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Chairman, Kanagawa Academy of Science and Technology

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The key to research is outstanding human resources

A Roundtable with the Assistants to the President

The key to research is outstanding human resources

On April 1, several new positions of Assistants to the President were established. The persons in these positions will advise on important management issues for NIMS.

Moderator: Dr. Bando is in charge of long-term planning, Dr. Hono, securing human resources, Dr. Onodera, research resources and evaluation, Dr. Muromachi, human resources development, and Dr. Nagai, innovation. I would like to ask each of you to discuss what you are doing in concrete terms.

Bando: In the past, we prepared a long-term plan which summarized NIMS' vision for the future. This time, however, we want to summarize and propose a plan that describes the ideal form of materials research not only at NIMS, but also in Japan and the world, in a "large-boned" vision. We want to summarize what were rather all-inclusive contents in the past from the standpoint of reform, and at the same time, we want to present the NIMS mission, that "Materials are of value only when they are really used," in clearer terms.

Hono: There are three routes to securing human resources, that is, hiring new graduates, hiring people in mid-career, and receiving post-docs and graduate students. In the Doctoral Program in Materials Science and Engineering, which is operated jointly by NIMS and the University of Tsukuba, we have created an environment where graduate students can work independently and devote their full energies to research in NIMS' unique "NIMS Junior Researcher System." Internationally, this kind of environment is considered natural, but it is a revolutionary system in Japan. Thanks to this system, this has become an extremely international specialization, in that more than half of the students in the doctoral course are applicants from overseas. At present, however, only Japanese students are enrolled in the master's course because proficiency in the Japanese language is necessary in classes. We are currently promoting a plan to internationalize the master's course as well, and are making efforts to launch this in 2008 in cooperation with the University of Tsukuba. On the other hand, when NIMS begins work in a new field of research, mid-career hiring is extremely important. Therefore, it is necessary to set targets and actively go headhunting. We want to further promote exchanges of human resources by creating an environment in which the site of activity can be moved easily from universities to NIMS by constructing an environment and facilities that make it possible to conduct research together with graduate school students, as is done in universities.

Onodera: Since NIMS became an Independent Administrative Institution (IAI), the number of researchers and joint research have both increased, and NIMS' activity has increased as a result of external funding and various other factors. For this reason, we must effectively utilize our space in response to these conditions. We have mid-term strategies for converting the space that we have now to laboratories, and short-term strategies for coping by immediately using this space as laboratories, as well as a long-term plan for constructing new laboratories. We would like to decide the optimum standards while reviewing NIMS' internal rules and standards in line with circumstances.

Muromachi: The quality of researchers is undoubtedly the most important factor determining the actual capabilities of a research institute. Of course, the training of researchers is also important, but it is a fact that the kind of people we hire plays a considerable part. Human resources development like that being done in the International Center for Young Scientists (ICYS) is extremely important, and we also want to study this in the future. What is demanded of NIMS as an IAI is human resources who can open up new fields in NIMS and carry out truly meaningful original research. For this, it has become important to grant researchers freedom and develop human resources in a stimulating environment.

Nagai: One of the promises of Japan's Abe Administration, Innovation 25, which is a long-term strategy initiative for the creation of innovation contributing to the growth in the field of medicine, engineering, and information technology, etc., will be reflected in the "large-boned" policies of the Abe Cabinet. We have therefore begun from the position of what this will mean for NIMS. Twenty examples of innovation appear in this, but materials are precisely the foundation for realizing these. If the foundation is not firm, the rest will fail. I believe that this also demands a high level of quality in "people."

Aiming at becoming a Center of Excellence in materials research.

Bando: The most important thing is "people." A research center will fail if it does not gather extremely talented people from around the world and constantly create new research fields. People with diversity are the key in this kind of new research. Creating a strategy for securing and training outstanding young researchers with diversity will ensure a bright future for NIMS and further increase our presence.

Hono: However, I feel that the character of a research center will become weak and unfocused if it expands its fields indiscriminately, like a department store, in the name of diversity. To some extent, there must be a framework for its fields.

Bando: That's true. That means creating a mechanism for expanding its scope in new fields while continuing to grow in its strong fields.

Nagai: When an institute uses competitive funding, researchers may change their own topics in line with that. Whether this really develops diversity is a concern.

Hono: But that also serves as an external force for renewing topics at certain intervals. If a researcher cannot find an opportunity for change, he or she will continue doing the same work, and the topic will become stale. In that case, there's also a possibility of losing competitiveness.

Muromachi: Ultimately, a balance is necessary. The question is where to place one's pivot foot.

Hono: I think we all agree that human resources are everything. Then, is NIMS an attractive place for truly top-level people?

Bando: Branding - as they say in business - is important, isn't it?

Hono: Branding is extremely effective for attracting outstanding young researchers and graduate students.

Bando: What enhances the power of the brand is the total capabilities of the organization.

Muromachi: If an institute has good researchers, its brand value will rise. And if its brand value rises, good researchers will come. It's a "virtuous circle."

Hono: There are people who say that NIMS is a center of excellence (COE) or base for materials research in Japan. Do you think that's true?

