NIMS NOW International

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NIMS roundtable –

Internationalization from Foreign Perspectives

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NIMS has dramatically increased its staff numbers in the last several years, including its roster of foreign staff. But still, attracting the best research staff is a continuing problem for NIMS and other research organizations.

NIMS NOW asked NIMS Fellow Dr.Ushioda and senior NIMS researchers to discuss the issue of internationalization, from the point of view of foreign permanent researchers.

NIMS NOW: Why is NIMS so enthusiastic about internationalization?

Dr. Ushioda: Well, there are various factors. On the practical side is the fact that we need more talent from abroad — I don't think we have the number or variety of talented researchers we will need in the future.

We're competing with the U.S., for example, which has several advantages in science – they are bigger and richer; they speak English, which is the international language of science; and they import the best talent from abroad. In comparison, most scientific research staff in Japan are domestically trained, mostly with little experience outside these islands, so from a global competitive standpoint, we need to attract talented people from all over the world.

Dr. Andreas Doenni, International Coordinator
International Affairs Office

Dr. Jinhua Ye, MANA Principal Investigator
Managing Director,
Photo Catalytic Materials Center

The other benefits we hope to gain are, first of all, having our staff, scientific and administrative, able to work with people from outside Japan. It's cheaper to have foreigners come here, especially only the very good ones. Those are, I think, clearly definable benefits.

And besides, it's more fun to have different kinds of people to work with.

Dr. Golberg: When you bring together people from different societies and cultures, everybody benefits from the problem-solving skills of other nations. For example, I'm from Russia, and I spent more than 13 years in Japan. In my career, I've visited many research centers – in Germany, Australia, the U.S., France, the U.K., Belgium, Mexico, all over. So I have rich experience in international communities. I've found that it is much easier to do science if you have different nationalities on your team.

For example, Russia has a different system of education — in math and physics, we get a lot of problems that we have to solve from the beginning without being told how to do it. You have to use your own way of thinking. Here it's a very different attitude – you go for perfection, but you usually have an example of how to do it. In Russia, people are eager to solve problems in a different way from any other people.

In Japan the *sensei* is like a guru, so students and researchers would never say, "You are wrong." But in Russia and other European countries, it is vice versa. Both these ways are not good, I think. But if you mix the two attitudes, it's like a melting pot, and you can get much more creative results.

I'm quite happy to be working here, because in many ways NIMS is the best institute in the world. I have worked in many research organizations. Here we have much more freedom to solve problems without pressure from management. That is why I came here to study nanotubes. At that time it was a relatively new field, and people didn't know much about them.

I think it's important to have people with different problem-solving skills. I must say, with respect to making very precise, accurate experiments, the Japanese are the best scientists. But when you're doing something new, maybe they need a spark, a push – if you don't have that, it's very difficult to do creative research.

Dr. Doenni: Regarding internationalization, I am from Switzerland, a small country, but with four different official languages, so even inside the same country, the atmosphere is already international. The native language as well as the mentality is very different for the people living in the South of Switzerland near Italy, in the West of Switzerland near France or in the Northeast of Switzerland near Germany and Austria.

In contrast, Japan is an island country with only one language and still very few foreigners. So many Japanese don't get enough opportunities to experience an international atmosphere and to practice communication to the international community in a foreign language. Once internationalization has made enough progress in Japan, it will bring a lot of benefits to the Japanese people.

Dr. Ye: When I came to Japan more than 20 years ago, this was very much a closed country. It was very difficult to find a job in Japan for foreign nationals, not only at the universities, but also in the national labs. Nowadays it is quite different, but still, not only NIMS but also other research labs must take this into consideration.

People might ask, why internationalization? Why now? When competing in the international arena, science and technology are very important in determining the status of a country. This is especially true nowadays, with all the environment, energy and resources problems, and it also applies to human society.

In the U.S., they started a long time ago exploring ways to better use human resources. For example, universities in the U.S. offer scholarships and fellowships to the best students, even undergrads. They even go to other Asian countries to recruit very young science students. The Japanese government has realized it must take this kind of approach as well.

In Japan in recent years, young people have not been going into science. Another problem is the decline of the population as a whole. From this point of view Japan really has no choice but to internationalize.

Dr. Ushioda: That's true. When I taught at grad school in California, we used to say, "Where are the Americans?" Most of the grad students were Chinese or Indian. Americans were not going into science, opting instead for banking, business, law, medicine, etc. I think that trend is propagating here. In the U.S., that's ok, because the foreign researchers stay, and it's a nation of immigrants. But Japan has difficulty in that regard; Japanese society is not used to interacting and competing with other societies.

The government has decided to boost the number of foreigners, particularly in science, but there are many problems, especially with language.

Dr. Golberg: There are especially problems related to the use of *kanji*. Spoken Japanese is relatively easy to learn; the grammar is not so difficult. But most time-consuming is *kanji*. So for most Chinese people it's easier, they can understand immediately, but for me, I have to keep studying *kanji* all my life.

(*kanji* : Japanese writing system using Chinese characters)

Dr. Ye: I think in a few years China will be competing with Japan and the U.S. to get good people from around the world. Now the salary is not high enough, and not so many foreigners are working in China. But in 10 years probably the situation will change.

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

Dr. Dmitri Golberg, MANA Principal Investigator
Group Leader,
Nanomaterials Synthesis and Analysis Group
Associate Professor, University of Tsukuba

NN: What is the reputation of NIMS overseas? Is it well known?

Dr. Doenni: The name NIMS is an important trademark. When I go somewhere, many people have heard of NIMS. If only about the statistics, which are impressive. The remarkable achievements in the last years are a result of the strategy chosen by the NIMS president, Prof. Teruo Kishi.

Dr. Ushioda: And credibility and the reliability of data are more important factors.

