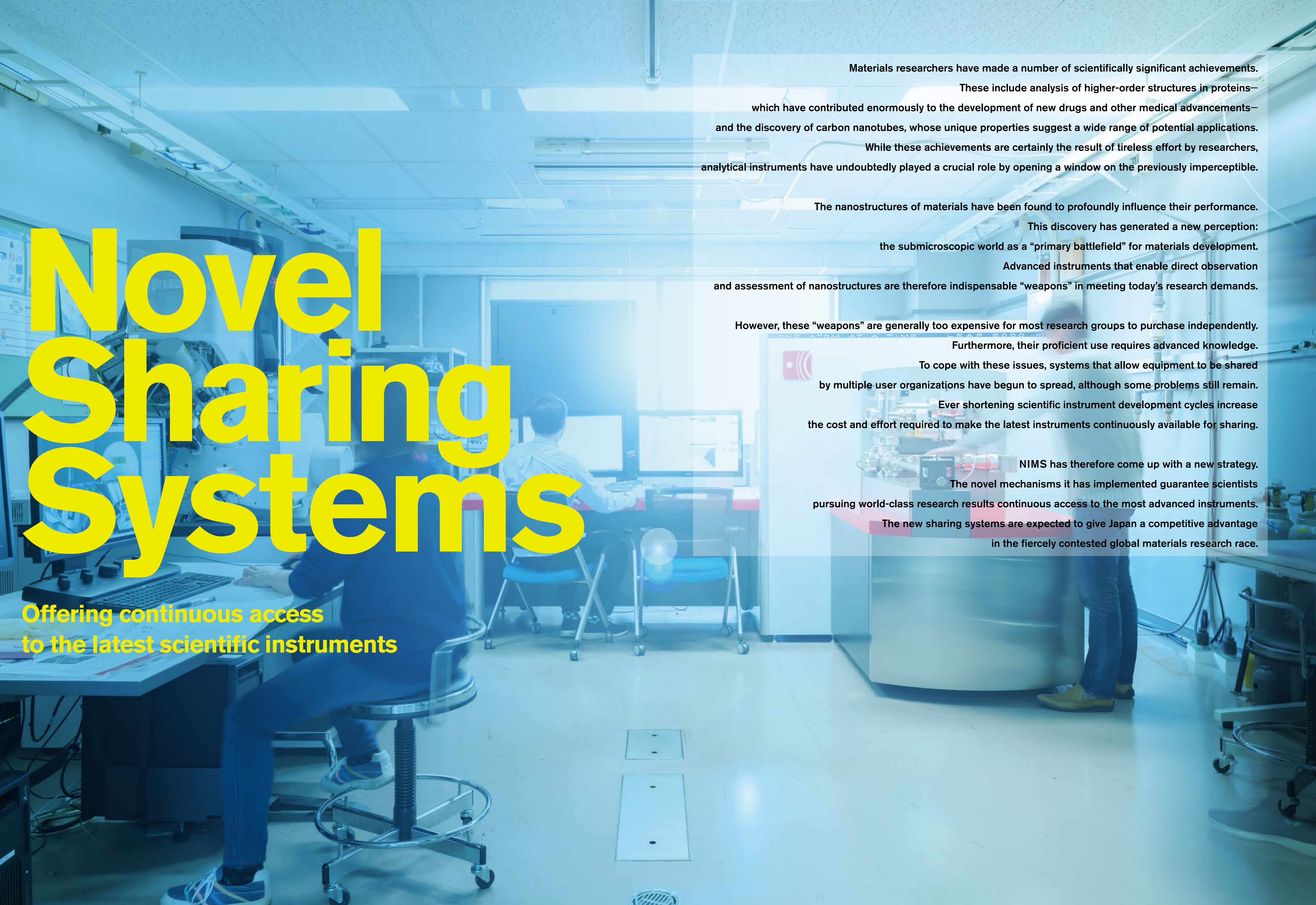
2019

NIMS NOW INTERNATIONAL No.3

NATIONAL INSTITUTE FOR MATERIALS SCIENCE

Novel Sharing Systems

Offering continuous access to the latest scientific instruments



Novel Sharing Systems

Offering continuous access to the latest scientific instruments

Materials researchers have made a number of scientifically significant achievements. These include analysis of higher-order structures in proteins—which have contributed enormously to the development of new drugs and other medical advancements—and the discovery of carbon nanotubes, whose unique properties suggest a wide range of potential applications. While these achievements are certainly the result of tireless effort by researchers, analytical instruments have undoubtedly played a crucial role by opening a window on the previously imperceptible.

The nanostructures of materials have been found to profoundly influence their performance. This discovery has generated a new perception: the submicroscopic world as a “primary battlefield” for materials development. Advanced instruments that enable direct observation and assessment of nanostructures are therefore indispensable “weapons” in meeting today’s research demands.

However, these “weapons” are generally too expensive for most research groups to purchase independently. Furthermore, their proficient use requires advanced knowledge. To cope with these issues, systems that allow equipment to be shared by multiple user organizations have begun to spread, although some problems still remain. Ever shortening scientific instrument development cycles increase the cost and effort required to make the latest instruments continuously available for sharing.