Nagai: If you talk to people in industry, you probably recognize that NIMS is evaluated as the research institute that's closest to becoming a COE.

Bando: I think we're on a good course.

Muromachi: At least the potential is there. Because we have this scale.

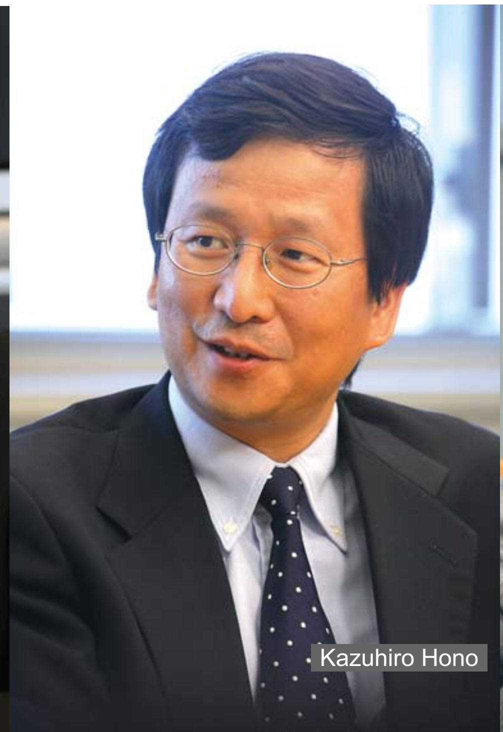
Nagai: There are cases where problems that can't be solved by going to 10 universities can only be solved by NIMS.

Hono: However, in recent announcements of research center creation, the possibility that multiple research institutes will be adopted in one field has been extremely low. If that's so, there's a big difference between being on a pretty good course and being the top runner.

Bando: After all, the conditions for developing star players are necessary. That should be done at the international level, I think.

Hono: When we go headhunting at universities, I think things will change if we can make special offers, pay the costs of relocating equipment, and create an environment in which students can also come.

Moderator: I keenly felt that whether NIMS becomes a COE or not depends on whether everyone can fully achieve their assigned missions. If results are achieved, I hope you will discuss them in this forum. Thank you very much for sharing your thoughts with us today.



- Eiji Muromachi
  Coordinating Director, Nanoscale Materials
  Managing Director, Advanced Nano Materials Laboratory
- Hidehiro Onodera
  Managing Director
  Materials Reliability Center
- Kotobu Nagai
  Coordinating Director
  Materials Research for the Environment and Energy
- Kazuhiro Hono, NIMS Fellow
  Managing Director
  Magnetic Materials Center
- Yoshio Bando, NIMS Fellow
  Managing Director
  International Center for Young Scientists (ICYS)

SPECIAL Interview

The Most Important Thing in Research is the Sense of "Skillful Conception"

Akira Fujishima
Chairman
Kanagawa Academy of Science and Technology

Stains and bacteria on the surfaces of materials are decomposed by strong oxidizing power. Practical application of the photocatalytic effect, which is a unique technology that originated in Japan, is progressing in applications that involve self-cleaning and anti-clouding using deodorizing and superhydrophilicity. Examples include use in first-class car smoking rooms and window glass on the Shinkansen superexpress train.

Profile

Akira Fujishima
Dr. Fujishima graduated from the Faculty of Engineering, Yokohama National University. He completed his doctorate at the School of Engineering, University of Tokyo and then served as Assistant Professor in the Faculty of Engineering, Kanagawa University, as Assistant Professor, Associate Professor, and Professor in the Faculty of Engineering, University of Tokyo, and as Professor in the School of Engineering, University of Tokyo. He is currently Chairman of the Kanagawa Academy of Science and Technology and President of the Chemical Society of Japan.

Discovery is the result of an encounter with the unexpected

Please tell us about your "encounter" with titanium oxide.

When I entered the photographic chemistry laboratory in the graduate school at the University of Tokyo, Dr. Kenichi Honda was Associate Professor. At just that time, a paper on the electrical decomposition of water using a zinc oxide electrode was published reporting that oxygen was evolved in this process, but the zinc oxide dissolved. Because I myself thought that light-sensitive materials are extremely interesting, I consulted with Prof. Honda and began research on photoresponse. At my earnest request, Prof. Honda, who was making a business trip to the United States, obtained some single crystals for me. Using zinc oxide, I tried reproducing the research published in the paper, and the material dissolved. I was searching for a material that still was not used and that can be utilized in copiers. In light-responsive semiconductors, cadmium sulfide, silver halides, and other materials were used in addition to zinc oxide, but none of these was satisfactory. By chance, an older student, Takeaki Iida, was doing research on photophysics with single crystals of titanium oxide in the lab next door. Titanium oxide is an extremely hard material, with hardness similar to diamond. It is also chemically stable and does not dissolve in acids or alkalis. I asked Dr. Iida about the manufacturer of titanium oxide, and then obtained single crystals by writing a letter to the president of the company.

And that was an unexpected encounter - that is, serendipity.

