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NIMS Project
NIMS Projects and Recent Achievements

Photocatalytic Materials Center

- Theoretical Research on Adsorption of Water Molecules on Surface of Metal Oxide Photocatalyst

Research Highlights

- Combinatorial Sputter Coating System
- Fabrication of Oriented Thin Film Using Nanosheet

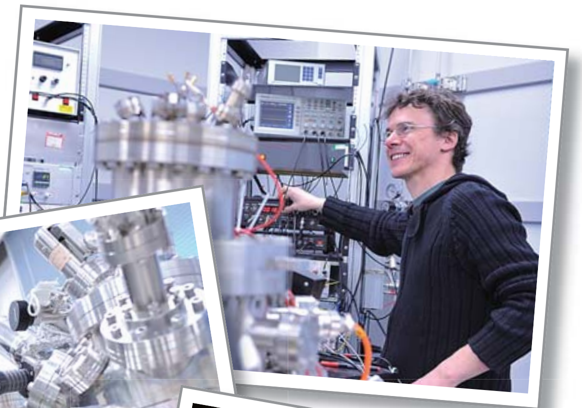
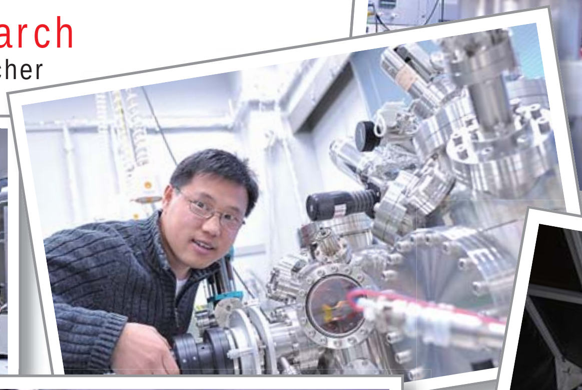
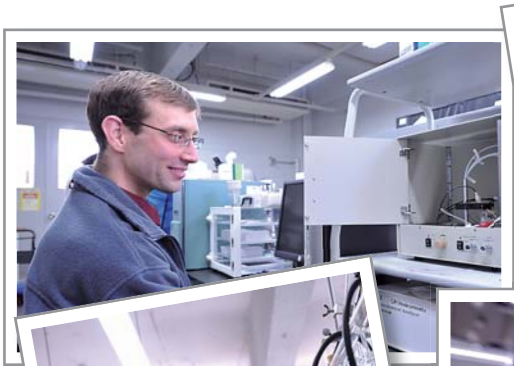
The Challenge of the International Center for Young Scientists
– 5 Years of Effort in Human Resources Development and Internationalization –

Yoshio Bando, NIMS Fellow and Director-General of ICYS

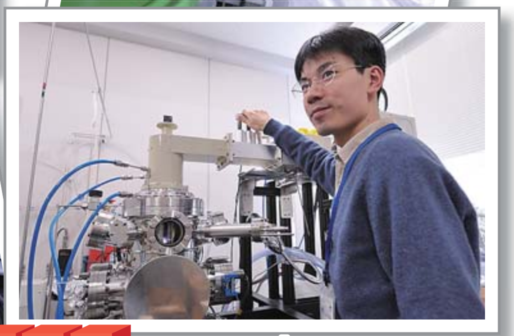
FACE フェイス interview

Teamwork is crucial for independent research

Jonathan Hill, NIMS senior researcher




SPECIAL Interview

Anthony Cheetham
Goldsmiths' Professor of Materials Science
University of Cambridge

"Harnessing the Energy of Global Science"

International Center for Young Scientists

The Challenge of the International Center for Young Scientists

– 5 Years of Effort in Human Resources Development and Internationalization –

NIMS founded the International Center for Young Scientists (ICYS) in September 2003, supported by the science and technology promotion subsidy of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), in order to build up an attractive research institute where is widely open internationally and to bring together the most talented researchers from around the world to continually produce outstanding research results, with aiming of becoming one of the world's leading research center in materials science and technology. The ICYS is a unique research organization that can be called a "leading international pioneers district" for promoting human resources development and internationalization at NIMS.

The ICYS brings together a number of extremely capable young scientists from countries around the world in one place and allows them to carry out independent research based on their own ideas, across differences in nationality and language. The aim of these activities is to draw out the originality of each of these researchers to the fullest possible extent and nurture the outstanding researchers who will be responsible for the next generation. Transforming NIMS into a more international research organization through the process of creating an attractive research center for young scientists was also a major objective of this project.

NIMS Fellow and Director-General of ICYS
Yoshio Bando

The 4 I'S (In4), the keywords of ICYS mission

International | Independent | Interdisciplinary | Innovative

International

To secure outstanding young scientists from around the world, the ICYS sought talented researchers internationally including partners institute with collaborative agreements. We finally selected 81 young researchers from 27 countries out of approximately 1000 persons from 63 countries, after a strict screening of documents reviews and interviews. We also ensured top young researchers who are tenured researchers of the Institute of Physics of the Chinese Academy of Sciences and the Hungarian Academy of Sciences (HAS), as temporary transfers.

ICYS Recruitment Results (as of December, 2007)

Countries of applicants

Country	Number of Applicants
China	259
India	222
Korea	39
Japan	32
Russia	28
UK	18
Germany	11
Czech Republic	11
France	10
USA	10
Others	305
Total	945

From 63 countries
Total 945 persons

Countries of accepted researchers

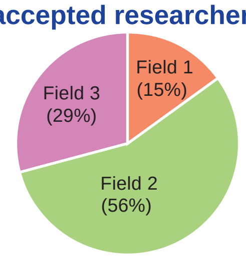
Country	Number of Applicants
China	14 (2)
USA	6 (4)
India	6 (2)
UK	6
France	5 (2)
Korea	5 (1)
Germany	4 (2)
Japan	4
Czech, Italy, Sweden	3 each (1)
Switzerland	3
Spain, Hungary, Australia	2 each (3)
Taiwan	2 (1)
Canada, Russia, Ukraine, Mexico, etc (11 countries)	1 each (5)
Total (27countries)	81 (23)

