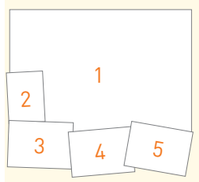
Four Seasons of KRISS - Autumn

Deepening shades of autumn at KRISS



1. Shy scarlet-tinged leaves, shaped like a baby's hand, covering the Main Admin Building.
2. Trees soaring straight into the sky with their coverings changed for the winter.
3. Ginkgo leaves exhibiting the nature's cleanest and finest yellow.
4. Cosmos flowers rustling in the autumn breeze.
5. Fallen leaves covering the KRISS campus.

KRISS Korea Research Institute of Standards and Science

To subscribe, please contact: Ms. Mi Hong

• Telephone (+) 82-42-868-5443 • Fax (+) 82-42-868-5444 • E-mail mihong@kriss.re.kr

• Website **http://english.kriss.re.kr** • Address 209 Gajeong-Ro, Yuseong-gu, Daejeon 305-340, Republic of Korea

Development of Korea's First Primary Frequency Standard, 'KRISS-1'

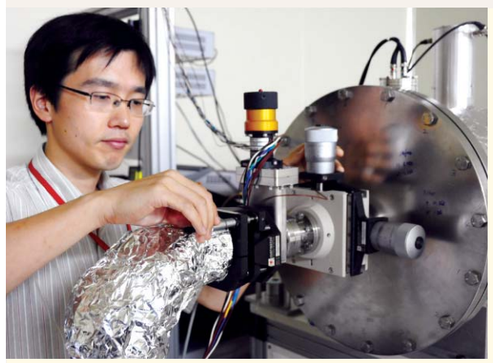
Developed Successfully by 100% KRISS personnel

The Length & Time Metrology Center of the Division of Physical metrology at KRISS successfully developed Korea's first primary frequency standard, 'KRISS-1' by 100% KRISS personnel.

At present, KRISS generates Korean Standard Time (KST) using four commercial hydrogen masers and five commercial cesium clocks and maintain KST to be traceable to UTC (Coordinated Universal Time) through international time comparison.

Although commercial cesium clocks are based on the clock transition of cesium atoms, the second generated from commercial atomic clock has a duration not the same as that of the SI second which is defined to be 'the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground stat of the cesium 133 atom'. As the frequency biases of clock transition are caused by the environmental physical quantities such as magnetic field, electric field, light, temperature, motional and gravitational effects, and so on, the frequency biases introduced by such variable physical quantities need to be taken into account. However, frequency biases in commercial atomic clocks cannot be identified and therefore, we can not compensate the second generated from commercial atomic clocks for biases caused by physical effects.

A primary frequency standard is a laboratory atomic clock that realizes the definition of second. With this clock, all significant frequency biases



| Aligning Atomic Beam of KRISS-1 |

| Total View of KRISS-1 |

KRISS NEWS
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can be measured. KRISS measured all significant biases of KRISS-1, which is developed at KRISS as a PFS, and evaluated the accuracy of KRISS-1. The evaluated statistical uncertainty (type-A) and systematic uncertainty (type-B) of KRISS-1 is less than a part of 10^{14} and a few parts of 10^{15}, respectively, which gives the combined uncertainty of a part of 10^{14}. The frequency difference between KRISS-1 and UTC was measured from July 7 to September 30, 2008. The frequency measurement shows that the frequencies of KRISS-1 and UTC are in good agreement within a few parts of 10^{15}. Finally, Korea now has a PFS which realizes the definition of second with an accuracy of a part of 10^{14}.

"The newly developed KRISS-1, which is currently undergoing the international reporting process, will contribute to the generation of TAI and UTC," said Dr. Taeg Yong Kwon, Chief of the Length & Time Metrology Center of KRISS. He added, "KRISS-1 is highly significant in that Korea has secured a primary frequency standard that realizes the SI second, the true standard of time."