Electrodes of titanium oxide and platinum gave off bubbles when exposed to light. When we analyzed these with a chromatograph, we found that oxygen evolves from the titanium oxide electrode, while the platinum electrode gives off hydrogen. This has become known as the Honda-Fujishima effect. I was extremely moved by the fact this phenomenon was close to the photosynthesis that occurs at the surface of a plant's leaves. I had originally studied electrochemistry, and I had encountered the perfect material in titanium oxide. Realizing that oxygen and hydrogen were generated, I contributed my first paper in 1969. Next, I had an opportunity to make a presentation at a meeting of the Japanese Photochemistry Association, but fewer than 10 people attended and there were no questions. Later, a leading scientist in electrochemistry told me that the decomposition of water by simple exposure to light was impossible, leaving me quite chagrined.

But things changed. . . .

In 1972, my paper easily passed review by the well-known British Journal "Nature" and was published. In the autumn of the following year, 1973, the 1st Oil Crisis occurred. The fact that a Japanese researcher had proposed a method of obtaining hydrogen from water using sunlight in "Nature" became a topic of conversation at international conferences, and a reporter for the Asahi Shimbun Newspaper who'd heard about it came to interview me. This became the lead article on page one of the Asahi Shimbun on New Year's Day, 1974. After that, things changed. There was great interest, and as a research method for achieving this effect with low-cost materials, we produced titanium oxide on a large scale by roasting metallic titanium with a burner and continued our experiments to obtain hydrogen using sunlight. In terms of efficiency, this reached the same level as single crystals. However, even though we obtained 7 liters of hydrogen in one day, the energy conversion ratio was only 0.3 %, which meant that it was completely impractical. This marked the end of one phase in research on obtaining hydrogen.

Practical application requires a "plus α" technology

What led to practical application?

In 1989, I had a conversation with Dr. Kazuhito Hashimoto (now Professor, School of Engineering, University of Tokyo) to the effect that, while energy conversion was also important, it might be possible to use the "strong oxidizing power" that's capable of decomposing water in some way. Around that time, Dr. Toshiya Watanabe, who had been doing research on deodorizing for toilets at the Basic Research Center of TOTO, LTD., happened to visit the laboratory. That led to the start of joint research on deodorizing and disinfecting by coating titanium oxide on tiles. In particular, we obtained good results with disinfection. This was the first application.

In fact, you changed the concept of your work.

But that doesn't mean that what followed was easy. Thinking it might be possible to purify water with a photocatalyst, we lined up goldfish bowls in the staff room and tried an experiment, but it didn't go well. The algae grew faster than the photocatalyst could decompose it. With the support of a company, we also carried out an experiment in which we attempted to clean up the Tama River by coating titanium oxide on stones in the river, but this ended in total failure. In another example, because Escherichia coli and Pseudomonas aeruginosa can be killed by coating titanium oxide on tile, we thought this could be used in hospital operating rooms, but the photocatalyst isn't effective in the dark, so this was also a failure. Therefore, after coating the titanium oxide on the tile, we also applied silver. Bacteria are killed by the titanium oxide in the daytime and by the silver in the dark or at night. Use in practical applications isn't possible if the material isn't effective 24 hours a day, like this. I'm constantly saying that "plus α" technology is important, and this was a "plus α" technology of that time.

So when a problem of this type becomes apparent, you respond by carrying out additional experiments?

That's right. There's also the example of removing oil stains from light covers in tunnels. Again, we tried coating titanium oxide, but the results were unsatisfactory. Although titanium oxide is coated on the glass, its photocatalytic activity is lost because it's treated in an electric furnace. However, quartz and Pyrex give good results. Although we didn't know why at first, with ordinary soda glass and the like, we found that sodium titanate forms due to the presence of sodium ions, and the activity of the titanium oxide is lost. We solved this problem by introducing a silica barrier layer. Until you carry out experiments, you believe that you'll obtain the expected results, but when problems arise, you understand a variety of things, and by repeating this process, you realize the reason.

Is effort necessary in groping your way toward an answer? Or does it come in a flash of inspiration?

It perhaps comes because I'm always discussing with wonderful people. I think it's precisely in that kind of environment that you can find answers. In research, the atmosphere is extremely important. Many outstanding results are often found at the same time. As one more comment about research, although I'm constantly saying this, without sense, research is futile. Sense in the form of "skillful conception" is most important. After that, wide knowledge is necessary. One must also be interested in something and convince oneself that it's interesting. Regardless of the subject, you won't put yourself into it if it's not interesting.

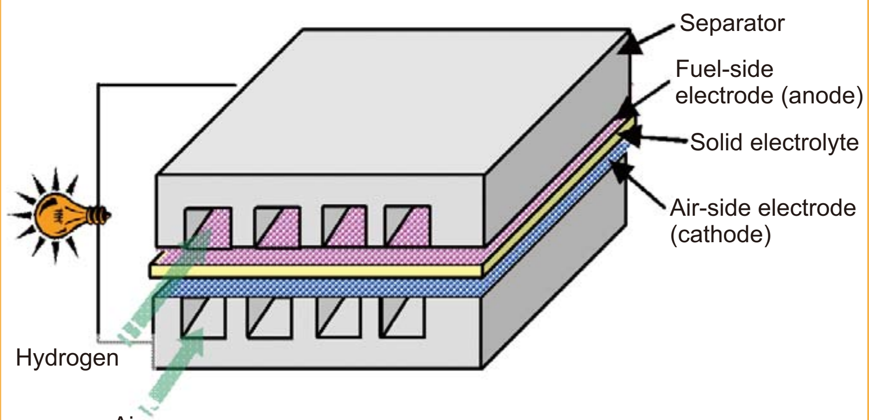
Having discovered the principle, now you're developing it for practical applications.

