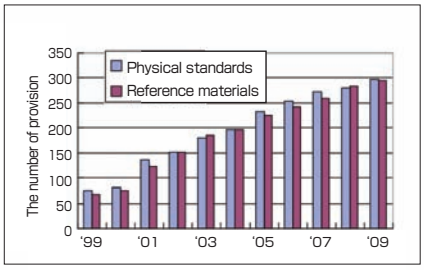
Milestones in 2010

Development of measurement standards is the common base of industrial technology. It is indispensable for intellectual infrastructure, particularly for maintenance and strengthening of global competitiveness of domestic industries, for improvement of reliability and for realization of a safe and secure life of the people. Moreover, in order to advance international mutual recognition in criteria/standards and inspection/verification (criteria certification area), existence of such measurement standards that ensure international equivalence is indispensable. However, our country is behind Europe and the U.S. in terms of development and supply of measurement standards. In order to advance creative research and development, to ensure technical capability to survive in international competition, and to establish business conditions that are attractive in international dealings, etc. in the world, it is important to establish an organized supply of measurement standards that does not depend on foreign countries.

For this purpose, NMIJ acts as a core organization to gather opinions/comments from the Japan Metrology Forum (a federation of domestic industrial organizations related to measurement standards) and the social need. NMIJ aims at establishing about 250 kinds of physics standards and 250 kinds of reference materials by the end of FY 2010. We carried out a consistent plan through the 1st (FY2001–2004) and the 2nd (FY2005–2009) medium terms of AIST. As a result, we achieved the numerical target earlier than scheduled. Now, it is possible to provide a measurement standards supply service that is comparable to that of Europe and the U.S.

The quality management system of NMIJ

NMIJ has improved the quality of measurement standards, reduced uncertainty, expanded the range, and increased the degree of sophistication. NMIJ has built a quality system that is based on international standards such as ISO/IEC 17025 and ISO GUIDE 34. These are related to requirements for the competence of calibration laboratories and reference material producers. Thus, NMIJ has established a system to enable a reliable calibration service and reference materials supply. Moreover,



National measurement standards provision plan

NMIJ has undergone an examination (peer review) from overseas national metrology institutes, etc. NMIJ has participated positively in international comparisons for measurement standards, and endeavored to confirm international equivalence and to ensure international reliability. Moreover, NMIJ has positively corresponded to the international trend of the calibration capability of national metrology institutes. As of April 1, 2010, 741 kinds of measurement standards were registered into the database (KCDB Appendix. C) of the International Bureau of Weights and Measures. This is the eighth largest number of registrations in the world. Our registration is comparable to that of Europe and the U.S. in terms of the number of registration items and the level of supply quality.

New deployment of NMIJ

NMIJ established and disseminated measurement standards within and outside our country. NMIJ organized the NMIJ Metrology Club in 2005 to provide information about international metrology activity, to survey requests for establishment of measurement standards and to have a close relationship with industries. In 2004, the three East Asian countries (Japan, China, Korea) started a joint development project of reference materials. NMIJ has contributed positively to promote this project. NMIJ has submitted a joint proposal to the International Committee for Weights and Measures concerning international key comparisons of the organic mercury in food, etc.

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Akihiro Mito

Cooperation and Competition Following International Mutual Recognition - The World after the Conclusion of CIPM-MRA -

Competence in metrology of each country

In recent years, a key word of "globalization" is advancing for good or for bad. This trend is not limited to economy. The metrology has originally had an international nature. In 1999, the International Committee for Weights and Measures concluded a mutual recognition agreement (CIPM-MRA). After this, more international co-operations are requested and competitions are more intense, because this agreement has been intended to guarantee mutual equivalence. It was agreed to publicly announce the results of international key comparisons and list up the calibration items and their CMCs (Calibration and Measurement Capabilities). The data of each country is released from the website of International Bureau of Weights and Measures as KCDB (Key Comparison Database) (http://kcdb.bipm.org/). CIPM-MRA has been signed now by 75 economies and three international organizations. In this KCDB, 703 international key comparisons, 248 supplementary comparisons and a total of 23,184 CMCs have been registered. The table shows the total number of CMCs, number of international comparison participation, and number of pilot laboratories undertaken for these comparisons. These figures indicate the " capability" of the countries in metrology as result of the conclusions of CIPM–MRA.

Names of countries (in decreasing order of number of comparisons)	Number of registered CMCs	Number of participated international comparisons	Number of pilot laboratories
Germany	1707	330	105
U.S.	2279	315	60
U.K.	1290	310	60
Japan	741	260	40
France	973	260	35
Russia	1426	225	15
Korea	934	220	25
China	735	210	10
Australia	314	170	20
Italy	592	165	15

Total number of CMCs, number of participated international comparisons and number of undertaken pilot laboratories for comparisons

Japan's cooperation with international metrology research institutions

On the one hand, in order to maintain the equivalence and transparency of CMCs, it is necessary to establish a quality system and traceability. For this purpose, NMIJ and many metrology research institutions in the world reinforced their organizations to establish a quality system and traceability, which conform to ISO/IEC 17025 and other international standards. The CMCs registration rule specifies that the internal check shall be done first by Regional Metrology Organization (RMO), such as Asia Pacific Metrology Plan (APMP), and then, shall be reviewed by external RMOs. So, the importance of RMO has increased. On the other hand, the uppermost traceability tends to concentrate on the most influential standards organizations. In North and South America, the U.S. National Institute of Standards and Technology (NIST) plays a leading role. In Europe, German Physikalisch-Technische Bundesanstalt (PTB) is gaining influence steadily. We are proud that in Asia, NMIJ has played a major role. Japan is the top in Asia in terms of the number of participated international comparisons and the number of pilot laboratories undertaken for these comparisons. In addition, Dr. Hidetaka Imai (former Vice-President of AIST) took heavy responsibility for management of APMP as a chair from 1999 to 2003. NMIJ also managed the secretariat office for eight years from 1999. During the past ten years, NMIJ sent six chairs for TC/SC, and contributed their human resources greatly. Furthermore, we contributed to the establishment of metrology organization in Asia. In 1998, the National Institute of Metrology Thailand (NIMT) was established. In order to support NIMT to be able to join CIPM–MRA and NIMT is accepted internationally as a metrology research institution, we launched JICA/NIMT project through the Japan International Cooperation Agency (JICA) fund. Many researchers of NMIJ cooperated, and carried out training courses in Thailand and Japan, making a great contribution.

Strengthening of the metrology research institutions in Asia

Thus, during ten years after conclusion of CIPM-MRA, we have established and maintained traceability and a quality system under international cooperation. On the other hand, the fight for leadership is intensifying, especially in Asia. China allocated a huge area of campus in the Beijing suburbs for the National Institute of Metrology, and is rapidly constructing facilities and introducing the newest equipment. The number of personnel and annual total budget of the Korea Research Institute of Standard and Science are already larger than NMIJ, and these gaps are spreading more and more. The National Measurement Institute of Australia has been re-organized with the legal metrology department in 2004 as a national organization to strengthen the standards system including standard materials for food and chemistry. In Asia, as shown in the table, a dominant ecomomy is absent. Asian area is now entering the period of a full-scale competition to be the leader of this region. After conclusion of CIPM-MRA, NMIJ has increased its functions and has held somehow the major status in Asia at present. But, China, Korea and Australia are endeavoring more actively to strengthen their organizations. In order to against to such severe competition, more resources are needed and it is important to get more support from of our limited resources.

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Yoshio Hino

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Traceability and the JCSS System - The Spread of Measurement Literacy and the Expansion of Calibration Laboratories -

Cooperation with manufacturers and calibration laboratories

As mentioned in other articles in this issue, NMIJ continues establishment of physical standards and reference materials based on the Intellectual Infrastructure Improvement Plan. The scene where these standards are used in the industrial world is increasing. The two factors that contributed to such a result are mentioned below.