The Time & Frequency Lab. plans to focus its research resources on the development of an optical clock, the next-generation primary frequency standard, while steadily carrying out research on enhancing KRISS-1 performance. And also, various theoretical and experimental methods developed in the development of KRISS-1 will be used to evaluate the performance of atomic fountain clock that is currently under development at KRISS.

| Dr. Kwang-Hwa Chung, Former President of KRISS |

Dr. Kwang Hwa Chung, Former President of KRISS, Elected to CIPM

Receiving Recognition Equaling Institutions of Advanced Nations

Dr. Kwang Hwa Chung, the former President of KRISS, has been elected a member of the International Committee of Weights and Measures (Comité International des Poids et Mesures, CIPM). Dr. Chung has served as an international expert specializing in vacuum measurement. In addition to her long research background, she has also served on the ISO Technical Committee and has chaired the APMP.

The CIPM is a permanent executive committee responsible for the actual operation of General Conference on Weights and Measures (Conférence Générale des Poids et Mesures, CGPM), the highest decision-making body in the field of metrology.

Better Standards, Better Life!

KRISS NEWS
Korea Research Institute of Standards and Science

The CIPM's members are elected from among metrology scientists on the basis of their research achievements and contribution to activities of the international metrology society. The fact that the present and past CIPM members include Dr. Siegbahn (1981) and four other Nobel physics awardees demonstrates the outstanding scientific capabilities of the CIPM's members.

Since KRISS's admission as a regular member in the three fields of length, temperature and luminous intensity in 1988, it has served as a regular member state on all its nine fields, with the exception of the Unit Consultative Committee.

"The regular members of each consultative committees consist of representatives of national metrology institutes whose capabilities in the respective field have been recognized," said one KRISS official. "If you are elected as a regular member of each working-level committee, it means you have capabilities comparable to those of the advanced states."

With a Korean participation in the CIPM, Korea is now able to speedily obtain the latest information required for establishing the direction for developing Korean standards and precision measurement technologies.

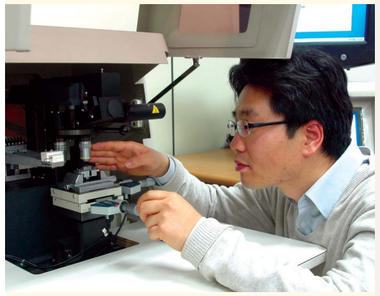
"The roles of metrology, national metrology institutes and international standards organizations have emerged as customer demand increases with regard to the reliability of products, services and new technologies," said Dr. Chung. "We will upgrade Korea's technological competence in measurement science to the world's best level while keeping abreast of the advanced nations in terms of the activities of the CIPM, the representative international organization in the field of metrology."

Dr. Chung is the second Korean CIPM member, following Dr. Myung-Sai Chung, another former KRISS President who was appointed as a member to the CIPM in 1996 and served until the end of last year.

Research Highlights

Precision Measurement Technology Developed for Nano Hardness/Strength of Nano Material

Measuring strength of nano material with 3D deformation images!

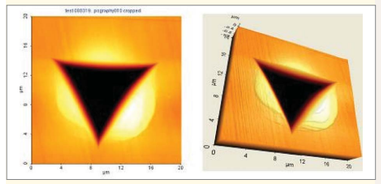


Measurement of nano material hardness

Dr. Yun-Hee Lee of KRISS's Energy Infrastructure Center opened a new way towards the practical application of nano materials by developing technologies to analyze their insufficient strength or abnormal deformation against external load, which have been identified as limiting factors in super-strong nano materials.

Dr. Lee has developed 'measurement technologies for image-based nanomechanical properties' that analyze true hardness and strength by generating 3D images with an atomic force microscope of sub-micron indentation generated by pressing a hard diamond pyramid on to the surface of a super-strong nano material. A patent application was filed for this technology in June of last year and it was introduced in the Journal of Physics D: Applied Physics in 2007.

If the hardness of nano materials is measured by analyzing the penetration depth of an indenter using the existing nano-indenter hardness test, the surrounding material pile-up or load distribution cannot be accurately analyzed, as only the indenter penetration depth is analyzed. Accordingly, a high risk is experienced in the entire process of nano material selection, design, and production because over 50% exaggerated property data is obtained when the conventional hardness of a nano material is measured.