( ): short-term researchers included in total

From 27 countries
Total: 81 persons

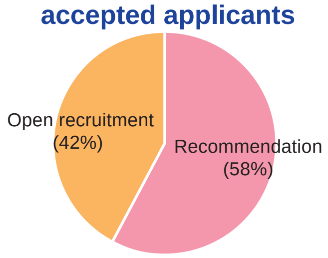
Average age : 31.7 (long-term researchers)

Research field of accepted researchers



Field 1: Nano-electronics, nano-biology
Field 2: Nano-materials, advanced processing, new measurement and computation science
Field 3: Metals, ceramics, organic materials and their composites

Recruitment method of accepted applicants



One of the ICYS distinctive features is the use of English as a common language. In order to create an environment in which foreign researchers can focus to their research independently without any language barriers, administration and technical staff with excellent English-language proficiency were assigned to the project to actively support researchers in various aspects such as employment process, orientations, procurement of materials, maintenance and safety control of common experimental equipment and labs, applications for external funding, patent application procedures, and others. We also prepared useful English guidebooks "Life in NIMS," which provides information about living in Japan and an "ICYS Guide," containing information related to research activities.

Interdisciplinary & Innovative

By bringing together young researchers from different nationalities into a single environment, the ICYS expected to produce the exciting new interdisciplinary research across the boundaries of specialized fields from a friction of intellects. For this reason, the ICYS gathered many of the world's outstanding young scientists from a number of nations. We call this mutually-stimulating international environment a "melting pot."

To ensure that this melting pot environment is used effectively, the ICYS created various situations which encouraged mutual exchanges between the researchers. The weekly ICYS Seminar provides opportunities to present and discuss research, and coffee break each afternoon is for free conversation time among researchers. The discussions and conversation here foster exchanges between young people from different cultures and different scientific fields, and have led to novel interdisciplinary research ideas and many previously-unimagined cooperative research relationships.

ICYS Seminar

Coffee Break

The ICYS also holds a variety of events to broaden activities in human resources development, not only within NIMS, but also in Japan and internationally. One such event is the ICYS-ICMR Summer School, which is held jointly with the International Center for Materials Research (ICMR) at the University of California at Santa Barbara in the US. Graduate students and post-docs from around the world are invited, and intensive courses are given by distinguished teachers, including ICYS Executive Advisors. This event has been held twice, had 70 participants from approximately 15 countries in each time, and is useful for a future international network of young researchers.

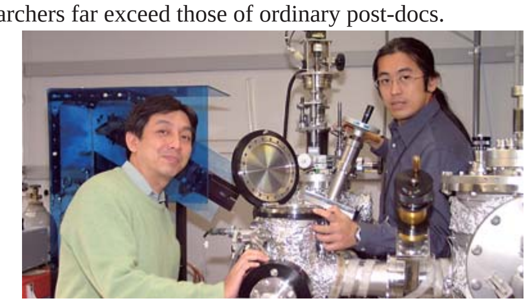
ICYS-ICMR Summer School on Nanomaterials 2007

2007 Summer School Lecturer (affiliation)
1. Anthony K. Cheetham (ICMR/UCSB)
2. C.N.R. Rao (JNCASR, India)
3. Ram Seshadri (UCSB)
4. Kazuyuki Hirao (Kyoto University)
5. Akira Fujishima (Kanagawa Academy of Science and Technology)
6. Kazue Kurihara (Tohoku University)
7. Hideo Hosono (Tokyo Institute of Technology)
8. Uzi Landman (Georgia Institute of Technology)
9. Morinobu Endo (Shinshu University)
10. Hideki Ichinose (RIKEN : Institute of Physical and Chemical Research)
11. Samuel I. Stupp (Northwestern University)
12. Atsushi Oshiyama (University of Tsukuba)
13. Seizo Morita (Osaka University)
14. A. Ajayaghosh (NIST, India)
15. Dmitri Golberg (NIMS)

Independent

A key point for human resources development in the ICYS is strengthening independence. To this end, the ICYS has taken on the challenge of implementing a new system which conducts research with respect for the independence of young researchers to carry out their research by their own ideas , for example, by providing financial support for research, the introduction of a mentor system consisting of Group Leaders from NIMS research groups. Young researchers in the ICYS not only carry out research based on their own abilities, but also find joint research partners in order to broaden insights, and thus grow into researchers with the ability to create international networks. The 431 results over the course of approximately 5 years have been published in international journals, and about 40% of the published papers were carried in top journals in the fields of materials science, physics, chemistry, and nanotechnology.

The research results and management capabilities of ICYS researchers far exceed those of ordinary post-docs.



ICYS Research Fellow, Dr. Y.Y.Hsu(right) and his mentor, Dr. Shunichi Arisawa

Results of Human Resources Development in the ICYS

The results of human resources development can be measured by the number of researchers who advance in their careers after leaving the ICYS. From this viewpoint, career development is one of the key activities of the ICYS. Among those who have "left the nest" from the ICYS, four persons have taken positions at Tohoku University and other universities and institutions in Japan, while around 20 have gone on to universities and research institutes in other nations, including the CNRS (National Center for Scientific Research in France), Trinity College (University of Dublin in Ireland), and others.

In addition, 15 persons have been hired as NIMS researchers to date (including decision not yet officially announced). Thus, the ICYS can also be a gateway to a career at NIMS for young researchers.

Over the past 4 years, the 53 new researchers hired by NIMS have been assigned for approximately 1 year to the ICYS, where they developed their independence and international awareness, and as a result, have grown into core researchers at NIMS.

Effect on NIMS by ICYS achievements

The English job interview at ICYS was adopted in the employment procedure for researchers at NIMS beginning in 2004. The large increase in the number of applications from overseas has also contributed to the hiring of outstanding non-Japanese researchers. As a result, the number of non-Japanese research staff at NIMS has increased from 16 in 2003, when the ICYS was launched, to 37 as of 2008. The scope of activity of non-Japanese researchers has also expanded greatly since the ICYS was launched, approximately 8 foreign researchers have been appointed to the positions of Group Leader at NIMS for the first time in NIMS history.

