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Innovation, Imagination and Creativity

Dr. James K. Gimzewski

Distinguished Professor
UCLA Chemistry & Biochemistry Department
Director
CNSI Nano & Pico Characterization Core Facility

Special Feature

F/A/C/E フェイス interview

NIMS is engaged in a variety of initiatives to create an international research environment that sets the global standard. To this end, we are inviting experts who have been active in a variety of areas to serve as leaders. In this Special Feature, three leaders who joined the NIMS in April discuss their respective efforts.

Young Scientists – Take on the Challenge of New Fields!

Yukichi Umakoshi, Vice President

Prof. Umakoshi had a remarkable record of achievements in a wide range of fields at Osaka University, including not only materials engineering, and particularly the functional properties of intermetallic compounds, but also engineering-based approaches to diagnosis and therapy for bone disease and bone regeneration. As Dean of the Graduate School of Engineering and Trustee/Vice President of Osaka University, he also led a number of large-scale projects and implemented organizational reforms.

You were a member of the NIMS Evaluation Committee, but after actually becoming a Vice President, what are your impressions?

NIMS has achieved wonderful results in a number of areas, including numerical targets like the number of published papers and citation index, as well as implementation of large-scale projects and organizational and operational reforms led by the President. After coming here, I've reconfirmed the feelings that I had as a member of the Evaluation Committee. NIMS' efforts to improve its infrastructure, meaning equipment and facilities, are also outstanding. As NIMS is one of the world's core research institutes in materials science, its philosophy should be that "The true value of materials is in their use". However, I have the impression that NIMS tends to place priority on the pure science aspect at the expense of the essential practical side of materials. I'm not saying that NIMS has to manufacture devices and develop products. Of course, invention and discovery, like the discovery of novel functions and search for new substances, are important, but in order for materials research to contribute to human society by building a more affluent society, slow-but-steady research from the viewpoint that "the value of materials is in their use" is necessary.

What other things have you noticed since joining NIMS?

Internationalization is progressing. NIMS might be No. 1 in Japan in this respect. I think that the number of young researchers particularly around the age of 30, is small. There are many older people, including myself. Those people has a lot of experiences, which is very important. But, they may possible to give a kind of pressure to young researchers at the same time. Young people can take on challenges of new fields even there might be risks, it will produce intense peaks sometime. And NIMS needs to encourage those young researchers. Research has to be a challenge to the unknown field.

As another point, there is a vertical restriction in education at universities, but this kind of restriction does not exist here, so I hope we can act more flexibly, without limiting the operating subsidy to projects and centers and the like. The change from national laboratory to Independent Administrative Institution (IAI) increased our freedom in research. I hope that NIMS will take advantage of that fact to cooperate and communicate with researchers in other fields, both internally and externally, and to take on the challenge of new fields.

What do you hope for in young researchers?

Needless to say, not only the quest for truth and elucidation of nature, but also the desire to help people and enrich our lives, are the starting point for science and technology. A huge amount of tax money goes into science & technology development with nation's hope. I want young people to be aware of that responsibility. Creating an environment in which it is possible to do research freely is important. However, speaking from my own experience, sometimes intense external pressure is also necessary. When a researcher takes on the challenge of a new field, he or she will encounter many difficulties and intense external pressure, and those lead to new ideas. Sometimes you need the kind of situation to squeeze a new idea. The chance to take on challenges is distributed equally, but there are big differences in the results, depending on whether people take advantage of these chances or not. I want young people to boldly challenge that pressure. My position is managing the organization so as to secure ample external funding and keep a free research environment. We need to keep in mind that must respond to the society. That was the mission of the former national laboratories.

What is your dream?

The development of the semiconductor led to today's information society, and the invention of duralumin resulted in dramatic progress in aircraft, fundamentally transforming transportation. The fact that progress in materials research leads to revolutionary changes in society is one of the inevitabilities of history. Today, we live in an era when we can identify individual atoms, and it is possible to create new materials by performing operations on atoms, almost as if we're manipulating them with tweezers. Taking advantage of nanotechnology, we have the capability to create substances and materials that can give birth to new industries and revolutionize society. At the center of this is NIMS. It's my dream that NIMS will help to realize this.

Expansion of "Joint Doctoral Program" with University Graduate Schools

NIMS Graduate School Team, Human Resources Development Office
Ken-ichi Shida, Senior Adviser

Senior Adviser Ken-ichi Shida has accumulated diverse experiences in his career, including work in the laboratory and overseas office of a private company, as well as management of the R&D division, and has also served as Managing Director of the Society of Polymer Science, Japan and Representative of the Tokyo Office of Hokkaido University. Taking advantage of these experiences, he is now NIMS Senior Advisor, assigned as Head of the NIMS Graduate Program Team, which was newly established in the Human Resources Development Office in April 2008.

What was your motivation for coming to NIMS?

I was the Representative of the Tokyo Office of Hokkaido University for almost 4 years, until this March. During this period, I mainly focused on creating the Graduate School of Tourism Studies, but I also took part in various other new initiatives, such as the Hokkaido University Seminars in Tokyo, joint annual report meetings with Kyushu University, and so on. Then I participated in discussions on a Joint Doctoral Program between Hokkaido University and NIMS as Representative of the Tokyo Office in the final half-year. I believe I was invited to NIMS to make the most of my experience.

Does that mean that the central focus of your work is collaboration with universities?