NIMS has therefore come up with a new strategy. The novel mechanisms it has implemented guarantee scientists pursuing world-class research results continuous access to the most advanced instruments. The new sharing systems are expected to give Japan a competitive advantage in the fiercely contested global materials research race.

President of JEOL Ltd.
Chairman of the Nanotechnology Business Creation Initiative

GON-EMON KURIHARA

KAZUHITO HASHIMOTO

President of
the National Institute for Materials Science (NIMS)

Special Dialogue

Boosting Japan's research competitiveness through strategic use of analytical instruments

Cutting edge analytical instruments give scientists pursuing world-class research results a competitive advantage. However, stagnation in Japanese research funding over the past 20 years has made it difficult for researchers to purchase expensive analytical instruments and establish satisfactory research environments. What can be done to address these issues? As a leader in the analytical instrument industry, Gon-emon Kurihara has been leading JEOL, the Nanotechnology Business Creation Initiative and the Japan Analytical Instruments Manufacturers' Association. Mr.Kurihara and NIMS President Kazuhito Hashimoto discussed ways in which analytical instrument development and materials research can be advanced in mutually beneficial ways.

Hashimoto: Japan's budget for science and technology has barely increased at all over the last 20 years. From your perspective as a veteran developer and marketer of scientific instruments, what is your perception of the landscape in which researchers have been operating and how has it changed over time?

Kurihara: I would like to speak from the viewpoint of analytical instrument manufacture industry, sales of analytical instruments have increased continuously over the past 20 years. However, this increase is due only to increased sales of instruments for medical use, whereas sales of high-end instruments for materials research in Japan—transmission electron microscopes and nuclear magnetic resonance spectrometers (NMRs), for example—did not increase in either the public or private sector. On the other hand, exports of analytical instruments to China and India have increased, with the result that the Chinese market has become approximately five times the size of the Japanese market. This international comparison indicates that Japanese researchers are in a challenging competitive situation and leaves me with a sense of crisis.

Hashimoto: As a member of the Japanese government's Council for Science, Technology and Innovation, I often hear from participants in its meetings remark that Japan cannot compete globally if the current situation persists and therefore the research budget must be increased. However, given that Japan has now become a super-aged society, the nation cannot really afford to significantly increase its science and technology budget. In the age to come, we have to come up with creative ideas.

"Rental" scheme has made the most advanced instruments easily accessible

Hashimoto: NIMS has earned a global reputation for its analytical capabilities in materials science which has been supported by the state-of-the-art analytical instruments. We also have researchers proficient in the use of these instruments and capable of preparing high-quality samples. Without our personnel, we would be unable to generate the most advanced data even with these sophisticated instruments.

Kurihara: I call these relationships "two sides of the same coin." JEOL draws strength as a Japanese manufacturer of electron microscopes and other analytical instruments used in materials science from Japan's world-class materials research capabilities, including NIMS.

Hashimoto: I believe that this complementary relationship should be the focus of our strategies to advance Japan's materials research capabilities despite budgetary restrictions. Designing systems capable of benefiting both users and manufacturers of analytical instruments is of great importance.

This very idea drove us to create the "open lab program," a high-end electron microscope sharing service, which was launched last year (see p.8). This program makes the latest analytical instruments continuously available for use by researchers at NIMS, companies and universities. Specifically, rental companies first purchase JEOL's state-of-the-art electron microscopes and lease them to us (NIMS) under a one-year contract. We then recruit companies interested in using the instruments and allow them to share the high rental fees, creating an environment in which company researchers can utilize the latest instruments at much lower cost. While this scheme has been very convenient for instrument users, I have been wanting to sound out JEOL's views on this as an instrument maker.

Kurihara: This is the first such scheme implemented by a national research institute and I have been paying close attention to it. The advantage of this scheme is that users can have access to the latest equipment at any time. This age demands speed, requiring researchers to utilize the most advanced analytical instruments to generate the most advanced data.

In order for this scheme to function properly over the long term, as an analytical instrument manufacturer, we need to continuously produce the world's most advanced instruments. Although we have a great responsibility, it is very important that we maintain the impetus to continuously supply the most advanced equipments to researchers. I think the rental scheme is a breakthrough because it makes the most advanced instruments—normally too expensive to purchase—readily available to researchers.

We sell our instruments to rental companies. After the rental periods expire, the rental companies are then entitled to sell them on the second-hand market. They may use our client network for this purpose. As a result, this scheme has generated new business and benefited us as a manufacturer, the rental companies and NIMS.

Establishing an "analytical instrument showroom" at NIMS

Hashimoto: The CAMECA-NIMS 3DAP Laboratory was launched in 2018 to make 3D atom probe technology available to interested researchers (see p.13). Because the atom probe is very expensive to purchase, the CAMECA business unit of AMETEK Co., Ltd.—the manufacturer of the technology—made the instrument available at NIMS for use by universities and companies. NIMS and CAMECA signed a contract under which NIMS agreed to provide space and supply electricity to the instrument. In return, NIMS is permitted to use it for free for a portion of the time during which it is in operation. The contract likewise allows CAMECA to provide 3D atom probe utilization services to external users at NIMS.

Kurihara: I envision the new lab functioning like a showroom where the products brought to NIMS are displayed and promoted. We have recognized that NIMS is an ideal venue to which company researchers can be invited to try out new scientific instruments and realize their usefulness. I expect this system to be successful.