Dr. Doenni: Another interesting factor is how people treat you when you attend an international conference. Many scientists know about NIMS. But when I give them my name card they say, "Oh,you're from Japan! You don't look Japanese!" No one tells a participant from America that he doesn't look American. But if you're European-looking and come from Japan, people are surprised and don't believe that it is possible. The widespread belief is that not so many people can get a permanent positions in Japan. We have to change that perception.

Dr. Golberg: Tsukuba is the best place for this. I went to some countryside places in Kyushu and children looked at me like I'm from outer space. They've never seen a real European face before. But in Tsukuba there are many foreigners, and it's very international. The population is 200,000, and 7,000 of them are foreign researchers.

NN: Some of you are international coordinators. What do you do as international coordinators, and what have your results been?

Dr. Doenni: During the last 17 years I have lived in Japan most of the time. For more than 10 years I have done coordination of international research collaborations, mainly between Japan and Europe. I have used my large network of personal contacts to help scientists from Japan and Europe to get access to interesting high-quality experimental facilities. Later for several years I have worked in international business management, and since November 2007 I have been doing international research management here at NIMS.

In my present position I want to contribute a lot to the further progress of internationalization of NIMS. It is important to bring more excellent foreign scientists to NIMS. We need to actively recruit the best young scientists through personal contact, rather than just making advertisements.

During the successful ICYS (International Center for Young Scientists) program from 2003 to March 2008, internationalization of NIMS has made visible progress. Now with the new MANA (International Center for Materials Nanoarchitectonics) project, which started in October 2007, internationalization of NIMS can make huge progress. I'm working for the MANA project and I have already succeeded in opening all four planned MANA satellite institutions in Europe and the U.S.. But MANA is a long-term project of 10 years. We are still just at the beginning and within the next years the structure of the MANA project may be dramatically changed.

Dr. Ye: I come from China, so I have very strong ties with lots of universities in China. I came to Japan as an exchange student, along with about 50 excellent young students. More than half of them are now in very important positions in Chinese universities. I am also an adjunct professor at Nanjing University, one of the top five universities in China, and so I am in a good position to find candidates for joint research at NIMS.

For Chinese, the first choice is the U.S., I have to admit. Second is Europe, and third is Japan. It's not only the language, it's also career prospects. Until now only a few positions have been offered to foreign researchers in Japan. That is changing, but the belief among the scientific community is still there.

So one of my functions is to try and break down such stereotypes. And I always give NIMS as an example. I tell people that we have many foreign researchers, who are permanent staff, and are treated very well, and some of them have been promoted to very responsible positions.

Dr. Golberg: I started working with the University of Tsukuba (UT) in a joint doctoral program called the NIMS Course* about 5 years ago. At that time, about 18 researchers from NIMS were appointed professors, of whom I was one.

This is a good tie-up, because of the reputation of UT and NIMS. UT is one of the top schools in Japan; it boasts three noble prize winners, and it has a reputation as a top scientific institution. This is complemented by the reputation of NIMS – when you merge these two famous institutions, you get very nice, attractive, powerful organization.

NIMS has about 20 high-resolution transmission electron microscopes, whereas UT has maybe three or four. To have a session on a TEM, people have to wait four to five weeks sometimes; at NIMS you don't have to wait at all. NIMS has an extraordinary experimental base; it's one of the strongest experimental institutes in the world, and you could have easy access after training.

At NIMS you can work by yourself. For young people this is very important, because they can take courses at UT by very famous professors, then they go to NIMS and use outstanding facilities.

Recently I had a good example of how things are changing: this year, for the first time, a Japanese young researcher approached me and asked, "Prof. Golberg, could you be my supervisor?" Usually if you have many Japanese professors and one foreigner, the Japanese young men will choose the Japanese for their supervisor. They are very shy – maybe they don't speak good English, or they want a more regular Japanese professor or something. This was a real sign of change; Japanese students are changing.

NN: What are the targets for NIMS?

Dr. Ushioda: In practical areas, I think we need to change. But cultural, non-practical aspects of society, for example cultural practices and flavor, should be retained, not globalized or internationalized.

My ideal is to nurture at this institution an environment at which anybody can come here and can feel that he or she can get things done, can do good science, no matter where he or she comes from.

* The doctoral program in Materials Science and Engineering at the University of Tsukuba
http://www.nims.go.jp/graduate/english

NIMS Permanent Researchers from Overseas

NIMS has 274 foreign researchers from 32 countries (as of July 2008). Over forty people became permanent staff under the tenure track system. They make siginificant contributions to the research at NIMS.

Nanoscale Materials

- Renzhi Ma, China — Soft Ionics Group, Nanoscale Materials Center
- Dmitri Golberg, Russia — Group Leader Nanomaterials Synthesis and Analysis Group, Nanoscale Materials Center
- Chengchun Tang, China — Nanomaterials Synthesis and Analysis Group, Nanoscale Materials Center
- Chunyi Zhi, China — Nanomaterials Synthesis and Analysis Group, Nanoscale Materials Center
- Byung-Nam Kim, Korea — Fine-grained Refractory Materials Group, Nano Ceramics Center
- Rong-Jun Xie, China — Nitride Particle Group, Nano Ceramics Center
- Byung-koog Jang, Korea — Fine Particle Processing Group, Nano Ceramics Center
- Jiguang Li, China — Plasma Processing Group, Nano Ceramics Center
- Jian Jin, China — Functional Thin Films Group, Organic Nanomaterials Center
- Xinsheng Peng, China — Functional Thin Films Group, Organic Nanomaterials Center
- Mi-Jeong Kim, Korea — Macromorecules Group, Organic Nanomaterials Center
- Jonathan P Hill, UK — Supermolecules Group, Organic Nanomaterials Center