That's right. Currently, NIMS has cooperative relationships with many universities throughout Japan. Among them, the Doctoral Program in Materials Science and Engineering in the University of Tsukuba is different from its cooperative relationships with other universities. This Doctoral Program is substantially established in NIMS. In the program, NIMS researchers serve as a department head, visiting professors, and associate professors of the University of Tsukuba, and provide research guidance as principal academic advisers, taking advantage of the excellent research circumstances at NIMS. To distinguish this from our conventional cooperative graduate programs, we named this system the "Joint Doctoral Program." We have also begun negotiations with other key universities aiming to expand this kind of program. In the recent couple of months, Joint Doctoral Programs in "Advanced Functional Chemistry" and "Frontier Biomaterials Science" were established at Hokkaido University in the Graduate School of Science and Graduate School of Life Science, respectively, and talented young students are now being accepted to these new programs from overseas as well as Japan.

Is this Joint Doctoral Program an effective means of attracting outstanding human resources?

The United States is recruiting top-class students from overseas countries like India and China and letting them do research under extremely favorable conditions, but Japan is very slow in adopting policies for achieving this. Therefore, we should exert all possible efforts to develop the Joint Doctoral Program that I was discussing a moment ago. If young people come, they will also have an extremely important effect in energizing NIMS itself. NIMS is one of the world's top research institutes in materials science. Our research will be further activated by the young graduate students, while they will be able to get degrees here and will have many chances to find good positions at universities and laboratories in Japan and other countries.

What do you expect in NIMS?

Historically, the basis of NIMS was research in metals and inorganic materials. We have around 400 researchers, of whom only 40 to 50 are engaged in biomaterials and polymer areas. As I have many acquaintances in universities and private companies in polymer-related fields, I think I could be of some help to NIMS researchers in these fields. And, in organic materials area, NIMS should make strategic efforts in distinctive and selective research fields such as organic EL, solar cells, fuel cells, biotechnology, tissue regeneration, and biomaterials.

Do you have any advice for researchers?

Even in the most basic research, you should keep in mind that your work will be of practical use in the future. There may be some researchers who dislike developmental research. However, I would say, returning to the fundamental issues in the process of developmental research is sometimes very effective in cultivating a new field.

What is your dream?

I hope to build a proper system for strengthening the Joint Doctoral Program. This is really a practical job, not a dream. Simply appointing researchers as teachers and recruiting doctoral students does not make a graduate school. We will have to make a firm organizational response in NIMS, envisioning more than 100 students, and as many as around 200 in the future.

Promoting Internationalization while Preserving our Unique Culture

Director, ICYS-IMAT/Director-General, NIMS Nanotechnology Support Network
Sukekatsu Ushioda, NIMS Fellow

Dr. Ushioda graduated from Dartmouth College and finished graduate school at University of Pennsylvania, and then taught in the Department of Physics at University of California, Irvine. After returning to Japan, he joined Tohoku University, where he was engaged in research on physical and chemical surface phenomena at the atomic level, using STM light emission spectrometry. Subsequently, he served as President of Japan Advanced Institute of Science and Technology. Dr. Ushioda was appointed Director of ICYS-IMAT, which was newly established at NIMS Sengen Site in April of this year because of his rich experience in scientific research in Japan and US.

When did your relationship with NIMS actually begin?

When ICYS (International Center for Young Scientists) was being launched in 2003, Prof. Kishi asked me to help, and I was named Executive Adviser of ICYS. I started to visit NIMS Namiki Site, where ICYS was located, on monthly basis. I continued to visit NIMS after I became President of Japan Advanced Institute of Science and Technology. I thought of myself as a sounding board for the young people in ICYS. I met foreign researchers individually, and had discussions on their research topics. Because there were many points that I couldn't understand, they had to explain their work at my non-specialist level. In doing so, the researchers themselves came up with new ideas some times. One of my roles was to provide that kind of stimulus, so that the researchers have a chance to try out their ideas . When I heard their explanations of their work, some times I realized that certain people in Japan are also doing related work. Then I suggested contacting them for possible collaboration. So I also gave advice that was useful for networking. These are also the things I do in the new ICYS-IMAT.

Concretely, what is your role?

I think it's similar to my role in ICYS. Basically, my job is to recruit top young researchers from abroad and assist their development as scientists. The members of ICYS-IMAT can do independent research using world-class equipment with ample research funding, and they have considerable freedom in doing the research that they really want to persue. I think this program is also meaningful in that Japanese researchers participate and do creative work in an environment of mutual stimulation. In ICYS-IMAT we also want to help create an administrative structure and develop personnel that can operate in line with the global standard.

This is based on the success of ICYS?

The ICYS project gave a great deal of stimulus to Namiki Site. Not only the researchers but also the administrative staff had to become bilingual in Japanese and English, in order to respond to researchers from other countries. Unfortunately, Sengen Site was basically not involved in these efforts during the first term of ICYS. This year ICYS-IMAT was established at Sengen Site. ICYS-IMAT is not a Sengen Branch of the ICYS, which is located in Namiki Site, but rather it is meant to be an independent program in close coordination with ICYS at Namiki Site. This is where we are, and we have to take the initiative in our work at Sengen Site. I understood that President Kishi's intention is to use ICYS-IMAT to stimulate Sengen Site as did ICYS at Namiki Site. One immediate goal is to change the conditions in the administrative sector, where almost nobody speaks English at Sengen Site. We need to train our staff to be bilingual at the practical level. The situation is similar with the MANA Program (International Center for Materials Nanoarchitectonics). NIMS as a whole has to strengthen the English language capabilities to become an international center of materials research. To attract outstanding researchers from Europe and the United States, some kind of extra advantage is necessary. At the very least, an environment where people can do their work without any language and administrative barriers is basic. Since it will take a certain amount of time to raise the level of the international environment, not only in universities, but also including the Independent Administrative Institutions, it is necessary to start, even if gradually. ICYS and ICYS-IMAT are both significant as a start in an effort to conform to the global standard.

