NIMS NOW International

2009. Jan-Feb

Special Feature

NIMS Researchers Win Awards

200kV field emission TEM (FE-TEM)

Aiming to Become an Even More Open Research Institute

A Happy New Year to all our friends!

NIMS celebrates its 8th New Year as an Independent Administrative Institution (IAI).

Prof. Teruo Kishi
President, NIMS

The vision of NIMS as a R&D-oriented Independent Administrative Institution (IAI) is to develop and maintain cutting-edge facilities and equipment, and carry out large research projects with innovative concepts. The identity of NIMS, which is clearly different from that of universities, is to conduct interdisciplinary and long term materials research by combining the expertise and capabilities of independent-minded research professionals. Collaboration between fundamental research from a scientific viewpoint and practical research under our motto that "the value of materials is in their use" is important for carrying out our materials research.

During the past eight years, we have created seeds of new research in the fields of environmental and energy-related materials, information and communications materials, biomaterials, and so on, which is accomplished by not only expanding and improving our original fields, metal materials and inorganic materials, but also introducing and developing a new field, organic and polymer materials. In addition, we intensively promote nanotechnologies as a tool for materials development, focusing on "Nanotechnology Driven Materials Research for Sustainability" as the research direction which NIMS should take.

Where our research system is concerned, we are creating a flat research organization and securing and fostering young researchers. We have also put effort into forming an interdisciplinary, multicultural research environment that we call a "melting pot," which brings together diverse researchers having different scientific fields, ethnic backgrounds, and cultures from all over the world. Our efforts have lead to the establishment of the International Center for Young Scientists (ICYS), which has been appreciated in Japan and overseas. Our next challenge is to promote further internationalization with the Asian nations.

In addition to progress in some numerical indexes such as the number of published papers, our researchers have made a number of interesting achievements that are expected to become practical applications. These achievements are steadily leading to collaborations with private companies in Japan and other countries, aiming at innovation. In the area of research infrastructure, we are continuing to expand and improve our facilities which are open to outside users, at the Nano Foundry Station, Beam Line Station, High Voltage Electron Microscopy Station, and High Magnetic Field Station, and smoothly advancing the development of the intellectual infrastructure for materials research, at the Data Sheet Station and Database Station.

We are particularly enhancing human resources development. Joint graduate school programs are a typical example, through which we accept many students who are actively engaged in research at NIMS, from our partner universities in Japan and elsewhere, including the University of Tsukuba, Hokkaido University, and Waseda University. In addition, around 200 postdoctoral researchers from Japan and other countries are also being hired on a regular basis. We consider it important to create an atmosphere in which some number of these post-docs can become tenured NIMS researchers.

I believe that the future directions for materials research will be in "hybrid materials," "fusion of materials and devices (parts of products)," and "active use of nanotechnology." "Science and technology diplomacy," such as the creation of laboratories in other countries, will also be an important role. The concept of an "Open Research Institute" which attracts researchers from around the world should be one direction for NIMS in promoting this kind of diplomacy. We declared our intention to create such an institute last year, and we will continue to promote this concept during this year.

Based on our accomplishments of research and internationalization, in 2007, NIMS was selected as one of the five top institutes in Japan, called World Premier International (WPI) Research Centers. We have been evaluated on many aspects and have had busy daily lives since becoming an IAI. However, I would like to continue my effort to secure the best research environment and human resources development.

In closing, I would like to wish all of our friends and colleagues a very Happy New Year, and a pleasant and rewarding year in 2009.

NIMS Researchers Win Awards

In 2008, many NIMS researchers received awards in recognition of their outstanding achievements. In the following pages, we spotlight four groups of researchers and provide an overview of their works.

Advancing Optical Technology by Controlling Single Crystal Defects
– Research Leads to Establishment of Venture Firm –

NIMS Fellow, Kenji Kitamura Receives the Japan Science and Technology Agency's Inoue Harushige Award

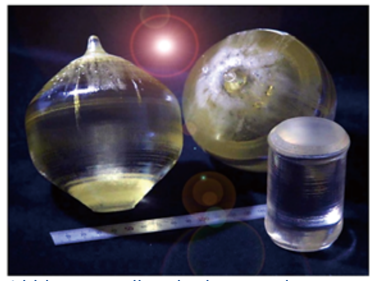
The Inoue Harushige Award has been awarded since 1976 to recognize private sector development and commercial production of the creative achievements of universities and research institutions. The award is named after Harushige Inoue, who contributed to advances in industrial chemistry and to the development of the national laboratories, and it is intended to nurture promising new technologies. The award is distinguished by the fact that it is given to both researchers and entrepreneurs in pairs. This year, the prize has been awarded to NIMS fellow Kenji Kitamura and entrepreneur Yasunori Furukawa, a former NIMS researcher who is now the president of OXIDE Corporation. It is the first venture firm to spin out from a national laboratory based on Kitamura's group research.

Kitamura, who was Managing Director of the Optronic Materials Center, focused on defects in the single crystals used to produce devices. His objective was to determine what effect these defects have on crystal properties and functions and how these defects can be controlled.

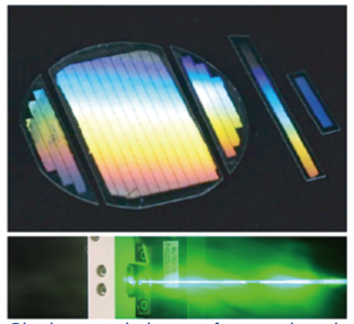
Lithium niobate single crystals are used as frequency selection filters in TVs and video units. Devices with lithium tantalite single crystals are used in mobile telephones. These crystals are an integral part of our daily lives. However, single crystals manufactured using conventional methods contain excessive quantities of niobium and tantalum, and as a result these crystals have many defects. Although they can be used in TVs and video units and cellular telephones, they are not suitable for optical applications. Despite the need to improve functions in such laser beam application fields as next-generation, high-capacity, high-speed optical communications, no technology had been found that could control these single crystal defects.