Materials Research for Environment and Energy

- Yuefeng Gu, China — Group Leader High Strength Materials Group, High Temperature Materials Center
- De-hai Ping, China — High temperature Materials Group, High Temperature Materials Center
- Dongfeng He, China — SQUID Group, Superconducting Materials Center
- Jinhua Ye, China — Managing Director Photocatalytic Materials Center
- Je-Deok Kim, Korea — Nano Ionics Materials Group, Fuel Cell Materials Center
- Fei Ye, China — Nano Ionics Materials Group, Fuel Cell Materials Center
- Ya Xu, China — Intermetallic Catalysts Group, Fuel Cell Materials Center
- Alok Singh, India — Lightweight Alloys Group, Structural Metals Center

Nanotech-driven Materials Research for Information Technology

- Encarnación Antonia García Víllora, Spain — Frequency Conversion Group, Optronic Materials Center
- Taras Kolodiazhnyi, Canada — Optoelectronics Group, Optronic Materials Center

Nanotech-driven Materials Research for Biotechnology

- Guoping Chen, China — Group Leader Polymeric Biomaterials Group, Biomaterials Center
- Martin Pumera, Czech Republic — Biomaterial Systems Group, Biomaterials Center

Key Nanotechnologies

- Huabing Wang, China — Nano Quantum Electronics Group, Nano System Functionality Center
- Minghui Song, China — Advanced Electron Microscopy Group, Advanced Nano Characterization Center
- Igor V Solovyev, Russia — First-Principles Simulation Group(2), Computational Materials Science Center
- Anirban Bandyopadhyay, India — Advanced Scanning Probe Microscopy Group, Advanced Nano Characterization Center

Exploratory Reserch Laboratories

- Jie Tang, China — Group Leader 1D Nanomaterials Group, Innovative Materials Engineering Laboratory
- Fuxing Yin, China — Progressive Materials Research Group, Innovative Materials Engineering Laboratory
- Sherif A.El-Safty, Egypt — Interdisciplinary Research Group, Innovative Materials Engineering Laboratory
- Oleg Vasylkiv, Ukraine — Interdisciplinary Research Group, Innovative Materials Engineering Laboratory

Materials Research for Reliability and Safety

- Hai Qiu, China — Materials Creation and Reliability Group, Materials Reliability Center
- Meiyong Liao, China — Optical Sensor Group, Sensor Materials Center
- Xiaobing Ren, China — Ferroic Physics Group, Sensor Materials Center
- Christopher Mercer, USA — Composite Materials Group, Composites and Coatings Center
- Shuqi Guo, China — Composite Materials Group, Composites and Coatings Center

International Center for Materials Nanoarchitectonics (MANA)

- Alexei A Belik, Russia
- Ajayan Vinu, India
- Lionel Vayssieres, France
- Xiao Hu, China — Principal Investigator

Department of Materials Infrastructure

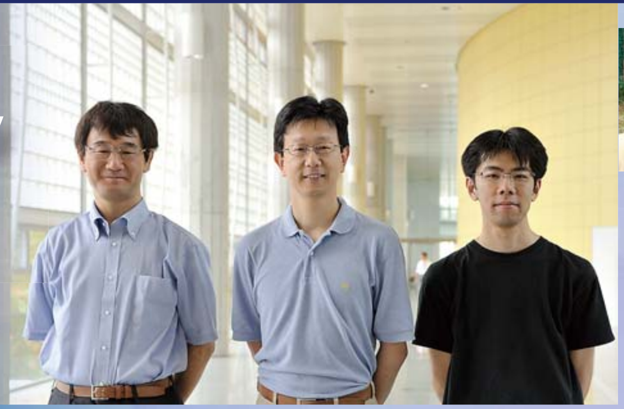
- Yibin Xu, China — Materials Database Station

Planning Division

- Andreas Doenni, Switzerland — International Affairs Office

Micro Demultiplexer Fabricated by Self-Assembly of Microspheres

- Optical Wiring Utilizing Self-Assembly Process -




Nano Physics Group, Quantum Dot Research Center

Advanced Device Materials Group, Advanced Electronic Materials Center†

Institute of Multidisciplinary Research for Advanced Materials, Tohoku University††

Tadashi Mitsui, Yutaka Wakayama†, Tsunenobu Onodera††, Hidetoshi Oikawa†† (Professor)

In recent years, optical communication in integrated circuits has attracted considerable interest as an approach to achieve high speed in computers, as it is becoming increasingly difficult to cope with the amount of data processed in circuits and transmission speed with conventional electrical wiring. However, arbitrary wiring with bending radii of several μm or less is not possible with conventional optical waveguide because the difference in the refractive indices of the light path and the outer part is small, resulting in light leakage.

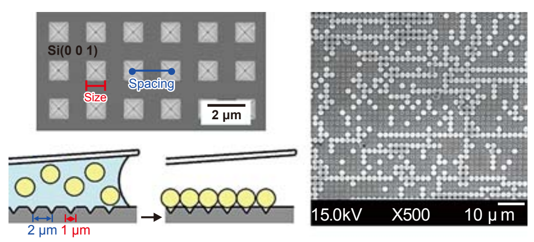
In order to overcome this problem, much attentions are focused on optical wiring fabricated by coupling optical resonators with a size of several μm. (Technically, this is referred to as a coupled-resonator optical waveguide, or CROW.) Because these optical resonators can be made from material with a high refractive index and can be fabricated to a ring or disk shape, light can be confined within it and forced to travel in a circular path in the interior. The function as waveguide is realized by successively transmitting light between adjacent resonators with no difference in refractive index. In particular, because spherical optical resonators have high symmetry, their orientation does not affect to optical properties. This means that it is possible to arrange the resonators by self-assembly using the phenomenon in which structures form naturally in a solution. From this viewpoint, realization of an energy saving process can also be expected. We fabricated microsphere wiring with 90° bends using a lithographically-patterned silicon substrate as a template (**Fig. 1**, upper left). When an inclined sheet of glass was placed above the substrate and an aqueous suspension containing microspheres with an diameter of 2μm was injected into the space between the two, the interface retreated as drying progressed, and as a result, the microspheres were captured on the template (**Fig. 1**, lower left). From a scanning electron microscope (SEM) image of this optical waveguide (**Fig. 1**, right), it can be understood that linear parts with a length of several 10 times of μm have formed, and 90° bending parts exist at a number of points.