Observation of Material pile-up phenomenon around Indentation on super-strong amorphous materials

The newly developed technology has not only solved existing problems, so far encountered, in the nano indenter hardness test but has also broadened the diversity of materials that can be measured thanks to its outstanding technological flexibility.

For example, a new technology that converts true hardness into the strength of nano materials will be able to change the paradigm of material property assessment as well as nano materials by replacing the shortened elongation test, a basic test essential to the measurement of material properties.

"Up until now, super-strong nano materials could not be used for applications where both safety and durability were required as there was no technology capable of assessing their physical properties accurately," said Dr. Yun-Hee Lee. "The development of super-strong nano materials equipped with both safety and durability will be accelerated as we will be able to discover the root cause of their unstable transformation using the newly developed technology for measuring true hardness."

Development of Primary Standard Materials for Greenhouse Gas

Entrust Korean Peninsula climate change with KRISS!

Methods for measuring, monitoring and assessing greenhouse gases on the Korean peninsula have been developed with 100% domestic technologies. KRISS' Environmental Metrology Center has established a strategy to address climate change and global warming, which have emerged as the topic of worldwide concern, by developing measuring equipment and standard materials for greenhouse gases.

SF_6 Greenhouse Gas Measuring Equipment can measure greenhouse gas in minimal amounts up to 6 ppt (one trillionth) on the Korean peninsula in real time. This equipment has been installed at the Climate Change Monitoring Center (Anmyeon-do) to observe greenhouse gases on the peninsula. The data gathered by this equipment will be registered at the World Meteorological Organization (WMO)-World Data Center (WDC).

Greenhouse gas standard materials is supplied to industrial entities emitting greenhouse gas or environment management service providers. The standard substance thus supplied is mainly used for assessing devices (e.g. scrubber) designed to reduce greenhouse gas emissions or for measuring the amount emitted. KRISS transfers measurement technologies of F-compounds greenhouse gases to industries which prepare the CDM project.

For scrubber, KRISS transfers the measurement technologies to industries and cooperates by testing new products developed to remove greenhouse gas. The greenhouse gas-removal device has earned scores of billions of Wons from exports to China and Taiwan, newly emerging semiconductor-producing countries.

Concerning the development of standard materials, "The automatic weighing system used for preparing a standard material for greenhouse gas has obtained many patents," said Dr. Jeong-Soon Lee. "We continue to receive purchase enquiries concerning the development technologies and the system itself from different countries around the world, including the USA, Singapore and Malaysia."

Measuring greenhouse gas of SF6 with a newly developed equipment

The gravimetric preparation method enables one to prepare standard materials by measuring the weight of ingredient gases. KRISS owns the 'Automatic weighing system for the preparation of standard gas by the gravimetry,' which was developed with local technologies.

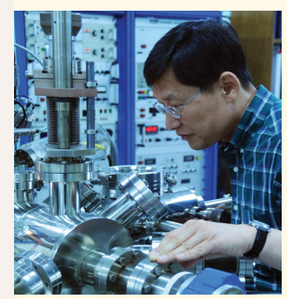
The KRISS developed system and technologies for measuring greenhouse gas have been recognized as world-class. When the technologies are used for measuring greenhouse gas on the Korean peninsula and in the Far East, it will be used as greenhouse gas data that have won international reliability. It will further help Korea win the advantageous position during post Kyoto negotiations on climate change.

Measurement Technology and CRM Developed for Super-thin Semiconductor Film

A ruler to measure thickness to one billionth of a meter

Dr. Kyung Joong Kim, Chief of Nanometrology Center of KRISS has succeeded in developing a measurement technology for the exact thickness of oxide film up to one nanometer (1 nm, one billionth of a meter), which has been recognized as one of the most important tasks in semiconductor fabrication process.