Kitamura developed a new method that enabled the raw material for manufacturing single crystals to be supplied in a steady manner. Using this method, he succeeded in producing single crystals with very few defects. In 1998, it was demonstrated that incorporating these crystals into devices resulted in a significant improvement in the properties needed for the conversion of laser light frequencies. This confirmed the practical value of the technology. Kitamura and Furukawa obtained several patents and founded OXIDE Corporation in 2000, with this technology as its core business. The company has experienced steady growth, targeting small-scale markets that tend not to attract the involvement of large corporations. OXIDE Corporation is currently making preparations to go public.

Even having a proprietary material with the ability to change laser beam wavelengths did not prepare Kitamura for how difficult it would be to actually create and sell products.



Lithium tantalite single crystals manufactured by kitamura's method.
(Left: 4inches dia. Right: 2inches dia.)



Single crystal element for wavelength conversion (Top) and converted green laser beam.

In 2003, he established SWING, Ltd. in response to requests for device products. Last year he also established a research center at the University of Washington in Seattle. Research at the center is currently focused on the development of medical care, environmental and safety technologies utilizing laser wavelengths. Kitamura says he wants to conduct wide-ranging joint research to meet urgent needs in the U.S.A. His journey of discovery with single crystals has led from materials to devices and on to laser applications, and it shows no sign of ending anytime soon.

Creating Functional Materials from Inorganic Nanosheets
– A Breakthrough Resulting from an Encounter with a Different Field –

Field Coordinator, Takayoshi Sasaki and MANA Scientist, Minoru Osada Are Awarded the Tsukuba Prize by the Science and Technology Promotion Foundation of Ibaraki Prefecture

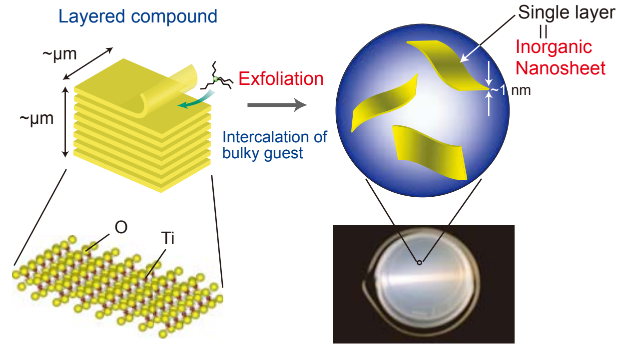
The Tsukuba Prize is awarded to individual researchers and groups working in Ibaraki Prefecture that have produced internationally recognized achievements in a wide range of science and engineering fields. This marks the third time that a

NIMS researcher has been honored with this award. As many of Japan's most prominent researchers are based in Ibaraki Prefecture, the award carries special significance.

Shortly after joining National Institute for Research in Inorganic Materials (the predecessor of the present NIMS), Takayoshi Sasaki began material research into titanium oxide having a layered structure. Although at first it might appear to be quite ordinary as a material, subsequently, it was learned that the individual layers of ultra-thin two-dimensional crystals, which Sasaki named “nanosheets” can be peeled off and have properties similar to those of semiconductors. At that point, research developed at a dramatic pace.

An inorganic chemist by training, Sasaki went on to discover many types of nanosheets, including manganese oxide, hydroxides formed with various metal ions, and so on. Each of these was a sheet-like single crystal measuring only about one nanometer (several atoms) in thickness. It was learned that these nanosheets can be made to possess many different properties depending on what combination of metals is used. These include nanosheets that exhibit dielectric and ferromagnetic properties, and even unique nanosheets that can become superconductors.

Takayoshi Sasaki, Field Coordinator of MANA (Left) and Minoru Osada, MANA Scientist



Creation of Nanosheets, Titanium oxide is used as an example

These nanosheets can be assembled and organized to form nanostructured materials with unique functions. Moreover, they can be handled in the same manner as paper, making it possible to create hollow structures such as tubes. "Right now nanosheets are making the transition from substance to material," says Sakaki. "We'll know in the next five years that they can become useful materials."

Co-winner Minoru Osada specialized originally in solid state physics. Upon joining NIMS, however, he was assigned to Sasaki's laboratory, which comprises a group of chemists. The arrival of this young researcher from a different field was the trigger that produced the new approach of utilizing nanosheets. Osada is always intending to be an "adventurer," and his efforts to bring out the electrical and magnetic properties of these materials have begun to produce advances that will be key to the development of IT technologies such as high-capacity memory and insulating films for transistors.

Although researchers normally have few opportunities to acquaint their families with the nature of their work, the winners say the Tsukuba Prize appears to have had the unexpected benefit of increasing their families’ appreciation of their work. We look forward to seeing their quiet, diligent efforts flower brilliantly in the not-too-distant future.

Developing Temperature-resistant Ferrous Materials
– Designed to Achieve Thermal Power Generation with Low CO_2 Emissions –

Group Leader, Fujio Abe Receives the Tanigawa-Harris Award (from the Japan Institute of Metals) and the Mishima Prize (from the Iron and Steel Institute of Japan)

Because it produces large quantities of CO_2 emissions, coal-fired thermal power generation tends to be viewed as a technology that should be replaced by other, more environmentally conscious power generation methods. However, currently about one-fourth of Japan's power comes from coal-fired thermal power generation. Many third world nations are also forced to rely on inexpensive coal to supply most of their energy demand. From the standpoint of energy security and safety as well, many countries have been unable to eliminate coal as one of their sources of energy. The fact that coal reserves are plentiful and relatively evenly distributed has also resulted in a reappraisal of the advantages of coal-fired thermal power generation.