The effect of the ICYS has also been seen on international collaboration between NIMS and foreign institutions. In comparison with the year when the ICYS was established, the number of foreign institutions with which NIMS has concluded memorandums of understanding (MOU) on research cooperation and sister institution has increased four-fold, and now exceeds 130. The ICYS has also had other important results, for example, in international collaboration advisors in NIMS itself, the International Joint Graduate School Program, an international collaborative grant-in-aid system, system for inviting non-Japanese researchers, and other areas. NIMS/ICYS have established an alumni system, which will enable exchanges with young researchers after leaving Japan.

Future Efforts

The success of the ICYS contributed to the selection in September 2007 of the NIMS proposal “International Center for Material Nanoarchitectonics (MANA)” in MEXT’s World Premier International Research Center (WPI) Initiative. MANA will carry out material research to realize sustainable development of society based on the new technology system called nanoarchitectonics. At the same time, taking advantage of the experience cultivated at the ICYS in realizing true internationalization and training young research leaders, NIMS also intends to transform itself into one of the world’s top research centers through the activities of MANA.

The ICYS was a 5-year project which will be concluded at the end of March 2008. However, its organization will be inherited at the NIMS Namiki and Sengen Sites beginning in April 2008 as the ICYS-MANA and ICYS-IMAT (Interdisciplinary Materials Research), respectively, and will continue to make an important contribution to internationalization and human resources development at NIMS in the future.

As mentioned, the ICYS took on the challenge of innovation in a revolutionary new research system based on the “4 I’s,” which was unprecedented not only in Japan, but in the world. We believe that this is Japan’s first “pioneering experimental station” for internationalization and human resources development. Fortunately, the ICYS produced a large number of outstanding research achievements, and also opened the way to rewarding career paths at research institutions in Japan and other countries for ICYS researchers. Thus, the challenge for the ICYS was not limited to innovation in NIMS itself. We believe that the ICYS will become a model for organizational innovation in universities and public research institutes in Japan as a whole.

The ICYS Newsletter: “melting pot”

“Melting pot” is a newsletter for readers in Japan and other countries, which publishes the results of research and exchanges at the ICYS. In addition to reports on activities and introductions of research at the ICYS, interviews with famous researchers provide a fresh new editorial approach. “melting pot” was published in English and Japanese editions 3 times each year.

http://www.nims.go.jp/icys/jp/01about/mpot.html

Guides to daily life and research for foreign researchers arriving in Japan: “Life in NIMS” and “ICYS Guide”

These easy-to-understand bilingual guidebooks (English/Japanese) contain a wealth of information on daily life after entering the country and research system at NIMS.

Case Studies of accepting non-Japanese workers: “This is the ICYS” (Nikkei BP)

Since the ICYS was launched, our employment system of non-Japanese kept improved dramatically and promoted communication with English as a common language. As a result, NIMS has grown to become one of the most international research centers in Japan

Based on our unique experiences through accepting foreign researchers at the ICYS last 5 years, we published “This is the ICYS” (Nikkei BP) as problem solving samples. This book offers an extremely useful reference for other Japanese research institutes engaged in internationalization.

FACE フェイス interview

After earning a degree in applied chemistry at Kingston University in London, Dr. Jonathan Hill moved to Brunel University in London to do his PhD in chemistry. His first post-doc position was in Osaka, at Osaka National Research Institute (ONRI, now part of Advanced Industrial Science and Technology). Then, after working at the University of East Anglia in the UK, and the University of Karlsruhe in Germany, he found himself back in Japan, in Tokyo for two years, then at ICYS starting in 2004. He has been a NIMS employee for a year. Dr. Hill recently spoke with NIMS Now about his experiences as a NIMS researcher.

Dr. Jonathan Hill, NIMS Senior Researcher
Supermolecules Group
Advanced Nano Materials Laboratory

Teamwork is crucial for independent research

To start, could you tell us about your work?

I work with supermolecules and large molecular systems, sometimes polymers and sometimes hybrid materials. We’ve been looking for advanced electronic and optical properties in organic materials and nanomaterials, but now we're starting to branch out into hybrids involving nanoparticles and polymers.

What makes them “supermolecules”?

That word is a direct translation from the Japanese chobunshi – but they are perhaps more accurately called “supramolecules.” We deal with large molecules and polymers, so you could also say that they are supermolecules, in a sense. We also look at intermolecular interactions, how the molecules organize themselves. Within individual molecules, atoms form strong covalent bonds with each other. But supramolecules interact through weaker interactions, such as hydrogen bonding – DNA is a typical example.

What applications does this work have?

There are a lot of potential applications. One of the main ones we're looking at is light harvesting. There’s a lot of interest in alternative energy right now, so we want to create light-harvesting arrays using organic chemistry.

How did you get involved with ICYS?

I did post-doc work in Tokyo, and when the contract ended one of my friends suggested ICYS. Until then I had not done research on a completely independent basis. But at ICYS you are independent, which is the main attraction of ICYS for most of the people working there.

Is this independence an advantage in your work?

When I first came to ICYS, it was good to work independently. But after a while, you realize that most projects require some teamwork – you can’t do everything yourself. So from that point of view, having a lot of people working independently can be a bit unusual. However, there are certainly benefits in terms of starting real cross-disciplinary research projects and simply by interacting with researchers from other disciplines.

It's difficult to do cross-disciplinary research independently. For example, in my work, if I want to determine a crystal structure, I make the compounds and the crystals, but I need somebody to help with X-ray measurements, etc. As an independent researcher I have to be responsible for the intellectual leadership of that project, but I’m always working as part of a team with other researchers. So you have to be flexible.

Why did you decide to stay here instead of returning to the U.K.?

