NATIONAL INSTITUTE FOR MATERIALS SCIENCE

NIMS NOW INTERNATIONAL

No.4
2015

Spearheading Collaboration with Industry

NIMS' Research Makes Impacts on Society

Dream came true with a perfect match: NIMS' Material and the Aviation Industry

The Boeing 787 Dreamliner is a mid-size jetliner of the next generation.
To create a mid-size plane capable of long-range flight,
they had to reduce airframe weight and also develop an extremely
efficient engine by raising its combustion temperature.

When Rolls-Royce Limited, taking charge of developing the jetliner,
was in search of outstanding heat-resistant materials necessary to create a
highly-efficient engine, NIMS developed a nickel-base superalloy
with the world' s highest heat-resistant (1,100° C).

So, the two organizations together took up the challenge of
developing highly-efficient engine materials in 2006.

As a result of this collaborative endeavor, we can see today
the Boeing 787 Dreamliner soaring through the sky.

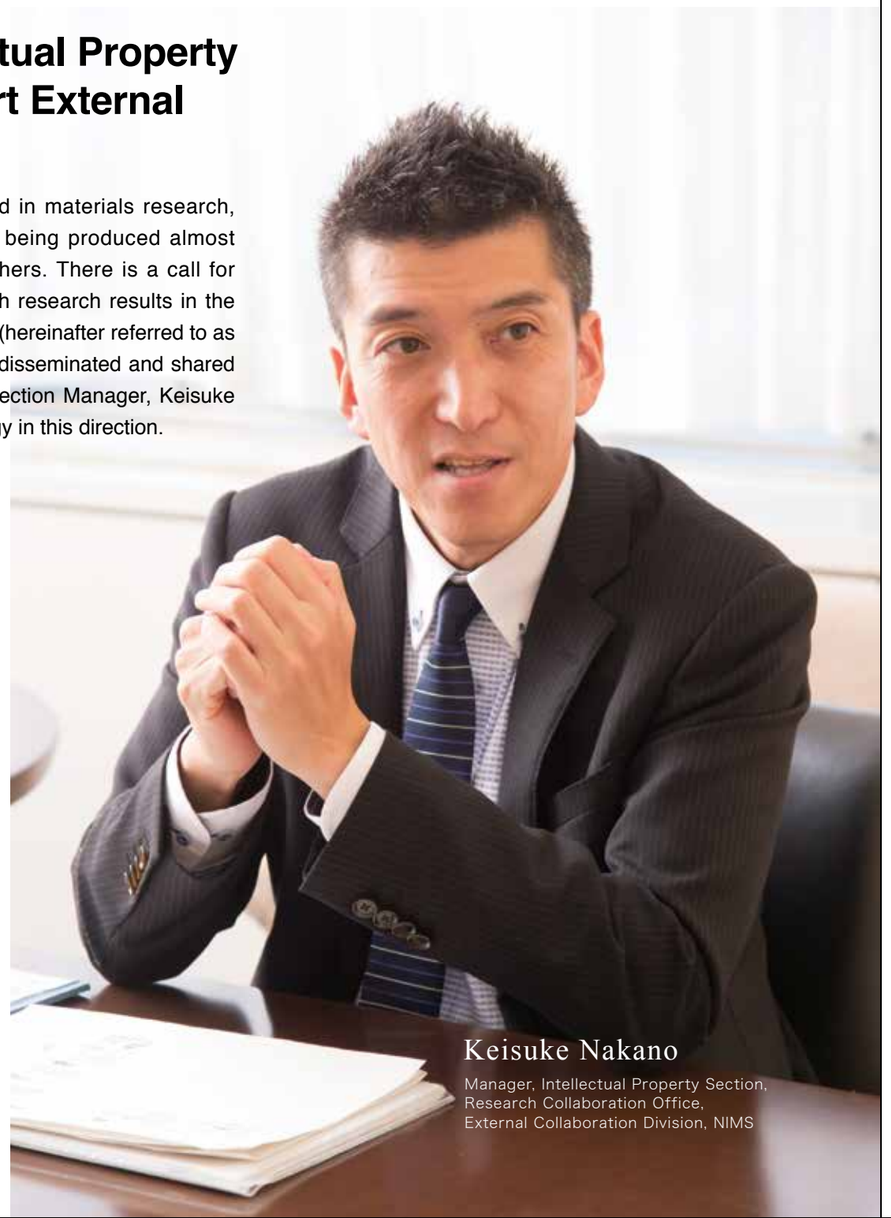
Now, in 2015, what is NIMS up to in terms of its collaboration with industry?
This issue of NIMS NOW features NIMS' latest initiatives in this aspect.

Strategic Use of Intellectual Property

For Bringing Out "Intelligence" as Property to Industry, and to Society

Strategic Intellectual Property Activities Support External Collaboration

At NIMS, an institute specialized in materials research, innovative research results are being produced almost everyday by competent researchers. There is a call for actions to secure and utilize such research results in the form of intellectual property rights (hereinafter referred to as "IP") so that these results will be disseminated and shared in society. Intellectual Property Section Manager, Keisuke Nakano, explains NIMS' IP strategy in this direction.



Keisuke Nakano
Manager, Intellectual Property Section,
Research Collaboration Office,
External Collaboration Division, NIMS

Never Miss a Chance to Acquire Seeds of Success through "In-house Operation of Patents"

It is no exaggeration to say that collaboration with companies will never begin without any prospect for IP. However, Japanese research institutes and universities have not yet been able to find an answer to what would be the best way to handle IP. Faced with this challenge, such other research entities have an eye on NIMS' IP strategy.

"NIMS' IP activities are recognized as unique and leading-edge initiatives," says NIMS Intellectual Property Section Manager, Keisuke Nakano.

The following points can be cited as the major characteristics of NIMS's IP activities:

(1) in-house operation of patents; (2) emphasis on applying for foreign patents; (3) maintaining process invention as know-how (instead of applying for patents); and (4) a unique patent portfolio strategy.

Let us look at these characteristics one by one. First, "in-house operation of patents" means that NIMS has its internal patent specialists draft patent application documents, without having to use outside patent firms. At present, NIMS is the only domestic research institute that carries out the process of filing all domestic applications (except for joint patent applications) in-house.

As for why NIMS has taken this step toward in-house operation of patents, Nakano mentions two reasons: to avoid losing the chance to file applications and to save filing costs.