Hashimoto: This system was established at NIMS because NIMS has the world's top researchers skilled in measurement techniques. They will train instrument operators—to be hired by NIMS and paid by CAMECA—to support users. The experience gained by these operators will continuously contribute to the accumulation of advanced measurement know-how at NIMS. This showroom scheme has the potential to develop into further projects, as CAMECA is considering future R&D collaboration with NIMS.

"Monitors" assist in the development of instruments that meet today's demands

Hashimoto: NIMS purchased JEOL's state-of-the-art 800 MHz wide-bore NMR last year. Since then, JEOL and NIMS have been using it to jointly develop new probes as part of the "JEOL-NIMS Laboratory for Analytical Technology" initiatives that started in 2015 (see p.12). During this joint project, NIMS researchers use and become "Monitors" of JEOL's prototype probes and assist in JEOL's efforts to commercialize them by providing feedback. I believe that both NIMS and JEOL can benefit from this project: NIMS will learn how to use the latest NMRs while JEOL can develop various types of probes as options to be added to their products, thereby increasing its competitiveness in the market.

Kurihara: I agree. NIMS and JEOL are currently developing an ultrasensitive NMR capable of measuring solid samples. Most NMR analyses in the past have focused on liquid samples. JEOL's unique technology has enabled its NMR products to perform ultrasensitive analysis of solid samples. Its products are distinctly different from those of its competitors.

Hashimoto: I have great expectations for the NMR currently being developed because solid substances are more commonly used than liquids in materials research. However, I understand that the NMR at this stage is suited only for measuring carbons in organic materials, such as carbon polymers, and that measurement of other solids still requires highly elaborate techniques.

Kurihara: Yes. That is why we are currently developing a new, more user-friendly probe capable of simplifying analysis of a wider range of solids. Because analytical instrument makers do not possess the types of materials which researchers are actually measuring, we lack knowledge of the types of materials current that researchers are interested in measuring and the types of data they want to collect using NMR. Collaborative research with NIMS is important as it allows us to gather this information, which is vital to the development of instruments that are in step with the changing needs of researchers.

Compilation of diverse data lead to the creation of new values

Kurihara: Up to this point, we have discussed different schemes that facilitate continuous utilization of the latest analytical instruments by researchers. If NIMS compiles all of the data generated by its diverse array of scientific instruments, perhaps the data can be used for innovative endeavors.

Hashimoto: In the future, we plan to compile data generated by the most advanced instruments, process it into big data and use it in materials informatics research. Initially, we are asking users of these instruments to provide data under mutual agreements. In addition, NIMS has recently taken the initiative in standardizing the formats of data generated by various analytical instruments so that the same platform can handle data from different sources. We will then create a translation device capable of standardizing data formats and terminology by consulting with measurement instrument makers to learn the data formats they use and the definitions of abbreviations used in data. We will then make the standardized data available on a website to which interested researchers will have full access. The establishment of this system may lead to the development of a common platform for the global research community, including Japan.

Kurihara: Building hardware is our strong suit; building software is not. However, to meet today's research demands, we intend to strengthen our data strategies.

Hashimoto: In relation to the point you just raised, NIMS urgently needs to discuss the ways in which it partners with analytical instrument manufacturers, such as JEOL. We appreciate JEOL's continued collaboration and support.

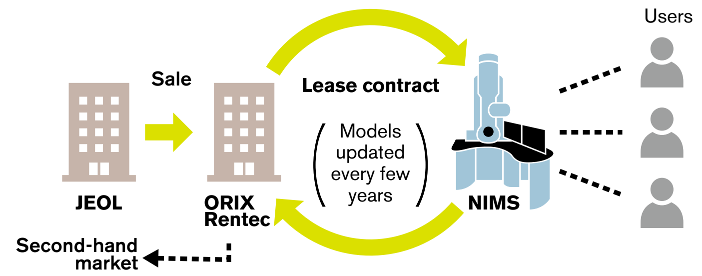
(by Akiko Ikeda, Sci-Tech Communications)

Rental and sharing ecosystem of cutting-edge instrument

The use of scientific instruments capable of generating the most advanced data is vital to gaining an advantage amid intensifying R&D competition. Commercially available scientific instruments are frequently updated and new functions are added, but it is impractical for most research institutions to purchase these new and expensive instruments themselves.

In May 2018, NIMS, JEOL Ltd. and ORIX Rentec Corporation jointly launched the "Open Lab Program", the world's first system designed to make a high-end electron microscope (EM) available at NIMS for shared use by multiple companies through lease contracts. We asked Masaki Takeguchi, the program director, about the mechanisms and objectives of the program.

Masaki Takeguchi
TEM Station Director, Transmission Electron Microscopy Station, Research Network and Facility Services Division



ORIX Rentic purchases high-end electron microscopes (EMs) from JEOL and leases them to NIMS, where the EMs are made available for shared use by various companies. When a lease contract expires, the EM models in use will be replaced with the latest models. Decommissioned EMs are expected to become available for resale on the second-hand market.