Next, we observed the propagation of light at these branching points with a near-field scanning optical microscope (**Fig. 2**, upper left). Light emitted from a microsphere containing a fluorescent dye arranged at the end of the CROW propagated through it, and the light was collected with optical fibers placed near Point A and Point B and measured (**Fig. 2**, lower left). Two resonance peaks were observed in the spectrum measured at Point A, but of these, in the spectrum measured at Point B, the intensity of the peak on the short wavelength side (transverse magnetic mode: TM16,1) was weak (**Fig. 2**, right). This is thought to be because the light with the peak on the short wavelength side cannot resonate with the next microsphere at the branching point. This phenomenon shows that the CROW itself has a splitting (demultiplexing) function which selects out light of an arbitrary wavelength from multiplexed wave with multiple wavelengths, and suggests the possibility of even larger volume transmission in optical waveguide for integrated circuits.

These research results were obtained as part of the collaborative project between NIMS and the Institute of Multidisciplinary Research for Advanced Materials of Tohoku University.

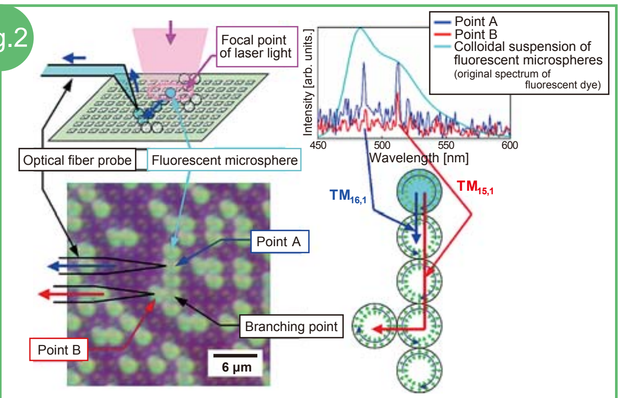
T. Mitsui, et al, Opt. Lett. 2008, 33, 1189-1191.
T. Onodera, et al, Jpn. J. Appl. Phys. 2008, 47, 1404-1407.
T. Mitsui, et al, Nano. Lett. 2008, 8, 853-858.

Fig.1



(Top left) SEM image of substrate prepared by patterning.
(Lower left) Self-assembly process using the capillary phenomenon.
(Right) Microsphere optical wiring formed on the patterned substrate.

Fig.2



(Upper left) Schematic diagram of the near field microscopy. Violet laser light (wavelength: 405nm) is irradiated with an objective lens, exciting the fluorescent microsphere.
(Lower left) Optical microscope image of CROW and the positions of measurement of the propagation light.
(Upper right) Spectra of the propagation light. Shown in light blue is the spectrum of the fluorescent dye.
(Lower right) Schematic diagram of light splitting and wavelength selection by resonance mode.

Research Highlights

Nanosensor Design for Efficient Naked-eye Sensing of Multiple Toxic Metal Ions


Materials Interdisciplinary Group, Innovation Materials Engineering Laboratory

National Institute of Advanced Industrial Science and Technology (AIST), Sendai†

Sherif A. El-Safty, Adel A. Ismail†, Hideyuki Matsunaga†, Takaaki Hanaoka†, Fujio Mizukami† (Director)

Human health risks associated with the increased release of toxic metals have drawn attention to their vectors of presentation. The complete remediation of trace amounts of these toxic ions are of particular interest in environments. Because most pollutants in various environments are at concentrations far below the detection limits of the most commonly used treatment methods, there is a growing demand worldwide to develop optical chemical sensor materials for accurate and rapid detection and for selective recognition of pollutant species. To make optical sensors more applicable for high-grade analytical demands, problems in their visual sensing systems that make them unattractive candidates for detection of analytes need to be solved, such as non-flexible, intensive design strategies, relatively high operating cost, and long real-time detection.

Here, we extensively report a simple yet general method that we called the "building-blocks" approach of optical nanosensors. This strategy is an approach based on a dense pattern of immobilized hydrophobic and hydrophilic receptors with intrinsic mobility via extremely robust constructed sequences onto 3D nanoscale structures without the common use of silane- or thiol-coupling agents. For instance, the polarity of the 3D HOM monoliths was fine-tuned by the dense dispersion of cationic surfactant such as dilauryl dimethyl ammonium bromide (DDAB), **Scheme 1**. This design enabled control of possible leaching out of all possible probes used during the ion-sensing recognition and the naked-eye detection of multiple metal ions, as we recently reported.[1]

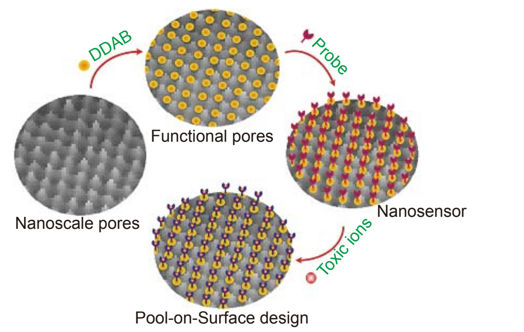
A key advantage in this approach is the ability to create highly accessible, flexible, and fine-tuned surface probes that make the character of the sensing systems likely to be pool-on-surface in which high flux of the metal analytes across the indicator molecules is rapidly achieved. Evidence for the fidelity of control design of optical nanosensors was that the "pool-on-surface" sensing systems exhibited efficient recognition and signaling of multiple metal ions. Key to our development design is that although these probes are used for sensing recognition of metal ions in solution up to ~10^{-6}-10^{-7} mol/dm^3, our nanosensors enabled to create sensing responses with revisable, selective and sensitive recognition down to sub-picomolar (~10^{-11} mol/dm^3), for first time, in rapid sensing responses (in the order of seconds), **Fig. 1**.