Dr. Kim developed an accurate and reproducible method to measure the film thickness of less than 1 nm using XPS, and the result has been published in



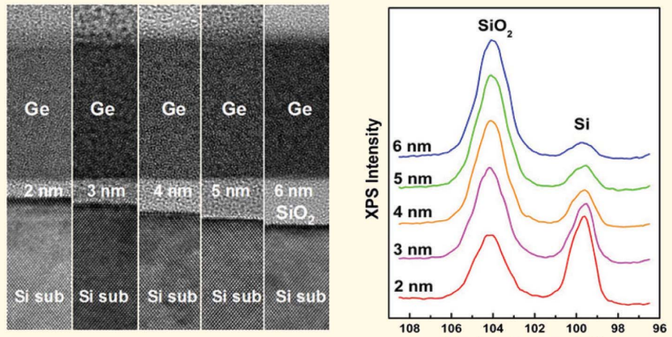
Measurement of oxide thickness with XPS

Metrologia, an authoritative academic metrology journal. Furthermore, Dr. Kim established a traceable method to determine the thickness of nanometer oxide film using a mutual calibration method which combines the strong points of XPS and high-resolution TEM to calibrate thickness scale by compensating the weak points of each method. He also developed Certified Reference Material (CRM) for the measurement of film thickness.

KRISS exhibited a world-class measurement capability in the key comparison (K-32) for the measurement of nanometer SiO2 film thickness, which was the first key comparison organized by surface analysis working group of CIPM.

"The mutual calibration method will act as a crucial role to lead an international agreement in the determination of nanometer film thickness and to stop a long tense controversy among the national metrology institutes (NMI) of advanced countries, and it will be used as an essential technology for the next-generation semiconductor industry,"said Dr. Kim.

The newly developed thickness measurement method of ultra-thin film has been applied for the semiconductor fabrication lines of Samsung Electronics and Hynix Semiconductor companies. Recently, KRISS has performed an international consulting project from the request of CAMECA (France) for the development of CRMs for film thickness measurement by LEXES which is being introduced into local semiconductor fabrication lines.



| Thickness measurement results of SiO2 films up to 2~6 nanometers by XPS and high-resolution TEM |

KRISS has a plan to lead an international round robin test by developing an international standard and CRMs for the thickness measurement of nanometer oxide films. The newly developed technology and measurement standards will enhance the measurement capabilities of domestic semiconductor industries and will be supplied to manufacturers of semiconductor measurement equipment so that they can be used in industrial fields.

Korean-German Joint Research Team Develops Terabit FeRAM Core Technologies

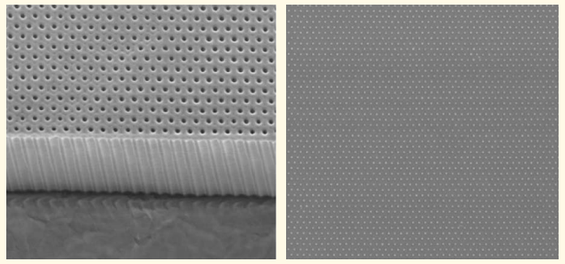
Changes to lead the future of electronics

Scientists announced that they have developed a new technology for the next generation non-volatile ferroelectric random access memory (FeRAM) with near Terabit density that is capable of storing data of more than 1,500 compact discs (CDs) on a coin-sized chip.

The electronics of the future are becoming increasingly smaller and lighter, as well as more powerful and faster. A new technology developed jointly by the Korea Research Institute of Standards and Science (KRISS), Pohang University of Science and Technology (POSTECH) in Korea, and Max Planck Institute of Microstructure Physics in Germany may help to achieve these goals. The new method enables the production of particularly densely-packed memory storage. The researchers housed capacitors made out of platinum and lead-zirconate-titanate (PZT) with a density of 176 billion bits on a square inch - a world record for this material. The work has been evaluated as a key technology that could resolve the problems associated with miniaturization of capacitors, which has long been considered as a prerequisite technological task for achieving ultra-high storage density (Nature

Nanotechnology, 15 June 2008).