Similar reasons to joining ICYS in the first place. I joined the Supermolecules research group in NIMS, and things fell into place. Joining NIMS actually consolidates my position in terms of my research projects – I can continue doing this or other research topics depending on who joins the group. Our group is rapidly growing and diversifying, so we’re getting a lot of different kinds of researchers coming to work here.

One important thing about staying here in Japan instead of the U.K. is that the work I’m doing now I think is more highly appreciated in Japan. In the U.K., in organic synthesis, they concentrate on polymers and pharmaceuticals. Here there is more academic interest in organic synthesis.

Also my wife is Japanese, which was another good reason to stay.

You’re also a NIMS ambassador. What does that involve?

Part of the work is concerned with making connections in the U.K. to encourage appropriate researchers to come and work at NIMS. So I contact universities that have the relevant capacity to provide post-doctoral or other researchers to work here.

Photocatalytic Materials Center

Research and Development of High Functionality Photocatalytic Materials

In recent years, efforts to deal with the serious global environmental pollution and energy problems are indispensable to the future of humankind. Photocatalysis came to the attention as one of the technologies solving both problems. Photocatalytic materials make possible to decompose harmful substances and to produce hydrogen from water. The UV-responsive photocatalyst TiO_2 is currently used in practical applications. However, because this photocatalyst absorbs virtually no visible light, which is the main component of solar light and indoor artificial lighting (**Fig. 1**), its efficiency is low and applications are limited. Therefore, we are grappling with the development of novel visible-light-responsive photocatalysts and fundamental research for achieving high functionality.

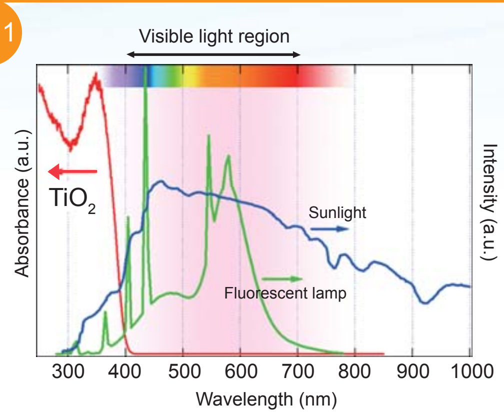
The Advanced Materials Group has been involved in the development of novel photocatalytic materials which respond not only to UV light, but also to visible light, based on control of the crystal structure and electronic structure of oxide-based semiconductors. The photocatalysts are expected to be used in high efficiency hydrogen production processes and decomposition/removal of harmful organic substances. **Fig. 2** shows the visible-light decomposition performance of a newly-developed $NaBiO_3$ photocatalyst for use with methylene blue dye, which is frequently found in industrial waste water. The performance of the material is substantially superior to that of visible-light-responsive nitrogen-doped TiO_2.

The Nano-Structure Control Group is carrying out the research with the aim of realizing high performance in photocatalysts by applying nanotechnology. **Fig. 3** shows a scanning electron microscope (SEM) image of $SrSnO_3$ photocatalyst synthesized by a solution deposition method. Because the surface area of the material is greatly increased in comparison with materials synthesized by a solid-state reaction, the activity of a hydrogen evolution was improved by approximately 8 times.

The Fundamental Process Group is executing theoretical and experimental researches on factors controlling photocatalytic activity, which are useful in the design of highly efficient materials and achievement of high performance. Up to now, a great deal of information has been obtained from theoretical research on the relationship between the electronic structure and activity of photocatalytic materials, and dynamic characteristics of water molecules on the catalyst surface (see following page).

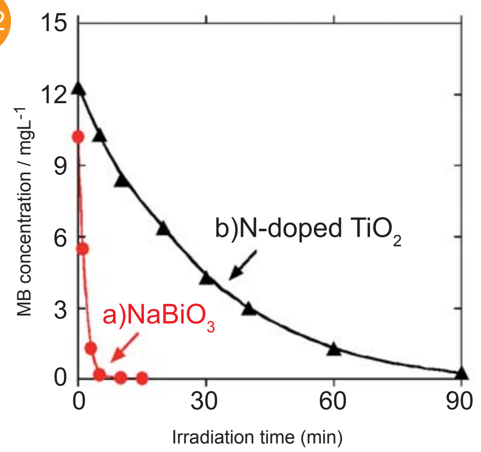
In order to further develop our research outcome from the viewpoints of both the environment and energy problems, we have attempted to realize practical uses of the developed materials in cooperation with industry. Indeed, new photocatalytic purification device with high performance has been successfully supplied to market as a fruit of collaboration with a company. At present, we are very interested in developing applications in the environmental filed of novel visible-light-responsive photocatalyst which functions under illumination of blue LED lamps. Thereby we have forwarded new joint research with companies as an urgent subject.

Fig.1



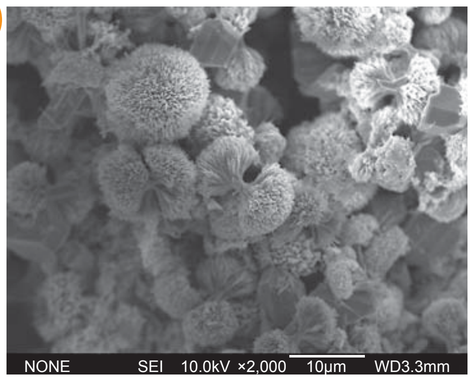
Spectra of sunlight and indoor lighting (fluorescent light), and optical absorbance of TiO_2.

Fig.2



Decomposition of methylene blue (MB) by $NaBiO_3$ under visible light irradiation.

Fig.3



Electron microscope image of $SrSnO_3$ photocatalyst synthesized by solution deposition method.

Theoretical Research on Adsorption of Water Molecules on Surface of Metal Oxide Photocatalyst

Fundamental Process Group, Photocatalytic Materials Center

Mitsutake Oshikiri

The properties of photocatalytic functions depend largely on bandgap, photo-excitation rate, mobility of an excited electron or hole, the structure of a relaxed surface or a target molecule adsorbate on the surface, and other factors. The aim of this research is to predict the effects of these factors by various first-principles calculations* and to obtain guidelines for designing photocatalysts suited to intended purposes.