In fact, the building-blocks approach also offers long-term stability of the sensing systems. No degradation of the optical efficiency of the pool-on-surface sensing in terms of their functionality was detected, despite long-term storage (~1 year). Such advantages are the key in developing this approach to become the optimal method used to increase the visual detection of multiple metal ions.

[1] S. A. El-Safty, A. Ismail, H. Matsunaga, T. Hanaoka, F. Mizukami, Adv. Funct. Mater. 2008. 18, 1485-1500.

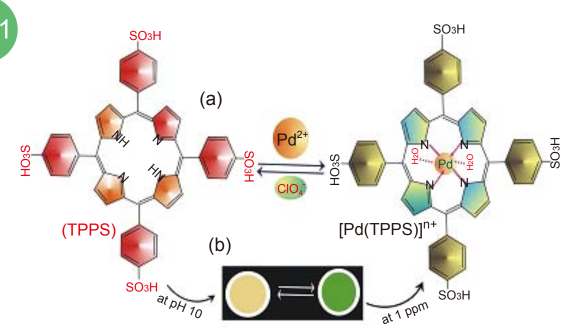
Senior Researcher, Sherif A. El-safty started this research when he belonged to AIST. He moved to NIMS as a permanent researcher in April, 2008, and continues his outstanding research.

Scheme 1



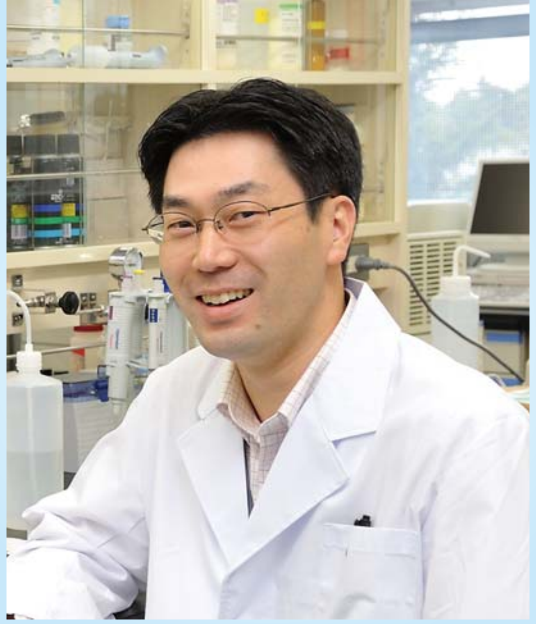
Representative design of pool-on-surface sensing system of toxic metal ions in aqueous water by the sequential construction of hydrophobic and hydrophilic chromophores that have different molecular sizes and character onto 3D HOM pore surfaces "carriers" via building-blocks approach.

Fig.1



The formation of the metal-to-ligand charge transfer [M-Probe]$^{n+}$ complexes (a) and the "naked-eye" color changes (b) during the recognition of Pd^{2+} ions using tetraphenylporphine tetrasulfonic acid (TPPS)-doped pool-on-surface design at specific pH of 10.
Note: The possible induction of the reversible sensing systems was observed by adding the $C_2O_4^{2-}$ anion as a stripping agent.

In surgical operations, time in surgery can be reduced and the physical and mental stress on the patient can be alleviated if incisions can be closed with an adhesive rather than sutures. The medical adhesives now in use either have high adhesive strength but cause an inflammation reaction, or do not cause an inflammation reaction but have the drawback of low adhesive strength. Senior Researcher Tetsushi Taguchi of the Biomaterials Center developed a patient-friendly adhesive which solves these problems and possesses excellent adhesive properties. Based on this achievement, Dr. Taguchi received the Young Scientist Award of the Minister of MEXT (Ministry of Education, Culture, Sports, Science and Technology) for fiscal year 2008 in the field of science and technology for "Research on Materials Technologies for Bonding Interfaces of Biological Tissues."



Tetsushi Taguchi, Senior Researcher
Biomaterial Systems Group, Biomaterials Center

Development of Medical Adhesive with Low Toxicity and Excellent Healing Effect

How did you conceive of the idea of an adhesive using polymers?

I was a member of a research team under Dr. Junzo Tanaka, who is now a Professor at Tokyo Institute of Technology, but at the time was the Managing Director of the Biomaterials Center at NIMS, in the research field "Structure and Functions of Polymer Composite Systems," which was working on the theme of creating regenerative medical materials in the CREST Program (CREST: Core Research for Evolutional Science and Technology) of the Japan Science and Technology Agency (at the time, Japan Science and Technology Corporation). I was in charge of developing the materials for cartilage and for the interface between hard tissue and soft tissue. Later, when I had joined NIMS and was beginning new work, I was looking for a theme with a high level of originality. In this process, my attention was drawn to the crosslinking reaction which occurs when a mixture of a polymer solution and cells is injected into the body and hardens.

So, it was a beginning of your research on crosslinking agents?

Crosslinking agents are used in medical adhesives, but mainly-used aldehyde based crosslinkers are not patient-friendly, as they display toxicity. For this reason, I decided to investigate crosslinkers which enable to crosslink polymers. To create a patient-friendly adhesive, it is preferable to use a substance that exists in the body, but this is basically limited to the amino acids and organic acids. I thought that I would try a new substance from among these which would have the potential for patenting. As a result, I eventually settled on organic acids such as citric acid, malic acid.