The first factor is cooperation with external organizations. The goal of the Intellectual Infrastructure Improvement Plan was to reach the same level of intellectual infrastructure as there is in foreign countries. But, national metrology institutes such as the U.S. National Institute of Standards and Technology (NIST) and the German Physikalisch-Technische Bundesanstalt (PTB) have a far larger scale than NMIJ. A level comparable to these nations cannot be reached by NMIJ alone.

Fortunately, Japan has many measuring instrument manufacturers that are top level in the world. Private calibration laboratories are highly competent. The goal cannot be reached by NMIJ alone. If NMIJ cooperates with these manufacturers and calibration laboratories and addresses the issue with all-Japan structure, then the goal can be reached. The manufactures, calibration laboratories and NMIJ collaborated and achieved the Intellectual Infrastructure Improvement Plan earlier than scheduled.

Establishment of the JCSS system

The second factor is the construction of a framework to supply the established standards to the industrial world. In order to enable standards to be used actually, we have to collectively improve the system that supplies standards smoothly. Here an important role is played by the Japan Calibration Service System (JCSS).

The JCSS system is the calibration laboratories accreditation system that started with revision of the Measurement Law in 1993. (It became the calibration laboratories registration system from July 1, 2005.)

In the JCSS system, International Accreditation Japan (IA Japan) of the National Institute of Technology and Evaluation (NITE) receives an application from calibration laboratories, examines compliance with ISO/IEC 17025 which should be complied with by calibration laboratories and with requirements of the Measurement Law, and then registers the applicant. Here I would like to state clearly that IA Japan is an important and indispensable partner to disseminate standards in addition to the measuring instruments manufacturers and calibration laboratories.

Aiming at the improvement in global competitiveness of industry

In order to offer products and service of high quality in the industrial world, it is indispensable that the measurement used there is accurate. It is also important that the traceability of the measuring instruments used for that purpose is secured. The calibration laboratories registered under the JCSS system are entitled to publish a calibration certificate containing the logo mark as shown in Fig 1. When users find this mark in a calibration certificate, they are easily assured that the calibration has been registered by the Measurement Law and the resultant calibration is highly reliable.

Recognition of the JCSS system in the industrial world is increasing gradually. In keeping pace with the progress of the Intellectual Infrastructure Improvement Plan, a steady increase has been seen in the number of registered laboratories (Fig. 2) and the number of calibration certificates issued (Fig. 3).

But compared with all the calibration work being done in Japan, the number of JCSS calibration certificates issued is still limited. Also in future, we should endeavor to expand coverage of the JCSS system and to increase the number of registered companies. At the same time we should popularize calibration so that industries may understand the necessity of accurate calibration. Such an endeavor will lead to improvement in the global competitiveness of Japanese industry.

Deputy Director, Metrology Institute of Japan
Toshiyuki Takatsuji

JCSS

Fig.1 The JCSS registered calibration laboratories are entitled to publish calibration certificates containing this logo mark (Reprinted by courtesy of NITE)

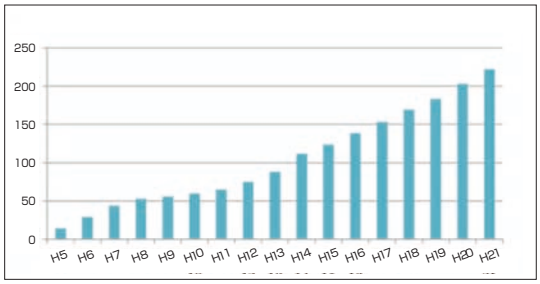

Fig.2 Number of JCSS registered companies

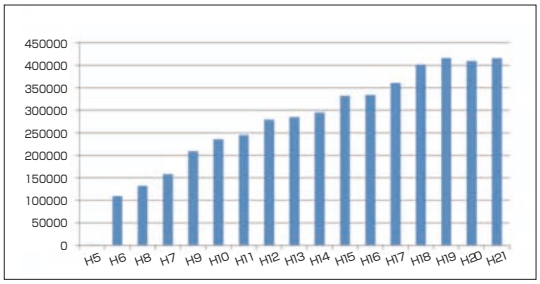

Fig.3 Number of JCSS calibration certificates published

A Bottom-up Approach for Dissemination and Enlightenment – The NMIJ Metrology Club

The growth

The NMIJ Metrology Club was launched in 2005 as a 17 club organization. As of October 2010, it has vastly grown to 30 clubs (among 28 clubs are currently recruiting club members). Each club corresponds respectively to the 12 measurement technical fields. The total number of club members is 1686 persons. The members gather from about 700 organizations including 550 private firms.

The NMIJ Metrology Club is a hub for the club members who are engaged in metrology, measurement and quality control in the industry and the NMIJ staff, to further strengthen their cooperation through the club activities. The club's activities include not only general activities such as holding lecture meetings, workshops and laboratory tours of NMIJ, but also comparison tests and other programs to improve member's calibration skills, and furthermore, collaboration activities for standardization.

The Activities

The following are some of the recent achievements through the activities.

[Frequency, Lengths, Dimensions field] Time & Frequency Club and Optical Comb Club jointly held a week long time and frequency seminar in both 2009 and 2010. Various programs are available, including the basics of a time frequency standard, the applied technology of optical comb, and a live demonstration of remote calibration of frequency standards.

[Acoustics, Ultrasound, Vibration field] Vibration Club surveys the trend of vibration monitoring in industrial plants and the trend of the standards for vibration testing equipment. In order to improve calibration competence of calibration laboratories or manufacturers, the club carried out the round-robin test of a charge amplifier in 2010. The club carried out a similar round-robin test for shock acceleration.

[Electricity, Electromagnetic Waves field] DC & Low Frequency Electricity Standards Club held seminars actively, and provided a forum to share and solve the technical issues for extending the calibration scope. The club has played a major role in spreading the scheme of calibration under the JCSS. Radio-Frequency Club held the training course on measurement apparatus. Electromagnetic Fields Club performed precise evaluation of an electromagnetic-environment measurement technology, and has taken up the calibration and uncertainty evaluation methods of measurement apparatus.

[Temperature and humidity field] Temperature & Humidity Club sends out information through lecture meetings, etc. In the club, calibration laboratories as well as the users of measuring instrument exchange opinions to solve issues closely related to calibration. The club cooperated with the DC & Low Frequency Electricity Standards Club to hold a "Workshop on temperature indicators" which had been an unsolved but important topic lying between the two fields. The club also exchanged opinions with related manufacturers and calibration laboratories seeking the necessity of thermometer calibration higher than 1500 °C.

[Uncertainty, Metrology Standards field] The Uncertainty Club has 442 members and operates as the most characteristic club in NMIJ Metrology Club. The club takes the lead in spreading the concept of "uncertainty of measurement" which is generally difficult to understand. The club handles a numerous number of technical consultations that are triggered by the participation to the club. The club plays an important role in giving advice to individually specific cases.