What is your dream?

My dream is to ensure that things are done reasonably and fairly in the Japanese society as a matter of course. I don't want to see globalization in a very low-level sense. The world will be a boring place, if every country becomes the same. Japan has a distinctive history and a unique culture, and this unique culture will be diluted and become uninteresting, if globalization takes place in matters beyond practical aspects like science, technology, and the operation of organizations. However, in order to work with people from around the world, the practical aspects must unavoidably conform to the global standard. It's also my hope to work toward changing the global standard to reflect the tastes of Japanese people.

SPECIAL Interview

Innovation, Imagination and Creativity

Dr. Gimzewski pioneered research on mechanical and electrical contacts with single atoms and molecules using scanning tunneling microscopy (STM) and was one of the first persons to image molecules with STM in 1985. He is involved in a wide range of projects, including X-ray sources, ions and nuclear fusion using pyroelectric crystals, direct deposition of carbon nanotubes, and single-molecule DNA profiling. Dr. Gimzewski is also involved in collaborative art-science works that have been shown throughout the world.
He spoke to NIMS NOW, when he was visiting NIMS for ICYS Final Workshop/MANA Int'l Symposium in March, 2008. We, first asked about a newly opening joint lab at UCLA as one of MANA Satellite Operation.

Dr. James K. Gimzewski

Distinguished Professor
UCLA Chemistry & Biochemistry Department
Director
CNSI Nano & Pico Characterization Core Facility

NIMS NOW: What sort of research will the new lab be doing?

Dr. Gimzewski: We'll have two main focuses – one is the MANA Brain, an artificial synaptic connection network. It will behave a bit like the human brain with learning capability, and be based on Dr. Aono's atomic switch technology, combined with technology I developed for patterning materials. We envisage an "neuromorphic", multistate system in which some connections can be weaker, some stronger, like in a neuronal synapse. In a way this is a bio-mimetic approach to an alternate form of computation.

The other focus is related to work I do with very small crystals that can generate X-rays. I want to make an array of atomic-size X-ray sources, which can be used for different kinds of microscopy.

NN: Is this different from other international agreements?

JG: Yes, it's the first time MEXT is funding a project with such close collaboration, including lab space. A lot of it has to do with Aono-san and I knowing each other for over 16 years. We never had the opportunity to do joint publications, though we've often met and discussed ideas. Now we have the facilities to develop them, and I think it's going to be pretty good.

NN: Could you tell us about your work in sono-cytology?

JG: This is a new field, detecting sounds produced by what we think are various molecular motors that move fluids around within the cell. My collaborator in Italy, Dr. Carlo Venturce, works with stem cells, and we believe we can tell what kind of tissue a stem cell will differentiate into just by the sounds it makes; he can also input sound energy and change how the cell changes. This could have huge implications for cancer treatment.

NN: What are your personal goals in your research?

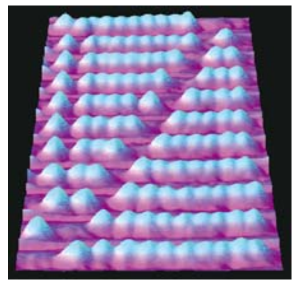
JG: To find something that changes this planet in a dramatic, positive way – a key innovation, and it may be a way to couple our mind to the outside world in a different way. The MANA Brain is a beginning; it could plausibly replace neurons, even cure Alzheimer's disease. But that's a long way off.

NN: What do you expect in the short term, the next few years?

JG: We'll see a whole series of new remote medical diagnostics and biosensors. I'm hoping for a breakthrough in solar power – there's no reason we can't have highly efficient solar panels. As the price of oil goes up, new intelligent materials in cars will become viable, especially carbon nanotubes.

NN: What message would you like to give to young researchers in this field?

JG: Nanotechnology is the most important thing on Planet Earth, in terms of sustainability. Young researchers have the most marvelous opportunity imaginable – to define this field. And they'll have to do with innovation, imagination and creativity.



Nano Abacus
The world smallest calculator – He and scientists at the IBM Research Division's Zurich laboratory have built an abacus with individual molecules formed by C_{60} as beads in 1996.

Innovative Materials Engineering Laboratory

– Discovering the Dreams Hidden in Materials –

Materials are the basic elements that support the human activities and living in every areas. The appearance of new materials or new material technologies are the origin of the dreams of creating new value and affluence. Discovering these dreams requires pioneering research to create materials which have not existed in the past, make those materials manifest functions, and open the way to new applications, basic research to fully investigate the properties of substance and materials and link them to new knowledge, and comprehensive research to ensure that this knowledge and technology are in harmony with society and industry. The Innovative Materials Engineering Laboratory brings together researchers who carry out materials research based on a variety of approaches. These are truly 21st century alchemists who are advancing research to realize the dreams hidden in materials, taking advantage of the fields which are their particular strengths, from thoroughgoing basic research to research on practical applications in collaboration with industry. In the composition of its groups, the operation of the Innovative Materials Engineering Laboratory also brings together researchers from different fields from the viewpoint of promoting interdisciplinary exchanges through which each can contribute to diverse new concepts.