And you created an adhesive by mixing a polymer with these substances?

First, I studied liquid-liquid adhesives comprising a crosslinker solution and a polymer solution, but we couldn't achieve adequate adhesion property with this type. Therefore, I investigated a solid-liquid type adhesive using a crosslinker powder synthesized from tartaric acid and a polymer solution. Tartaric acid is not found in the body, but because 100% of this substance is metabolized and eliminated in the body, it can also be used in pharmaceuticals. A crosslinking reaction occurs when a crosslinker powder synthesized from tartaric acid is mixed with albumin, which is a biopolymer, and tissues are perfectly bonded. When we tried bonding skin in animal experiments, we observed a good reaction, and we found that healing is good, and the inflammation reaction is incomparably better than with aldehyde based adhesives.

What about adhesive strength?

Although aldehyde based adhesives cause an inflammation reaction, because they have strong adhesive strength, they are used in the surgery other than cardiac surgery which causes life-and-death situations. Fibrin based adhesives, which employ the blood coagulation process, don't have strong adhesive strength, but this type accounts for more than 95% of the adhesives used in Japan. However, the fibrin type can't be considered completely safe, because it's made from blood, which means there is a possibility of viral infection. As a distinctive feature of the solid-liquid adhesive made from albumin and the crosslinker synthesized from tartaric acid, because the adhesive has the property of dissolving easily in water, it displays high adhesive strength in a short period of time. In clinical use, biocompatibility is also necessary, in addition to high adhesive strength in a short time, but the new adhesive has no problems from this viewpoint. If the crosslinker synthesized from tartaric acid is used, it produces a byproduct. Even though we say that this adhesive is biocompatible, this is a matter of concern because this is a foreign substance in the body. Thus, further work will be necessary to create substances which are adapted to the individual types of tissues and organs. This will require gradual, step-by-step improvement in the respective medical departments.

What kind of research are you considering in the future?

In the cell transplantation used in treating the heart and liver, cells are injected into the affected part with a syringe, but only about 10% of the injected cells actually survive. In other words, the remaining 90% are wasted. I would like to develop an adhesive which increases the survival rate to 100%.

First, one challenge is to create materials for use in medical treatment. Another is to establish a technology for formation of organs. Of course, this is extremely difficult, but I would like to create an adhesive using a cell manipulation technique for assembling cells in 3 dimensions.

Research on Materials and Techniques for Bonding Biological Tissue Interface

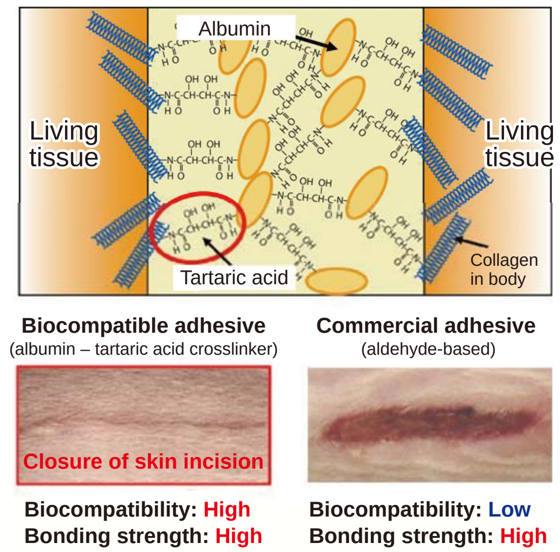
Recipient of the FY2008 Young Scientist Award of the Minister of MEXT **Tetsushi Taguchi**

After surgical operations on soft tissue such as skin, organs, and blood vessels, it is absolutely necessary to close the incision. Normally, sutures are used in closing the affected part, but a simpler, quicker closure technique using medical adhesives has been devised, and several types are already used in clinical medicine. The medical adhesives now used consist of two ingredients, namely, a biopolymer and an aldehyde based crosslinker (formaldehyde, glutaraldehyde, etc.). Aldehyde based crosslinkers act to insolubilize the biopolymer in water by crosslinking. Although this type of adhesive possesses high adhesive strength, the residual crosslinking agent in the adhesive displays toxicity, and as a result, healing is delayed.

Therefore, with the aim of developing an adhesive which does not use an aldehyde compound and provides a combination of excellent strength properties and biocompatibility, we developed an adhesive which consists of a crosslinker, in which an active ester is introduced in an organic acid such as citric acid, tartaric acid, etc. that can be metabolized and eliminated from the body as a substitute for the aldehyde based crosslinking agents, and albumin, which is a spherical protein with a diameter of approximately 10nm. An investigation of the hardening time of this adhesive revealed that its maximum adhesive strength is achieved in less than 10min, and its adhesive strength is more than 3 times higher than that of other commercial adhesives (aldehyde based, fibrin based). This high adhesive strength is attributed to the fact that crosslinkers synthesized from organic acids such as tartaric acid react not only with the albumin in the adhesive, but also with the collagen in the living body tissue (**Fig. 1**, top). The results of an investigation of biocompatibility and the skin closure capacity in animal experiments showed that degradation of the adhesive in the body and adequate tissue closure are possible (**Fig. 1**, bottom). At present, research is in progress in cooperation with universities and private companies, aiming at clinical use and practical application of this adhesive.