FeRAM is a random access memory similar in construction to dynamic random access memory (DRAM), but uses a ferroelectric material instead of a dielectric layer in a capacitor. It has attracted considerable attention as a next-generation memory due to its advantages over conventional Flash memory, including non-volatility, lower power consumption, faster performance and a much greater maximum number of write-erase cycles. However, FeRAM has mainly been used in portable PCs, mobile phones or smart cards requiring a relatively low storage capacity, because it was technically difficult to increase data storage density.



| Scanning electron microscopy (SEM) images of nanoporous alumina mask with honeycomb-like arrangement of pores **(left)** and array of nanocapacitors fabricated from alumina mask **(right)** |

The researchers produced for the first time arrays of individually addressable platinum-PZT-platinum nanocapacitors by depositing materials through an extremely finely perforated alumina mask with honeycomb-like nanohole pattern, and thus were able to demonstrate an FeRAM with near terabit storage density.

The newly developed method is so generic that it can be readily extended to other materials systems that consist of non-toxic substances or that are free from the notorious electrical fatigue that causes drastic loss of data after some million number of write-erase cycles. The method is advantageous in terms of process time and cost over conventional lithography processes.

With an extension of the present technology, the joint research team is currently conducting investigation on multiferroic systems, which have the potential of next-generation memory elements that feature both ferroelectric and ferromagnetic properties.

Development of DNA CRM for Biotech Core Materials

New BT industries supported with DNA CRM!

Dr. Sang-Ryoul Park of KRISS's Health Metrology Center has succeeded in developing DNA analysis technology and CRMs with a measurement uncertainty of 1% by applying high precision ICP-OES to DNA analysis.

The existing DNA measurement method, which uses UV absorption, has a measurement uncertainty between 10 and 30%, reducing the reliability of the test results when accurate analysis is required.

The newly developed method can accurately measure the amount of DNA by quantifying the phosphorous (P) atoms that exist at the phosphor-diester bonds of DNA, which strictly maintains 1 to 1 ratio to the number of bases of the DNA. The quantity of phosphorus can be accurately determined using ICP-OES combined with microwave-assisted digestion. This method was recently recognized by the international metrology society as a primary DNA quantitation method for its high degree of precision.

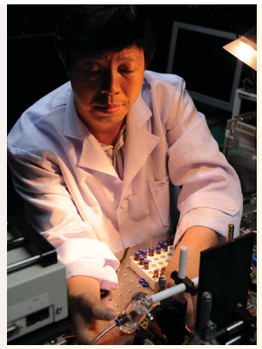
The research team also developed a method of accurately quantifying trace amount of DNA by counting individual DNA molecules utilizing high sensitivity flow cytometry. KRISS is the world's front-end in establishing the counting method as a candidate reference method for trace amount of DNA. This method may provide an accurate quantifying standard for collecting DNA evidence at crime scenes as it can measure super-low density DNA.

The newly developed technology enables highly accurate and reliable measurement with only a 1% margin of uncertainty, to

provide a starting point for representing the exact amount of DNA in mol (one of seven SI units that represent the amount of substances).

The world-class superiority of the current research achievement was recognized when it was presented at the 11th-BERM international symposium held in Tsukuba, Japan. The related technologies have obtained patents both in Korea and the USA.

The research team plans to share the newly developed DNA CRM with hospitals, research institutes, industries, and testing agencies, while utilizing them to analyze DNA and develop measurement equipment. It is expected that the quality of BT products - whose safety, efficacy and contents have so far been subject to constant and rigorous questioning - will be better maintained and warranted as the reliability of their measurement results will be greatly assured by the new technology.



| Counting DNA molecules using a super-sensitive flow cytometry system |

Femto-second Laser-based Ultra-precision Processing Technology and Equipment Developed

1,000 trillionth of a second, controlling instant time!

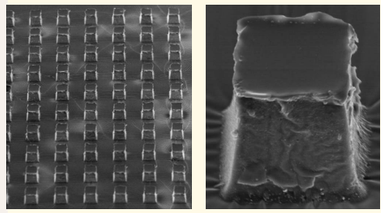
Dr. Sae Chae Jeoung's research team at the Advanced Instrumentation Center of KRISS recently developed material processing technologies for dicing and fine-processing of large-size ultra-thin silicon and sapphire wafers that are essential materials for the mass-production of semiconductor and LED devices.

The new technology has resolved the limitations of the existing thin wafer processing with both high productivity and accuracy. Mass-production with such a high precision in processing was impossible with the existing diamond sawing technology. The research team achieved this development based on the results of the research of earlier metrology related to the non-linear interaction between materials and femto-second laser beams.