Technical field	Name of club (number of members)
Frequency, Lengths, Dimensions	Optical Comb Club (61), Time & Frequency Club (132), Length Club(149), Non-contact CMM Assessment Club (42), Dimensional Club(110)
Force, Vacuum, Pressure	Force & Torque Club (84), Vacuum Club (48), Bourdon Tube Pressure Gauge Club (50)
Acoustics, Ultrasound, Vibration	Ultrasound Club (102), Vibration Club (97)
Temperature, Humidity	Temperature & Humidity Club (257)
Flow	Flow Club (118)
Thermophysical Properties, Materials	Solid-State Thermphysical Properties Club (74), Fluid Properties club (56), Nano-Materials Club (52), Polymer Club (39), Particle Club (34)
Electricity, Electromagnetic Waves	DC & Low Frequency Electricity Standards Club (159), Radio-Frequency Club (173), Electromagnetic Fields Club (134)
Quantum Radiation	Ionizing Radiation Club (139)
Photometry & Radiometry	Optical Radiation Club (60)
Inorganic & Organic Analytical chemistry	pH Club (44), Standard Gas Club (38), Standardization of Laboratory Medicine Club (–) Note 2), Inorganic Analytical Chemistry Club (recruiting
Uncertainty, Metrology Standards	Uncertainty Club (442), Metrology Standards Club (–) Note 2)
Legal Metrology, Software	Legal Metrology Club (261), Measuring Instruments Software Club (recruiting starts in September, 2010)

Note 1) Club members often belong to two or more clubs. The sum of members shown in this table does not agree with the actual total number of members.
Note 2) The Standardization of Laboratory Medicine Club and the Metrology Standards Club are at present not recruiting members.

The clubs under the NMIJ Metrology Club and the number of members (July 2010) Note 1)

Logo mark of the NMIJ Metrology Club

The future prospect

The club activities have brought great benefits to both club members and NMIJ, since in coincidence to when the NMIJ Metrology Club began its activity, many national measurement standards had been established according to the top-down Measurement Standards Development Program assigned by the government. Through the club activities, questions such as, "How do we establish traceability from the national measurement standards to the measuring instrument of the industrial world?", "What uncertainty is required in each item?", "What service scope has the most urgent demand?", were resolved by gathering opinions of the measurement standards organizations, the measuring instrument manufacturers, calibration laboratories, and industrial users. From the information collected, the necessary frameworks were planned, and the technical issues to be solved were clarified through this bottom-up approach.

Upon drafting the 3rd term plan of NMIJ described in this special feature article "NMIJ in the 3rd term", the NMIJ Metrology Club has given significant contributions for the survey and analysis of the demands. The NMIJ Metrology Club had expanded and strengthened relations with related organizations and companies. Our staffs were kindly offered to directly visit about 134 companies during the "3rd Term Demands Survey Activity" standing upon that strong relation. We are sure that the activities of the NMIJ Metrology Club will continuously contribute to disseminate measurement standards and to improve reliability of measurement in future.

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Masaru Arai

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Measurement Standards in Society

○Secure/safe social infrastructure

Reference material that supports the reliability of analytical value

The result of analysis or measurement must be always "accurate", no matter who, when and where the measurement is made. Today goods and people move worldwide. Secure/safe foods are needed. Environmental monitoring is carried out on a global scale. Clinical examination is indispensable for health maintenance. In all of these fields, analytical value must be accurate and reliable enough for mutual comparison and verification beyond the limit of time and space. Reliability of analytical value is supported by three factors. Firstly, the analytical method must be backed by science and be highly reliable. Secondly, the analytical skill must be vouched by the skill and conformity tests. Thirdly, reference material is indispensable. Especially, reference material guarantees the traceability of an analytical result and evaluates validity of an analytical method/technology. So, the development of reference materials is strongly required. To support the fields of environmental preservation, safe food, and clinical examination, NMIJ has developed and supplied various reference materials.

Reference materials used for environment and food analyses

In the field of environment or food, NMIJ has developed the following reference materials: a polished rice powder reference material to analyze trace elements (including cadmium), a brown rice powder reference material to analyze residual agricultural chemicals, a fish meat powder (broadbill swordfish, codfish, sea bass) or edible brown algae powder reference material to analyze trace elements, arsenic compounds, organic mercury compounds, etc. NMIJ supplies a river water or marine sediment reference material which is required to investigate the environmental impact and environmental records of the following substances: harmful elements, organotin compounds, polychlorinated biphenyls (PCB), residual agricultural chemicals, polycyclic aromatic hydrocarbons, etc. Furthermore, NMIJ supports industries that aim at the realization of an eco-friendly society. For that purpose, NMIJ supplies relevant reference materials that responds the RoHS directive to regulate harmful substances contained in electric/electronic equipment (to analyze cadmium, chromium, lead, mercury, bromine-based flame retardant that are contained in the plastic), and a lead-free solder reference material, etc.

Clinical chemistry reference material

In the field of clinical examination, over recent years inspection results have been strongly required to be traceable and exchangeable. Inspection organizations have introduced the laboratory accreditation system. In the fields of clinical examination and biological substance analyses, it is often difficult to realize traceability to SI. In order to develop reference materials, we have established analytical methods where traceability has been newly secured. We have participated in international comparisons that are sponsored by the Consultative Committee for Amount of Substance as we carried out research and development. So far, NMIJ has developed pure substance reference materials of relatively low-molecular-weight substances, such as urea, uric acid, creatinine, hydrocortisone, etc. In order to analyze biological substances, such as protein and nucleic acid, we have developed a quantitative analysis method that uses the isotopic dilution mass spectrometry, etc. Using this method, we have developed various amino acid reference material series and a C reactivity protein solution reference material. On the other hand, we have developed a reference material whose composition is similar to a real sample, such as a serum reference material to analyze coltisol and a reference material to analyze steroid hormone in serum. Thus, we have cooperated in the establishment of a reference material system in the clinical chemistry field.

Certified reference materials of NMIJ, AIST(NMIJ CRM)

Nuclear magnetic resonance equipment (NMR) to analyze high-purity organic compounds

Deputy Director, Metrology Institute of Japan
Koichi Chiba

Measurement Standards in Society

○ Measurement Standards for supporting daily life

Measurement standards in medical field

Now we live in a full-scale aged society. Realization of a society with a healthy longevity and the preservation of a favorable living environment have become more important as issues which society should tackle from now on. Especially, while medical technology becomes more sophisticated, ensuring of the reliability of medical diagnostic and therapy equipments is an indispensable requirement to obtain secure and safe medical service. In particular, ultrasonic diagnosis/therapy and radiotherapy require establishment of accurate measurement standards, in order to evaluate the performance of the medical equipments.

In order to secure the safety of the medical diagnosis/therapy, NMIJ has prepared various measurement standards that are related to ultrasound and radiation. Concretely, NMIJ intends to contribute to performance evaluation of the therapyequipment using high intensity ultrasound and the high performance ultrasonic diagnostic equipment using high frequency ultrasound. For that purpose, NMIJ has developed various standards for ultrasonic measurements: the ultrasound power standard, the ultrasonic pressure standard (calibration of a hydrophone sensitivity), ultrasonic field parameters, etc. In order to ensure safety of radiotherapy and improve therapeutic gain, we have been developing various radiation standards. They are the absorbed-dose-to-water standard for high-energy X-rays and the electron beams that are used for a clinical linear accelerator, dose standards for brachytherapy that is used for cancer therapy and intravascular irradiation, and a mammography dose standard required for a breast cancer medical checkup. We have started calibration services to industries and medical practices. We also plan to expand the calibration range and to add new category of standards, in order to support development of more advanced medical equipment and improvement of therapeutic gains.

Measurement standards for human safety

In order to keep healthy living environment, NMIJ has developed/provided measurement standards concerning the vibration which influences directly/indirectly the human body. We have established the vibration acceleration standards for the frequency range of several Hz to several kHz,

The national standard to calibrate the dosemeters for mammography radiation

and started to supply the calibration services with them. These standards disseminate as the standard for vibration measurement as for various problems, such as the low-frequency vibration in wind power generation, the earthquake resistance and safety of a nuclear power plant, and the improvement in accuracy of seismometers. We intend to develop new category of standards, in order to respond to the new industrial needs such as phase calibration of an accelerometer.