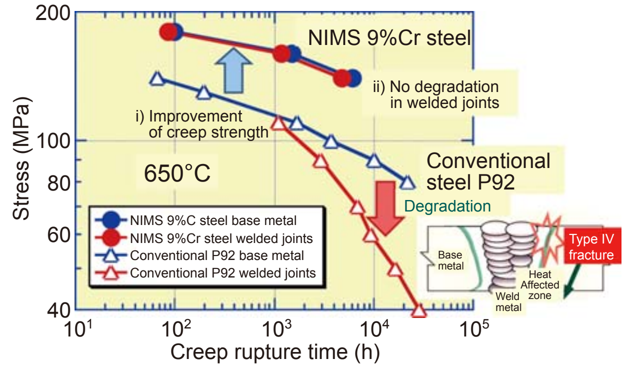
What is needed is a way to generate power efficiently from coal while reducing CO_2 emissions. It is estimated that generating power from coal at 700°C, 100°C higher than the temperature currently used, would reduce emissions by 13%. Continuous long-term operation at high temperatures would increase efficiency, but this would slowly but surely produce deformation

(creep) in the steam pipes and other parts, ultimately resulting in damage. There is also the danger that the interior of the steel pipes would become oxidized by high-temperature steam, causing the walls to become thin and eventually crack. Another danger is the possibility that the welds may prematurely rupture.

Fujio Abe has studied metallic materials that can withstand high temperatures, such as those for nuclear power reactors and fusion reactor. Utilizing this experience, he conducted research into steel that would enable thermal power plants to operate at temperatures of 650°C or higher. His goals were threefold: to increase creep strength, to improve oxidation resistance, and to prevent welds from deteriorating.

Steels are composed of aggregations of crystals. When Abe took a closer look, he realized that deterioration tended to occur at the boundaries between aggregations of crystals. Adding alloy elements with the aim of strengthening the steel did not improve the boundary strength. Accordingly, Abe hit upon the idea of adding boron, which tends to segregate at the boundaries. Steel is produced by adding carbon and nitrogen to iron; the boron forms a compound with nitrogen. It was necessary to search for the appropriate proportion of these two elements to add. "An unexpected bit of good news was that we found that adding boron also prevents the welds from deteriorating," says Abe. The problem of improving oxidation resistance was resolved through pretreatment in argon gas at 700°C to create a thin protective scale on the surface. In this way, the basic guidelines for alloy design were established, and Abe was awarded these prizes for the series of achievements that led to this point.

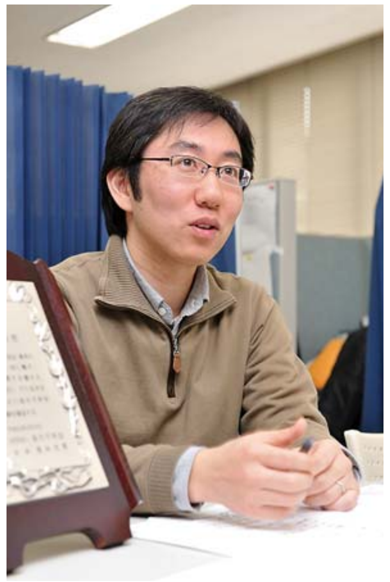
In a Ministry of Economy, Trade and Industry project that began in 2008, this material was selected as a candidate for use when building plants designed to operate at 700°C. "My dream will come true if it is actually used," says Abe. "But that may be in 20 years." Still, he looks forward to that day with great excitement.



High-strength NiMS-9%Cr steel for power plants

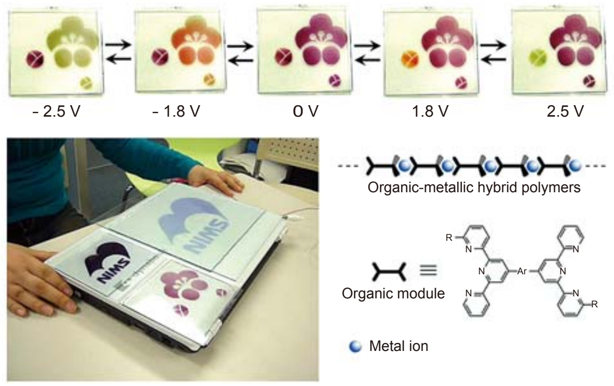
Discovering the Electrochromic Functions of Organic-Metallic Hybrid Polymers
– Making Multicolor Electronic Paper a Reality –

MANA Independent Scientist, Masayoshi Higuchi Receives the Hitachi Chemical Award from the Society of Polymer Science, Japan



Masayoshi Higuchi, who joined NIMS five years ago, is a dynamic young researcher working at the WPI Center for Materials Nanoarchitectonics (MANA) established in 2007. Although his area of specialization was organometallic compounds, he worked under a leader who specialized in polymers, and this spurred him to begin studying the polymerization of organic metal compounds. It is known that passing electricity through a solution containing organic metal compounds reverses their color; this is known as the electrochromic effect. The coloration is caused by the charge tranfer between the metal ions and the organic compound. When many molecules of this type are joined together to form a polymer, it is then possible for them to be used as a material. However, it does not normally occur to specialists in organic metals to try to turn them into polymers. Similarly, polymer specialists have little experience with molecular bonding that include metals. The successful formation of a bridge between two areas is the primary feature of this technology. Higuchi's interest and ambition were "to take it to the point where something I created could be used in the marketplace," and so he was quick to realize that this substance might be able to play a role in providing color to electronic paper.

Electronic paper is expected to become a next-generation product for the display of information. However, currently only black and white display is in the market, and for the past few years companies have struggled to find a way to bring color to electronic paper without adversely affecting its weight and flexibility. The polymer created by Higuchi has two types of metal ions and enables devices with red, blue, green and transparent display capability to become a reality. The current research objective is to find an appropriate combination of metals and organic molecules to produce multiple colors that are even more vivid and beautiful. Higuchi is very happy that his involvement with MANA has led him to receive his very first award. "I'm grateful that MANA provides an environment that allows me to freely conduct research," he says.