Takeguchi first explained the historical background that led to the establishment of the program. "Electron microscopes—which enable atomic-level observation of samples by irradiating them with an electron beam—have played a vital role in materials R&D. The performance of materials has been found to be greatly influenced by the nanostructural arrangement of the various atoms of which they are composed. Direct observation of nanostructures is therefore a highly efficient approach to materials development. Increasing demand for this approach has recently led to the development of a succession of new EM-related technologies, shortening product life cycles. The use of the latest instruments to collect the most advanced R&D data is crucial to maintaining and strengthening Japan's international research competitiveness. However, stagnation in Japan's research budgets in recent years has made it difficult for companies and universities to procure the latest instruments on their own. To address this issue, I focused my attention on the sharing services that have begun to emerge in other fields, including automobile transportation. We then launched EM rental and sharing services in collaboration with JEOL and ORIX Rentec."

Making cutting-edge EMs accessible to up to 10 companies annually

The rental and sharing services work as follows. ORIX Rentec first purchases a high-end EM product, JEM-F200 (photo at left), from JEOL and then leases it to NIMS. The lease contract is renewed annually and the lease fees are covered by the annual usage fees paid by program member companies. After several years of rentals, the EM model then in use will be replaced with the latest high-end model. "The greatest advantage of this service is that it can make the most advanced EMs continuously available for use by many researchers," Takeguchi said. "With this system in place, Japan is now adequately equipped for global competition."

The average annual usage fee paid by each company in FY2018 was estimated to be 3.51 million yen, excluding tax. This figure assumes that the selling price for the JEM-F200 is about 200 million yen, that its life cycle is seven years and that the program will accept no more than 10 companies as members to allow each to have sufficient access to the EMs.

Member companies can use the EMs as many times as they wish and are not obliged to disclose their research results. In addition, they can learn skills needed to operate EMs by participating in workshops held by JEOL.

NIMS has also acquired its own slots for EM utilization by paying an annual usage fee. NIMS and its joint research partners are allowed to use the JEM-F200 during these slots.

JEOL and ORIX Rentec are also expected to benefit substantially from this service. "ORIX Rentec plans to sell used EMs at lower prices to interested buyers after their leases expire," Takeguchi said. "I expect that the number of EMs used by R&D institutions will grow as a result of this scheme."

Pursuing increased use of instrument rental and sharing services

Seven companies joined the Open Lab Program in FY2018 and all gave it positive feedback. All seven have expressed the intention to renew their contracts for FY2019 and a new company is expected to join.

The program has already produced some significant research progress. For example, the JEM-F200 is equipped with a highly sensitive camera that enables operando measurements, an EM function of great interest to member companies. Operando measurement techniques allow direct observation of continuously changing phenomena in devices and materials. Researchers are able to capture atomic and ionic movements, greatly facilitating their battery and catalysis development efforts. In addition, the JEM-F200's camera is capable of performing the new 4D-STEM (four-dimensional scanning transmission electron microscopy) function. This function can be used to visualize distortions, electric fields and magnetic fields in materials at nano levels, and member companies have been leveraging it in their applied research projects.

Under the contracts between member companies and NIMS, if companies permit, NIMS store data collected using the JEM-F200 on NIMS' server. NIMS plans to use accumulated data in materials informatics (MI), a discipline in which informatics techniques are applied to materials science.

"All of Japan's R&D institutions are currently facing a dilemma: they want to use the most advanced instruments but lack the opportunity. To address this problem, I hope to establish and popularize rental and sharing services—not only for EMs but also for other scientific instruments—throughout Japan. I believe that this approach will strengthen Japan's global competitiveness in materials science," said Takeguchi enthusiastically.

(by Kumi Yamada)

System 2 SHOWROOM | CAMECA-NIMS 3DAP LABORATORY

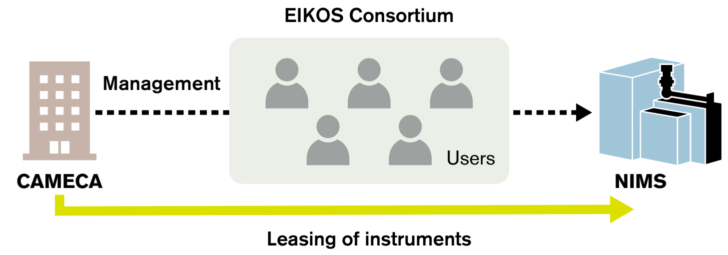
NIMS as a venue for widening the use of advanced technologies

High-performance analytical instruments may be difficult to popularize if they require advanced expertise to operate, are expensive or are not very accessible.
The slowing of technological progress as a result of these factors could inhibit materials development.

To address this concern, NIMS and the CAMECA business unit of AMETEK Co., Ltd. jointly founded "the CAMECA-NIMS 3DAP Laboratory" in June 2018.
The lab at NIMS invites researchers from companies, universities and other institutions to use three-dimensional atom probes (3DAPs) at low cost.

We asked Tadakatsu Ohkubo at NIMS—the CAMECA-NIMS 3DAP Laboratory Manager—about the operation and advantages of the lab.

Tadakatsu Ohkubo
Laboratory Manager, CAMECA-NIMS 3DAP Laboratory/ Group Leader, Magnetic Materials Analysis Group, Research Center for Magnetic and Spintronic Materials



CAMECA has made its the latest 3D atom probe available at NIMS without charging rental fees. Researchers interested in using the probe need only join the CAMECA-managed EIKOS Consortium and pay for the number of days of use. Under the contract, NIMS researchers are permitted to use the probe for 25% of the total number of days they are in operation.