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(current Senior Planning Manager,
Planning Headquarters)
Yasuhiro Nakamura

○ Measurement Standards support industrial technology

Made in Japan

The superiority of a Japanese-made industrial commodities is now recognized all over the world. From the post-war period to the rapid economic growth period, we wiped away the bad reputation of "Cheap goods are poor in quality, because you get what you pay for" about the Japanese products and established a quality brand "Made in Japan". Since then, about a half century has passed.

In order to maintain the brand "Made in Japan" and to realize stable economic growth in resource-starved Japan, it is essential to add high value in industry. It is important to have the base of advanced science that supports continued technological innovation. Moreover, establishment of measurement standards that realizes a robust quality control is absolutely necessary in order to maintain high quality. Moreover, to deploy globally the discovered added value it is necessary to improve measurement standards for supporting international commerce.

The measurement standards for semiconductors

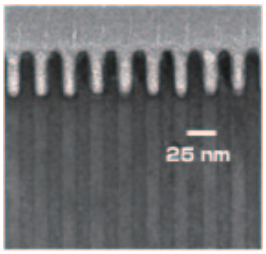
NMIJ has developed the nanostructure evaluation technology that is used for research and development or quality control in the semiconductor industry where there is

For inquiries about this article : National Metrology Institute of Japan (NMIJ) http://www.nmij.jp/english/

global and keen competition. Based on that technology, we have developed/supplied one-dimensional lattices and nano thin-film reference materials. Some of those are the ruler on a smallest-in-the-world scale. Moreover, we have developed/supplied a reference material for evaluating the amount of dopants injected very shallowly or for evaluating the pore of the low-k film. Furthermore, we have developed/supplied the Thermophysical property measurement technology and reference materials. These are indispensable for design/evaluation of high-density recording media, such as DVD.

In recent years, nanotechnology has been widely applied to industry. As a result, industrial standardization of nanotechnology is making progress internationally. In order to promote industrial standardization and social acceptance of nanotechnology, it is very important to improve the measurement standards that support the measurement result. For this reason, in addition to the above standards for nanostructure measurement, we have established the nanoparticle size standards. As a base to realize robust quality control, we have developed reference materials and industrial standards for nanoparticles such as polystyrene and titania. We also plan to develop and supply nanoparticle standards where a distributed state is specified.

NMIJ carries out research and development in order to steadily improve the standards that support the industrial technology over a wide range from R&D to the manufacturing processes.



The "ruler" of a 1/40,000-millimeter unit

Principal Researcher, Metrology Institute of Japan
Toshiyuki Fujimoto

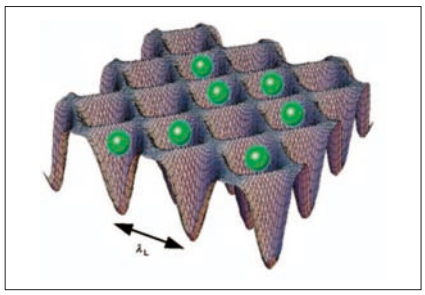
○ Next-generation's measurement standards /calibration system

Technological innovation and redefinition of SI units

The mass is "the last prototype standard". Now, it is to be determined by either "balance between the electromagnetic force and gravity" or "the number of atoms". (NMIJ is the convener of the latter project.) If these approaches are realized, then the definition of a whole unit system will become independent from artifacts. Instead, the system will be defined as "a reproducible system" based on natural phenomena. If the definition of mass is revised, then all units will be derived fundamentally from a time standard. Length already serves as a unit derived from a time standard by making the speed of light in a vacuum into a constant. After the definition of mass is revised, then electromagnetism, mass, etc. will be derived from a time standard. The time standard has the highest accuracy of 14 to 15 digits that is realized by the resonance microwave of the cesium atom. In order to replace this by the laser light of a visible region and to realize accuracy of 16 to 17 digits, NMIJ and institutes in several other nations are developing a new system (proposed by the University of Tokyo) that uses the optical resonance of the atomic group captured in "the optical lattice" (see the figure of conceptual image).

The next-generation calibration system

The development/change of these measurement standards, even if it occurs, will not change the social calibration system significantly. For example, even if the definition for mass standard is changed, the system that calibrates a balance with a weight will be used as it is. But, in order to simplify calibration and to correspond to sophistication, technical development is under way. The fundamental direction is an epoch-making attempt. It will shorten and simplify the path from the metrology standard laboratory to the measuring instrument on the spot. The typical example is remote calibration. This system has already been mostly established for time and frequency. For other units, calibration methods using the Internet are being developed. Future utilization is expected.


The conceptual image of an optical lattice clock

Deputy Director, Metrology Institute of Japan
Katuo Seta

The National Metrology Institute of Japan (NMIJ) in the 3rd Term

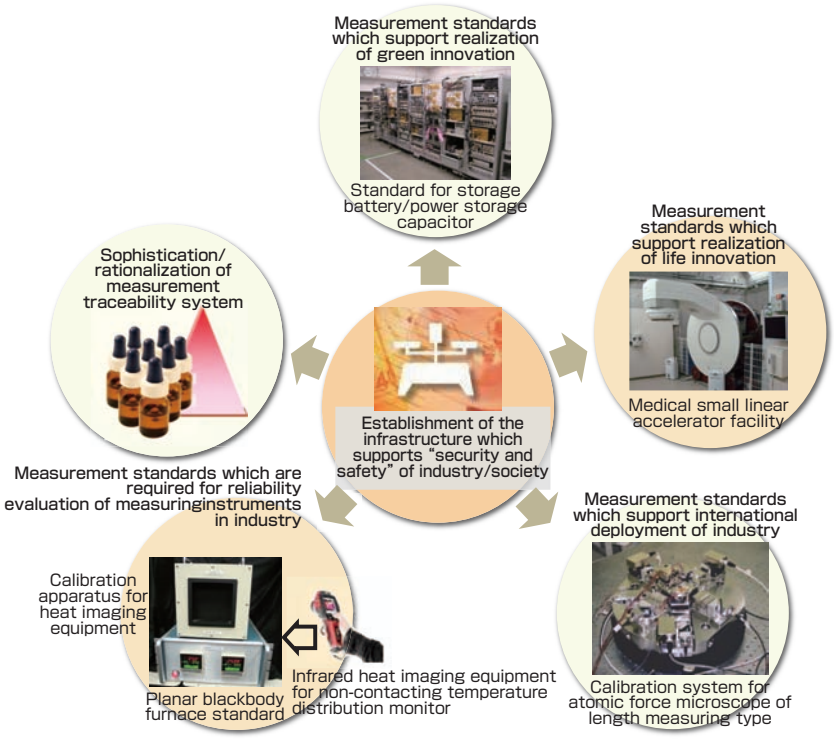
AIST's strategy in the 3rd term

The 3rd term of AIST covers five years after 2010. The medium term targets and plans to realize them are as follows: (1) development of new measurement standards contributing to green innovation and life innovation and supporting international deployment of industries; (2) steady maintenance and supply, sophistication, rationalization of national measurement standards; (3) implementation of legal metrology and promotion of related industrial standardization; (4) development of next generation's measurement standards and global cooperation and competition contributing to international measurement standard system; (5) training personnel for metrology. These are five main items.

Among these, the most important items for the 3rd term plan are as follows: contribution to "green innovation" and "life innovation", sophistication of national measurement standards, contribution to international standardization and conformity assessment, etc. These are aligned with the issues to be addressed by AIST as a whole. They are environment/energy, health, security/safety, international standardization, certification, etc.