As one example, this article presents the results of a simulation of the adsorption of water molecules on the surface of a metal oxide photocatalyst by first-principles molecular dynamics. The well-known photocatalyst TiO_2 can generate both hydrogen and oxygen from pure water under irradiation with UV light. The metal-oxide composite $BiVO_4$ is not capable of generating hydrogen or oxygen from pure water. However, with water containing a sacrificial reagent** ($AgNO_3$, etc.), it is known that this composite can form oxygen by oxidizing water while reducing the sacrificial reagent under irradiation ranging from UV to visible light up to wavelengths of approximately 520µm.

Fig. 1 shows the result of a prediction of the behavior of water molecule adsorption on the surface of $BiVO_4$ with exposed Bi ions. In general, the characteristics of molecule adsorption on metallic ions depend greatly on the coordination structure of the oxygen atoms surrounding the metallic ions and temperature. However, in a room temperature environment, we found that water molecules tend to be adsorbed stably in their existing molecular form on Bi ions, and adsorption in which water dissociates into –H and –OH (dissociative adsorption) tends not to occur. On the other hand, from **Fig. 2**, it can be understood that dissociative adsorption of a water molecule occurs extremely easily on Ti ions on a TiO_2 surface.

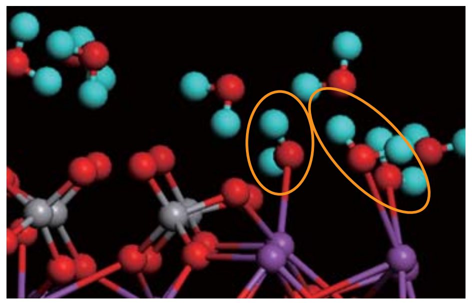
In addition, a comparison of the calculated results of water molecule adsorption on the surfaces of various metallic oxides and experimental phenomena revealed that the capability of dissociating the molecules on the surface is crucially important for obtaining photocatalysts with high activity. Key tasks for the future will include the creation of stable adsorption sites where dissociative adsorption occurs readily with skillful use of the characteristics of the crystal structure of the matrix catalyst together with optimization of the electronic structure, including the ionization potential, electron affinity, etc.

The phenomenon of molecule adsorption is only the first step followed by the photo-excitation, chemical reaction, desorption of products, etc. in a series of photocatalytic reactions. However, clarification of the conditions of dissociative adsorption can be expected to be an important aid in the search for new photocatalytic materials and development of photocatalysts with higher efficiency.

*First-principles calculation: In the original sense, this means a method of calculation using no empirical parameters and not referring to experimental data. However, in actuality, because calculations are in inevitably made using various approximation methods, comparison with experimental results (empirical knowledge) is necessary in judging the rationality of the approximation method used.

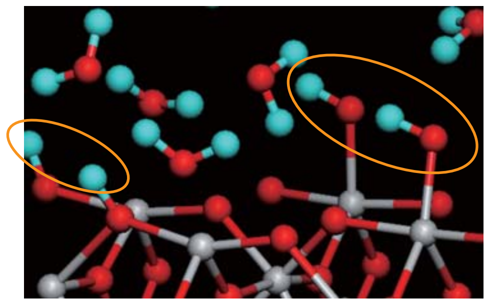
**Sacrificial reagent: An electron acceptor (oxidant) or electron donor (reductant) which can be used conveniently to materialize temporarily an oxidation or reduction reaction when checking for the presence or absence of an oxidation-reduction capacity in a photocatalyst. With $BiVO_4$, ,hydrogen is not formed because photo-excited electrons cannot be donated to H^+, but instead they are received by the Ag^+ electron acceptor of the sacrificial reagent, and both the oxidation (formation of oxygen) and reduction (deposition of silver) reactions can be sustained. Without a sacrificial reagent, the oxidation-reduction reactions are not both satisfied, and the reaction stops immediately.

Fig.1



Water molecules adsorbed on the (100) surface of $BiVO_4$. Dissociative adsorption on an exposed bismuth ion is not observed. Water molecules undergo molecular adsorption on the Bi ions (in circle). Light blue: hydrogen atom, red: oxygen atom, gray: vanadium atom, purple: bismuth atom.

Fig.2

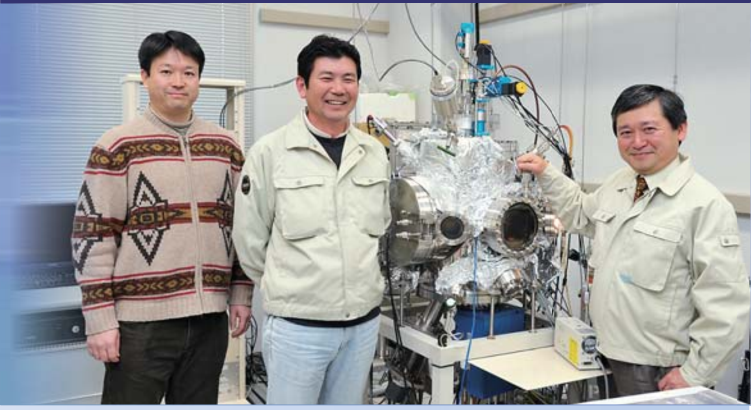


Water molecules adsorbed on the (001) surface of TiO_2 (rutile structure). Dissociative adsorption on an exposed titanium ion occurs easily (in circle). Gray: titanium atom, light blue: hydrogen atom, red: oxygen atom.