Basic Research Group

- Research on Materials' Socio-Engineering
  Quantitative indexes of resource risk and resource circulation
- Research on Molecular and Material Science
  Analytical methods and chemical evaluation of clean, high reliability new substances
- Research on Informatics
  Design of input software and problem-solving support systems
- Research on High Performance Copper Alloys
  Development of copper alloys with the world's best balance of strength and electric conductivity
- Research on Molecular Excited-State Dynamics in High Magnetic Field
  Elucidation of effects of high fields on electron excitation states
- Research on High Pressure/Nano Crystals
  Synthesis of nanocrystals under high pressure and search for new functions

Intense Research Group

- Research on Corrosion Analysis
  In-*situ* observation using Kelvin force microscope
- Research on Advanced Cryogenic Materials
  Development of the world's most advanced ceramic magnetic cooling storage materials
- Research on Phase Transformation in High Magnetic Fields
  Dynamics of structural transformation and structural control using magnetic fields
- Research on Plastic Deformation Processes
  Construction of technology for simultaneous control of qualities by plastic working
- Research on High Intensity Electron Sources
  Development of Cs_3Sb coated electrode for use as photocathode

Interdisciplinary Research Group

- Research on Design of Nano/Dynamic Materials
  Development of functional materials using nano-hybrid films
- Research on Advanced Nanoceramics/Processes
  Particle synthesis and functionalization using nano/reactor reaction
- Research on Steel Phase Transformation by 3D/4D Analysis
  Pursuit of principles for improvement of reliability of steel based on 3D/4D analysis

Eco-energy Group

- Research on Eco-Energy Device Materials
  Thermoelectric conversion materials from Mg_2Si-based to polymer-based

Crystals Science and Technology Group

- Research on Crystal Science
  Integration of functions and realization of multiple functions including ferroelectric, ferromagnetic, and other properties
- Research on Copper and Stainless Steel
  Research on atmospheric corrosion products including copper rust, nitrogen compounds, etc.

Lattice-Atomistic Research Group

- Research on Irradiation Effects
  Deformation and fracture caused by irradiation with high energy particles

Platinum Group Metals Group

- Research on Platinum Group Metals
  Development of high functionality, high strength materials taking advantage of high temperature properties of platinum family

1D Nanomaterials Group

- Research on one-dimensional Nanomaterials
  Creation, characterization, and application of nanotubes and nanowires

Progressive Materials Research Group

- Research on Electric Field/Discharge Processes
  Development of materials utilizing electrospinning and micro-discharge
- Research on High Damping Materials
  Development of vibration damping/seismic damping materials based on new mechanisms

Structural Functions Research Group

- Research on Structural Functionalities
  Structural functionalities of shape memory, ultra-elastic, magnetostrictive, vibration damping, and other functions

Nondestructive Evaluation Group

- Research on Nondestructive Evaluation
  Development of nondestructive evaluation techniques for materials using ultrasonic technology

The Challenge of In-*Situ* Observation of Hydrogen

– Reconsideration of the Role of Hydrogen in Material Damage –

Intense Research Group,
Innovative Materials Engineering Laboratory

Group Leader
Hiroyuki Masuda

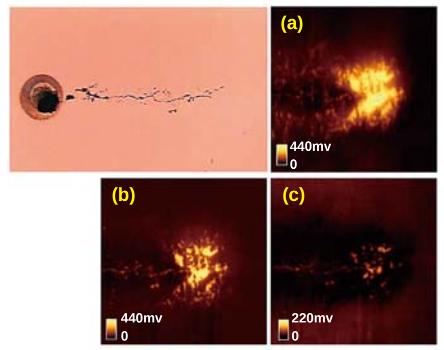
Nuclear power plants have been constructed in various countries from the viewpoint of CO_2 reduction in recent years. However, the problem of stress corrosion cracking (SCC) in stainless steel materials, the greatest enemy of safety in nuclear power plants, has not been solved in spite of a vast amount of research. In-*situ* measurement is necessary to solve the problem, detecting where hydrogen generated in the corrosion moves to, and whether the hydrogen generated cause corrosion and cracking. Since no measurement method had been established, this question had not been elucidated.

The discovery of the extremely interesting phenomenon that corrosion progresses only in the vicinity of tip of cracks in stainless steel led to the start of research on in-*situ* measurement of hydrogen. It was assumed that a corrosion-prone substance with a less noble potential forms in the vicinity of crack tips. A new SCC test method which enables scanning probe microscope observation was devised on the basis of the assumption. In this method, a load is placed on a thin sheet by slightly bending like a spring, a dozen droplets of $MgCl_2$, a bittern composition of seawater are deposited on it, and then it was exposed to an environment of a temperature of 70ºC and relative humidity of 30% (simulating the environment in which steel plates are placed under the sun in summer). In this ordinary environment, cracking occurs in SUS304 stainless steel in several hours. As advantages of this test method, 1) pretreatment for SEM observation is easy, 2) because the interior of the droplets is electrochemically independent, numerous experiments can be performed simultaneously, and 3) the load stress can be controlled by the bending condition (radius of curvature) of the specimen.