Contribution to "green innovation"

In order to address the urgent environment/energy problems, such as climatic change and effective use of natural resources, measurement standards and measuring technologies should contribute to green innovation. Such contribution is one of the tasks on which we put emphasis. During the 3rd term, we intend to carry out the following tasks. (1) As measurement standards that support the realization of new energy sources, we will develop, maintain, and supply standards for pressure and flow rate, standards to evaluate the capacitance and internal impedance of a power storage capacitor, and reference materials to analyze constituents in liquid fuel. (2) For the development and use of energy-saving technologies, we will develop, maintain, and supply standards for high-frequency electricity, optical-radiation, heat flux density, etc. (3) To support technologies to use biomass resources, reference materials for quality control, composition analysis, stability evaluation, etc. of bio-fuel, etc. will be developed, maintained, and supplied. (4) We will develop, maintain, and supply reference materials that are required to meet REACH regulation. Through this activity, we will establish measurement standards that are used to evaluate reliability of the resource recycle system.



Examples of AIST's important tasks and the expected results

Contribution to "life innovation"

In order to respond to the needs for a high-quality medical service, and to respond to the issues of an aging society with fewer children and care taking, we put an emphasis on the contribution to life innovation. (1) We will develop, maintain, and start to supply standards required for ultrasonic diagnostic equipment, radiotherapy equipment, etc. to establish measurement standards required to ensure reliability of medical care. (2) We will develop, maintain, and supply reference materials required to ensure safety of foods and to meet various rules and regulations. (3) As measurement standards that contribute to ensure soundness of living environment, reference materials required to analyze/ evaluate/measure air-pollution gases, global warming gases, poisonous gases will be developed, maintained, and supplied.

For inquiries about this article : National Metrology Institute of Japan (NMIJ) http://www.nmij.jp/english/

The World of Metrology is Expanding
～The 10-year historical locus of the National Metrology Institute of Japan (NMIJ)～

Sophistication of national measurement standards

We maintain the national measurement standards that have established so far. Based on the quality system of ISO/IEC 17025 etc., we steadily perform calibration service through JCSS (Japan Calibration Service System, calibration laboratories registration system based on the Measurement Law) and requested examinations and supply reference materials. Measurement standards contribute to energy-saving technologies, assurance of reliability of measuring instruments used in industries, and improvement of technical development competence of small-and-medium companies. In order to meet the sophisticated technical and social needs, we are increasing the degree of sophistication including the expansion of the supply range and reduction of uncertainty. We are carrying out technology transfers and rationalization of the supply system.

Through the participation in metrology-related associations and organizations and management of the NMIJ Measurement Club, we will survey and analyze the needs that are related to the metrology traceability system.

Contribution to international standardization and conformity assessment

Promotion of international standardization and conformity assessment is very important for the industries of our country. Also seen from the metrology side, it is important from a viewpoint of the spread of measurement traceability systems. It is a closely related field. In order to respond to the reinforcement of AIST's task, we are collaborating with the International Standards Promotion Division and other related divisions. We are participating in research and development bearing international standardization in mind and have started training personnel for the spread of the quality system.

Logo mark of National Metrology Institute of Japan

As mentioned above, NMIJ establishes and sophisticates measurement standards, and contributes to international standardization and conformity assessment. In the 3rd term, we will maintain and supply developed standards, develop new standards to meet the needs, and endeavor to ensure that measurement standards and traceability systems would be used more widely.

Director, NMIJ
Yukinobu Miki

Expectation for the National Metrology Institute of Japan (NMIJ)

Professor, Teikyo Heisei University
Norihiko Egi

It is really pleasing that NMIJ has achieved development beyond all expectations. Development of science and technology has promoted use of not only natural things but also artificial products as raw materials of various necessaries. We now handle the size as small as nanometers. Moreover, the distribution market has been expanded globally. The manufacturing processes have been subdivided into international division of labor. Therefore, the standards of manufacture must be the same all over the world. Even if "the standard of manufacture" is purely physical, we need the competence to realize it actually. Furthermore, if it concerns artificial products, then the reliability of standard itself is important. In an age of modern metrology like this, NMIJ has already established measurement standards in the level of nations with advanced metrology. When you see the finished products, you do not notice the importance of the manufacture standard. But, once any problems occur, it will be pointed out immediately that the product does not conform to the standard. The more precise machines are, the more reliable standards are required. The budget is as small as 10 ppm plus of Japanese GNP. Though there would be difficulties under such a stringent budget, we expect NMIJ to continue its effort toward the establishment of cutting-edge measurement standards.

UPDATE FROM THE CUTTING EDGE

Jul.-Sep. 2010

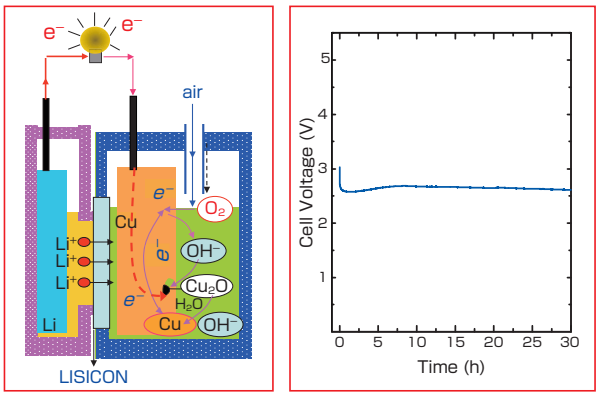
**The abstracts of the recent research information appearing in Vol.10 No.7-9 of "AIST TODAY" are introduced here, classified by research areas.
For inquiry about the full article, please contact the author via e-mail.**

Environment and Energy

A new type of Li-metal air fuel cell

Large capacity and low cost lithium air fuel cell using corrosion phenomenon

We have developed a new type of lithium-copper air fuel cell using the hybrid electrolyte (organic electrolyte/solid electrolyte/aqueous electrolyte). A copper positive electrode is placed in the aqueous electrolyte and metallic lithium is used as a negative electrode in the organic electrolyte. The copper electrode is oxidized by oxygen in the air to generate copper (I) oxide (Cu_2O). Upon discharge, lithium atoms of the negative electrode supply electrons to the wire and dissolve as lithium ions, which go through the solid electrolyte towards the aqueous electrolyte. At the positive electrode, supplied electrons reduce Cu_2O molecules to copper atoms that precipitate on the electrode. After the discharge, copper is oxidized again through copper-corrosion reaction. In this way, oxygen is electrochemically reduced and copper works as catalysts of the oxygen reduction. The developed lithium-copper air fuel cell based on the copper-corrosion reaction shows stable discharge.



(L)The lithium copper air fuel cell based on copper corrosion
(R)The discharge curve of the lithium copper air fuel cell

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AIST TODAY Vol.10 No.7 p.17 (2010)

Look up, and you will find the way from the sky

Remote synchronization system loaded on the first quasi-zenith satellite "MICHIBIKI"

We have been developing a remote synchronization system for the onboard crystal oscillator (RESSOX) of the quasi-zenith satellite system (QZSS) since 2003. QZSS is a three-satellite navigation/positioning system conceived to improve the positioning performance (satellite availability and position accuracy) of the presently available global positioning system (GPS) in areas where high-rise buildings and mountains reduce the number of visible GPS satellites in Japan. The orbital planes of QZSS satellites are inclined (at 43 degrees) from the equatorial plane, although the semi-major axis is the same as the geostationary satellites. RESSOX is conceived as a very precise radio-controlled clock. The target of RESSOX is synchronization within 10 ns between the ground station time standard and the onboard QZSS crystal oscillators. We have achieved a synchronization error within 2 ns in the ground experiments.