"As we engage in basic research at NIMS, we have difficulty in deciding whether or not we should file patent applications with regard to most of our research results. Yet, as we don't want to miss the opportunity to acquire seeds of success, we are eager to apply for as many patents as possible. So in 2007, we took a course toward taking care of ourselves in filing patent applications, sought to secure opportunities to file patent applications to the greatest possible extent by reducing fees payable to patent firms."

The in-house operation approach has brought about unexpected benefits as well. NIMS researchers are comfortable to consult with internal patent specialists who are their colleagues and attentive in listening to their ideas. It is now a regular step to take for NIMS researchers to consult with internal patent specialists concerning patents before they publish papers on their research results. NIMS' culture aimed at both publishing more research papers and acquiring more IP has thus been established.

"Other research institutes have not adopted the in-house operation approach because, I assume, it is difficult to secure and manage internal patent specialists, including personnel costs. We were also faced with this problem when we first launched this approach, but as it gradually started to work, we became confident in this approach and we increased the number of internal patent specialists from one to four."

The second point is emphasis on applying for foreign patents. Since NIMS frequently collaborates with global companies, it is a must to have foreign patents when carrying out collaborative research with such companies. In addition, most NIMS researchers are motivated to disseminate their research results on a global scale. For these reasons, NIMS puts much emphasis on applying for foreign patents.

"However, due to the large increase in costs for filing foreign patent applications caused by the recent yen depreciation and other factors, it is a crucial assignment for us to decide what inventions to file in which countries or regions," Nakano reveals the reality. At NIMS, to make a decision on this matter, the Intellectual Property Section, which is in charge of IP management, and the Technology Transfer Section, which is in charge of collaboration with companies, hold discussions and conduct rigorous screening of inventions in terms of the necessity to apply for foreign patents from two aspects, "Does this invention have potential for patent?" and "Does this invention have a high market value?", and present the outcome of the discussions as the Research Collaboration Office's proposal to the Intellectual Property Committee. This has produced an unexpected synergy effect. Both Sections examine and discuss whether or not to file a foreign patent application for each case through a serious and vigorous debate without compromising their respective views, which has ultimately caused the Intellectual Property Section to consider improvement of the quality of patent descriptions, and the Technology Transfer Section to consider effective use of patents.

Exclude Process Inventions from the Subject of Patent Applications

The third point is to exclude process inventions from the scope of patent applications.

"When we have developed a new material, the process for manufacturing is an important finding. However, it is not easy to identify the patent infringement of others using the manufacturing process in commercialized products," says Nakano.

Considering as such, NIMS does not file any patent applications with regard to process inventions. Rather, NIMS accumulates manufacturing processes as know-how and transfers the related technology for value to companies that wish to know the processes.

Nakano says, "During the period from 2004, when national universities were reorganized into incorporated entities, to around 2006, the government encouraged research institutes and universities to file patent applications, thus the total number of patent applications rapidly increased. However, what matters is not the number of patents you have, but how effective they are. From this viewpoint, we have worked on reviewing our IP activities in steps, and in 2010, we reached a conclusion that acquiring patents for manufacturing processes would result in our know-how flowing out, and so we adopted the policy not to apply for patents regarding process inventions."

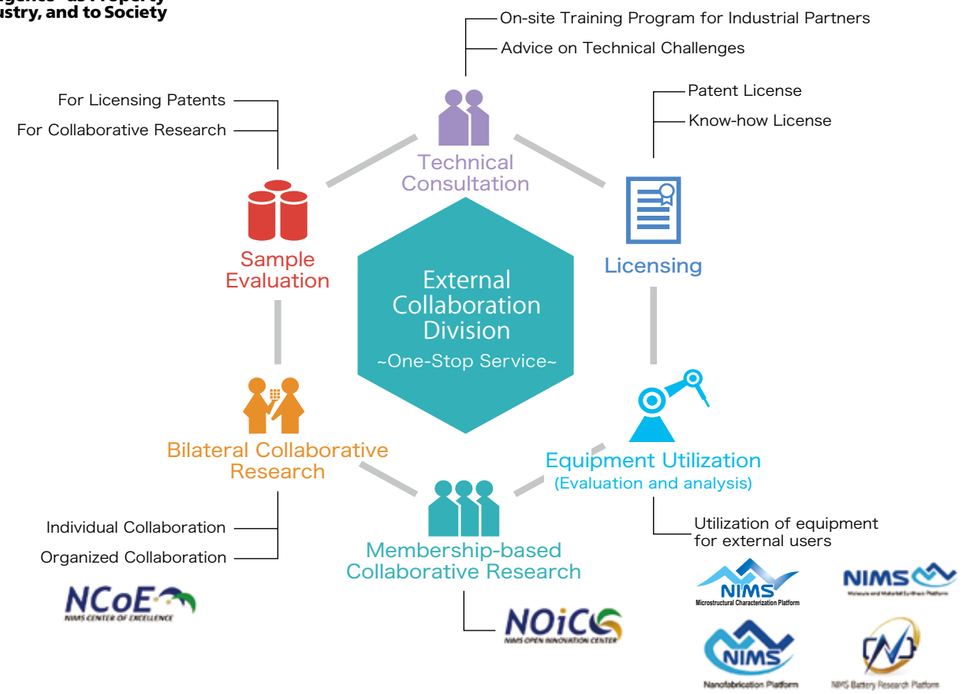
Patent Portfolio Strategy

The fourth point relates to NIMS' unique patent portfolio strategy, which Nakano describes as the "most distinctive feature among NIMS' IP activities."

To manage the patent portfolio necessary for the dissemination of research results, NIMS has a unique policy for handling patents in joint ownership acquired through collaborative research with companies.

The Patent Act provides that each owner of a jointly owned patent does not have to obtain consent from other joint owners when he practices the patent by himself but needs consent from all joint owners in order to license the patent out to a third party (Article 73). However, since research institutes and universities are entities that do not practice patents due to lack of capabilities for manufacturing, selling or otherwise dealing with products that involve patents, they would not be able to benefit from the patents without licensing these patents out to third parties. Some research institutes and universities seek payment of compensation from the partner companies for not practicing joint patents. In the past, NIMS was one of such institutes.