The 3DAP is an instrument capable of identifying the type and position of the atoms that compose a material — including difficult to detect light elements. For example, it played a crucial role in the development of neodymium magnets at NIMS. "3DAP analysis enabled us to understand the atomic distribution at grain boundaries in detail," Ohkubo said. "This finding led to a breakthrough in increasing magnetic performance."

USA-based AMETEK is currently the only company marketing 3DAPs. It acquired the French company CAMECA, a long-established 3DAP maker, and made it an AMETEK business unit, resulting in monopolization of the 3DAP market by the company. In addition to the lack of market competition, the technical skills necessary for effective 3DAP analysis are still largely unavailable to many researchers and the size of the 3DAP market remains smaller than that for other analytical instruments, such as electron microscopes. These circumstances have ensured that 3DAPs remain very expensive. To address these issues, the CAMECA business unit of AMETEK (hereinafter referred to simply as "CAMECA") launched the CAMECA-NIMS 3DAP Laboratory at NIMS in June 2018.

Skilled experts support the "showroom"

Formerly, a company or university that needed a 3DAP for its materials characterization but was unable to afford one had to commission another company with the proper equipment, or needed to ask AMETEK in the USA for a demonstration of their instrument. The newly established 3DAP lab has enabled interested researchers to use the latest 3DAP at NIMS by simply joining the CAMECA-managed consortium and paying for a number of days of use. At the showroom-style 3DAP lab, CAMECA has been providing companies and universities interested in purchasing 3DAPs, but hesitant to actually do so, with valuable opportunities to discover the capabilities and usefulness of these instruments firsthand.

CAMECA decided to partner with NIMS to establish the 3DAP lab because NIMS has a history of independently developing 3DAPs and has researchers well versed in their use. Although the new lab has greatly increased access to the latest 3DAP instruments, it remains difficult for many researchers to operate. In particular, preparation of samples for 3DAP analysis involves use of a FIB/SEM (focused ion beam / scanning electron microscopy); mastering this technique requires advanced skills and many years of experience. To assist users with these challenges, the lab employs well-trained 3DAP operators, and CAMECA's researcher is also staying at NIMS. The 3DAP is operated for 200 days annually. Under the current contract between NIMS and CAMECA, 150 days, 75% of the annual operating days, are allocated for 3DAP use by consortium-member companies and universities; the remaining 25% are set aside for NIMS researchers.

Asked about the benefits of the 3DAP lab to NIMS, Ohkubo answered, "we are allowed to use the instruments without paying for their installation or utilization. In addition, the consortium framework provides NIMS with new opportunities to engage in collaborative research with member companies and universities. In fact, we have launched several joint research projects with companies we have only recently become acquainted with."

External users of the 3DAP lab also enjoy benefits. They not only have convenient access to the latest 3DAP; they also have the chance to purchase the instruments used at NIMS at low cost, subject to separate agreements. This arrangement therefore benefits all of the parties involved: the instrument maker, NIMS and external users.

Making NIMS Asia's leading 3DAP center

The 3DAP lab is currently equipped with EIKOS-X, a major model available for shared use. NIMS also has the top-of-the-line 3DAP model: LEAP 5000 XS. EIKOS-X utilizes a visible laser which is suitable of analyzing metallic materials, whereas LEAP 5000 XS utilizes an ultraviolet laser which can additionally analyze a greater range of materials, such as insulators and semiconductors. Despite its lower capability of atom detection, EIKOS-X can more accurately identify different types of chemical elements, so is more appropriate for certain objectives, and costs about half as much as LEAP 5000 XS. "Both models are available for use by all consortium-member companies, universities, and the organizations currently engaged in joint research with NIMS," Ohkubo said. "This 3DAP lab scheme therefore offers external users valuable opportunities to compare these two models as purchasing options."

NIMS hopes that the reputation of the "latest 3DAP showroom" will grow widely, enabling NIMS to establish itself as Asia's leading 3DAP center.

(by Kumi Yamada)

CAMECA—NIMS 3DAP Laboratory
https://www.nims.go.jp/mmu/3daplab/index_e.html

Developing original instruments that anticipate near future needs available for shared use

Efforts to create completely novel materials sometimes require the development of revolutionary analytical instruments to meet current research demands.

To put this concept into practice, NIMS and JEOL, Ltd. founded the "JEOL-NIMS Laboratory for Analytical Technology" to collaboratively develop nuclear magnetic resonance (NMR) systems capable of more detailed materials analysis.

Since the establishment of the laboratory in October 2015, researchers from NIMS, companies and universities have been jointly using and monitoring the prototype NMR systems and providing feedback to help improve their functionality and ease of use.

We asked Tadashi Shimizu, the director of the laboratory, about the background leading to the establishment of the laboratory and its current status.