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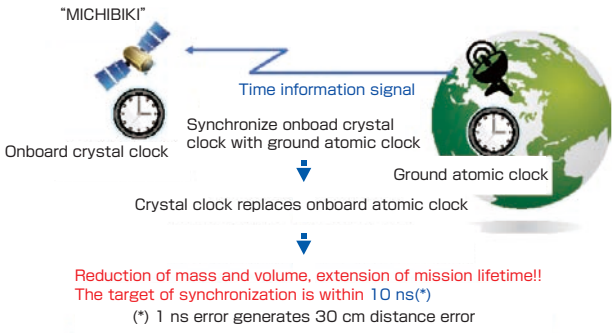

Outline of remote synchronization system

Tumor growth suppression activity by circadian clock molecule

Novel function of circadian clock gene, *Period2*

Some reports have indicated that the core clock gene, *Period2* (Per2) regulates the cell cycle, immune system and neural functions. To understand the effects of PER2 on tumor growth *in vivo*, stable transformants of murine sarcoma 180 (S-180) cell lines expressing different levels of PER2 were established. The growth of stable PER2 transformants *in vivo* was significantly and dose-dependently suppressed according to the amount of PER2 expressed, indicating that PER2 plays a role in the growth suppression of sarcoma cells. The anchorage-dependent and -independent growth *in vitro* and expression of the clock controlled cell-cycle related genes were not altered in the stable PER2 transformants. In contrast, susceptibility to murine natural killer (NK) cell cytolytic activity was enhanced in the PER2 transformants. Furthermore, the PER2 transformants suppressed cell motility and reduced fibronectin expression, but the expression of integrin receptors was not affected. These results suggest that sarcoma cells overexpressing PER2 suppress tumors *in vivo* by changing the nature of tumor cell adhesion.

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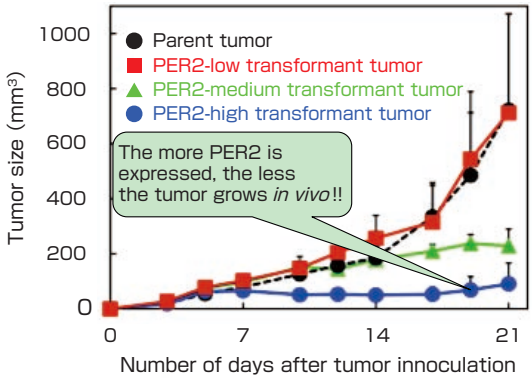

Tumor growth suppression *in vivo* of PER2 transformant tumor

Mask pattern optimization technology that extends life of current optical lithography

Improving the accuracy of lithography for LSI by approximately 20 %

We have developed a mask pattern optimization technology that improves the accuracy of LSI lithography by approximately 20 %. 30-nanometer generation lithography with ArF laser uses various technologies for achieving higher resolution such as immersion lithography in which liquid is filled between lens and wafers to enhance the resolution, but it is approaching its limit. The purpose of this research project is to extend the lifetime of ArF immersion lithography by improving the LSI photomask.

The Sub Resolution Assist Feature (SRAF), which modulates printed images of the main pattern, has been used to improve the resolution and the accuracy of the main circuit patterns. However, optimization of SRAF placement is becoming increasingly difficult as lithographic exposure approaches its resolution limits.

Our new technology applies an adaptive search algorithm based on the optimal gradient method to optimize the placement of SRAF which improves positioning and enhances critical dimension (CD) accuracy by approximately 20 %. The developed technology opens the door to extending the life of current ArF immersion lithography to the next generation and beyond.

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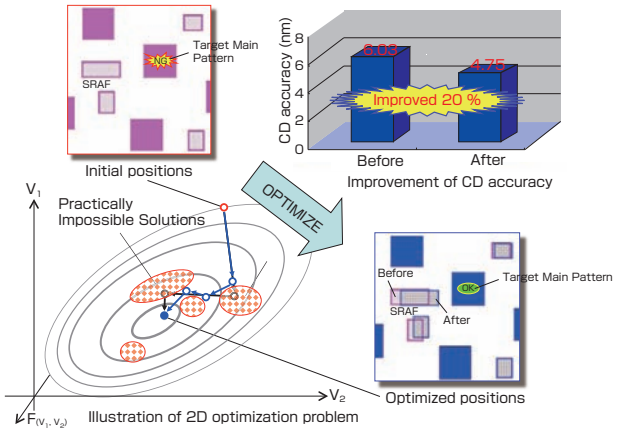

Illustration of initial and optimized patterns, 2D optimization problem and experimental results

Visualization of chemical reactions at atomic level

High-resolution transmission electron microscopy reveals the mechanism of chemical reactions between two fullerene molecules

We have developed high-resolution transmission electron microscopy to study the bimolecular reactions of fullerene and metallofullerene molecules in carbon nanotubes. Fullerene dimerization reactions start from an encounter of two molecules accelerated by phonons, photons, or electrons. The rate of reactions is often discussed from kinetics of the system and dynamics of molecules where the experimental conditions such as pressure, concentration, temperature, and existence of catalysts affect the system. Classic approaches to characterize such behaviors are based on the analysis of thermodynamics, spectroscopy, or microscopy that deal with enormous amounts or assembly of molecules in order to gain enough signal/noise ratios. Scientists have dreamed of capturing the very moment of reactions when the molecules change their structures. We have proved that the atomic resolution imaging of chemical reaction is indeed possible with moderate experimental conditions.

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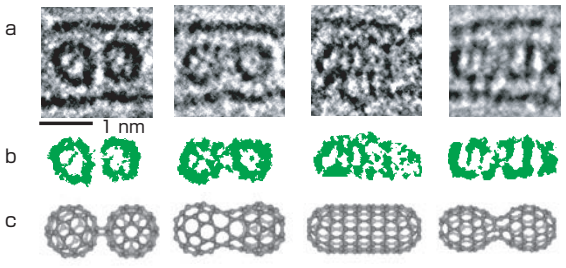

(a) Electron microscope images of C_{60} fullerene molecules
The molecules were irradiated with an electron beam and fused together by dimerization.
The electron doses increased from left to right, and the chemical reaction proceeded.
(b) Image emphasizing contrasts (light and dark) of the molecules
(c) Model structures of the molecules

Development of new rolling technology for commercial magnesium alloy sheet

Start of sample shipments for wide-width commercial magnesium alloy sheet with high room temperature formability

It is known that room-temperature formability of a magnesium alloy sheet is much lower than those of steel and aluminum alloy sheets. Thus, in the conventional press-forming process of a magnesium alloy sheet, a sheet and dies must be heated at above 250 °C. In the newly developed rolling process, a commercial magnesium alloy sheet is rolled at a temperature about 100 °C higher than that in the conventional rolling process. The magnesium alloy sheet processed by the new rolling process exhibits a significantly weak crystal orientation, resulting in the excellent room-temperature formability comparable to those of aluminum alloy sheets. This means that a conventional press-forming machine without heating equipment is available, and significant cost reduction and enhanced productivity are expected. In addition, since composition of the new magnesium alloy sheet is the same as those of commercial magnesium alloy sheets, conventional surface treatment processes are directly applicable.

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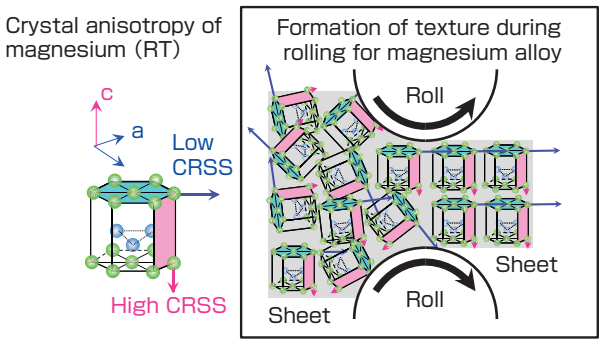

Crystal anisotropy of magnesium at room temperature (left), Formation of texture during rolling (right)

CRSS: Critical resolved sheat stress

Simple method for high-purity separation of metallic and semiconducting carbon nanotubes

An automated, continuous, and repeatable process would realize cost-efficient separation

We have developed a novel method to separate metallic and semiconducting single-wall carbon nanotubes (SWCNTs) with high purities using agarose gel column chromatography. The synthesis of SWCNTs usually yields a 1:2 mixture of metallic and semiconducting SWCNTs. Although these two types of SWCNTs must be separated for their application in electronic devices, this separation could not be achieved easily. The developed method uses a column filled with agarose gel beads, in which the semiconducting SWCNTs are selectively adsorbed and then eluted. The column can be used repeatedly, and the separation process can be easily automated. Purities of separation were 95 and 90 % for semiconducting and metallic SWCNTs, respectively. Because this continuous, repeatable separation method is applicable to a low-cost, large-scale process, it should enable the industrial production of metallic and semiconducting SWCNTs.