Nakano points out, "Many companies are unwilling to pay compensation, and such companies eventually abandon the collaboration with research institutes." If this is the case, NIMS would gain no income from IP,



and what is more, it would barely be able to achieve the goal of disseminating research results broadly in society. To break through this situation, NIMS changed its policy in 2011 and decided to enter into collaborative research agreements with companies under which NIMS is entitled to license joint patents to third parties at its discretion in exchange for seeking no compensation from the partner companies for not practicing the patents. Under this scheme, the parties make a comprehensive agreement at the time of starting collaborative research in order to avoid the requirement as prescribed in the Patent Act that consent be obtained from all joint owners for licensing a patent to a third party.

This scheme enables NIMS to license all patents in their patent portfolio, including those owned jointly with companies, to third parties. At the same time, it does not restrict NIMS' partner companies from licensing joint patents to third parties. In short, NIMS' patent portfolio strategy is to manage all its patents, including those for which it is the sole owner and those it owns jointly with others, and utilize them for the dissemination of research results, instead of seeking compensation from its partner companies for not practicing joint patents. With this scheme, even if the partner company changes its initial business plan and decides not to practice the joint patent, NIMS still has the option to license the patent to a third party, in an effort to promote the dissemination of research results.

While following this principle, NIMS also executes its patent portfolio strategy flexibly. For example, if one company nearly has a monopoly on a certain market, this means that NIMS allows that company to exclusively use the joint patent. Recognizing it as the most important goal to promote the dissemination of research results, NIMS makes flexible choices on a case-by-case basis in handling IP acquired through collaborative research.

Flexibility and Diversity in NIMS' External Collaboration

By implementing the four key measures in relation to IP, NIMS has established a foundation for disseminating research results in society. Then, based on the IP strategy, what kind of activities does NIMS actually carry out in order to achieve the dissemination of research results?

NIMS attaches great value to the partnerships with the companies with which it carries out collaborative research or to which it provides technical consultation or grants patent licenses, for the role they play in diffusing its research results in society. Accordingly, NIMS tries to flexibly respond to various requests from partner companies in the course of entering collaborative research agreements with them.

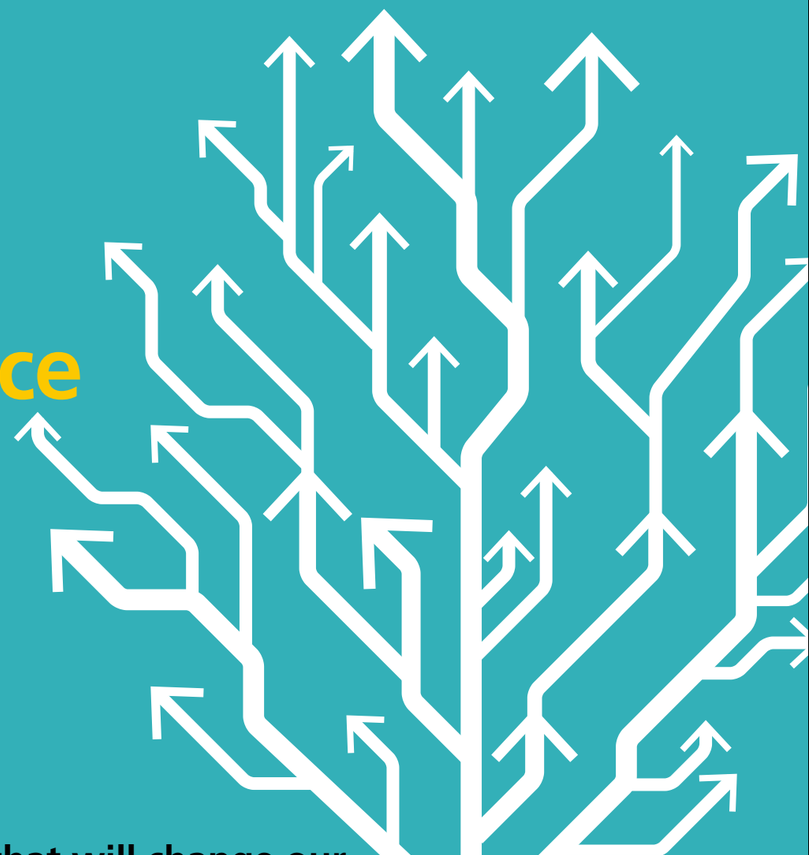
Moreover, NIMS has also actively pursued new ways of collaboration by changing its rules whenever it faces difficulties working with companies within its conventional collaborative frameworks. Figure above shows the framework for technology transfer that NIMS currently employs. NIMS carries out collaborative research not only within a bilateral framework but also within a membership-based framework via the NIMS Open Innovation Center (NOIC). In the field of bilateral joint research, NIMS has devised "organized collaboration" wherein multiple related collaborative research projects are managed and administered in an organized manner so that these projects will produce a synergy effect, in addition to the ordinary type of collaboration wherein each project is managed separately. The membership-based collaboration via NOIC and the organized collaboration via a NIMS Center of Excellence are described in more detail later.

In October 2014, NIMS launched a new initiative to encourage companies to collaborate with it (NIMS Partners Club; npc), which is also featured later.

NIMS will not be satisfied with the status quo but will continue creating new schemes of collaboration with companies as necessary.

Special Interviews with Key Persons of
Center of Excellence
Interview

Strategy and Science



Create "intelligence" that will change our lifestyles through well-managed collaboration

What kind of company keeps growing in today's world in which values are becoming increasingly diversified and complex?
What does it mean for a company to collaborate with a research institute like NIMS in order to continue to be innovative?
There is no end to innovation.
NIMS, as an institute specialized in materials research, keeps going together with companies to make innovation a reality.

Interviews with key persons of Centers of Excellence

NIMS-TOYOTA Materials Center of Excellence for Sustainable Mobility
Hideki Iba
General Manager, Battery Research Division, Higashifuji Technical Center, Toyota Motor Corp.

LG-NIMS Center of Excellence for Materials Science
Yoshinori Onoue
President, LG Electronics Japan Lab Inc.

Strategy and Science

Toward Endless Innovation

Interview

Serendipity takes place in well-managed research, and innovative science derived from it will save Japanese industry.

Hideki Iba
General Manager, Battery Research Division,
Higashifuji Technical Center,
Toyota Motor Corp.

What Does the Collaboration between Toyota and NIMS Mean for Science and Technology?

—The NIMS-TOYOTA Materials Center of Excellence for Sustainable Mobility was founded in July 2008 and is currently expected to make further progress. What was the purpose of establishing this center?