Figure 1 shows an optical microscope image and potential distribution images of a crack in SUS304 stainless steel (thickness: 0.07mm) which occurred during a 2 day test using a load stress of 801MPa. These images were obtained with a scanning probe microscope which was developed at NIMS and is the only instrument in the world capable of obtaining wide range potential distribution images. In-*situ* observation of the formation of a region of less noble potential in the vicinity of the crack tip and its extinction over time was possible. As discussed below, this is due to escape of hydrogen. In most cases, regions of less noble potential were observed around the crack tip immediately after the tests.

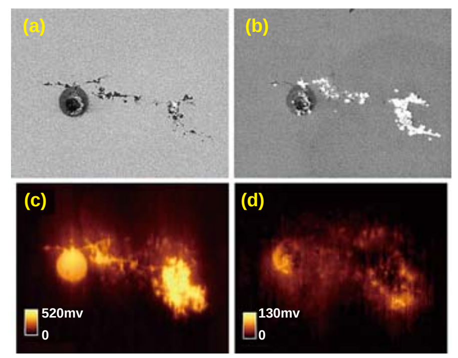
Figure 2 shows the results of an investigation of hydrogen by the silver decoration method, which makes it possible to visualize the distribution of hydrogen by deposition of silver. A large amount of silver is deposited around the crack tip, where the potential is less noble. After deposition, the hydrogen is consumed, and as a result, the less noble region becomes extinct. This fact demonstrated that there was a good correspondence between potential and the distribution of hydrogen. In the future, this method is expected to lead to new knowledge of the relationship between hydrogen and cracking and hydrogen and corrosion.

Fig.1



Optical microscope image of a crack (0.62mm x 0.4mm) and potential distribution images of the vicinity of the crack tip (0.4mm x 0.4mm) showing change over time. (a) Immediately after the test, (b) after 5 days, and (c) after 11 days. The scale in the figure shows the maximum potential difference. The bright part indicates less noble potential.

Fig.2



SEM images of a crack (a), (b) and potential distribution images (c), (d) (0.5mm x 0.4mm). (a) After silver removal, (b) after silver decoration, silver appearing as white, (c) immediately after the test, and (d) after silver removal. The test conditions were the same as in Fig. 1.

Realizing Ultra-Low Temperatures in Space

– Novel Cooling Technology using Magnetic Body: cADR –

Intense Research Group,Innovative Materials Engineering Laboratory
NASA Goddard Space Flight Center*1
Tokyo Institute of Technology*2 Chiba University*3

Takenori Numazawa Kenta Takahashi*3
Hiroharu Kamiya*2 Shogo Yoshioka*3
Peter Shirron*1 (upper left)

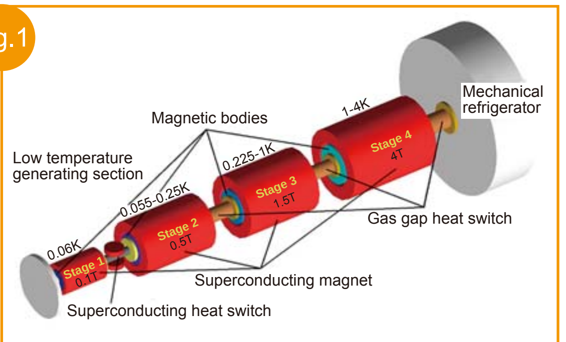
A succession of advanced physics experiments using space environments and low temperature environments are being planned. For example, in the operation of ultra-high resolution X-ray detection sensors, which will give new images of outer space, an ultra-low temperature environment of 0.1K or less is indispensable. Likewise, an ultra-low temperature environment of several K or less is necessary for growth of solid helium crystals unconstrained by the force of gravity.

Because the average temperature in space has been calculated at approximately 3K (-270ºC), it would seem that an ultra-low temperature can be realized simply. However, a vacuum insulation condition exists in space, which means radiation is the only effective means of heat transfer. Therefore, for cooling to ultra-low temperatures, liquid helium with a temperature of 4.2K must be carried from the ground to space. Because it is difficult to continue experiments if the liquid helium is consumed, realizing a cooling system which does not rely on a refrigerant is a key issue for space experiments. The Adiabatic Demagnetization Refrigerator (ADR), which uses the cooling effect of magnetic bodies (magneto-caloric effect), functions completely by magnetic operation and does not require a refrigerant. In particular, because a solid magnetic body is used, ADR is capable of producing ultra-low temperatures under zero gravity conditions. Thus, this technology has ideal features for a space refrigeration system, but because the ADR cycle includes heat absorption and heat generation stages, continuous cooling is difficult. Dr. Shirron of NASA, who was a co-researcher in this work, produced a splendid solution to this longstanding problem by using multiple ADR units operated with an offset in the phase of the cycles.

In cooperation with NASA, NIMS is developing a continuous ADR (cADR) which is suitable for various space experiments under the Ground-Based Space Utilization Research Program sponsored by the Japan Aerospace Exploration Agency (JAXA) since 2005. The composition of the system is shown in **Fig. 1**. One ADR unit comprises a magnetic body, magnet, and heat switch. By using four of these units in combination, it is possible to generate temperatures from 4K to 0.1K. A GdLiF4 ceramic magnetic body developed by NIMS is playing a critical role in this system, making it possible to realize a cooling capacity more than 30% higher than conventional technologies. This is an energy saving technology, as each unit achieves a cooling efficiency of 90%, and also possesses the high reliability required in space technologies. The most recent model of the cADR completed by NIMS is shown in **Fig. 2**.