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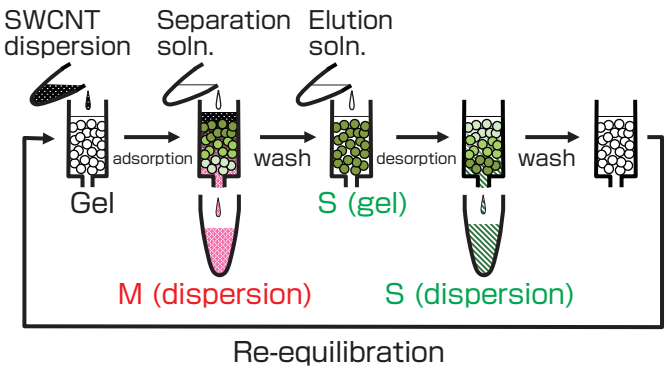

Schematic diagram of metal/semiconductor separation of SWCNTs using a column

Monitoring system for safety management of structures using elastico-luminescent materials

Real-time visualization of the shape distribution and propagation of cracks using elastico-luminescent sensors

We have developed a monitoring system that enables the visualization of the shape distribution and propagation of cracks in concrete by employing elastico-luminescent sensors. The safety-management monitoring system we have developed includes elastico-luminescent sensors that emit light upon mechanical stimulation (elastico-luminescence), image sensor nodes that monitor the distribution of luminescence intensity of the elastico-luminescent sensors, wireless photo detector nodes, a database for diagnosing the stress anomaly in the structure on the basis of the luminescence intensity, and a network system that coordinates the operation of these components. The appearance of a crack that occurs in the concrete of bridges and buildings is visualized by using this system, when the elastico-luminescent sensors of the system are placed on the structure surfaces. Moreover, we can predict the generation and propagation of the crack by diagnosing the stress anomaly in the structure. This monitoring system based on elastico-luminescence is expected to be used for inspection and maintenance of various structures including those made of concrete.

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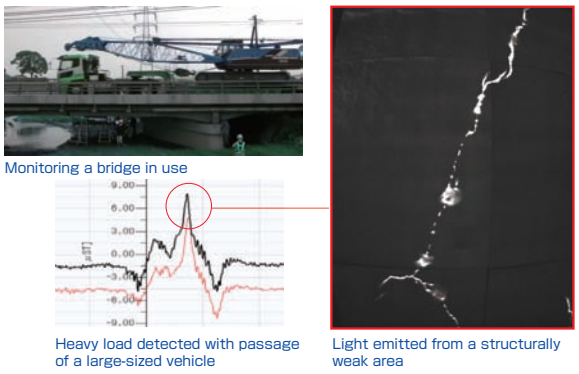

The safety-management monitoring system inspecting a bridge
In monitoring a bridge in use (top left), when a large-sized vehicle passed and a heavy load was added, abnormal image of elastico-luminescence was recorded.

Precise distribution system for frequency standard through optical fiber

Expectation for application to many areas as calibration, measurement, particle physics, and radio astronomy

A precise frequency transfer system using optical fiber has been developed. The purpose of the system is to distribute frequency standard with little deterioration to many distant users. It is composed of a phase compensation transmitter, bidirectional optical amplifiers, an optical distributor, and optical receivers. The system target is to achieve a stable transmission of hydrogen maser class signals. For short term stability, it shows the required optical received power to realize the Allan deviation of 1×10^{-13} (averaging time of 1 s). For long term stability, a new compensation method using dense wavelength division multiplexing signals is effective to suppress phase fluctuation induced by fiber temperature change. Experimental results show stability of 8×10^{-17} at 10^5 s in a fiber link of 160 km in total with one bidirectional optical amplifier. This system is expected to be useful in a wide variety of areas such as calibration, measurement, particle physics, and radio astronomy.

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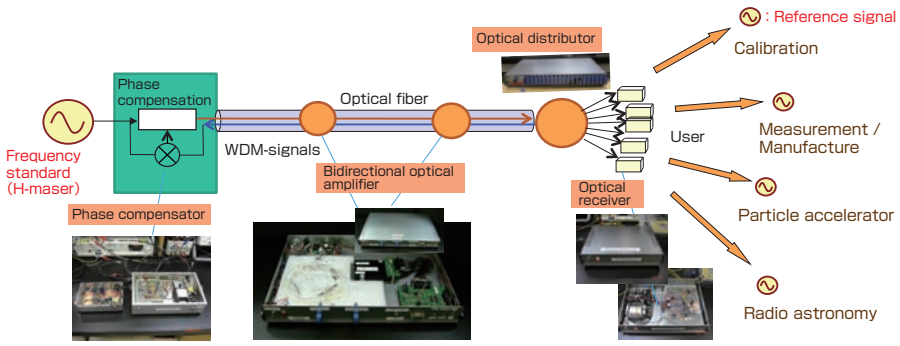

Main devices for precise frequency distribution system with optical fiber and its fields of application

Quantitative measurement of unsteady gas flow rate

Towards the sophisticated measurements of exhaust gas and medical application

It is very difficult to estimate the dynamic response of gas flowmeters quantitatively, since the variation of the pressure in an unsteady gas flow is accompanied by the variation of temperature that is quite difficult to measure quantitatively. The isothermal chamber proposed by Tokyo Institute of Technology has a potential to realize a quantitative unsteady gas flow generator because of its ability to keep the gas temperature almost constant during the variation of pressure. AIST is conducting an applied research work to establish an unsteady gas flow generator based on the isothermal chamber. The uncertainty of the instantaneous flow rate in unsteady flows is improved to 5 % by utilizing critical nozzles to define the inlet flow rate into the chamber. The generator shown in the picture can generate arbitrary waveforms by controlling the pressure in the chamber with the maximum instantaneous flow rate of 0.5 g/s at the atmospheric pressure. The flow rate of the generated flow measured by a high-speed laminar flowmeter coincides very well with the control signal fed into the generator.