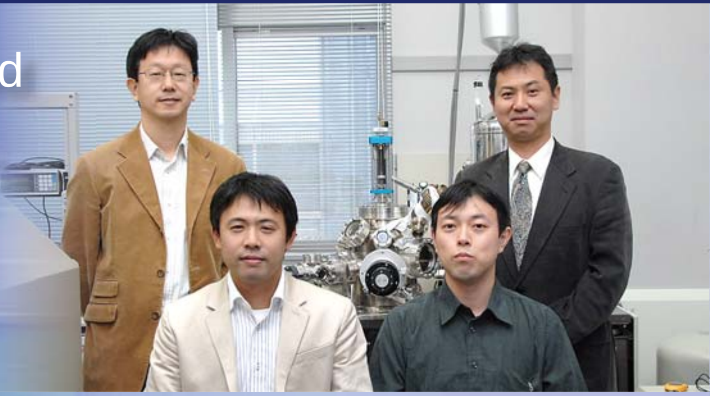
Growth of Molecular Wire and Application to Transistors

Advanced Device Materials Group,
Advanced Electronic Materials Center

Nano Functionality Integration Group,
Nano Systems Functionality Center†

Graduate School of Science and Technology,
Shizuoka University††

† Name of affiliated unit at time of research.



Yutaka Wakayama Kenji Kobayashi††
Ryoma Hayakawa Shinichi Machida†

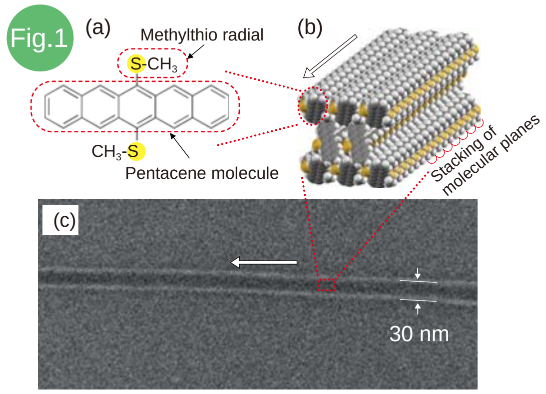
Today, the development of devices using organic molecules is actively progressing. As one advantage of these substances, organic molecules form a variety of molecular assemblies spontaneously, ranging from 0-dimensional single molecules to 1-dimensional molecular wires, 2-dimensional thin films, and 3-dimensional single crystals. For example, single molecules have attracted attention as the ultimate microdevice, and because thin films have been applied in organic transistors, etc., the development of flexible displays and similar applications is expected in the future. Improvement of charge transport is likely to be a issue in the coming years. Single crystals, in which the molecular arrangement is aligned, are advantageous from the viewpoint of charge transport, but because these materials cannot be mass-produced, they lack practicality. Molecular wires, with their 1-dimensional shape, offer a possible alternative. In fact, molecular wires have attracted interest as materials which provide both the electrical conductivity of single crystals and the flexibility of thin films. Therefore, we focused our efforts on the development of a transistor device using molecular wire.

First, we began by appropriately designing and synthesizing a molecular structure. In order to improve electrical conductivity, it is necessary to stack molecular planes, but many molecules do not form this type of arrangement. We solved this problem by attaching a methylthio radical to a pentacene molecule. When this molecule is subjected to vacuum vapor deposition, crystal growth to a wire shape occurs spontaneously, and the resulting wire is a defect-free single crystal (**Fig. 1**). As a result, we successively discovered that this wire possesses electrical conductivity one order higher than that of conventional organic semiconductors and so on. Furthermore, the fact that this molecular wire functions as a transistor was also confirmed.

Use of wire in transistors has various advantages, in that a high on-off ratio can be obtained, wires are favorable for high density integration, etc. In addition, if multiple wires are arranged in parallel and the current in each can be controlled independently, switching at the multi-value level may also be possible. This was realized using the molecular wire developed in our work. As shown in **Fig. 2**, two wires were connected in parallel, and the current in each was controlled independently by applying voltage from a probe which is normally used in electrical measurements. In comparison with the binary on-off switching in ordinary transistors, this experiment demonstrated the possibility of quaternary switching using two molecular wires (**Fig. 2**).

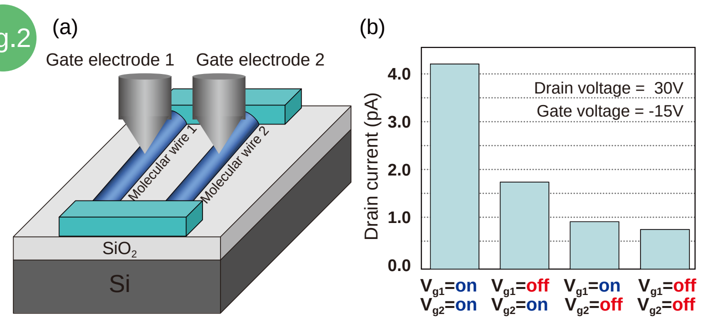
This research was carried out through joint work involving different fields, including organic chemistry, device physics, metrology science, and others. In the future, this type of interdisciplinary fusion will be indispensable in research on organic devices.

Fig.1



(a) Molecular structure, (b) crystal structure of the molecular wire, (c) electron microscope image of the molecular wire. The direction in which the molecular planes are stacked coincides with that of the long axis of the wire.

Fig.2



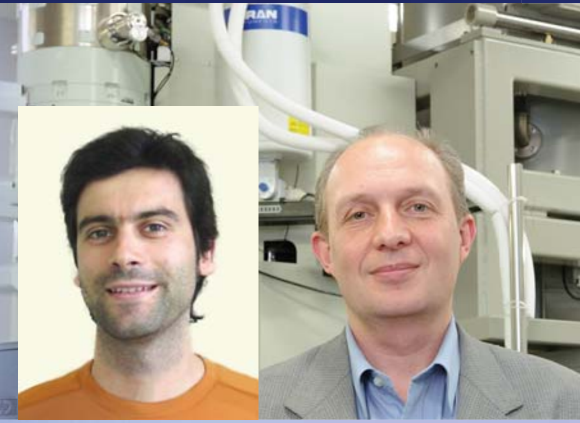
(a) Schematic diagram of the molecular wire transistor. Two molecular wires were connected in parallel, and the current in the respective wires was controlled by two gate electrodes.
(b) The total current value in the device was controlled by independently switching the voltage applied from the two gate electrodes. The device can be controlled to 4 values using the total of the "on" and "off" operations of the two switches.