This center was established with the goal of creating next-generation automobiles that will achieve both environmental conservation and economic growth. Under the leadership of Manager Dr. Chikashi Nishimura from NIMS, the center is operated in two major research fields, battery technology (Battery Core) and magnetic technology (Magnet Core). In the Battery Core led by Dr. Kazunori Takada, the research team works on the development of all-solid-state batteries that have much higher performance than lithium-ion batteries. The research team in the Magnet Core led by Dr. Kazuhiro Hono is engaged in research for developing high-performance magnets to be used in drive motors of hybrid vehicles without using rare metal such as dysprosium.

There are two reasons for this center's constant progress to date. First, it was not that we set up a framework first, like, "We should do industry-government-academia collaboration." Toyota and NIMS had already worked together in many collaborative research projects, and this center was created as an entity to comprehensively manage these projects. The creation of the center has made the research and development process move forward faster than before. The second reason is that NIMS perfectly plays a role as an intermediary between our company and universities.

—What does NIMS actually do as an intermediary?

The research and development process for materials is a cycle of three steps: "synthesis," "analysis," and "evaluation." Universities and research institutes such as NIMS create various kinds of new materials through synthesis. Our company sometimes has difficulty in understanding and evaluating the analysis results of such synthetic products. Here, NIMS researchers stand between the synthesis step and the evaluation step and translate the analysis results for us.

—Seven years have passed since the birth of the center. What achievements and effects have you seen so far?

This center aims to create innovative materials that can bring about a paradigm shift in markets. This cannot be achieved without dramatic progress in science, which may sometimes be derived from serendipity. I believe that serendipity is not merely accidental but takes place in deliberately managed research that is firmly focused on a goal. Collaboration between our company, which is good at research management for leading science to commercialization, and NIMS, which is good at basic research, produces more opportunities to make innovative scientific progress and develop it into commercial products.

For example, the research on atomic layer deposition (ALD) technique carried out by Dr. Toshihide Nabatame can be described as a fruit that is unique to this center. This research pursues technology for enhancing the performance of batteries by applying the technology originally applicable to electronic devices to the electrode materials of batteries. ALD is fundamental technology that is applicable not only to next-generation all-solid-state batteries but also to existing lithium-ion batteries. A collaborative attempt that would have never even been imagined has become reality through the gathering of researchers and engineers from a wide range of areas. I would say that this is one of the characteristic achievements made so far in this center.

While I was working toward opening this center, I was very impressed by NIMS' proposal which was beyond our company's expectation. Initially, our company had considered making a center that was to connect "analysis" technology for batteries and that for magnets. What NIMS proposed was to carry out collaboration with our company by reorganizing groups within NIMS that were engaged independently in synthesis, analysis and evaluation of battery materials and of magnetic materials, into two larger groups specialized in batteries and magnetics. I imagine that it was hard to break the boundaries of the research activities carried out separately for synthesis, analysis and evaluation. But NIMS' enthusiastic efforts toward creating this center made it a reality and connected the researchers in different groups together, while also making it easier for our company to collaborate with NIMS. I think this change has a large impact in terms of increasing the odds of innovation and it is a significant outcome.

—What do you expect from NIMS in the future?

I would like to request that NIMS take action to establish a framework for "materials informatics" as soon as possible. This would be an initiative to build a database of results of both "experiments" and "computer simulations" concerning structures and characteristics of materials.

This framework would dramatically increase the usability of research results obtained individually and accelerate research and development in Japan as a whole. Great progress has been made in this area in Europe and the United States, and unless we take action now, other countries will have caught up with us even in the field of materials where our country is currently in a superior position. I strongly hope that NIMS will take the lead in establishing a framework for "materials informatics" and devote its energies to raising the level of materials studies in Japan.

SCIENCE

Innovative Battery – Expected for Commercial Use

NIMS researcher Kazunori Takada, who is the leader of the Battery Core of the Center of Excellence, talked about all-solid-state batteries

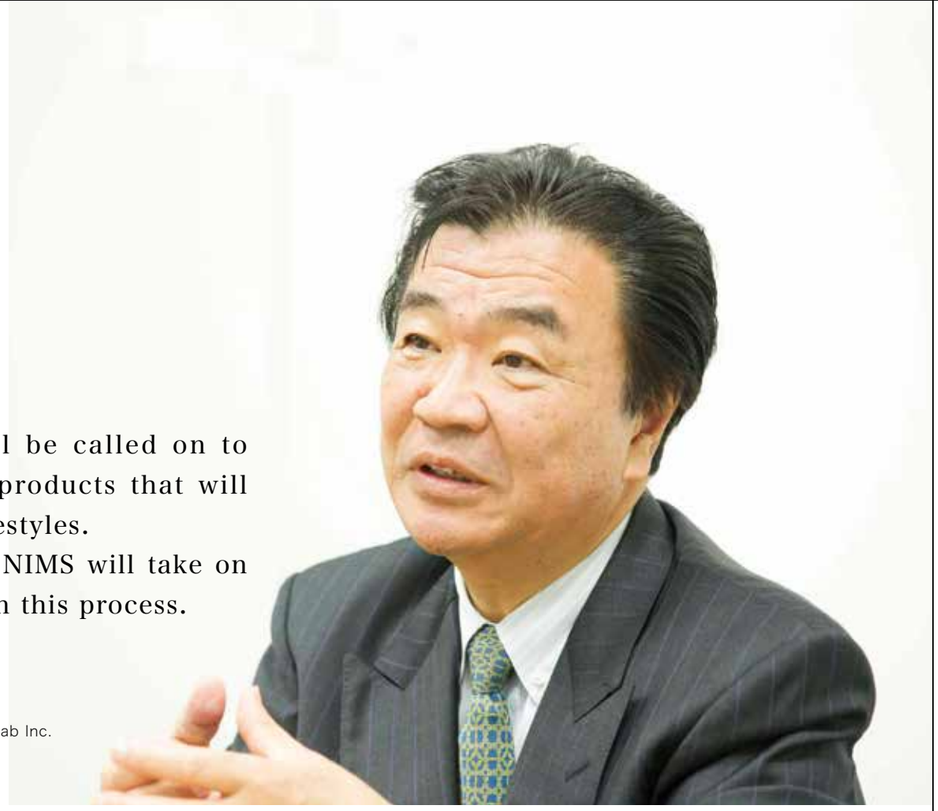
Lithium-ion batteries have been replacing the conventional nickel-metal hydride batteries as batteries used in vehicles. However, lithium-ion batteries need further improvement in terms of service life and reliability, and far greater improvement in performance is required for these batteries to be applied to electric vehicles without internal-combustion engines. To solve these challenges, Toyota focuses attention on all-solid-state batteries as an innovative type of next-generation battery with the potential to be a substitute for lithium-ion batteries. A battery wherein the positive electrode, negative electrode and electrolyte are all in a solid state can be made by using a solid electrolyte instead of a liquid electrolyte that is usually used in a lithium-ion battery. The use of a solid electrolyte suppresses decomposition reactions of the electrolyte at the electrode interface, making it possible to achieve a longer life and greater reliability; moreover, it allows battery designs to increase the energy density.