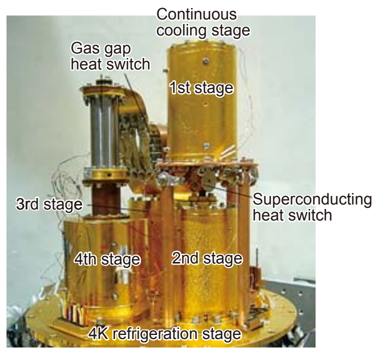
In order to simulate the experimental environment in space, we conducted a micro-gravity experiment with an aircraft (**Fig. 3**). The results demonstrated that the cADR is capable of 100% trouble-free operation in a zero gravity environment. At present, we are working to ensure that our cADR technology will be used in the next period of space experiments aboard the International Space Station "Kibo", which means hope in Japanese. We hope that all readers will continue to follow the development of the cADR technology in the future.

Fig.1



Schematic diagram of composition of cADR

Fig.2



Developed cADR for space use

Fig.3

Scene of micro-gravity experiment using aircraft

Success in Development of Novel Infrared Light Source using Plasmon Resonance

Nanophotonics Group, Quantum Dot Research Center
Nalux Co., Ltd.†
NIMS Nanotechnology Innovation Center††

Shortly after the success of the experiment

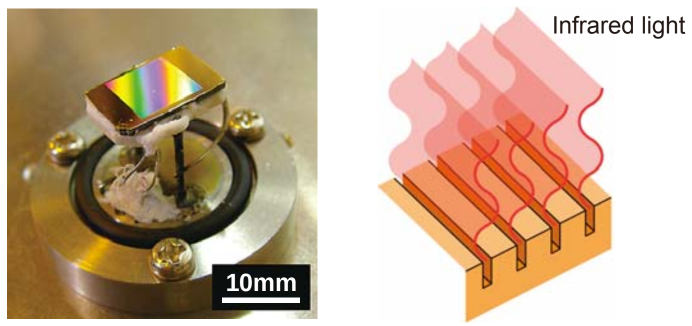
Hideki T. Miyazaki Katsumoto Ikeda† Takeshi Kasaya††

Many substances absorb light of specific wavelength in the infrared region of wavelengths from 2.5 to 15μm. Making use of this fact, techniques for measuring the concentration of CO_2 in the air and concentrations of harmful chemicals in liquids from the amount of transmission of infrared light of the specific wavelength have been developed and are playing an important role in environmental analysis. However, until now, the infrared light of the necessary wavelength had been extracted with a filter from light emitted by a black body light source and used in analysis. A black body light source is a device which radiates infrared light from the surface of an object (generally black) which is heated with an electric current. Examples include light bulbs and ceramic heaters. However, the light from black body light sources includes light with a very wide range of wavelengths. Only a narrow range of wavelength from this light is used, and the larger part is simply discarded unused. Thus, the conventional analytical technique was extremely energy inefficient. Development of LED and laser light sources which are capable of radiating only infrared light of the necessary wavelength is underway, but these technologies are still rarely used in this wavelength region due to problems of radiation intensity and cost.

In this research, we succeeded in the development of a novel infrared light source which radiates infrared light of designated wavelengths using plasmon resonance of gold. Plasmon resonance is a phenomenon in which the electrons in a metal synchronously oscillate, and is particularly remarkable in noble metals such as gold and silver. The infrared light source developed in this work is a device in which grooves with widths of several 10 to several 100 nm and depths of 500 nm to 1μm are made in the surface of gold with a period of 2-4μm (**Fig. 1**). When this surface is heated to approximately 200ºC, plasmon resonance is induced in the grooves, resulting in efficient radiation of infrared light limited to around to the designated wavelength (**Fig. 2**). This wavelength can be set as desired by adjusting the width, depth, and period of the grooves.

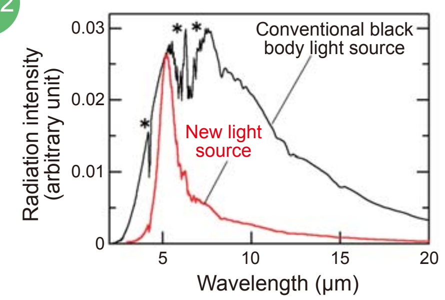
We also confirmed that it is possible to measure the concentration of chemicals in liquids using the developed infrared light source. This result suggests that the radiation intensity and wavelength width of our light source is already of a level at which application is possible. In order to mass produce products economically, manufacturing by copying a single mold is essential. This light source, has reached a stage near practical application in terms of manufacturing technology as it was fabricated using a mold from the prototype stage. Because the supplied electric energy is converted efficiently only to the infrared light which is actually necessary in analysis, this light source is particularly well suited for use in portable environmental measurement equipment operated with batteries. The authors wish to thank Elionix Co., Ltd. for its cooperation in this research.

Fig.1



The developed infrared light source. Infrared light is radiated from the part appearing in rainbow colors in the photograph at the left. An enlargement of this part is shown schematically at the right. Regular grooves have been made in the gold surface.

Fig.2



An example of the radiation spectrum. The black line shows the spectrum of the conventional black body light source. (The valleys shown by * marks are the effects of CO_2 and water in the air; these are not important features.)