Combinatorial Sputter Coating System

- A Coating Optimization with extremely high efficiency -

Micro-Nano Materials Engineering Group, Materials Reliability Center



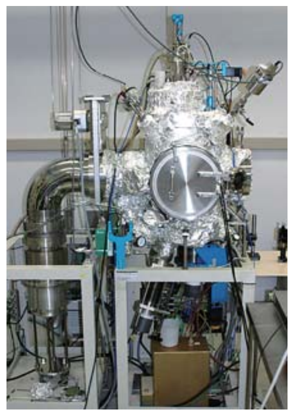
Group Leader
Masahiro Goto, Akira Kasahara, Masahiro Tosa

Coating requires various processes for adding outstanding new functions to the properties inherently possessed by a material itself, and is an extremely powerful development technique for high performance materials, making it possible to realize high performance, improved reliability, and longer life in coated materials. For this reason, coating has attracted attention in a wide range of fields including applications to industry, to biotechnology, to aerospace, and to others. Among coating techniques, sputter coating is widely used in industry as a practical coating method because coating at the micron film thickness level is simple and the performance of the film can be modified easily by changing the coating control parameters. On the other hand, because an extremely large number of combinations of coating film materials are conceivable and their performance is largely controlled by numerous coating control parameters, including the sputter gas pressure, sputter plasma generation power, and the like, the coating process tended to have poor reproducibility and optimization of film properties required considerable experimental time. Conversely, if these parameters could be controlled precisely and sputter coating could be performed with high efficiency, this would mean that coating films with the required functions and performance could be produced in a very short time.

In order to solve this problem, we developed the COmbinatorial Sputter COating System (COSCOS), which enables a variety of types of coating in a single process by making diverse changes in the coating conditions and precise, fully-automatic control of the coating control parameters (**Fig. 1**). **Fig. 2** shows an outline of the system. A total of 14 samples are set in a disk-shaped sample holder and introduced into the chamber at one time, and coating is performed under conditions determined individually for each sample. This process can be performed unattended with 14 pieces, thereby greatly reducing human error and total production time.

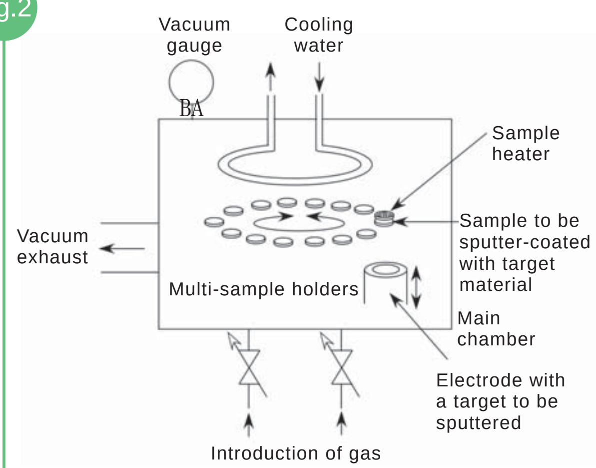
It is considered possible to use the COSCOS developed in this work in various fields as a powerful experimental tool for optimization of the coating process with high efficiency in a short period of time. The COSCOS is also expected to be useful in reducing the search time for coating films with new functions. In the future, we plan to develop a higher performance version of this system by expanding the technology to enable fully-automatic characterization of samples and plan to develop an advanced optimization mechanism for coating control parameters incorporating the multivariable analysis technique.

Fig.1



Photograph of a general view of the COSCOS (COmbinatorial Sputter COating System)

Fig.2

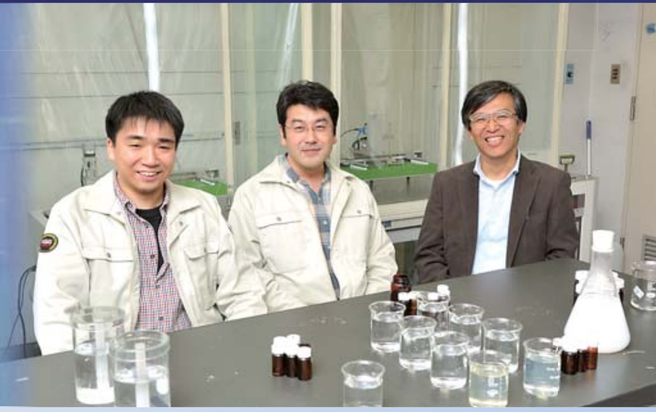


Schematic illustration of the COSCOS

Fabrication of Oriented Thin Film Using Nanosheet

- Sheet Only 1nm in Thickness Controls Crystal Growth -

Soft Chemistry Group, Nanoscale Materials Center



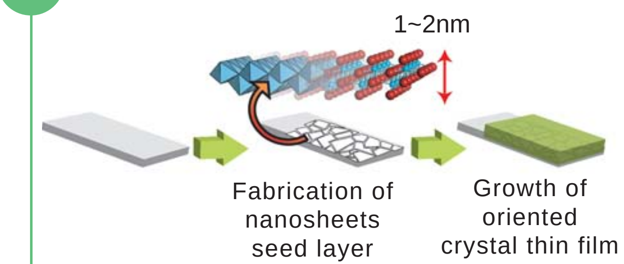
Managing Director
Tatsuo Shibata, Yasuo Ebina, Takayoshi Sasaki

Many of the electronic devices which are indispensable in modern society are produced by using thin film technology. First, it is necessary to produce a high quality crystal film for high performance electronic devices. For example, in transparent conductive thin films, like those used in liquid crystal televisions, touch panels, and similar products, a larger electrical current is possible using oriented films with high crystallinity and an oriented crystallographic orientation.

However, as films become thinner, it also becomes more difficult to produce high quality films. In particular, formation of a non-crystalline layer or a coarse, poor quality crystal layer between the substrate and the film is frequently a problem when a glass substrate is used. With substrates that cannot withstand heating, such as plastic films, obtaining a crystal film is itself difficult. For this reason, the proper approach to producing high quality crystal thin films at low temperature has become an important challenge for research. The key is the surface structure of the substrate. Specifically, it is possible to obtain a high quality crystal film at a lower temperature on a substrate if the substrate possesses a structure similar to that of the crystal being grown. The surfaces of substrates such as glass and plastic do not have a determined structure that can serve as an underlayer for thin films. Therefore, the method of growing target crystal on a substrate using a "seed" layer is investigated. This seed layer is fabricated first on a substrate, which has a structure closely resembling the target crystal and can be fabricated at a lower temperature. The target crystal is then grown on this seed layer.