However, electric current generated from an all-solid-state battery was generally low. In order to increase the output current, it is necessary to develop a solid electrolyte in which lithium-ion moves fast, but this was not enough. A large resistance component appears at the interface between the positive electrode and the solid electrolyte, and this lowers the battery's output performance. Through trial and error, we finally discovered in 2006 that a thin layer formed at the interface between the positive electrode and the solid electrolyte prevents the appearance of such resistance component. This discovery encouraged us to collaborate with Toyota in developing a battery employing such a unique interface structure, and now we have succeeded in producing output from an all-solid-state battery comparable to the output from a lithium-ion battery. Through a strong collaborative relationship with Toyota, we will continue development of this innovative battery toward putting it into commercial use.

Strategy and Science

Toward Endless Innovation

Interview



Manufacturers will be called on to create innovative products that will change people's lifestyles. Collaboration with NIMS will take on great significance in this process.

Yoshinori Onoue
President, LG Electronics Japan Lab Inc.

A Shift from *Monozukuri* to *Kotozukuri*: Material Research Will Be a Key for a Success.

—Please tell us about the position of the LG-NIMS Center of Excellence for Materials Science.

LG Electronics set up its R&D base in Japan where there is a wide range of industries and engineers equipped with a high level of technical capabilities. It is LG Electronics Japan Lab Inc., where I serve as a representative. We are attracted by the high level of material research in Japan. Material development is a very important research area that supports the basis for the development of industrial materials, components and products. However, since it generally requires an extended period of time, it is difficult for a private company to continue putting effort into such basic development in many situations.

In such a situation, it would be very reassuring to be able to rely on one of the world's leading research institutes specialized in materials, such as NIMS. Currently, the LG Group in Korea (hereinafter "LG") designates personnel to a special position that we call "Mr. NIMS," who are assigned with the role of putting together whole issues that LG faced in materials development, and accelerating research. This shows how much expectation we have for NIMS.

I have always thought that we should aim at "*kotozukuri* (value creation)" rather than "*monozukuri* (manufacturing)." Materials research holds the key for LG's success in achieving *kotozukuri*. (*koto*=stories, systems, values; *mono*=things; *zukuri*=making)

—What is *kotozukuri* actually?

"*Kotozukuri*" is not about just making products. It means renovating people's lifestyles or creating new business areas by way of innovative products.

When I assumed the representative post in September 2010, I thought about what LG would become in the next decade. If LG were to remain a mere manufacturing company, it would follow the same path as Japanese companies that experienced the "Lost Two Decades." In order to be a sustainable and growing company, LG must work on the development of products that offer new lifestyles, that is, *kotozukuri*.

Amid dramatic technological evolution and changes in the environment, *kotozukuri* can never be achieved without basic technologies that combine knowledge from various sectors. In this respect, development of innovative materials is a particularly important approach, and this is where the LG-NIMS Center of Excellence for Materials Science is expected to achieve results.

According to estimates, the world population will increase to 9.6 billion people by 2050. Population is expected to grow at a high rate especially in regions close to the equator. Such explosive population increase will make hygiene issues prominent. We are carrying out research while confronting these issues and asking ourselves, "What should we do to supply clear air and clear water at low prices?" Specifically, we are conducting research on sterilization and disinfection, and high-function membranes for filtering. In this research and development field, "materials" hold the key. I believe that we will also be able to contribute to society by establishing infrastructure and lifestyles that have never before been imagined in the near-equatorial regions by around 2050.

—What do you think about collaboration with a research institute like NIMS?

Earlier, I mentioned the "Lost Two Decades." Japan has gone through a time of hardship, and is now transforming its business field such as social infrastructure and energy creation into a new phase. Japanese companies will become more competitive in international markets. Meanwhile, schemes for research and development have also developed, for example, promotion of open innovation. Manufacturing companies find it hard to adapt to this complicated society with their own technical capabilities alone. It is impossible to achieve *kotozukuri* without the fusion of each company's original technology and the knowledge accumulated at a university or research institute.

Against such background, a unique materials research institute like NIMS will increase its presence. However, the uniqueness of its ideas will lose its meaning unless they are embodied in commercial products to some extent.

Companies manage their research and development while always looking at the final goal of commercialization and setting milestones backward from that goal. The LG-NIMS Center of Excellence for Materials Science is no exception. We carry out research projects with short-term and long-term goals in mind, and, as I see it, this management approach has worked well so far. For example, in the collaborative research project aimed at developing α-SiAlON phosphors, we have come fairly close to the stage of commercialization of this new material.

—Could you give some advice to NIMS?

NIMS is a unique and excellent research institute in the world, so I hope that it will further enhance its global presence. The attractiveness of NIMS' research activities, mainly in basic research, may not be easily understood, but, by actively trying to communicate the information on its activities to companies in a comprehensible fashion, like publishing this PR magazine, NIMS will be able to make itself more recognized and further enhance its existence value. I would recommend, by your allowance, that NIMS' department in charge of external collaboration introduce the concept of marketing strategy on a full scale.

For companies, basic research institutes that do not operate on a business basis can be their business partners if they work together. An ideal mode of collaboration is to maintain win-win relationships and create new values, and thereby bring change to society. I feel the potential to achieve this in our collaboration and hope to realize "*kotozukuri*" together with NIMS.