The new technology has increased speed of the dicing process to 12 times faster than the existing technologies by hybridizing nano- and femto-second laser beams in spatiotemporal domain. Based on the new technology, the research team succeeded in developing the equipment for dicing ultrathin silicon wafers with a diameter larger than 12 inch.

The related technology was published in Optics Express, the world' s best known optics journal, in 2006, after its superiority was recognized and ten patents were obtained. In January this year, the related technologies were transferred to Hanbit Nano-Biotech Co., Ltd.

The research team plans to develop ultra-fine material processing and surgery technologies for treating a disease related on neovascularization by combining femtosecond laser beam control and real time monitoring technologies so far developed. Furthermore, the research team succeeded in developing technologies that enable electrode patterning directly on boards using surface processing technologies for such new materials as poly silicon, which is essential to the development of solar cell and non-linear optical devices. It is



| Polymer recasting based on silicon wafer microprocessing technology **(right)** magnified X 32, right magnified x 500 **(left)** |

expected, on the basis of such technologies, that processing surfaces will be measured in real time during the processing process, and that the processes will be optimized by using an advanced ultrafast laser beam spectroscopic technologies.

| Operation of newly developed dicing equipment for 12-inch silicon memory wafers |

Friendly KRISS

Mr. Ahmed Abu-Sinna, KRISS Ph.D. candidate

| Second from the right |

Almost 4 years past since, I have arrived to Korean land, long time by the human consideration. Frankly speaking, I consider it as 4 months, why? This is the question, which I am going to answer. However, before this I should present myself. My name is Ahmed Abu-Sinna, I finished Master degree in Mechanical Engineering-Force Measurement from Egypt, and I used to work as an Assistant Researcher at NIS (National Institute of Standards, Egypt). Now I am about to finish my Ph.D. task in KRISS Force group under supervision of Dr. Dae-Im Kang. Currently I am at my final stage of the Ph.D. work which titled by Dead weight Machine-Loadcell Interaction, theoretically graduation is in February next year. The research is focusing more on the mutual influence between the loading frame and the loadcell in a way that allows us to present guidelines for such DWM manufacturers.

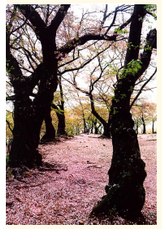
People, Place, these are the most influential factors in the KRISS formula, or you can say these are the basic pillars of KRISS. KRISS staff, as a part of the Korean nation, is very kind, generous, and keen people. They are so supportive and helpful. Upon my experience, there is no problem faced me unless I can find someone, usually not only one person, who is eager to solve it, whether this problem is concerning research or private. One thing that I am strongly noticed that the KRISS staff is always busy. All there minds and thinking in there jobs and how to improve there working and techniques and the most important thing, how to complete the job accurately. This keenness are very important for improving themselves and hence there society and country.

KRISS campus is an inspired place, very beautiful, very quit, and away from crowds. In addition, the institute is instrumented by the up-to-date technologies. There are no doubts that the succeeding KRISS boards are so generous in each thing concerning the researches. Let us now go for a walk outside KRISS. Surprisingly, you will find the same characteristics of Koreans in the streets are same like those who work for KRISS. Actually, in the beginning, I was thinking that this good treating morals of KRISS staff due to their scientific class. However, when you establish a direct contact with ordinary people in the streets, especially in the folk and popular markets, you will face the same good manners, the same politeness, and the same smile on the face.

When I said surprisingly, I meant that I thought this helpful spirits towards the foreigners are located only in my country Egypt, but I discovered the same here. Finally, I hope that the future cooperation between NIS and KRISS not only continue but also become stronger and more influential for both institutes and hence societies.

Activities and Events

The Spring Flower Festival

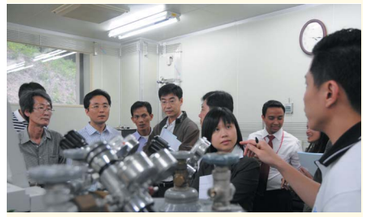


KRISS held the 9th Annual Spring Flower Festival for three days from April 24~27 to celebrate the spring blossoms with the local community residents. The Spring Flower Festival is held each year to promote closeness between KRISS's employees and local residents. During the festivity, KRISS opens its campus to the public to share the beauty of seasonal flowers in full bloom.