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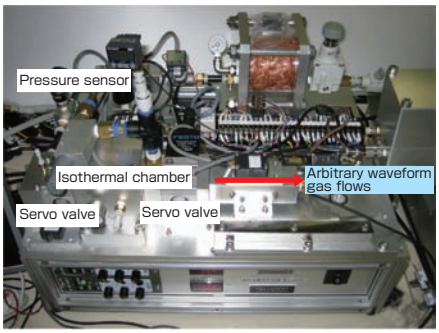
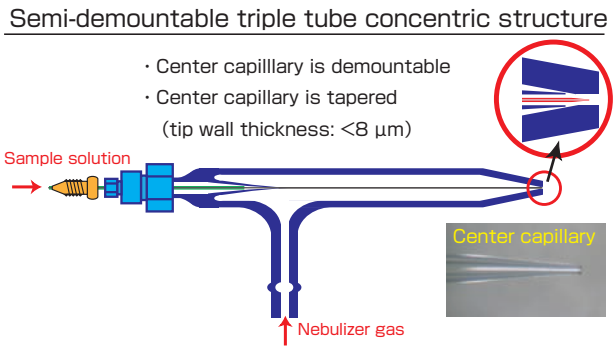


Unsteady gas flow generator

Development of high performance concentric nebulizer for plasma spectrometry

Semi-demountable triple tube concentric nebulizer

A nebulizer is one of the most important components in plasma spectrometers such as ICP-OES and ICP-MS. Nowadays, application of ICP-OES and ICP-MS to the analysis of low volume samples and/or samples with high salt-concentration has rapidly grown especially in semiconductor, clinical, biological, and environmental research fields. We developed a high performance concentric nebulizer (HPCN) for ICP-OES and ICP-MS. HPCN has a semi-demountable triple tube concentric structure. HPCN shows an excellent performance for the following three points; highly efficient aerosol generation, high tolerance for total dissolved solids (TDS), easy designing for various flow rates of solutions. In the nebulization by HPCN, a microthread liquid flow is formed inside the nebulizer nozzle by a flow focusing effect. This phenomenon gives both the efficient aerosol generation and the high TDS tolerance. Now, we have applied HPCN to various research fields such as material, clinical, biological, and nuclear fuel analysis.



Schematic diagram of HPCN

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Precise morphology measurement of nanostructures

Reference material for atomic force microscope (AFM) and precise morphometry

A cantilever with a sharp tip is one of the key components of the atomic force microscope (AFM), and it is the origin of artifacts in AFM images. A probe characterizer for AFM was developed to analyze the accurate probe-shape. A reference material, which includes accurate lines and spaces, was developed using multilayer-thin films. Lines and spaces ranging from 5 nm to 100 nm can be fabricated using a multi-layer film structure. The comb-shape grating was developed for correcting AFM images. Apparent probe shapes can be determined under various experimental parameters, and actual probe shape can be obtained under optimized set-points of force and feedback parameters. As a result, reliability of AFM images can be improved significantly.

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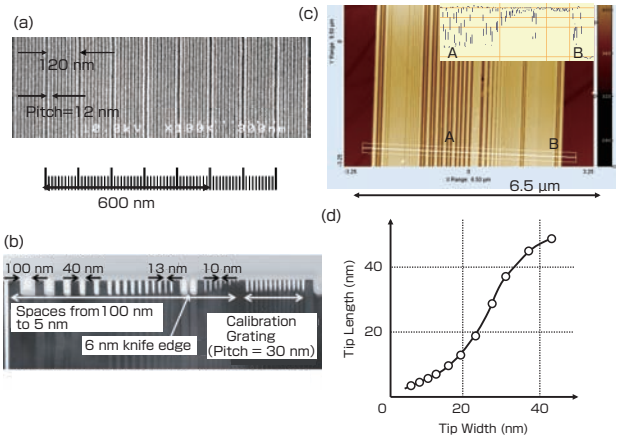

(a) Scanning electron micrograph of periodic grating for calibrating non-linearity of scanning system
(b) Transmission electron micrograph of AFM probe-shape characterizer
(c) AFM image of comb-shape characterizer
(d) Probe characteristic for quantitative analysis

In Brief

President Nomakuchi talks at IASP 2010 Daedeok

The 27th IASP World Conference on Science and Technology Parks (IASP 2010 Daedeok) was held by the International Association of Science Parks (IASP) on May 24-26, 2010, in Daejeon, Korea.

AIST President Tamotsu Nomakuchi gave an invited lecture titled “AIST as an Innovation Hub of Industrial Science and Technology for a Sustainable Society”, presenting activities in photovoltaics, Tsukuba Innovation Arena for Nanotechnology (TIA nano), and international industrial standardization as three examples of AIST open innovation. IASP is a nonprofit international association established in 1984 with the objective of creating a global network of science parks around the world and of promoting exchange and cooperation. There are presently 380 organizations from 72 countries belonging to the association. To this conference, 1200 people from 57 countries participated, and there were active discussions, with the main theme “global green development to overcome climate change, environmental and energy problems”. Korean Prime Minister Chung Un-Chan attended the opening ceremony, participated in the ribbon cutting with AIST President Nomakuchi, and the two had an opportunity for friendly talks. Director Kozo Uto of AIST Kyushu, and Director Koichi Sakuta of the International Affairs Department, AIST, also attended, and presented AIST’s activities toward the realization of a low carbon society.

AIST President Nomakuchi giving an invited lecture at IASP 2010 Daedeok

MOU Concluded with CEA-DRT, France at INC6 in Grenoble

At the 6th International Nanotechnology Conference on Communications and Cooperation (INC6) held on May 17-20, 2010 in Grenoble, France, AIST President Tamotsu Nomakuchi gave the opening speech as the chairperson of the organizing committee. To this conference, 130 participants attended from around the world principally from the US, Europe, and Japan. The next seventh conference was officially decided to be held in Tsukuba in May, 2011.

The French Alternative Energies and Atomic Energy Commission - Technology Research Directorate (CEA-DRT) and AIST are public research organizations of the largest scale in their countries, are very similar in the number of researchers, research topics, and objectives, and cover a large research area from basic research to applied research. On May 17, during INC6, AIST concluded a memorandum of understanding on comprehensive research cooperation (MOU) with CEA-DRT which is leading in industrial technology in the fields of nanotechnology and energy.

AIST is working on the establishment of "Tsukuba Innovation Arena for Nanotechnology (TIA nano)", a global research center for nanotechnology, in cooperation with the National Institute for Materials Science and the University of Tsukuba. CEA-DRT, on the other hand, has formed MINATEC (Micro and Nanotechnologies Innovation Campus), a global center that covers universities, businesses, and research organizations, in Grenoble, France. The two organizations have been exchanging researchers and executives, and have held workshops in research fields such as diamond, MEMS, and optical storage. The conclusion of MOU is to further strengthen and develop the cooperation between the two organizations.

AIST President Nomakuchi addressing INC6

CEA-DRT Director Jean Therme (right) and AIST President Nomakuchi signing the MOU between the two organizations

U.S.-Japan Workshop on Basic Science Project Development

The U.S.-Japan Workshop on Basic Science Project Development was held on June 2-4, 2010, at Sandia National Laboratories in New Mexico, US. The objective was to confirm the progress of research cooperation in basic sciences and renewable energy technology of the Japan-U.S. Clean Energy Technologies Action Plan and to discover and consider new issues for cooperation. The Action Plan is part of the Japan-U.S. cooperation project for research and standardization of Clean Energy Technologies, a project commissioned by the Ministry of Economy, Trade and Industry (METI).

On the Japan side, 23 people participated including Director Hiroshi Yamagata of the International Affairs Office, Industrial Science and Technology Policy and Environment Bureau, METI, AIST Vice-President Akira Yabe, AIST Research Coordinator Yoshiro Owadano, staff of International Affairs Department, AIST, and 14 researchers of AIST (4 were staying long-term in the US). From the US side, there were over 40 participants including Senior Policy Advisor/ Japan Kay Thompson, Office of European and Asian Affairs, Department of Energy (DOE), Director Robert Q. Huang of DOE Center for Integrated Nanotechnologies (CINT), and 35 researchers from 9 laboratories under DOE. Besides the general meeting, researchers were mainly divided in groups of 7 research fields (artificial photosynthesis, dye-sensitized photocells to generate hydrogen, novel energy storage or conversion devices utilizing nanotechnology, hydrogen storage materials, fuel cells, computational science for energy related materials, biofuels). There were exchange of opinions and discussions on individual research cooperation themes. Based on these activities, there is expectation for progress in further discussion among researchers and for acceleration for each topic of cooperation to take form.

General meeting of the workshop

Individual session

Cover Photos
Above: Unsteady gas flow generator (p. 17)
Below: Electron microscope images of C60 fullerene molecules (p. 14)

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