SCIENCE

Expectation for High-brightness and High-color-rendering

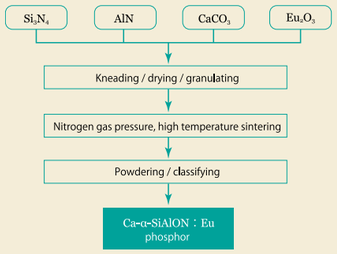
SiAlON phosphor

A white LED, which is widely used in lighting devices and liquid crystal display backlights, consists of a blue LED and a phosphor. The NIMS Sialon Group has developed the "SiAlON phosphor," which has received LG's attention with its high color rendering.

A phosphor is created by adding a minute amount of metal ions to a crystalline ceramic, which serves as a parent body. When these metal ions absorb incoming light, they become excited and emit light.

Conventional phosphors used in fluorescent lamps and cathode-ray tube televisions had been combined with oxide ceramic-based parent crystals. However, these phosphors could not be combined with blue LEDs because they required input of higher energy than blue light, namely ultraviolet radiation and electron beams. To deal with this issue, the Sialon Group considered using nitride ceramic-based parent crystals.

A crystal developed using nitride ceramic that contains silicon (Si) and aluminum (Al) is called SiAlON, the name formed by putting the initials of the constituent elements in order (Si-Al-O-N). The crystal has excellent heat and corrosion resistance, and is hard and durable. Just by changing the composition of the elements to be integrated into the parent crystal, you can create SiAlON phosphors that emit light with different wavelengths, that maintain high brightness even at high temperature, and that have superb mechanical properties. Due to these ideal characteristics, SiAlON phosphors are now widely used in white LEDs. The NIMS Sialon Group aims to develop new types of SiAlON phosphors with greater quality and put them into commercial use through collaboration with LG.



NIMS Open Innovation Center

NOIC Taking on the Challenge of Change

Open innovation—an attempt to create revolutionary new values by combining ideas born in and outside an organization.
NIMS is leading the way to build a truly "open" center.

Yoshiya Kawashima
Group Leader, NOIC Administration Group, External Collaboration Division, NIMS

Kenji Tsukamoto
Technical Advisor, Showa Denko K.K., Chairperson, NOIC Industrial Committee

Sow the seeds and cultivate the future growth of Science and Technology

—Since FY2012, NIMS has been operating a membership-based platform for collaboration called the NIMS Open Innovation Center (NOIC). Please explain the purpose and characteristics of NOIC.

Tsukamoto: The background factor for establishing NOIC was a strong concern that collaboration among industry, government and academia had not been carried out in a favorable fashion in Japan as compared to the West, and it therefore had not been as successful as expected. This is shown by the annual amount of royalty income that universities and research institutes gain from their intellectual properties: about 20 million dollars in Japan against about 3 billion dollars in the United States, more than one hundred times larger than the former. The level of science and technology in Japan can't be lower than that in the United States to that extent. We thought that this gap must exist because something is wrong with our way of conducting industry-government-academia collaboration. With this recognition, we launched NOIC as a new collaborative initiative.

Kawashima: NOIC is a project that is supported by NIMS' External Collaboration Division. It aims to provide a platform where members from industry and academia work together with NIMS in carrying out research activities, with the goal of accelerating innovation and spreading the research results widely in society.

Based on the government's 4th Science and Technology Basic Plan, we work on research under five themes including "battery materials" and "materials for thermal energy conversion" in an effort to cope with social challenges such as energy issues and environmental problems.

Tsukamoto: Usually, a company pairs with a university or research institute in conducting research. NOIC, by contrast, provides an open environment where companies and academic institutions can jointly study the research themes set by NOIC and share the results.

While academia members may participate in research at NOIC free of charge, companies have to pay a hefty amount of membership fee, say, 200,000 dollars as special members and 100,000 dollars as ordinary members. This fee system is derived from the reflection that Japanese companies had not provided sufficient funds for universities and public research institutes, as well as the concern that NOIC might become a sort of "salon" held merely for the purpose of socializing if it charges only 10,000 dollars or so. Within NOIC, companies firmly demand results in exchange for a fair amount of research funds they provide to universities and research institutes. Through this, industry and academia work hard while learning from each other. I believe that by doing so, we will be able to cause as many buds of science and technology as possible to bloom, among those that have not seen the light of day and have nearly withered away.

Another characteristic of NOIC is that it accepts researchers from foreign companies and institutes in addition to those from Japanese companies. By opening the door for membership to non-Japanese researchers, NOIC will grow into an international R&D base in materials science.

Collaborative Framework to Create the Value Chain

—While companies pursue profit, academic institutions attach importance to originality. It may not be easy for both parties to aim for the same goal. What measures does NOIC take in this respect?

Tsukamoto: In the research and development process, it is important to be clearly aware of the difference between "research" and "development." For example, in research and development regarding "thermoelectric devices" which directly convert heat into electricity, clarifying the mechanism of thermoelectric conversion is not a task that companies should tackle individually. In such field of universal fundamental science, researchers from industry and academia should cooperate rather than compete with each other in carrying out "research" while exchanging views. This approach will lead to raising the entire level of science and technology in Japan.

On the other hand, looking at the "development" stage toward putting the research results into commercial use, collaboration will not work if only material manufacturers participate in the project. To avoid this, NOIC invites a wide range of companies to join the project, from material manufacturers to device manufacturers, to establish a collaborative framework with a keen awareness of the value chain.

Kawashima: NOIC has a three-layer organizational structure consisting of a layer of researchers who actually engage in collaborative research, a layer of research managers who are in charge of managing research activities, and a layer of top management including CTOs of member companies, like Mr. Tsukamoto, and NIMS executives. This structure enables NOIC to strategically manage the research themes in connection with social challenges and carry out research and development with a clear sense of direction under the top management's decisions, thereby promoting commercialization of research results.

Keep up Efforts as a Frontrunner

—What would you cite as NOIC's achievements made thus far?

Kawashima: Steady results have been achieved in research on battery materials and materials for thermal energy conversion. Regarding the latter research theme, in particular, the research group led by NIMS researcher Takao Mori found a clue for elucidating the basic mechanism of thermoelectric conversion, boosting expectations not only for scientific achievements but also for a great success in commercialization through the application of this mechanism.

In 2014, we took up thermoelectric materials as a topic in the NIMS Research and Analysis Office Report. This report presents the current status and future challenges of thermoelectric technology and the latest and future research themes on thermoelectric materials. It also covers national strategy, global climate and research trends in this field. It received a good reputation for such substantial content. This could not be done without NOIC. I also feel that NIMS researchers' awareness has been changing through activities at NOIC.