Tadashi Shimizu
Laboratory Director, JEOL-NIMS Laboratory for Analytical Technology
Station Director, NMR Station, Research Network and Facility Services Division

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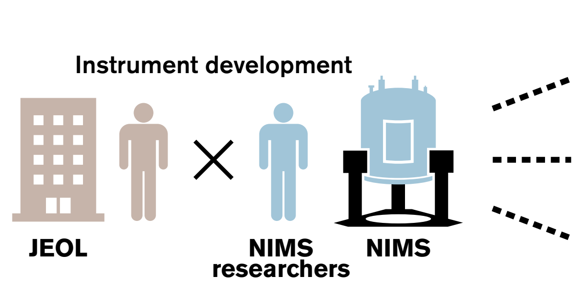


JEOL has installed ultrasensitive NMR systems capable of measuring solid samples equipped with a prototype probe at NIMS. Researchers from NIMS, companies and universities who use the systems provide feedback to JEOL to assist its product development efforts. The prototype NMR systems currently under development have been widely shared through the MEXT Nanotechnology Platform Japan Program.

An NMR system equipped with superconducting magnets is capable of analyzing materials' molecular structures, atomic bonding states and dynamic states.

Two types of NMR systems exist. One type is compatible with liquid samples (liquid-state NMR systems), while the other is compatible with solid samples (solid-state NMR systems). Most NMR analyses in the past has been particularly useful in biology using liquid-state NMR systems.

Growing expectations for solid-state NMR systems

Solid-state NMR systems are used to measure molecular structures in solid samples. This technology has some useful characteristics for materials development : it can measure the types of atoms and molecules in materials that are difficult to analyze using electron microscopes or X-ray analyzers and in materials with irregular atomic and molecular structures. It is also capable of discerning many different types of chemical elements, including light elements, at very high precision. "Discriminating between chemical elements in materials can be extremely difficult if they are composed of elements with adjacent atomic numbers; for example, materials composed of boron, carbon, nitrogen and oxygen," Shimizu said. "Only solid-state NMR systems can analyze the localized structures of these materials by accurately differentiating between their constituent elements."

However, the solid-state NMR system market is nearly one order of magnitude smaller than that of liquid-state NMR systems. The reason for this disparity is technological: the analysis of solid samples requires sensitivity and resolution several orders of magnitude greater than liquid samples and necessitating the development of more advanced technologies without huge cost.

Therefore NIMS and JEOL launched the "NIMS-JEOL Laboratory for Analytical Technology" to jointly develop solid-state NMR systems capable of analyzing inorganic materials.

"The research center invites researchers from companies and universities to try prototype NMR systems currently under joint development, monitor the performance of the systems and provide feedback to help the systems continuously improve," Shimizu said. "Through this approach, we aim to develop technologies that will satisfy the latest research needs. When technological development at the laboratory is completed, JEOL intends to develop commercial products and market them globally."

More than 10-fold Increase in NMR sensitivity

NMR systems are equipped with a so-called "probe," which irradiates a sample with electromagnetic waves and detects returning signals. The sensitivity and resolution of NMR systems generally increases parallel to the increasing performance of the probe and the magnetic strength of superconducting magnets (i.e., magnetic field intensity). Magnetic field intensity is a particularly important factor influencing the performance of NMR systems. NIMS has had the experience of developing an NMR system capable of generating the world's strongest magnetic field using small-diameter superconducting magnets. The smaller magnets were the key to efficiently increasing magnetic field intensity.

"After 10 years of R&D, we succeeded in developing an NMR system capable of generating the world's strongest magnetic field of 1,020 MHz in April 2015. This innovative technology has since been used in biological research, including protein analysis," Shimizu said. "We then applied this technology to large-diameter superconducting magnets, thereby developing practical solid-state NMR systems suitable for materials research."

Several prototype solid-state NMR systems are currently available for shared use at the research center and many companies and universities across Japan engaged in materials R&D have visited the lab to try them. In May 2019, a newly developed 800 MHz NMR system equipped with large-diameter superconducting magnets became available for trial use. "The probe technology we developed while attempting to generate the world's strongest magnetic field has enabled analyses that leverage the power of large-diameter superconducting magnets," Shimizu said. "The technology has also increased the sensitivity of conventional solid-state NMR systems by more than 10 times."

Shimizu further said, "In order for Japan to maintain its global competitiveness as a leading materials developer, it must develop new measurement technologies to make timely breakthrough discoveries that would be impossible using existing technologies, enabling materials scientists to promptly launch innovative research. We will continue engaging in R&D that will satisfy changing needs."

(by Kumi Yamada)

Microstructural Characterization Platform
https://www.nims.go.jp/nmcp/eng/equipment4.html

MESSAGES FROM THE PARTNERS

We invited the companies participating in collaborative activities highlighted in this NIMS NOW issue to share their thoughts.

JEOL Ltd.

Open Lab Program ▶p8
JEOL-NIMS Laboratory for Analytical Technology ▶p12

Instruments capable of analyzing and measuring microstructures are vital and necessary tools for R&D in a variety of scientific fields, including nanotechnology, materials science and biological / life science. Recent technological advances in instruments and applications have enabled the successive development of new instruments that can rapidly generate various types of purpose-specific precision data.

Although cutting edge instruments are in high demand, improvement of performance inevitably involves increase of cost. The recently launched the "Open Lab Program" is an effective means of achieving a favorable balance between supply and demand.

In addition, the new "JEOL-NIMS Laboratory for Excellence of Analytical Technology" has been established to leverage our respective state-of-the-art technologies with the goal of developing world-class NMR technologies capable of measuring solids—valuable tools in materials research. This initiative represents a breakthrough in Japan's current R&D efforts.