When I was invited to a symposium in Canada 12 or 13 years ago, I took titanium oxide-coated tile. A television station came to gather material and interviewed me because this was the world's first application of a photocatalyst. In Europe and America, the main stream was water purification by introducing titanium oxide powder into water and exposing it to light, and this is still being done today. However, with this method, the powder has to be removed later, which makes practical application difficult. For this reason, I fixed the titanium oxide on tile. That's also the reason for success. The photocatalyst has also been applied in producing window glass for the Shinkansen, and that uses a technology developed by Dr. Takayoshi Sasaki of NIMS Soft Chemistry Group.*

* For information on research by the Soft Chemistry Group, Nanoscale Materials Center, please visit our homepage:
http://www.nims.go.jp/softchem/index-e.html

Fuel Cell Materials Center

Nanostructured Fuel Cell Materials Research Project



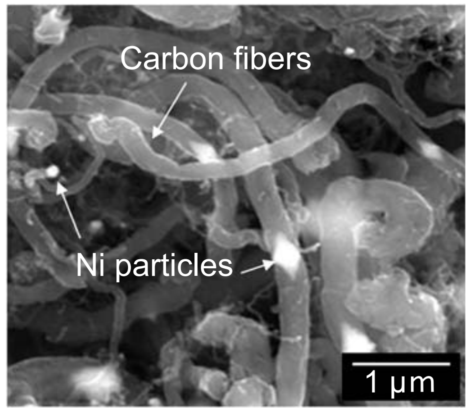
Schematic diagram of fuel cell

Fuel cells are clean power generating systems that produce electricity from air and fuel (hydrogen, etc.). Although there are several kinds of fuel cells, the focus of especially active research and development in recent years has been the solid polymer fuel cell and direct methanol fuel cell, which are low temperature-type fuel cells (operating temperature of approximately 100 °C or less), and the high temperature-type solid oxide fuel cell (SOFC; operating temperature of 1000 °C or more). Extremely strong expectations have been placed on practical application of these devices, but large problems exist with both the low temperature type and high temperature type.

With the low temperature type, platinum is necessary as a catalyst in order to decompose hydrogen molecules into protons and electrons. The fact that the performance of this platinum is deteriorated by even a trace amount of impurities, and particularly by carbon monoxide (CO), as well as resource-related limitations on platinum, make this type totally inadequate for wide popularization, for example, in automobile fuel cells. On the other hand, although the high temperature-type SOFC does not require a platinum catalyst, because the operating temperature is high, there are large restrictions on the materials for reasons such as thermal stress, mutual diffusion, and it is difficult to achieve low cost and long life.

Therefore, the NIMS Fuel Cell Materials Center is engaged in the development of solid electrolytes/electrodes and separator materials with the aim of realizing a revolutionary new type of fuel cell that operates at an easily-used temperature and continues to provide stable performance over the long term by solving these fundamental problems. Where the production of hydrogen fuel is concerned, the Center is developing catalyst materials to efficiently reform hydrogen from fossil fuels and alloy membrane materials to refine hydrogen to high purity. The **photo** at the right shows the surface of an Ni_3Al foil developed by the Center as observed with a scanning electron microscope. This foil functions as a catalyst in generating hydrogen by separating methanol. It was found that a composite structure of Ni particles and carbon fibers formed on the foil surface, and this has high catalytic action in the methanol decomposition reaction.

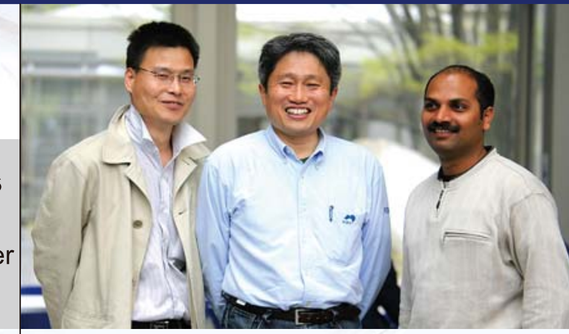
For more details: http://fuelcellmaterials.jp/en/



Ni particle/carbon fiber structure formed on the surface of an Ni_3Al intermetallic compound during the methanol decomposition reaction.

Development of Solid Electrolytes and Electrode Materials for Fuel Cell Applications

Nano Ionic Materials Group, Fuel Cell Materials Center



Deputy-Managing Director
Je-Deok Kim, Toshiyuki Mori, Ajayan Vinu

At present, the topics which are attracting the highest interest in fuel cells are "development of high quality solid electrolytes that can be operated in the 200-500 °C temperature range, which has been called the undeveloped operating temperature region in conventional fuel cells," and "development of fuel cell electrode materials which minimize the use of platinum and other rare metals." In both areas, we are engaged in pioneering research as the top runner in the world. This article introduces several examples of our research.