—What is NOIC's goal for the future?

Tsukamoto: Japan has strength in the field of materials, but if our conventional framework for industry-government-academia collaboration remains the same, we will not be able to take advantage of our strength and might fall behind in international competition. NOIC is a vehicle for changing Japan's industrial structure fundamentally. To achieve this, we, from industry, will firmly demand results from NOIC.

We will not be satisfied with the status quo, but will always be willing to introduce new systems for the evolution of NOIC. In 2015, NOIC launched the cross-appointment system. Under this new system, researchers enter into employment contracts with each of the universities, public research institutes and companies which they work for, so that they will be able to engage in their duties under the responsibilities of the respective entities. NOIC seeks to increase the depth of its activities by using this system.

We are at present in the tides of a great change of industry-government-academia collaboration in Japan . NOIC will keep up efforts as a frontrunner, leading such change.

Takuma NIHIRA
Representative Director, Penguin Systems Co., Ltd.

NIMS Partners Club

Direct Partnerships between NIMS and SMEs Created by npc

NIMS has been successful in its collaboration with global companies. At the same time, quite a number of its researchers are engaged in research activities that are suitable for collaboration with SMEs as well. "Materials and technologies developed at NIMS are sure to serve SMEs, which are the basis for Japanese industry." With such belief in mind, the NIMS Partners Club (hereinafter "npc") was launched in October 2014. Mr. Takuma Nihira, Representative Director of Penguin Systems Co., Ltd. that joined npc in February 2015, talked about his expectations for the club.

Penguin Systems Co., Ltd.
Founded in Tokyo in 1983. In 2006, upon Mr. Nihira's assumption of the presidency, the company concentrated its business on the development of researcher support software programs and moved to Tsukuba. With a good record of collaborative development projects with KEK and the University of Tsukuba, the company has established a reputation as a custom made software developer that goes along with researchers.

—What made you decide to join npc?

To tell you the truth, I had an impression that NIMS was somewhat more stiff and formal than other research institutes, in the beginning. But around September 2014, I had a chance to hear a speech by one of the Executive Vice President of NIMS, and came to know the organization's earnestness in public relations in an effort to impart its research results to as many people as possible. This experience changed my image of NIMS. Then, at the exhibition held in Akihabara in February 2015, a person from NIMS' External Collaboration Division visited our company's booth.

What attracted me first was the name of the club. I sensed its enthusiasm from the word "partner." Sound research and development will never be achieved if there is a superior-subordinate relationship between the contractor and the client. I know this well because our company's business philosophy is to be a "system developer accompanying researchers." I was so impressed by the concept of "partners on equal footing" that I filled in an application form to join the club on the next day.

—What do you discover after you joined npc?

Supposing that the ideal form of collaboration for companies is a needs-oriented one, I would say npc's framework is very close to the ideal. When we encounter a technology problem and make an inquiry to NIMS, we can acquire information about the technology seeds that have potential to solve our problem, and this happens at an amazing speed. What is more, npc comes between NIMS researchers and us and translate their needs. This framework really moved me. At the open exhibition held in April 2015, NIMS offered a tour especially for companies to visit its laboratories. That expresses NIMS's earnest attitude to be open to SMEs as well.

—What do you expect for npc in the future?

Most SMEs doing business in local areas, like our company, do not yet have a perfect system for management of legal affairs and intellectual property as required to make successes in collaborative research and development. To make up their weakness, the "All-Ibaraki Industrial Collaboration Consortium" has been inaugurated under the leadership of the Ibaraki Research & Development Association (IRDA), for which I serve as a chair. This consortium will offer a back-office function for common use among the members so as to provide support in the management of legal affairs and intellectual property for SMEs which are interested in collaborative research and development with research institutes. We are very grateful to research institutes for also setting up a support system for SMEs, like npc. I hope that NIMS will enhance npc's support system in cooperation with IRDA, and I wish to work together with NIMS toward the goal of vitalizing local economy through the concerted effort of all parties in Ibaraki, taking advantage of the concentration of various research institutes such as NIMS and universities in Tsukuba.

Join npc Contact: NIMS Partners Club Office ····· npc@nims.go.jp

Science is even more amazing than you think (maybe...) 7

Cosmetics and Hair Tonics which Came Out of Industry-Academia Collaboration

Written by Akio Etori
Title lettering and illustration by Shinsuke Yoshitake

Particle materials may exhibit many interesting properties as they become smaller and smaller. For example, when creating ceramic wares through sintering, a process of forming a solid mass of material by heating powder material, the smaller the particle size of the earth to be sintered is, the more thorough the compacting process becomes. Heat resistant ceramic materials such as silicon carbide and silicon nitride are difficult to sinter under ordinary conditions, but they are sintered soundly when they are in the form of ultrafine particles.

Similarly, to melt a large chunk of gold, it needs to be heated at the high temperature of 1,064°C. However, smaller pieces of gold can be melt at several hundred degrees. An exciting aspect of nanotechnology is to actively utilize these newly discovered physical phenomena. Here is a classic example of collaboration between basic researchers and industry in the field of nanotechnology.

Company A is a world leader in the field of powder technology. It manufactures and sells machines related to powder materials. The worldwide market for these types of machines was not very large as of 2005, with annual global sales of about 30 billion dollars.

Company A was likely a leader in this sector in terms of sales, which was roughly some 4 billion dollars across Europe, the United States and Japan, and of market share, which was 10-plus %. However, for some reason, Company A started selling cosmetics.

For a machine manufacturer, once a machine is sold to a client, that is usually the end of business with that client because it is unlikely for the company to be able to keep selling updated machines to the same client. In contrast, it is feasible for the company to repetitively sell things like cosmetics to customers as they frequently use them up.

Company A was planning to organize a system through which it can sell particle materials with added value, or what is known as nanoparticles. To this end, the company invited Professor B, who had been studying powder technology at a university, as an outside director to the company. At that time, the professor was studying drug delivery systems (DDS) using nanotechnology. So, Company A, along with its subsidiary company, submitted a research proposal to a certain governmental organization, and acquired a large grant to conduct research on DDS. Although the DDS research project was initiated, the company was concerned about the prospect that it would take at least 20 years for a new drug to be approved. Since the company could not afford to invest in this side business for such a long duration without other sources of profit, it decided to develop cosmetics in the same manner by which it intended to develop a DDS.