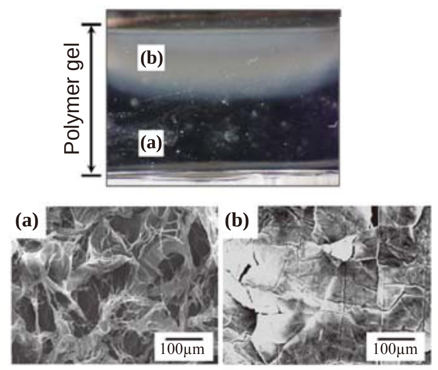
On the other hand, when bonding hard tissue and soft tissue, for example, bone and cartilage or bone and living tendon, techniques in which the soft tissue is fixed to the hard tissue by suturing or with metal screws or pins are used. However, these methods had the problem that fibrous tissue is formed between these tissues, resulting in inadequate bonding between the soft tissue and hard tissue. Therefore, the development of a hydroxyapatite (HAp: main constituent of hard tissue) formation technique which enables speedy treatment of the soft tissue in actual surgery had been desired. We developed a technique for achieving rapid gradient formation of calcium phosphate by the alternate soaking method (**Fig. 2**). This alternate soaking method is a technique in which calcium phosphate is formed at the material surface and interior by alternately immersing the material in a solution containing calcium or phosphoric acid ions. An evaluation of the calcium phosphate formed by this technique by X-ray diffraction, the infrared absorption spectrum, element analysis, and others found bone-like HAp. Using this technique, it is possible to form HAp in materials at a rate more than 100 times faster than with the conventional methods. Following sufficient biosafety testing, and a review by the Ethical Committee, a group centering on the Orthopedic Surgery Group, Institute of Clinical Medicine, University of Tsukuba (Dr. Masataka Sakane, Dr. Hirotaka Mutsuzaki, Dr. Naoyuki Ochiai) has already used this technique with six clinical patients, and has obtained favorable results.

Fig.1



(top) Bonding mechanism of biocompatible adhesive (albumin + tartaric acid crosslinker) and (bottom) closure of rat skin with biocompatible adhesive and commercial adhesive.

Fig.2



Cross sections of hydroxyapatite gradient material enabling bonding between hard tissue and soft tissue produced by alternate soaking method: (a) HAp non-formation surface, (b) HAp formation surface.

NIMS WEEK 2008

– Materials Science for Highly Efficient Use of Energy and Resources –

NIMS Week 2008 was held at the Tsukuba International Congress Center (Epochal Tsukuba) during a 5 day period from July 14 to July 18, in order to highlight the environmental and energy-related research being conducted at NIMS on the international stage, and to allow NIMS researchers to obtain advanced information and knowledge. The total number of visitors, including satellite symposiums, exceeded 1000, showing the high level of interest in environmental and energy issues.

The first day of the NIMS Conference, which was held on July 14-16, featured the Award Ceremony for the 2nd NIMS Award and a lecture by the recipients of the award. The recipients of this year's NIMS Award were a group consisting of Prof. A. G. Evans, Prof. D. R. Clarke, and Prof. C. G. Levi of the University of California at Santa Barbara, who developed a heat-resistant coating material technology for the blades used in combustion turbines enabling a broad increase in energy efficiency (Award title: "Enhancement of the Fuel Efficiency of Advanced Aero and Power Turbines through Material Innovation"). The awardees received a medal made of Ni-free, high nitrogen stainless steel, which was developed at NIMS, a certificate of the award, and a subsidiary prize. The Keynote lecture and prospective review lectures were presented after the NIMS Awardeees' lecture.

On July 15-16, nine organized symposiums were held with nearly 200 invited researchers from 18 foreign countries in the four fields of Materials for Extreme Environments, Electrical Energy Materials, Solar Energy Materials, and Light Weight Structural Materials. The lectures in these symposiums were all given by foreign and Japanese researchers who are authorities in their respective fields. Because there was no obligation to publish the proceedings, the speakers were encouraged to present the most recent research results and problems for future research. As a result, both the lectures and the discussions were rich in content and were very favorably received by the participants. It is also significant that the planning, realization, and management of this program were all left to NIMS young researchers. In the future, NIMS will make efforts to ensure that NIMS Week becomes firmly established as a forum for obtaining the world's most advanced information in connection with the materials science field.

NIMS Week URL: http://www.nims.go.jp/nimsconf08/

Keynote Lecture	Dr. Osamu Mishima NIMS Fellow	Prospects of Research Relating to Polyamorphism
Prospective Review Lecture	Prof. Teruo Kishi NIMS President	Energy Resources and NIMS
	Dr. Hiroshi Harada	High Temperature Materials for Ultra-Efficient Power Plants and Advanced Aeroengines
	Dr. Hiroaki Kumakura	Superconducting Materials for Efficient Use of Electrical Energy
	Dr. Jinfua Ye	Materials for Efficient Use of Solar Energy - Photocatalysts -
	Dr. Toshiji Mukai	Light Weight Structural Materials for Energy Conservation

Cover Photo: A scene at the NIMS Conference

(An interview with the recipients of the NIMS Award 2008 is scheduled for publication in the October issue of NIMS NOW.)

A Comprehensive Agreement with NCSU

The NCSU-NIMS Joint Workshop participants at the signing ceremony

(Jul. 18, 2008) As a part of the NIMS Week events, North Carolina State University (NCSU) -NIMS Joint Workshop was held at NIMS, Sengen-site.

A comprehensive agreement between NCSU and NIMS was signed at the workshop. Research collaboration and researcher exchange for materials for energy/environment and medicine/biotechnology, will be promoted based on the agreement. Seven Professors from NCSU, including Prof. John Gilligan, and NIMS researchers actively discussed their research collaboration.