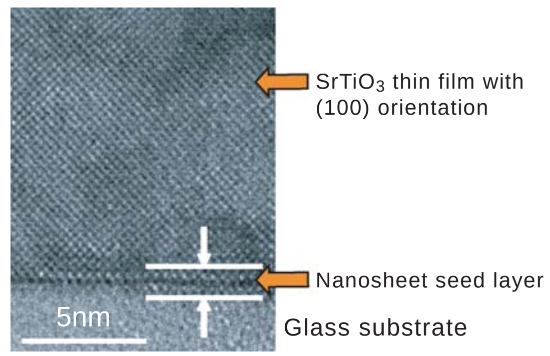
We are involved in research on the materials called "nanosheets", which are a type of 2-dimensional crystal. Nanosheets are oxide crystals with a thickness of only 1-2 nm, and are an attractive substance which can be likened to "paper" of atomic-level thinness. We proposed a method of controlling the surface structure of the substrate, as shown in **Fig. 1**, simply by applying a nanosheets with the desired structure. This technique is precisely like remodeling by applying wallpaper, but in the nanometer world. Nanosheets can be applied by using a simple, room-temperature solution deposition process. We have actually succeeded in fabricating high quality, crystallographically-oriented films of $SrTiO_3$, TiO_2, ZnO, and other substances using this process (**Fig. 2**). Because it will be necessary to apply crystal thin films of various materials to plastic films in order to realize flexible electronic devices, this technique is now the focus of keen interest.

Fig.1



Fabrication of oriented thin film by nanosheets seed method.

Fig.2



Transmission electron microscope (TEM) image of the cross section of an $SrTiO_3$ oriented thin film fabricated by the newly-developed nanosheet seed technique. It can be understood that an $SrTiO_3$ oriented film has grown on a $Ca_2Nb_3O_{10}$ seed nanosheet with a Perovskite-type structure.

SPECIAL Interview

"Harnessing the Energy of Global Science"

Dr. Anthony Cheetham, a scientist renowned for his groundbreaking work in inorganic materials, was the founding director and driving force behind the University of California, Santa Barbara (UCSB)'s International Center for Materials Research (ICMR). He is also an Executive Adviser of the NIMS International Center for Young Scientists (ICYS) and he co-organized the ICYS-ICMR Summer School on Nanomaterials 2007 held at NIMS in July. In October 2007 he moved to the University of Cambridge to become the next Goldsmiths' Professor of Materials Science

Professor Anthony Cheetham
Goldsmiths' Professor of Materials Science
University of Cambridge

Dr. Cheetham's research over the last 40 years has been primarily in inorganic materials, but for the last decade he has been working in the emerging field of hybrid organic/inorganic framework materials, an area that, despite its enormous potential for applications, is largely virgin territory with a lot of work still to be done and discoveries to be made. Hybrid materials, being semi-organic, have many of the advantages of organic materials, such as light weight, but their combination with metallic elements gives them unprecedented functionality. These hybrids allow scientists to design materials for specific applications, for example in catalysis, photoluminescence, and storage media for hydrogen gas in fuel cells.

Hybrid materials have both organic and inorganic components built into the same framework, which is like a kind of crystalline scaffolding. This suggests some very interesting possibilities. "You can make them porous with channels and spaces that are about the size of small molecules, so you can make the crystals like a sponge, and you can use them to separate small molecules from slightly bigger ones, or flat molecules from round ones," Dr. Cheetham said. "The pores can be much larger than those found in zeolites and they can have a wider range of chemical functionality."

He is also doing exciting work on a process called up-conversion, taking one form of energy, such as visible light, and adding energy to it to move it up the electromagnetic spectrum to make ultraviolet, or making infrared heat energy into visible light. If this could be made more efficient, the process would have a host of applications, for example in more efficient photocatalysts and solar cells, and the ability to take waste heat and convert it into light.

At ICYS Final Workshop /MANA International Symposium, March 2008

His work with the ICMR reflects Dr. Cheetham's commitment to developing science as a global, cooperative undertaking.

"Science is a very international business," he noted. "Unlike other disciplines, like law or history, which can be highly specific to certain countries or areas, science is the same everywhere, although countries do tend to develop their own scientific cultures."

Although Dr. Cheetham noted with dismay that "many students come to us having never owned a passport," some participants in the ICYS trips have called them life-changing experiences. "Students from the U.S. or Europe go to these meetings and get a sense of the quality and energy level of scientists from other countries, especially in Asia. They see all these incredibly eager and enthusiastic young people, hungry to learn, and realize that there are a lot of smart people out there, a lot of competition. It can be quite a shock for them."

He firmly believes that young people need to get international experience as part of their training. "Beyond the benefits to science, and to their own countries, there are other consequences as well, because such experience enhances understanding between different countries and cultures, something you can't get by staying at home and reading about it."

"If you're going to pursue science at the cutting edge, you need to know what's going on in other parts of the world, and you need exposure to the type of thinking that you get in other countries," he added. "We have to live with the realities of the world today, and that makes what we're doing at ICMR and ICYS that much more valuable."

NIMS NEWS

Dr. Ajayan Vinu receives the 21st KIA award in Iran

(Feb 5, 2008) Dr. Ajayan Vinu, Nano Ionics Materials Group of Fuel Cell Material center, received the 21st Khwarizmi International Award (KIA), which is the Iran Top Science Award being funded by UNESCO, WIPO etc, together with ICYS Executive advisor, Professor C.N.R. Rao. The ceremony took place at President's Conference Hall, Tehran, in Iran.

Dr. Vinu (left) and Prof. Rao

At the awards ceremony

Eleven outstanding candidates have been awarded by the KIA Final Jury out from a total of 968 projects resulting from years of research by domestic and foreign scientists including 192 foreign projects from 54 countries.