Carbon Nanotube Pipette: One Drop at a Time

Nanomaterials Synthesis and Analysis Group,
Nanoscale Materials Center†

International Center for Materials Nanoarchitectonics (MANA)

(†at present, with the University of Aveiro, Portugal)



Pedro M.F.J. Costa† Dmitri Golberg

Carbon nanotubes have great potential as miniature pipettes to deliver minute amounts of drugs, but it has so far been difficult to control the amount and timing of chemical released. We have found a smart way of using nanotubes as ultimate nanopipettes to store and release attogram (10^{-18} grams) amounts of copper iodide (CuI) in a fully controlled fashion. To do so we applied weak electrical pulses (several μA) to a CuI filled nanotube in a transmission electron microscope (TEM) equipped with a scanning tunneling microscope (STM) unit.

Firstly, the multi-walled nanotubes were treated so that their ends became opened, then they were filled with copper iodide. In order to open the tubes they were subjected to a strongly oxidizing acid treatment. Then the opened nanotubes were ground gently in a mortar together with a molar excess of CuI and the resulting mixture was placed in a quartz ampoule. This was then sealed under vacuum (10^{-3} Torr) and heated for 24 h in a furnace at 873 K. Finally, the ampoule was broken and the composite products were collected for analysis. The estimated sample filling yield was ~60-70%. The CuI forms discrete crystals inside the nanotubes, which can be then released one-by-one when a current pulse is passed through a tube placed between the two gold electrodes inside TEM, **Fig. 1**. The release process is totally different to all previously reported experiments on filled nanotubes, in which crystals have broken up or melted and the filling is continuously expelled from the nanotube.

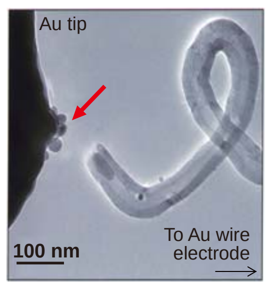
Furthermore, we found that the conductance of the nanotube increases as copper iodide is discharged, **Fig. 2**, because the edges of the CuI grains slow down charge carriers due to increased contact resistances on the grain boundaries. This means that the amount of filling left in the nanotube can be accuratelly monitored either by measuring the nanotube electrical resistance or by watching it under TEM.

The present study opens a wide horizon for the development of the prototype smart drug delivery systems under an ultimate control of the mass and timing of a chemical released from a minituare channel in a biological tissue/cell.

The research has been published *on-line* in *Nano Letters* on Aug. 28, 2008, doi: 10.1021/nl8012506, and has been nominated as a Research Highlight in *Nature Nanotechnology* on Sept. 5, 2008 doi:10.1038/nnano.2008.282, and has gotten the *Best Young Scientist Research Award* during the International Conference on *CARBON*, Nagano, July 13-18, 2008, by the *International Carbon Society*.

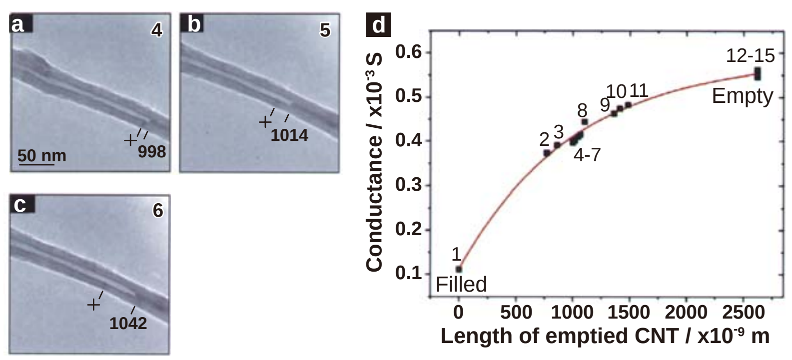
[1]Costa, P. M. F. J., Golberg D. *et al*. Stepwise current-driven release of attogram quantities of copper iodide encapsulated in carbon nanotubes. *Nano Lett*. 8, 3120 (2008).

Fig.1



A carbon nanotube pipette in action: a view of the nanotube-gold contact region displaying copper nanocrystals (arrowed) deposited in steps from a copper iodide-filled C nanotube. The nanotube was placed on a gold wire electrode (not shown, far to right), contacted to a gold tip inside TEM and sequential electrical pulses (nA range current) were passed through it.

Fig.2



(a-c) A copper-iodide-filled C nanotube experienced sequential discharge pulses inside TEM. The original filling level (cross) and the overall emptied nanotube length are marked. (d) A plot of the nanotube conductance vs the overall length of emptied nanotube. The points correspond to data where images were matched to the recorded I-V curves; e.g. the images (a,b,c) correspond to data points 4,5,6 in (d).)

Transmission Electron Microscopy

Transmission electron microscopy (TEM) is the only characterization technology which enables simultaneous structural observation with atomic level resolution, analysis, and characterization of physical properties. Because improvement of TEM imaging and analysis techniques is closely linked to the search for new knowledge in connection with materials, this advanced equipment enjoys the highest demand at NIMS. The Transmission Electron Microscopy Cluster was launched on April 1, 2008 in order to support researchers at TEM devices users and provide leading-edge materials analysis technology through shared use of TEM and further improvements in advanced TEM.

(1) Missions of the Transmission Electron Microscopy Cluster

The main missions of the Transmission Electron Microscopy Cluster are as follows.