In his research, Professor B first established a technology to lock vitamin derivatives in nanoparticles. Basically, he created nanocapsules, using same technology to place DDS drugs in nanoparticles. The way a nanocapsule works is that when it is orally administered, the capsule, made of a biocompatible material, dissolves in the patient's body, gradually releasing the drug it carries. This technology was also applicable to cosmetics as the capsule was capable of carrying such compounds as a skin whitening agent.

Through this approach, the company created innovative cosmetics by applying nanotechnology to the field of powder technology, and brought them to the world in only a few years.

In addition to cosmetics, the company also sells men's hair tonics. It developed a nanoparticle that encloses a hair tonic similar to the off-patent hair tonic produced by a major manufacturer. The nanoparticles administered to the scalp penetrate into the hair roots while effectively releasing their content into the roots.

The machine to produce ultrafine particles, which was developed by Company A, and the technology to lock various compounds in the nanoparticles, which was developed at a university, were fused into wonderful products in this industry-academia collaboration.

In addition to this example, more successful cases of collaboration between basic researchers and industry is expected to arise.

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.

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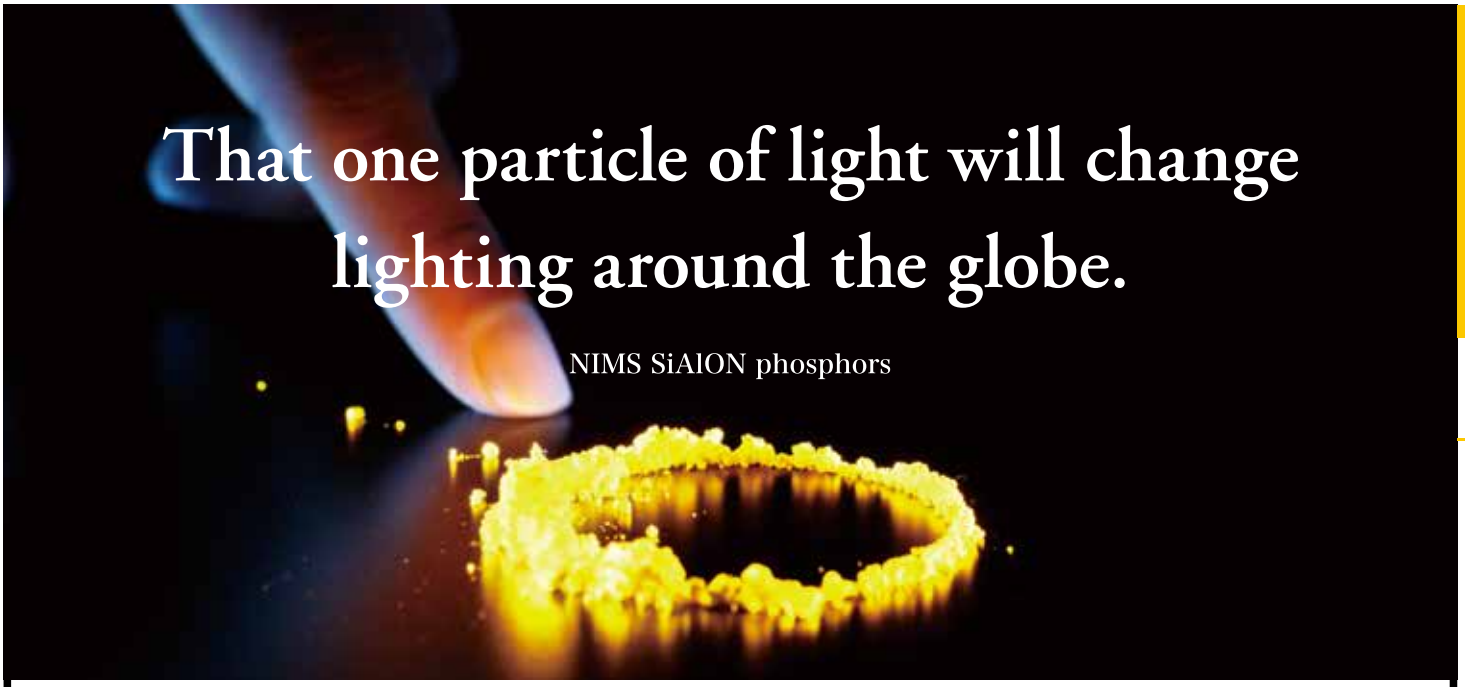

"My research cannot be completed by myself, but only through collaboration with a large number of people."

In spring of 2015, Dr. Naoto Hirosaki, NIMS Fellow, was awarded the Medal with Purple Ribbon and highly commended for his achievement in developing "SiAlON phosphors" for white light-emitting diodes (LEDs). We asked Dr. Hirosaki about being awarded the medal and his vision for the future.

"After the presentation ceremony, at the moment I had an audience with the Emperor at the Imperial Palace with the awarded medal pinned to my chest, strong emotions welled up within me," said Dr. Hirosaki calmly. "The medal was not awarded for an achievement made by myself alone. Materials are valuable only if they are put into use. The achievement, including the commercialization of the material, could only be made possible through joint research with a large number of people from upstream to downstream sectors, such as NIMS, companies and universities. So it may be that I received the medal on behalf of all the people involved."

While the excitement of being awarded of the medal still lingers, Dr. Hirosaki is currently accelerating his research at the NIMS Innovation Center for Advanced Phosphors (iCAP), which was established in January 2015. "In the area of LED lighting, there are demands for developing new phosphors to be applied to high-power outdoor lighting and automobile headlights, as well as for 8K television in the future. We are determined to succeed in such development and meet the needs of society." Dr. Hirosaki who is thus enthusiastically pushing forward his research has given an inspiring message to next-generation researchers. "I don't think I am doing anything special. But, while not knowing what kind of outcome awaits, when I believe in myself and pursue the path I have chosen, and I am able to gain the desired outcome—that is the moment when I feel the joy of having spent my career as a researcher. It is indeed important to make a detailed plan and to steadily put the plan into practice, but I would like to encourage young researchers to believe in themselves and courageously take on big challenges. I believe that, in time, such an attitude will bring them a moment of happiness as a scientist."

Naoto Hirosaki
NIMS Fellow;
Unit Director, SiAlON Unit,
Environment and Energy Materials Division;
and Director, Sialon Co., Ltd..

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