I earnestly hope that these pioneering programs will help promote the enhancement of research environments and the building of a basis for scientific and technological advancement.

Mr. Koichi Fukuyama
Director & Senior Executive Officer

ORIX Rentec Corporation

Open Lab Program ▶p8

Since its establishment in 1976 as Japan's first measurement instrument rental company, ORIX Rentec has been committed to satisfying its clients' various needs, including R&D, chiefly by offering rentals of high-tech equipment.

Through the "Open Lab Program" we participate in with NIMS, we use our more than 40 years of know-how to make our latest equipment available to researchers and offer rental schemes that permit our clients to replace older instruments with newer ones.

We sincerely hope that this program—which offers many researchers opportunities to conduct R&D using the latest technologies and techniques—will promote the strengthening of Japan's science and technology capabilities and the growth of Japanese industry.

Mr. Toshiyuki Okino
Corporate Executive Officer,
Head of Procurement Division,
Head of ICT Sales Division

AMETEK Co., Ltd.

CAMECA-NIMS 3DAP Laboratory ▶p10

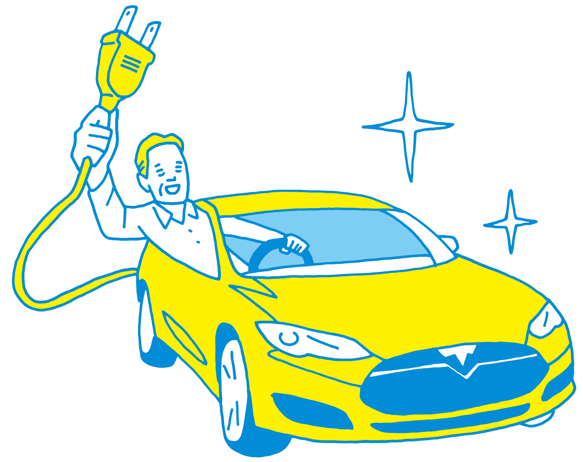
NIMS has played a role in this area for decades, using atom probes in the analysis of a wide variety of materials, extending the range of APT applications. CAMECA is leading the development and popularization of this method as the world's only manufacturer of 3D atom probe microscopes.

The CAMECA-NIMS 3DAP Laboratory will considerably lower the barrier to the use of atom probes in materials development, raising expectations for a variety of applications and making a significant contribution to academia and industry, particularly in the growing market for Additive Manufacturing of metals. CAMECA is excited to be working with NIMS, a world leader in materials research with unique academic expertise and a wide network of industrial partners.

Dr. Jesse Olson
AMETEK Material Analysis Division
Div. VP, CAMECA BU Manager

With NIMS' cooperation, we have established the "EIKOS Consortium", which provides consultation services to this lab's users. The consortium was launched in October 2018 and has been in full-scale operation since the beginning of 2019. Users of EIKOS-X—our main model in the lab—viewed it positively, commenting that it generated results superior to those generated by our previous higher-end models (i.e., the LEAP 4000 series). We offer researchers opportunities to gain real experience collecting data and conducting analyses using our prototype 3D atom probe, which we hope will lead to the establishment of 3D atom probes as highly effective materials research tools.

Mr. Songsu Cho
AMETEK Japan,
CAMECA BU manager



The Tesla Model S: an impressive driving experience

Text by Akio Etori
Illustration by Joe Okada (vision track)

Although it's been nearly 10 years since I last drove a car, I love automobiles; I've owned and driven them for over 50 years. I've never purchased larger passenger vehicles (i.e., the so-called "3-number vehicles" in Japan) or vehicles with automatic transmissions due to Japan's road conditions, to protect the environment and for other reasons. I have always chosen compact Japanese cars with manual transmissions, because when operated skillfully, vehicles with manual transmissions are more efficient and emit less carbon dioxide.

I recently had a stimulating opportunity to drive one of the hottest cars available today when I earned the chance to test drive an American electric automobile manufactured by Tesla, Inc. (Elon Musk, CEO). I was very excited as I approached the test drive location in Osaka's Shinsaibashi district—not very far from my home in Kyoto—in February 2019.

The Tesla showroom in Shinsaibashi had Model S sedans and Model X SUVs on display. An attendant patiently explained the features of these two models to me.

My first impression of the Model S was that it was much larger than expected; it appeared to be larger than a Toyota Crown. Particularly apparent was the vehicle's width, which gave the spacious appearance familiar in many other American vehicles. The larger design was somewhat surprising to me because most Japanese electric vehicles fall into the compact class.

Electric vehicles are not equipped with an engine or a transmission, freeing up additional space in the front and rear of the vehicle. The seats and other interior features can be more spaciously constructed. The battery is located beneath the vehicle's floor, which naturally lowers its center of gravity and increases stability. The model also has a disadvantage, however. I learned that the Model S weighs 2.2 tons; too heavy for mass production. The development of lighter-weight batteries is desirable.

As I began driving the Model S, it moved smoothly without making a sound.

I drove on public roads accompanied by the attendant, who sat in the passenger seat. I was fully satisfied with the vehicle's performance, including the ride comfort, acceleration, handling and breaking performance. Despite its large size, the Model S accelerated like a sports car. The lower half of the mounted navigation system display displayed clear rear view images, assisting safe driving.