- Maintenance, and operation of user facility TEM devices.
- Maintenance, and operation of advanced TEM devices, and developmental research on advanced electron microscope technologies.
- Education and information dissemination in NIMS.
- Implementation and coordination of joint research in NIMS.
- Device development research by acquiring large external funding.

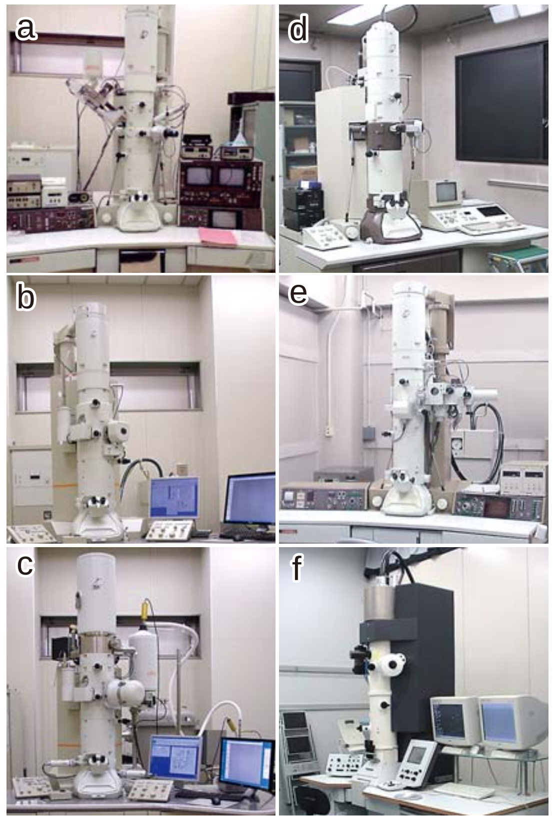
(2) Maintenance, and operation of user facility TEM devices

The Transmission Electron Microscopy Cluster currently manages 6 TEMs and various TEM specimen preparation devices and performs support work using these facilities. Photographs of the TEMs are shown in the accompanying figures. As TEM specimen preparation devices, a mechanical polishing device capable of reducing the thickness of TEM specimens to several 10µm, an ion milling device that uses the ion beam technique to reduce the thickness of TEM specimens to around 100nm, and a focused ion beam device for TEM specimen preparation which makes it possible to reduce a designated part of the specimen to a thickness of around 100nm are currently under construction. In the future, the Cluster will continue to improve its TEM-related equipment and provide research support reflecting the opinions of materials researchers.

(3) Plans for implementation of advanced TEM devices

To meet the requirements of materials research, the Cluster is engaged in implementation of the world's highest level TEM devices and development of materials characterization techniques using those devices. Members of this Cluster have investigated trends in TEM-related research in Japan and other countries and surveyed the device performance required in materials research since preparation for the establishment of the Cluster. In recent years, R&D on "single atom analysis TEM" with higher analytical sensitivity has been carried out based on the fact that material properties are controlled by the addition of trace elements and research on nanomaterials such as nanotubes is increasing. The Cluster aims to promote research and complete its equipment during FY2010, taking advantage of the accumulation of TEM research at NIMS to date.

Fig.



The 6 TEMs managed by the Transmission Electron Microscopy Cluster:
(a) 200kVTEM, (b) 200kVTEM,
(c) 200kV field emission TEM (FE-TEM),
(d) 100kVTEM, (e) 200kVTEM, (f) 200kV energy filter TEM.

Leading Researcher Dr. Takashi Nakanishi is engaged in research projects as a member of the Macromolecules Group at NIMS. Since April 2007, he has also been involved in a joint research program in Germany as a Group Leader at the Max Planck Institute (MPI) of Colloids and Interfaces utilizing "NIMS Research Abroad Program." Applying a unique approach, Dr. Nakanishi developed a fullerene thin film with a superhydrophobic property for the first time in the world, and has also undertaken the development of a fullerene soft-material with a liquid crystalline property.

Takashi Nakanishi
Senior Researcher, Macromolecules Group, Organic Nanomaterials Center, NIMS
Group Leader in MPI-NIMS International Joint Laboratory, Max Planck Institute of Colloids and Interfaces
PRESTO Research Fellow, Japan Science and Technology Agency (JST)

Developing Sustainable and Multi-talented Materials through Simple Organic Synthesis and Molecular Organizations

What made you start your current research?

I joined NIMS in April 2004. For my research project I selected the fullerene as a material which can lead to the development of multi-functional materials. Because fullerenes can be chemically modified in organic synthetic manners and also have the inorganic nature of carbon, I believe that fullerenes have the diversified potential to lead to materials. By assembling molecules and arranging them in various morphologies, I realized that it would be possible to explore for substances with the potential to become materials based on their morphology.

Concretely, what method did you use?

Because fullerenes readily assemble and form random aggregates, intentional and precise control of the morphology was extremely difficult. Therefore, I modified fullerenes by attaching a substituent part corresponding to legs. By skillfully manipulating the balance between the two, it became possible to selectively produce assembly structures with various shapes using one same molecule.

In modifications, did you use only alkyl chains?

Here, I modified fullerenes with long alkyl chains and changed the type of the organic solvent in which the molecules were dissolved. It is possible to prepare infinite types of solvents, and appropriate conditions can be found among these. One recent result was the development of a microparticle material with a jagged flake-shaped structure at the outer surface. This surface has a superhydrophobic property, and thus has a self-cleaning function, shedding water like a lotus leaf. This was the first time in the world that a superhydrophobic thin film was developed using the fullerene as the material. As a distinctive feature of this material, it is possible to recover and reuse the original material if it is dissolved with a solvent suited to the conditions.