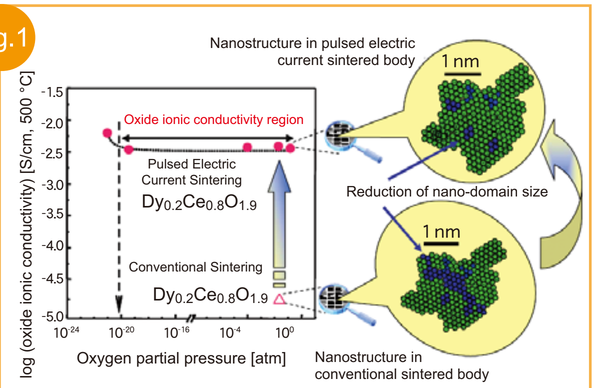
In order to develop a solid electrolyte which shows high ionic conductivity in the aforementioned temperature region, two approaches were used, that is, from the high temperature side and from the low temperature side. In the high temperature approach, an ultimate analysis of nano-structure in the solid oxide electrolytes was performed. So far, the subtle change of nano-structure is under detectable level of standard X-ray diffraction analysis. We ascertained that the nano-structural feature (= nano-domain) lowered the conductivity. We succeeded in increasing conductivity by reducing size and amount of those nano-domains (**Fig. 1**). On the low temperature side, we developed a polymer solid electrolyte in which the acid/base interface in the polymer as a high speed conduction pathway for diffusion of protons (**Fig. 2**).

In the development of electrodes, we synthesized a novel pore size tunable porous material with a huge pore volume and are working to reduce the amount of platinum used to 1/10 than in commercially available electrodes (**Fig. 3**). We are now engaged in developing an electrode which will overcome a major drawback of platinum electrodes, namely, the need for high purity (7 N or higher) hydrogen and can be used without problems with fuels having high concentrations of CO (>1 %), and succeeded in developing a NIMS-original platinum-cerium composite electrode which has performance superior to that of commercially available platinum-ruthenium alloy electrodes.

In all of these efforts, we are attempting to realize high performance based always on the results of analysis of the microstructure at atomic scale, and are carrying out research aimed at the development of innovative high performance fuel cell materials.

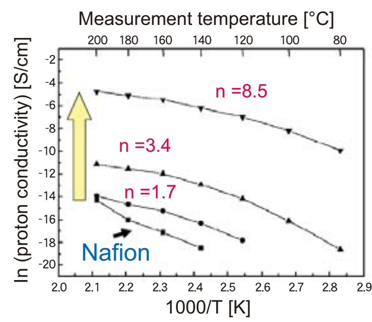
For more details: http://fuelcellmaterials.jp/en/modules/myinfo3/

Fig.1



Improvement of oxide ionic conductivity by optimizing nano-structural features in the solid oxide electrolyte.

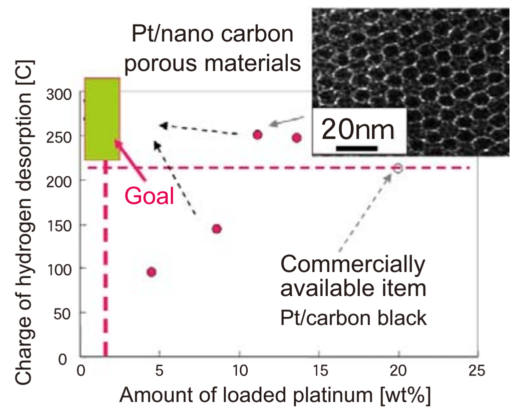
Fig.2



n=density of benzimidazole/density of sulphonic acid group

Conductivity in the 100-200 °C range was conspicuously improved by increasing benzimidazole content in Nafion, which is a representative solid polymer electrolyte, and introducing an acid/base interface as a high speed diffusion pathway of proton.

Fig.3



Development of a fuel cell electrode that reduces platinum use by employing nanoporous material.

Electrochromic Material Capable of Multi-Color Display with Single Layer

- A Breakthrough for the Development of Full-Color Electronic Paper -

Functional Modules Group, Organic Nanomaterials Center

Masayoshi Higuchi

"Electronic paper" has attracted attention as a next-generation display material, and several forms are being studied for practical application. Basically, the display mode of electronic paper is monochrome (black and white), and full color is difficult with conventional techniques. Nevertheless, full color is desired in display materials.

On the other hand, because the electroconductive polymer developed by Prof. Shirakawa et al., who received the Nobel Prize in Chemistry in 2000, shows excellent electrochromism (property of reversible color change in material by electrochemical redox process), high expectations have been placed on it as base material for full-color electronic paper. However, because this color change is based on a structural change in the polymer, its stability is poor and color adjustment is difficult. In order to express 3 or more colors using these polymers, it is necessary to create a multilayer device consisting of different polymers, but as a result, the light weight and flexibility which are expected in electronic paper are lost.