President of National Chiao Tung University visits NIMS

(Jan.29,2008) Prof. Chung-Yu WU (President of National Chiao Tung University:NCTU) visited NIMS with Prof. Steve. S. Chung (Dean of International Affairs, NCTU), Prof. Yung-Show FANG (Dean of Department of civil Engineering, NCTU), and Dr. Ching-Fa Yeh (Director of Science & Technology Division, Taipei Economic and Cultural Representative Office in Japan). They met Prof. Teruo Kishi (President of NIMS), Tetsushi Uehara (Vice President of NIMS). After the introduction of NIMS, they had a laboratory tour at Nanotechnology Innovation Center.

From left: Prof. Yung-Show FANG, Prof. Chung-Yu WU, Prof. Teruo KISHI, Prof. Steve. S. Chung, Tetsushi Uehara, Masahiro Takemura, Dr. Ching-Fa Yeh

An India-NIMS Workshop is held at JNCASR in India

(December 17-18, 2007) – A workshop was held at the Jawaharlal Nehru Center for Advanced Scientific Research (JNCASR) in Bangalore City in India with the objective strengthening cooperation between NIMS and India, which has achieved dramatic industrial and economic growth in recent years, and has also attracted attention for its high educational level. NIMS had already concluded a Sister Institute Agreement with India's National Environmental Engineering Research Institute and has begun receiving students from Anna University and JNCASR under Joint Graduate School Agreements. In addition, NIMS has concluded 7 MOUs with institutes in India under which joint research is being conducted. On this occasion, NIMS Vice President Masaki Kitagawa and 12 other NIMS researchers visited India and deepened friendships with persons at the cooperating institutes on the Indian side. Approximately 80 researchers and students participated in the workshop. A total of 25 presentations were given by Indian and Japanese researchers. The visit also featured vigorous discussions on mutual advanced technologies and discussions on vitalization of research cooperation in the future.

The JNCASR is currently expanding its laboratory building and has constructed a new nano analysis facility for joint use at the nearby Indian Institute of Science, thus displaying truly rapid growth.

Workshop participants (in the courtyard at the JNCASR).

At the India-NIMS Workshop

MEXT Vice Minister Kenshiro Matsunami Visits NIMS

(February 18, 2008) – Vice Minister Kenshiro Matsunami of Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) visited NIMS. After receiving a brief explanation from NIMS President Prof. Teruo Kishi, Mr. Matsunami visited the High Voltage Electron Microscopy Station, High Magnetic Field Station, and NanoFoundry Station, which are main research facilities of the new International Center for Materials Nanoarchitectonics (MANA), an important NIMS project under MEXT's World Premier International (WPI) Research Center Initiative. The Vice Minister also visited the International Center for Young Scientists (ICYS), which as played a key role in internationalization at NIMS. The functions of the ICYS will be inherited by MANA at the end of March, 2008.

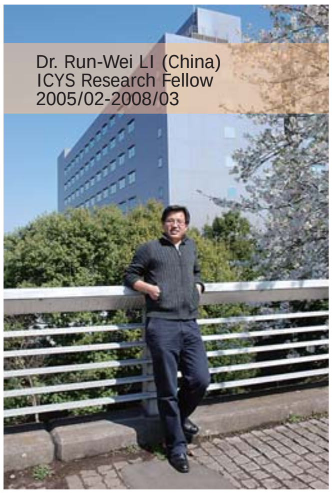
A New NIMS Venture Company "Comet, Inc." is established

(December 26, 2007) – The National Institute for Materials Science (NIMS; President: Prof. Kishi) approved Comet, Inc. (established Dec. 26, 2007, Representative Director and President: Noriyoshi Osumi, Representative Director: Masayoshi Shimizu) as a new "NIMS Venture Company" which will be supported by NIMS. The mission of the new company is to expand the practical applications of high throughput combinatorial materials which had accumulated and developed by research over many years at NIMS, mainly utilizing high throughput bulk sample preparation apparatuses, thin film forming devices, and high throughput characterization tools.

And especially the research results achieved in the university-IAI (Independent Administrative Institute) collaborative leading project "Combinatorial Materials Exploration and Technology (COMET)" under project leader Prof. Emeritus Hideomi Koinuma of Tokyo Institute of Technology, as well as other related research, are being applied in technology transfer. The Head Office of Comet, Inc. is located at the Namiki Site of NIMS, where the company is carrying out its new business.

For details, please visit the Comet, Inc. website: http://www.comet-nht.com/index (Japanese only)

Hello from NIMS


Dr. Run-Wei LI (China)
ICYS Research Fellow
2005/02-2008/03

My name is Run-Wei Li, from China. I received my PhD degree from the Institute of Physics (IOP), Chinese Academy of Sciences (CAS) in 2002. I then spent 13 months in Osaka University as a JSPS research fellow, and about one and a half years in Kaiserslautern University (Germany) as an AvH (Alexander von Humboldt) research fellow. On February 1, 2005, I joined the International Center for Young Scientists (ICYS), a novel and unique platform for fostering young researchers, and started my life in Tsukuba city.

During my stay in ICYS, I am mainly focusing on the fabrication and characterization of highly ordered nanostructures on Si surfaces, and studying the underlying mechanism of the self-organization process by scanning tunneling microscopy. I have greatly benefited by communicating with famous executive and academic advisors, visiting professors, and also ICYS fellows, who come from various countries with different cultures and research backgrounds. This has been immensely instructive and beneficial for not only my research in ICYS, but also my future career.

Outside of the lab, I have enjoyed life in Tsukuba with my "big" family. My parents and also my parents-in-law visited me and stayed here for several months. Together, we enjoyed traveling, climbing Tsukuba Mountain, and even just staying in the park near my house. Moreover, my second lovely daughter was born in 2007, the year of the "Golden Pig" in the Chinese calendar. This little "golden pig" is one of my big harvests in Tsukuba. All the fun has been captured in my album and my mind.

I came to Tsukuba when my first daughter was around 6 months old. When my second daughter reaches around 6 months old, I will leave ICYS and join the Ningbo Institute of Materials Technology and Engineering (NIMTE), CAS, in China, where I will work on multi-functional materials and nanodevices. I look forward to the collaborations with NIMS, and I will always welcome you to visit NIMTE in the near future.

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