The Model S appears to be fundamentally ready for practical use given thzat its mileage per charge has reached 500 km—equivalent to that of gasoline vehicles—and it is equipped with a special battery recharger. The vehicle uses lithium ion batteries made by Japan's own Panasonic, and the company has invested a great deal of effort in their development, earning Japan's battery technology a global reputation.

As a supporter of electric vehicles and hoping for their popularization, I was very satisfied with the test drive experience.

That said, at approximately 10 million yen, the current Model S is very expensive. I was informed that the recently released mass-production model will cost 5 million yen. To make electric vehicles more appealing to consumers, their prices will need to be lowered to further close the price gap between electric and gasoline vehicles. In addition, I feel that electric vehicles intended for sale in Japan should be smaller.

Advances in battery technology will be essential to enhancing electric vehicles in every way by reducing their weight, cost and size. The development of more durable batteries would offer long-distance travelers an increased sense of security. Such batteries would also potentially be useful as household storage batteries or similar devices capable of storing electricity from power-generating facilities and supplying it as needed, in addition to their use as vehicle batteries.

Many countries around the world are currently engaged in intense competition in the development of advanced batteries. I hope to see truly revolutionary batteries invented that will allow electric vehicles to replace conventional vehicles everywhere.

Akio Etori: Born in 1934. Science journalist. After graduating from College of Arts and Sciences, the University of Tokyo, he produced mainly science programs as a television producer and director at Nihon Educational Television (current TV Asahi) and TV Tokyo, after which he became the editor in chief of the science magazine Nikkei Science. Successively he held posts including director of Nikkei Science Inc., executive director of Mita Press Inc., visiting professor of the Research Center for Advanced Science and Technology, the University of Tokyo, and director of the Japan Science Foundation.

NIMS NEWS

1 NIMS Researcher Ken Sakaushi wins PCCP Prize

Ken Sakaushi (Senior Researcher, Center for Green Research on Energy and Environmental Materials, NIMS) is the winner of the PCCP Prize for Outstanding Achievement of Young Scientists in Physical Chemistry and Chemical Physics of the Royal Society of Chemistry (RSC) in 2019.

The PCCP Prize is awarded to promising young scientists less than 35 years of age in recognition of their outstanding contributions in topics covered by the RSC journal, Physical Chemistry Chemical Physics (PCCP), including such as physical chemistry, theoretical chemistry and coordination chemistry. The winners of this prize are recognized by the representatives of the RSC, its publications (PCCP and Faraday Discussions) and the Chemical Society of Japan (CSJ).

The award ceremony was held as part of the “International Chemists’ Evening,” the international symposium reception held during the 99th CSJ annual meeting in March 2019. Dr. Sakaushi received his certificate and the prize from PCCP Prize Selection Committee Chairman Prof. Dr. Yasuhiro Iwasawa.

2 NIMS and Technische Universität Darmstadt sign International Cooperative Graduate Program Agreement

On June 5, 2019, President of Technische Universität Darmstadt (TU Darmstadt), Prof. Hans Jürgen Prömel visited NIMS accompanied by representatives of the university and signed International Cooperative Graduate Program (ICGP) Agreement, which is aiming to educate students by cooperating . This ICGP Agreement became the first one with a university in Germany.

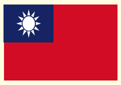
TU Darmstadt is one of the leading engineering university in Germany and produced a lot of notable faculty and alumni. Darmstadt is called “City of Science” and renowned as a birth place of the chemical element “Darmstadtium” and “Hassium”. It is expected that NIMS accepts many excellent students from TU Darmstadt and study to obtain their degrees supervised by NIMS researchers.

Signing Ceremony at NIMS. Prof. Hans Jürgen Prömel (President of TU Darmstadt; left) and Dr. Kazuhiro Hono (Executive Vice President of NIMS).

Hello from NIMS

Hi! My name is Ying-Chiao Wang. I worked as a visiting researcher at NIMS from May 2018. Five months later, I was accepted by the International Center for Young Scientists (ICYS) program and officially became a NIMS employee. I am a baseball fanatic. I feel that “baseball is the most direct competition between strength and speed” . Here, baseball can be seen as a connector. Similar to baseball, “materials are the most direct bridge between science and application” . Based on this concept, my research direction is to apply functional materials with various advantages to organic optoelectronic devices. As we know, Japanese baseball has always been a delicate style, leading to a leading position in the world. Not only baseball, but Japanese culture often uses this attitude as the main faith. Therefore, I chose to continue my research career in Japan. Among them, NIMS is the leading research institute in the field of materials in Japan. At the same time, ICYS also brings more opportunities for cooperation among young scientists. I especially cherish this opportunity to enter this international research unit for material research. I hope that in the future, I will have the opportunity to apply my research to life.

Unicorn Gundam at Odaiba, Tokyo



Ying-Chiao Wang
(Taiwan)
ICYS Research Fellow, ICYS

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To subscribe, contact:
Dr. Yasufumi Nakamichi, Publisher
Public Relations Office, NIMS
1-2-1 Sengen, Tsukuba, Ibaraki, 305-0047 JAPAN
Phone: +81-29-859-2026, Fax: +81-29-859-2017
Email: inquiry@nims.go.jp

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