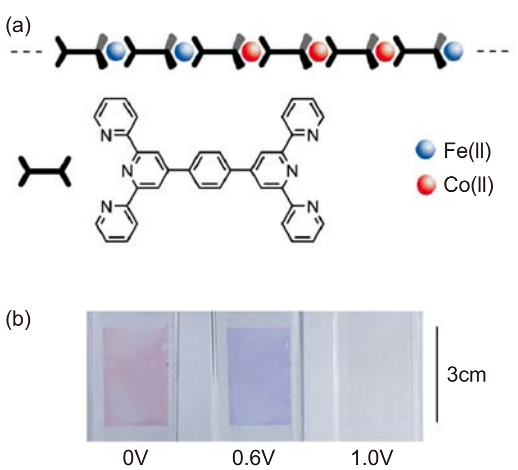
Recently, we succeeded in synthesizing a polymer in which metallic ions and organic molecules are arranged like a "string of beads" (**Fig. (a)**) by employing the attraction (coordinate bonding force) between metallic ions and organic substances. This new type of polymer displays an extremely high color expression property based on the "metal-to-ligand charge transfer" absorption (absorption based on charge transfer that occurs as a result of coordination of the organic substance with the metal ion), and also discovered that repeated display of this color expression ⇔ color extinction process is possible by electrochemical redox the metal ions in the polymer. Because this color change is not accompanied by structural changes, as in the conventional material, there is no structural deterioration and stable drivability over the long term can be expected.

Furthermore, by introducing two species of metallic ions in the polymer, we succeeded in displaying three colors (red, blue, colorless transparent) with a single-layer film (**Fig. (b)**). By chemically modifying the organic component, we also succeeded in controlling the energy gap in the "metal-to-ligand charge transfer" and displaying green.

This achievement is considered to be one breakthrough toward realizing full color in electronic paper. Because the metallic ions and organic molecules can be selected freely with this new type of polymer, it will be possible to design and synthesize polymers which display a variety of colors in the future. The polymer obtained in this research is a new material which offers a combination of good electrochromism and stability not found in conventional organic materials, and also has an excellent film-forming property.

Because new materials which possess a combination of formability and functionality will be indispensable in the development of next-generation electronic and optical devices such as electronic papers, this material is expected to have a wide ripple effect in industry in the future.

Fig

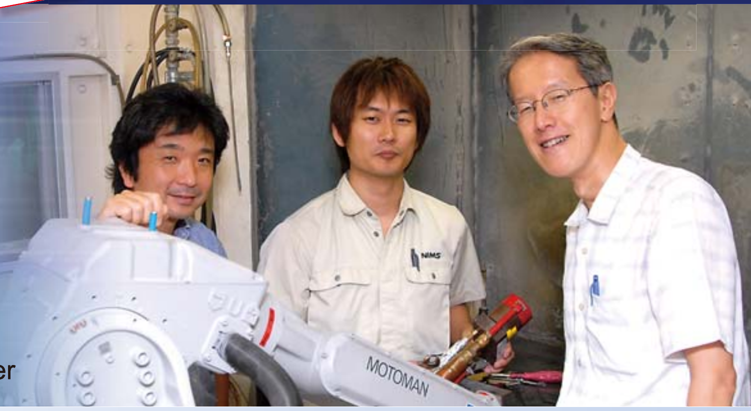


(a) Polymer in which 2 species of metal ions and organic molecules form a "string of beads," and (b) colors displayed by the polymer film at various electric potentials (red → blue → transparent colorless).

For more details: http://www.nims.go.jp/fmg/index_e.html

What Happens When High Temperature Droplets Impact at High Speed?

- Success in Visualization of Plasma Spray Particle Impinging Process -



Coating Materials Group, Composites and Coatings Center

Managing Director

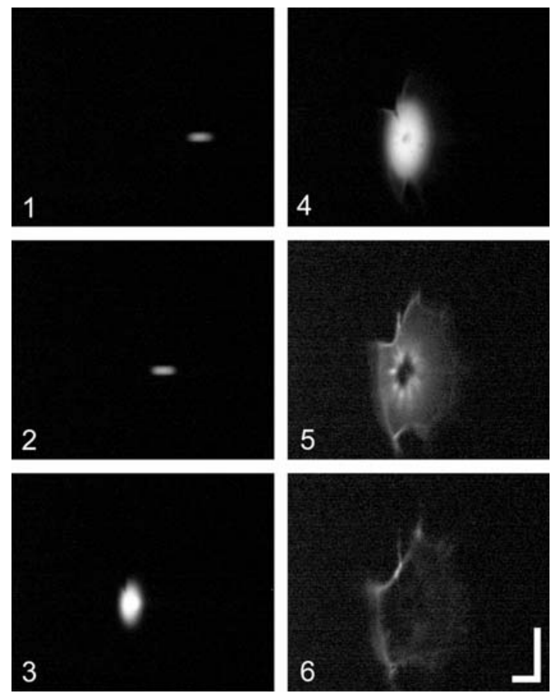
Hideyuki Murakami, Kentaro Shinoda, Seiji Kuroda