Visit of Mr. Lim Chuan Poh, Chairman of the A*STAR, Republic of Singapore

(May 13, 2008) Mr. Lim Chuan Poh, Chairman of the Agency for Science, Technology and Research (A*STAR), Republic of Singapore visited NIMS with Prof. Chong Tow Chong, Executive Director of the Science and Engineering Research Council (SERC), A*STAR, Dr. Yeo You Huan, Head of the International Division, SERC, A*STAR, and Mr. Tay Chor Shen, Senior Officer, SERC, A*STAR. The visitors met Prof. Teruo Kishi, President of NIMS, Prof. Masakazu Aono, Director General of MANA[1], and Dr. Masaki Kitagawa, Vice President of NIMS. The delegation gave an overview of recent research activities in Singapore and the new research center to be opened in October. Mr. Poh, who is also a member of the WPI program[2] Assessment Committee, asked many keen questions, especially in biomedical-related fields during the lab tour and the introduction of NIMS including MANA.


Chairman Lim Chuan Poh (left) during the lab tour of the Bio-Materials Center.

[1] MANA International Center for Materials Nanoarchitectonics, a new center established recently by NIMS under the WPI program.
[2] WPI Program World Premiere International Research Center Initiative program, sponsored by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT).

US Undergraduate Students to Experience 11 Weeks of Research Activities at NIMS

(May 26, 2008) Five US students arrived at NIMS for a 11 weeks research project in nanotechnology as an internship program sponsored by the National Nanotechnology Infrastructure Network (NNIN). NNIN has been conducting a program called Research Experience for Undergraduates (REU) to enable students to experience nanotechnology research with state-of-the-art equipment for over 10 years with funding by the National Science Foundation (NSF). Starting this year, a new program was added to develop scientists' global awareness through experience in a multinational research environment. The five excellent students visting NIMS were selected from among students who completed the REU program in the previous year.

The selection of NIMS for the new program from among leading institutes worldwide indicates that NIMS is recognized as a top class research institute and marks a high evaluation of its system for receiving international researchers and deep partnership with NNIN.


Dr. Rathbun (right), Dr. Healy(left), and the five visiting students.

IWSDRM 2008 is held at NIMS

(Jul 7-9, 2008) – Since the discovery of superconductivity in diamonds, we have learned that many semiconductors also become superconducting, including silicon and SiC, AlN, and others. While new iron-based superconductors have also been discovered, leading to a new superconductivity boom, the 2nd International Workshop on Superconductivity in Diamond and Related Materials (IWSDRM) 2008 was held recently at NIMS. This event was very rich in content, with 58 lectures, including a poster session, and featured extremely enthusiastic discussions.

One theme of the workshop was superconductivity in semiconductors. It has been argued that insulators can all become superconductors like diamonds. This means that the possibilities of new superconductor substances are greatly expanding. The news that the superconducting transition temperature (Tc) of fullerenes had been increased to around 40K is another remarkable point. Strong and keen interest could been seen in the discussion of recent data on iron-based superconductors. Throughout this event, future developments in metal-insulator transition and superconductivity control can be eagerly anticipated. The year 2008 should be commemorated as the 100th Anniversary of the successful liquefaction of helium, and 3 years from now, 2011 will mark the 100th year since the discovery of superconductivity. Even more remarkable progress is expected in superconductivity in the years to come.


IWSDRM2008 Participants

Workshop on Nanomaterials for Energy and Environmental Protection in Warsaw

(Jun 16-17, 2008) A workshop on "Nanomaterials for Energy and Environmental Protection" was held over a two day period on June 16-17 in Warsaw, Poland with the purpose of deepening exchanges and collaboration between NIMS and the nations of Central and Eastern Europe. Distinguished researchers were invited from research institutes and universities representing nine nations (Poland, Switzerland, Austria, the Czech Republic, Slovakia, Hungary, Slovenia, Romania, and Ukraine). A total of 20 research presentations were given, including five by NIMS.

This workshop was co-sponsored by three organizations, NIMS, the Warsaw University of Technology (WUT), and Swiss Federal Laboratories for Materials Testing and Research (EMPA). The three organizations had concluded bilateral agreements on comprehensive research cooperation or joint graduate school programs separately in the past. During this workshop, these three institutes newly signed a Memorandum of Understanding on joint cooperation to strengthen the education and career development of young scientists.


The signing ceremony for the new agreement: From the left, Prof. Schlapbach, Director-General of EMPA, Prof. Kishi, President of NIMS, and Prof. Jakubiak, Vice-Rector of WUT

Exhibition on Materials for the Environment and Energy

(May 29-30, 2008) NIMS recently sponsored the "Exhibition on Materials for the Environment and Energy (The Key to World Class Innovation: Materials Technology)," which was held at the Tokyo Big Sight International Exhibition Center May 29-30. The first day began with opening remarks by Prof. Teruo Kishi, President of NIMS, followed by lectures by a number of eminent scientists from Japan and other countries. The second day featured a panel exhibition. Researchers and participants engaged in a lively exchange of questions and answers at the poster session for an exhibition of advanced research in Eighty eight (EE) fields, showing high interest in research related to environmental and energy (EE) problems. At the corporate exhibition, many participants listened with keen interest to the commentaries on exhibitions of products and services which contribute to solving environmental and energy problems. This event also included a research presentation exhibition by high school students, who made presentations on research based on the unique approach characteristic of high-school students. In debate with the presenters, both visitors and other researchers participating in the exhibition displayed strong interest. The enthusiasm with which these young scientists explained their work was clear proof that Japan has a rising generation of researchers with great potential to carry on this country's outstanding tradition of science and technology in the future. The total number of visitors at the exhibition exceeded 1000. Taking advantage of the results of this exhibition and the invaluable feedback from visitors and others, NIMS will vigorously promote research in all areas, with its gaze fixed firmly on today's urgent environmental and energy problems.