Conversely, if molecular design is performed in such a way that assembly of the fullerenes is completely prevented by combining fullerenes and alkyl chains, the result is a substance which is a "liquid" at room temperature. In my latest research, I developed a "liquid crystal material", which is self-organized at the molecular level while displaying the fluidity of a liquid, depending on the applied temperature. These liquid and liquid crystalline materials also possess the semiconducting and redox-active nature of the fullerene. In the course of my work to date, I have gradually come to see the possibility of using fullerenes as a bulk-scaled material. Because the molecules that I have prepared are the result of simple organic synthesis (only 2 steps), I believe that they have high potential as organic soft-materials. It is noteworthy that it is possible to keep a fullerene content of approximately 50% in the molecules produced by this method. In the future, I would also like to perform simpler optimization towards practical applications of organic soft matters.

Please tell us about your experience at the MPI, where you hold a position as a Group Leader.

A director at the MPI clearly told us "quality is rather more important than quantity." MPI focuses on basic and fundamental science much more than NIMS. In the evaluation of the field of chemistry in Germany, MPI Colloids and Interfaces to which I belong, holds the top position among research institutes and universities, it is necessary to steadily improve the quality of research to maintain that position.

How do you conduct research at both NIMS and MPI?

I do research at the two institutes in parallel. I understand the work that I've done at NIMS more deeply in the environment at MPI, and my results at MPI are useful as feedback in materials research aiming at applications at NIMS. This project at MPI will continue until March of 2010.

What is your next goal?

You may have an impression that the stiffness of organic materials is inferior in comparison to that of inorganic materials. Conversely, I would like to take advantage of control of the complex shapes and morphologies which is possible with organic "soft-matters", and transcribe that to inorganic "hard-matters". If it is possible to use one material in a variety of applications by recovering and reusing organic materials, this can contribute to a sustainable science (society). I think that this kind of "multi-talented material" can be realized precisely because these are organic substances.

NIMS Illumination

– The final collaboration with neighborhood –

Stepping back in time 17 years to 1992, National Research Institute for Metals, which was one of the predecessors of NIMS, was constructing a new main research building at Sengen for relocation from Tokyo. At the time, Tsukuba Science City was pitch-black dark at night. In that dark, lonely landscape, the construction workers hit on the idea of illuminating the Tsukuba night with Christmas lights, and began to light a large Christmas light illumination on the wall of the 8-story building.

Today, multicolored lights can be seen in the town, but in those days, this was such an epoch-making idea that the streets around the building were crowded with sightseers who were visiting to see the Christmas lights. NIMS also received many letters and phone calls from people who were moved by the display.

The following year, when the Institute had just moved into its new building, it invited students from a nearby elementary school to submit designs as part of efforts to strengthen its friendship with the neighboring community. Following this, selection of a work submitted by 6th grade students became an annual custom. Each year, volunteers and an Illumination Committee made up of NIMS researchers create the work, which is as large as 8m in width and 16m in height, using on a design drawing based on the themes of Christmas and the sign of the coming year in Chinese astrology. The students who submitted the design help in putting on the finishing touches. Parents are invited to the Lighting ceremony and share in the joy of this event. We think that this event not only deepens communications between NIMS and the community, but perhaps also inspires hopes and dreams in the 6th graders, who are nearing graduation, when they see their own designs lighting up the night sky so magnificently.

The Lighting ceremony for the final NIMS illumination, which so many have loved for so long, was held in the evening on December 12, 2008, with many students and their parents watching. As a present to NIMS, a chorus of elementary school students sang an anthem filled with appreciation. Dr. Fujitsuka, the Chairperson of the Illumination Committee, who had been involved with this event since the first year, concluded the ceremony with remarks charged with the heartfelt hope that "everyone will grow up to become NIMS researchers, and one day you will begin this Illumination event once again."

The NIMS Illumination was concluded on January 7, 2009, bringing an end to the 16 year history of this event.

We at NIMS wish to thank all those concerned for their cooperation.

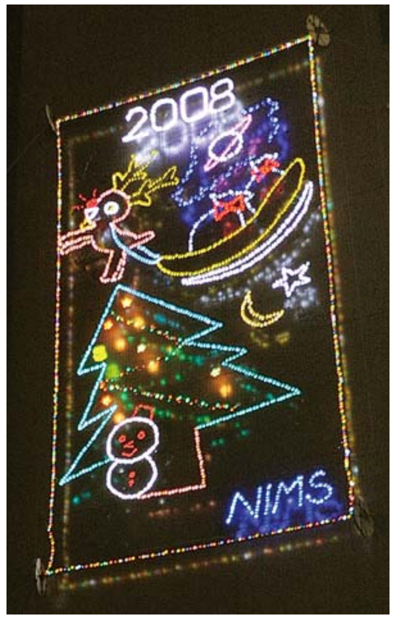
The 1st NIMS Illumination in 1992

First use of blue/white LEDs (2000)

The TX'mas Illumination commemorating the start of Tsukuba Express (TX) rail service in 2005

Elementary students putting on the finishing touches

Dr. Fujitsuka giving instructions



2008-2009: The final NIMS Illumination

NIMS NEWS

NIMS President Kishi Receives the 1st Kishinoue Award

(Dec. 10, 2008) Prof. Teruo Kishi, President of NIMS, received the 1st Kishinoue Award at the 19th International Acoustic Emission Symposium – IAES-19, which was held at the Fukui Institute for Fundamental Chemistry at Kyoto University December 8-12, 2008. The award is named after Prof. Kishinoue of Tokyo Imperial University, who published the world's first paper announcing the measurement of acoustic emission (AE) in 1934. It is given for outstanding research achievements in international conferences on AE sponsored by the Ad Hoc Research & Technical Committee on Acoustic Emission of the Japanese Society for Non-destructive Inspection.

The Kishinoue Award was presented to Prof. Kishi in recognition of his research on "Non-destructive Evaluation Method for Materials by Inverse Problem Analysis of Acoustic Emission" while at the University of Tokyo and his distinguished contributions in the above AE Research Committee. Following a special lecture by Prof. Kishi on "New Trends in Materials Research and Non-destructive Evaluation" in the afternoon on December 10, the award ceremony was held at the Holiday Inn Kyoto Hotel.