The behavior of particles when they impact and splash is extremely beautiful, as exemplified by the milk crown, and has fascinated many people. Droplet impacting phenomena also play an important role in industrial processes and are closely related to a wide range of basic technologies, including ink jet printing, fuel injection in diesel engines, spraying of agricultural chemicals, and others. At present, a type of ceramic coating called thermal barrier coating is used to protect high temperature components from heat in gas turbines used in power plant, and the impact of droplets is also the key to this process. In this technique, which is called the plasma spray coating process, ceramic powder with a size of several 10s of microns is injected as raw material into a thermal plasma that reaches a temperature as high as 10,000 K, and a coating is formed by melting and spraying this material on a substrate. At this time, the individual sprayed particles become molten droplets with a temperature on the order of 3000 K and impinge on the substrate at a high speed of 100-200 m/s, forming pancake-shaped deposits called splats. Because these splats form a coating by depositing in an overlapping manner, it is no exaggeration to say that the deformation/solidification behavior of the individual sprayed particles controls the properties of the coating. For this reason, an elucidation of this behavior is strongly desired.

Therefore, in joint work with Kinki University, we developed an *in-situ* observation system in order to visualize the impact process of sprayed particles. This measurement system makes it possible to selectively detect single sprayed particles from among the countless particles in the plasma plume and photograph their impacting behavior at 1 million frames/second. The **accompanying figure** shows the evolution of the impacting behavior of sprayed particles, which was photographed for the first time in the world. Until now, it had been known that sprayed particles splash on a room-temperature substrate, and this causes deterioration of the coating quality, but the process was not well understood. This series of impact photographs reveals that the particle does not actually splash from the start of the impact, but rather, splash after first spreading to nearly 15 times its original diameter, and the center part has already cooled in this spreading process.

Our understanding of the spray process is being advanced by gradual clarification of the behavior of sprayed particles, as in this example, and as a result, new development is being achieved in coating technology.

Fig



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Photographs of the sprayed particle impact process taken at 1 million frames per second, showing the behavior when a 50 μm molten droplet travels from the right side of the photo toward the left at 170 m/s (1-2), and impinges on a smooth, room temperature substrate and deforms (3-6). The high temperature part is shown in white, and the low temperature part is black. (Exposure time: 500 ns; white lines represent 200 μm in each direction.)

For more details: http://www.nims.go.jp/cccenter/coating/homeeng.htm

This project, which was adopted in the "Program for Promotion Establishment of Strategic Research Centers" under the Special Coordination Fund for Promoting Science and Technology of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), was launched in 2003 and entered its 5th and final year in 2007. We asked the Center's Director-General to speak about what has been attempted in the International Center for Young Scientists (ICYS), its achievements, and its aspirations for the future as it opens new research fields unfettered by the conventional framework through free, independent research by the young researchers who have gathered from around the world.

Achievements and Aspirations of the ICYS in the 5th Year of the Project

NIMS Fellow **Yoshio Bando**
Director-General
International Center for Young Scientists (ICYS)

Internationalization, securing human resources, and opening new research fields.

What is necessary to make NIMS one of the world's top research centers? We proposed three challenges for organizational reform. The first was internationalization. The question is how to employ outstanding foreign scientists as NIMS' permanent researchers and create an environment that facilitates the research of these foreign researchers. The second was securing and developing human resources, meaning how to secure and train excellent young people. The third was opening new research fields. How can we incorporate, in NIMS, research that we have not done in the past? The ICYS was established to meet these challenges.

Original ideas are born in a stimulating environment where young researchers from different fields, different cultures, and different nationalities and ethnic backgrounds gather in one place. We call this environment a "melting pot." We thought that new research fields would be born and young researchers can be developed in this kind of environment.

The object of the ICYS is researchers who received their doctorates in any country no more than 10 years previously. To date, we have had around 900 applications from 61 countries. From these, we have accepted about 50 persons from 25 countries for long-term stays and a total of approximately 70 including short-term stays. Thus, this is a multinational group of researchers.

An outstanding reputation earned by promoting independent research.

The keywords for operation of the ICYS are the "4 Ins," Independent, International, Interdisciplinary, and Innovative, which means we give our young international researchers independence to conduct interdisciplinary, innovative new research.

For example, to promote independence, in the ICYS, we provide research grants so that individual researchers can take on the challenge of the research that they want to do. These research grants allow the researchers to attend foreign congresses at their own discretion, arrange joint research and carry out research with other institutes, and purchase necessary equipment. In other words, ICYS researchers do not receive instructions from some superior, but rather, are allowed to manage their own work. Of course, research is carried out based on the researcher's own idea, but because they are still young, people who can provide advice on their research are necessary. We call such advisors "mentors." Mentors respect the individual's independence and provide support to ensure the progress of the research. The fact that the young researcher plays the main role is a major difference from post-doc programs. In providing research grants, one aim is to internationalize the administrative division. Solving problems when foreign researchers are dissatisfied gives us opportunities to learn common international business practices, including differences in systems. To make good use of the experience of the last 5 years in operation in the future, we plan to collect examples of this "experiment in internationalization" in book form.

When we initially launched the ICYS, we thought that many similar centers probably existed around the world, but in reality, there are no examples of this kind of project, which means the ICYS is an extremely unique presence. When eminent researchers from overseas visit NIMS, we ask their opinions of the ICYS experiment, and they have given a very positive evaluation of the fact that we allow young researchers to carry out their research freely in an international environment.