The first day lectures by eminent speakers and invited international guests
Theme : "Global Contribution and Integration of Knowledge"
(in the order of presentations)

Prof. Ryoichi Yamamoto,
Institute of Industrial Science, the University of Tokyo
"Global Warming and Eco-Innovation"

Dr. Shuzo Nishioka,
National Institute of Environmental Studies
"The Road to a Low Carbon Society"

Dr. Adrian Nitsche,
First Secretary, Embassy of the Federal Republic of Germany in Japan
"A German Approach towards Energy Saving and Environmental Protection"

Prof. DAI Yande,
Deputy Director-General, Energy Research Institute,
National Development and Reform Commission (NDRC), China
"The Status of Energy Supply and Demand in China and its Relative Policies of Energy Conservation as well as Environmental Protection"

Dr. David Clarke,
Chief Executive, Energy Technologies Institution (ETI), UK
"Challenges in Materials R&D in Solving Environment and Energy Problems – The UK Energy Technologies Institute Response"

Prof. Itaru Yasui,
Principal Fellow, Center for Research and Development Strategy,
Japan Science and Technology Agency
Vice-Rector, Emeritus, United Nations University
"What is Technology in a Sustainable Society?"

Dr. Tapan Chakrabarti,
Acting Director, National Environmental Engineering Research Institute (NEERI), India
"Environmental Issues in India? NEERI's Efforts to Address the Air and Water Cleanup"

cover picture: A scene of presentation by Prof. Yamamoto


Lecture by Dr. Nishioka


High school students' presentations at the poster session on May 30.

NIMS Office at University of Washington (UW) Opens

The UW Tower of the University of Washington.

(Jun 2, 2008) The Opening Ceremony for a NIMS Overseas Operation Office was held at UW Tower adjacent to the Main Campus of UW. A group of 8 persons headed by Vice President Tetsuji Noda attended from NIMS, while 36 persons, including Prof. O'Donnel, Dean of the College of Engineering, participated from the University of Washington side.

The ceremony began with an opening greeting by Prof. Fumio Ohuchi, UW Professor of Materials Science and Engineering, then Vice President Tetsuji Noda expressed the high expectations placed on the new UW office. After an introduction of NIMS including the ICYS-MANA and IMAT, Prof. Ohuchi explained the long cooperative relationship between NIMS and UW up to the present in the background of the opening of the new office. Other speakers included Mr. Mitsunori Namba, Consulate-General of Japan in Seattle, who also described the expectations on the NIMS Overseas Operation Office in Seattle, and Dr. George Scholes of the FEI Company, who closed the ceremony with remarks on the importance of cooperation.

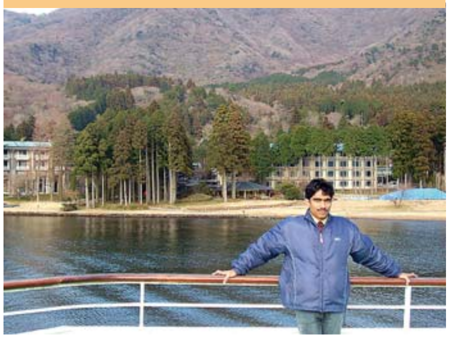
The entrance of the NIMS Overseas Operation Office.

The office will be a base for NIMS PR activities in the US and human resource exchange including graduate students. It also aims at the enhancement of linkage and promotion with US industries. Dr. Kenji Kitamura, NIMS Fellow and Dr. Ohuchi manage the office as Research Directors.

At present, the NIMS Overseas Operation Office is temporarily located on the first floor of a 4-story building facing Roosevelt Blvd. near the University. In the future, the Office will be moved to the 4th floor of the same building.

Hello from NIMS

Hari Srinivas Goripati (India)
From Dec 2006 to present
Junior Research Assistant,
Magnetic Materials Center



[On a Trip tip to Hakone.]

Namasté (an Indian way of wishing with respect), I am Hari Srinivas Goripati from India. I joined the doctoral program, jointly offered by NIMS and the University of Tsukuba in April 2007. Before coming to Tsukuba I did my masters in engineering with a specialization in metallurgy at Indian Institute of Science, Bangalore.

At NIMS, my main scientific research is on synthesis and characterization of current perpendicular to plane giant magneto resistance spin valve structures and is supervised by Prof. Hono. The state-of-the- art facilities in group and NIMS allow me to conduct my research at the highest quality far from any hassles. As a part my research, I am supposed to give group seminars very frequently from which I get a lot of inputs and suggestions from my Professor and colleagues. Further, I hone my research skills, attending the seminars conducted by NIMS as well as my group. I am thankful to my Professor for choosing me as one of his group members at such a world class institute.

[With my Lab mates on a trip to Mt. Fuji.]

Apart from my academics and research I chill out playing badminton with NIMS badminton club members. This is just an example of the concern that NIMS has for its staff by providing them some welfare facilities. Unlike many Japanese cities Tsukuba is altogether a different city with a calm and serene atmosphere, spread with trees and parks which make it a perfect city for research. The culture and heritage of Japan is interesting to watch as some similarities can be drawn between Japan and India, like the way Japanese bring their palms together to offer prayers to the God.

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