NIMS NEWS

NIMS Signes a MOU with CISM

(Jul. 17, 2008) The NIMS Optronic Materials Center and Sensor Materials Center signed a memorandum of understanding (MOU) on "Intelligent Sensor Materials for Safety and Security" with the Center for Industrial Sensors and Measurements (CISM) of Ohio State University in the United States. Prof. Akbar, who is the founder of CISM, is a researcher with remarkable achievements in the fields of chemical sensors and electronic ceramics, and has also had previous exchanges with NIMS, for example, delivering the keynote address at the NIMS-sponsored symposium "Promotion of Sensor Materials and Technologies to Protect Safety and Security." Based on the signing of this MOU, the two institutes plan to conduct closer exchanges of research information and human resources and more active joint research in connection with sensor development.

From the left, Dr. Naoki Ohashi, Managing Director of the Optronic Materials Center, Prof. Sheikh Akbar of CISM, and Researcher Takeshi Ogaki of the Sensor Materials Center.

NIMS Signes a MOU with KIMS

(Jul. 17, 2008) The NIMS Structural Metals Center signed an MOU for research collaboration with the Department of Materials Processing, Korea Institute of Materials Science (KIMS), Changwon, Korea. KIMS was established as a subsidiary institute of the Korea Institute of Machinery and Materials (KIMM) in 2007, and is a member insitute of the World Materials Research Institutes Forum (WMRIF). Dr. Yong Tai Lee, principal researcher of KIMS, is an excellent researcher in the field of structural titanium alloys, and has had a close relationship with the titanium research group at NIMS for more than 10 years. The two institutions agreed to promote the exchange of researchers and research information and conduct collaborative research on the development and evaluation of Ti_2AlNb-based high temperature titanium alloys.

From Left: Dr. Satoshi Emura, Senior Researcher, Dr. Kaneaki Tsuzaki, Managing Director and Dr. Yong Tai Lee, Principal Researcher (KIMS).

University of Tsukuba Graduate School Programs at NIMS Nano-Foundry

(Jul. 17, 2008) The Graduate School of Pure and Applied Sciences, University of Tsukuba, which has concluded a joint Doctoral Program agreement with NIMS, conducted a course "Nano Processing /Measurement and Foundry Practice" as part of its Master's Course in the Doctoral Program in Applied Physics. The large-scale nanofoundry facilities at NIMS were used as the site of the practical exercises. This was the first attempt to use these facilities in support of the Graduate School.

This is an introductory course for students who wish to acquire nanotechnology processing techniques, and is organized so that students can grasp the outline of the subject in both the classroom and practical aspects. In the practical part of the course, students select from two alternatives, either the Device Course or the Nanomeasurement Course. The program is designed as an experiential type course which is conducted in an integrated manner from detailed lectures on the processes to measurement of the performance of trial-manufactured devices.

The practical exercises were conducted as an intensive course in the latter part of July with a total of 18 participating students. In the recent course, detailed guidance was given to small groups of 4-5 students per team. The program was not only a significant experience for the participating students, but also revealed the potential for utilization of the large-scale facilities at NIMS in the future.

A practical exercise at clean room, 2-d Nano-patterning Foundry

Minister of State Seiko Noda Visited NIMS

(Aug. 12, 2008) Seiko Noda, Japan's Minister of State for Science and Technology Policy, visited the NIMS Sengen Site. After receiving a general explanation of NIMS and MANA (International Center for Materials Nanoarchitectonics), Ms. Noda visited the Rolls-Royce Centre of Excellence for Aerospace Materials, where the NIMS High Temperature Materials Center is engaged in joint research with Rolls-Royce, and various advanced research facilities on which NIMS prides itself, including the 3-D Nano-Integration Foundry and the Bio-Organic Materials Facility of the Nano Technology Innovation Center.

The Minister also exchanged views with six NIMS researchers, including three female researchers and three foreign researchers in MANA, and discussed the motivation to work as a researcher and the mid- and long-term perspectives of how society will benefit from the research performed at NIMS.

At the High Temperature Materials Center: Minister Noda receiving an explanation of a gas turbine rotor.

The 5th Nantotechnology Summer School

(Jul.28-Aug.1, 2008) The NIMS/MANA (Japan) – IRC*1(UK) – UCLA/CNSI*2 (USA) Nantotechnology Students' Summer School was held at the NIMS Namiki Site over a 5 day period from July 28 to August 1. A total of 24 students from Japan, the UK, and the US and 8 researchers supporting the school program attended, and discussed their own recent research results and potential joint research. This summer school was begun to promote enlightenment and encourage exchanges between graduate students engaged in nanotechnology research by NIMS and IRC. Starting this year, the program expanded its participants to involve the three nations of Japan, the UK, and the US by including graduate students from UCLA and CNSI in the United States. With attendance of Prof. Gimzewski of UCLA, the summer school gave valuable stimulation to all the participants throughout the 5 day program. NIMS looks forward to future events in this series.

Enjoying the Japanese Cultural event

*1 IRC:International Research Collaboration
*2 CNSI:California NanoSystem Institute

WMRIF Workshop for Young Scientists

(Jul. 22-25, 2008) The World Materials Research Institute Forum (WMRIF) Workshop for Young Scientists was held at NIMS over a 4 day period from July 22 to July 25.Thirty young scientists from 15 institutes in 13 countries who were recommended by member institutes of the WMRIF, gave presentations regarding the following three topics.

- Materials for sustainable energy and environment applications
- Materials to increase the safety and reliability of components
- Materials simulation

Three outstanding presenters were selected for "Best Paper Award", and received a free visit for WMRIF member institute(s). Dr. Goh Kuan Eng Johnson, Research Engineer of the Institute of Materials Research & Engineering, Singapore, was awarded the 1st Prize. (Title: Hot electron transport through thin pentacene film). Dr. Thorsten Pretsch, BAM Federal Institute for Materials Research and Testing, Germany won the 2nd Prize, and Dr. Chandler Becker, National Institute of Standards and Technology, USA, won the 3rd Prize.

The program included group discussions, lab tour and other activities, and produced important results in the creation of an international network of young scientists.

Lab touring on the final day

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