Vietnamese Delegation Visit KRISS

The 7 member group Vietnamese government delegation led by the Deputy Minister of the Ministry of Science and Technology of Vietnam and the Director of VMI, visited KRISS on May 8 and 9. The purpose of the visit was to benchmark KRISS' overall operational status, including the status and the amount of support provided by the Korean government, the architectural layout and the construction of the KRISS research buildings and facilities, as well as the institute's R&D activities.

6th Workshop of APMP/TCQM Gas Analysis Working Group



KRISS held the APMP TCQM GA workshop from May 19~23. The workshop was held under the theme of the 'Present Progress and the Future Development of the Gas Metrology' and was participated by 41 experts from over 7 countries including China, Japan, and Singapore.

'Sunshine Day' for the House of Peace Residents

On Saturday, May 24, the Sunshine Day for the House of Peace residents was held on the lawns of KRISS campus. The event is to provide opportunity for the handicapped residents of the House of Peace to enjoy the sunshine on a bright spring day. 83 handicapped residents of the House of Peace joined 20 KRISS volunteers and over 730 additional volunteers from various parts of the country to enjoy various events.

Symposium Held to Commemorate the 'World Metrology Day'

To commemorate the World Metrology Day, KRISS held a symposium under the theme of 'Sports and Metrology' in the Seoul Hall of the Seoul Olympic Parktel on May 20. Participants were able to view the present and future of metrology in sports.

7th Measurement Clubs Integrated Workshop

KRISS held the Measurement Clubs Integrated Workshop at the Daejeon Convention Center from May 22~23. The Measurement Club is a forum which enables industry experts to understand and exchange information on the technological developments in metrology.

Quality Management System Training Provided to COSQC Staff

KRISS provided a workshop on quality management system to 14 members of Iraq's COSQC (Central Organization for Standardization and Quality Control) on May 16~29.

3rd Integrated Workshop on Reference Standards

KRISS held the 3rd Integrated Workshop on Reference Standards on June 12~13 to enable Korea's reference standards experts to better understand the system of reference standards used by key domestic industries. At the workshop, diverse measures were discussed to develop and foster the reference standards required by various domestic industries. Major standards put to debate at the workshop were for the heart and brain vascular system, genome information, and heat properties.

25th Workshop on National Standards System and Precision Measurement

The 25th Workshop on the National Standards System and Precision Measurement was held by KRISS on June 11~26. In all, 355 trainees from 62 countries have so far participated in the NSS Workshop. 13 metrology experts from 13 countries participated in the workshop to share their professional insights in the field of metrology.

Ethiopian Education Minister Visits KRISS

Ethiopia's Education Minister, Wondwossen Kiflu, and his party visited KRISS on Tuesday 17th of June. The delegate visited KRISS with a view to establish a framework for the restoration of Ethiopia's national industries by benchmarking KRISS, which has become the national metrology institute comparable to those of the advanced nations within just 30 years since establishment.

ANMET General Assembly

KRISS held the 6th ANMET General Assembly on September 29~30. The General Assembly was participated by 20 material assessment technology experts from 11 countries, including Japan, China, Malaysia, Singapore, Thailand, Mexico, and Australia, who held intensive discussions about cooperation measures among international organizations aiming to standardize material testing, facilitate the traceability of materials testing, and establish metrology standards for materials testing.

Appointment of Dr. Myungsoo Kim, the 10th President of KRISS

The Inauguration Ceremony for the 10th President of KRISS was held at KRISS on the 9th of December. Over 300 prominent members of the science community, including Dr. Dongpil Min, president of the Korea Research Council of Fundamental Science & Technology, Congressman Sang-min Lee, and KRISS employees, participated in the event. Dr. Myunsoo Kim pledged his determination to lead KRISS into the world's Top 5 National Metrology Institutes by focusing on performance, people, and unified corporate culture.