In any case, the creation of a multinational group of young researchers, training as researchers by deepening mutual exchanges, and production of original new research results have become the aims of the ICYS. We are positively creating opportunities for exchanges of ideas, for example, by providing time for "coffee breaks" as a place for exchanges (see cover photo), holding weekly ICYS seminars to provide chances for presentations on research, and similar activities.

Where securing outstanding human resources is concerned, although it is difficult to judge immediately whether the training of a researcher has been successful or not, the results in the ICYS have been highly evaluated, and thus far around 15 ICYS members have improved their careers and gone on to higher positions. In Japan, ICYS alumni have obtained positions with the Japan Advanced Institute of Science and Technology, Tohoku University, private companies, and others, while overseas, our former members have been hired in tenured positions at London University, Trinity College Dublin, France's National Center for Scientific Research (CNRS), and elsewhere. Naturally, this program has also contributed to securing human resources at NIMS. Five former ICYS Fellows have already been hired as NIMS' permanent researcher, and informal decisions have been made on several others.

Young researchers gathered at the party for ICYS founding anniversary (April 17, 2007)

Continuing activities as an "engine" for research at NIMS.

ICYS researchers are conducting exploratory research in the three priority fields of "nanoelectronics and nanobiotechnology," "nanoscale materials, new metrology, and computational materials science," and "metals, ceramics, polymers and their hybrids." Although the creation of new research fields in NIMS is also an issue, to date, the ICYS has consciously conducted research which had not been done in the past. In the future, the research fields that NIMS wants to strengthen and the exploratory research which will provide the starting point for such work will be created by the ICYS. Thus, the ICYS will play the role of an "engine" driving research in NIMS. We expect that human resources trained in the ICYS will all show a sense of presence as core personnel and future Group Leaders in NIMS, the buds of the research which is born here will be cultivated in NIMS and will contribute to the creation of new research in NIMS.

From this viewpoint, 5 years is a short time. To a certain extent, it is indispensable to constantly activate the organization by promoting activities continuously. Because efforts in the ICYS have been carried out successfully, NIMS will continue this project as a post-ICYS program from April 2008.

For more details: http://www.nims.go.jp/icys/

Doctoral Program in Materials Science and Engineering, University of Tsukuba ～Entrance Exam for April 2008 Admission～

The Doctoral Program in Materials Science and Engineering will hold an Entrance Exam in August 2007 for enrollment in April 2008. The program is managed by NIMS and the University of Tsukuba, Graduate School of Pure and Applied Sciences, and selected scientists from NIMS have joined the graduate school faculty and supervise students' thesis research. Please feel free to contact us for details at anytime.

SCHEDULE

Distribution of Application Documents	Now being distributed
Application Period	July 24-26, 2007
Oral Examination*	August 21-22, 2007
Announcement of Test Results	September 3, 2007
Enrollment	April 1, 2008

*At oral examination, applicants must submit the score card of English proficiency test (TOEIC or TOEFL).


A scene at the seminar.

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Hello from NIMS

My New Life in Japan

Yuanzhao Yao (China)
University of Tsukuba Ph.D. Student
NIMS Junior Researcher (April 2007 - March 2010)
Nano Photonics Group, Quantum Dot Research Center

It is my pleasure to have this opportunity to introduce myself. I am Yuanzhao Yao from China. Now I am a Ph.D. student in the Nano Photonics Group of the Quantum Dot Research Center (QDRC) under the supervision of Prof. Kazuaki Sakoda.

About three years ago, my cousin became a Ph.D. student at NIMS when I had just begun my Master's course in Tianjin University, China. Hearing a lot of praise of NIMS from my cousin drove me to wish to visit and learn at NIMS on my own, and then my wish became a strong will. Fortunately, I became a Ph.D. student at NIMS this April and have found that it is really an extraordinary place for researchers. It is true that here at NIMS you can find everything that researchers need.


[At the Japanese language class (author; first from right)]

Starting my new life here was not as hard as I had thought. Tsukuba is a clean, quiet and woody city. It's a great feeling to ride a bike in the morning, smell fresh air and feel a breeze. The weather here is similar to that of my home town, Tianjin. I am also impressed with people's kindness here. My supervisor and my colleagues really help me a lot with both my work and my daily life. Discussion and collaboration with them have been a great benefit to me, and I am acquiring a great experience. Here, please let me express my gratitude to all the group members.


[(From right) My cousin, Yongzhao, his daughter, Keji-chan, his wife, Suyan, and I]

To understand the Japanese culture better, I am taking a Japanese language course at the University of Tsukuba International Student Center. In this class, I have made some friends from different countries, and I am sure my life will be more colorful with them. But most importantly, I would like to thank my cousin and his family. They give their full support to me, which makes my life in Japan more comfortable. They also give me the warmth of family so that I can concentrate on my work.

As the Chinese say: Well begun is half done. I have already had a wonderful start at NIMS, and I believe that the period of doctor's course study at NIMS will become a fantastic and memorable time of my life.

National Institute for Materials Science
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