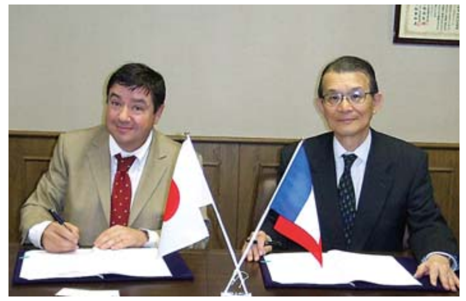
Prof. Kishi receiving the Kishinoue Award from the Chairman of the Ad Hoc Research & Technical Committee on AE.

Saint-Gobain and NIMS Begin Research Collaboration

(Nov. 25, 2008) Saint-Gobain, the French global company, and NIMS, have taken the first step for a long-term research collaboration on various aspects of materials science. The first collaboration contract was signed on November 25, 2008 by Prof. Kishi, president of NIMS, and Dr. Roux, R&D Vice-President Saint-Gobain. The project will focus on combinatorial materials.

Saint-Gobain is a world leader in materials for the construction markets, headquartered in France, with about 210,000 employees and manufacturing plants in 57 countries (including 8 manufacturing plants and 870 employees in Japan).

The joint research now underway marks the first step toward many other collaborative research efforts in the future, and through the long-term partnership between the two, will help to create opportunities for both parties to utilize the results of research on various leading-edge materials in developing practical products.



Dr. Roux, R&D Vice-President of Saint-Gobain(left) and Prof. Kishi at the signing ceremony

Deepening of Int'l Cooperation with Nanjing University

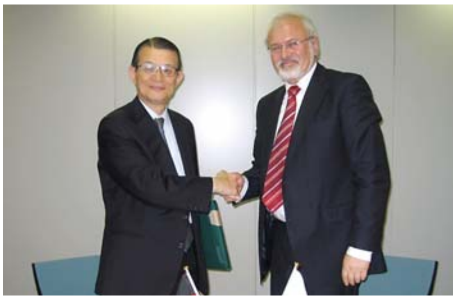
(Nov. 7, 2008) An International Joint Graduate School agreement between NIMS and China's Nanjing University was concluded during a visit by a four-person delegation from Nanjing University, which was led by President Chen Jun. In line with the aim of the agreement to receive undergraduates at NIMS, a certain number of graduate students will be accepted at NIMS each year. The Chinese party also toured the NIMS Center for Nanotechnology Network and the International Center for Materials Nanoarchitectonics (MANA).

(Jan. 9, 2009) A party of NIMS led by President Prof. Teruo Kishi made a courtesy visit to Nanjing University in China, and held a mini-workshop introducing recent research at the two institutions in the field of materials science, including research on nanotechnology materials and photocatalyst materials. NIMS and Nanjing University have previously concluded two memorandums of understanding (MOU) on international joint research, a sister institute agreement, and an international joint graduate school agreement. This visit is expected to contribute to deeper collaboration and cooperation between the two institutions in the future, such as holding periodic workshops, etc.

A scene from the mini-workshop at Nanjing University

NIMS Concluded a Sister Institute Agreement with Germany's Karlsruhe Research Center

(Oct. 17, 2008) NIMS signed a sister institute agreement (comprehensive research cooperation agreement) with Germany's Karlsruhe Research Center. The Karlsruhe Research Center is affiliated with the Helmholtz Association in Germany, and is a representative German COE in the field of nanotechnology. It is also the leading organization for Germany's important nanotechnology network, NanoMat. Under the agreement, the two sides will promote joint research and exchanges of human resources.



Prof. Eberhard Umbach and President Kishi of NIMS shaking hands at the signing ceremony.

MANA International Symposium 2009

The International Center for Materials Nanoarchitectonics (MANA) at NIMS is pleased to announce that the Second MANA International Symposium will be held in Tsukuba on February 25 - 27, 2009.

Presentations will be given by confirmed invited speakers from UK, Germany, USA and Japan, and by members of MANA and ICYS. The symposium will focus on the four fields, Nano-Materials, Nano-Systems, Nano-Green and Nano-Bio. The main aim of this symposium is to bring together experts in these fields, and to promote the research achievements of the MANA project.

For details: http://www.nims.go.jp/mana_2009/

Hello from NIMS

Al salamo alikom　アッサラーム アラエクム　السلام عليكم

Maybe some of you will be surprised by this greeting; it is the Islamic and Arabic greeting which can be used at any time of the day or night. Its meaning is "Peace be upon you" which reflects the deep morals of all people of this race. It is very simple and I hope that all of you can practice it. It is written in Katakana, English, and Arabic, so please try it in a funny way.

My name is Moataz M. Mekawy, and I was born and raised in Cairo, Egypt by a very kind and warm-hearted family. I graduated from Cairo University, Faculty of Science, and started my career at an international company dealing with analysis and instrumentation, which gave me the chance to travel and meet many nationalities and to get a better understanding of them. I then joined Tohoku University, Graduate School of Science, where I gained research knowledge in analytical chemistry and material sciences. I joined NIMS in September 2008. You can see that I have lived in many societies, and worked in pure business, pure academia, and pure research. In NIMS, I am with the Innovative Materials Engineering Laboratory, Materials Interdisciplinary Group.

Moataz M. Mekawy (Egypt)
September 2008 - present
Materials Interdisciplinary group, Innovative Materials Engineering Laboratory

[Golden Pavilion (*Kinkakuji*) at Kyoto]

Although I have not been at NIMS for long, I feel that most of the NIMS staff that I have interacted with have a kind heart and cooperative personality. I can say that the way of life in NIMS is completely different from others. I have visited many places in Japan and I hope to be able to visit the whole country. Moreover, I'm a big fan of Japan's first international soccer team, as well as *Gamba Osaka* and *Vegalta Sendai*.

Usually the first period is the most difficult at any place; I look forward to the opportunity to interact with all NIMS staff, both inside and outside the laboratory.

Thank you and best regards, *douzo yoroshiku*.

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