CONVERGENCE

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MANA

International Center for Materials Nanoarchitectonics (MANA)

Hiroyuki SAKAKI 榊 裕之

Completed the doctoral course in electronic engineering at the School of Engineering, the University of Tokyo in 1973. Served as a professor at the Institute of Industrial Science, University of Tokyo since 1987, and at the Research Center for Advanced Science and Technology since 1988. Vice president and professor of the Toyota Technological Institute since 2007. Professor emeritus of the University of Tokyo. Successive service in various posts, including as president of the Japan Society of Applied Physics and chair of the Semiconductor Division of IUPAP. Member of the Science Council of Japan. Person of Cultural Merits in 2008. Specializes in solid-state electronics.

Attracting opportunity *and* talent *by* providing freedom *from* pressure

The seeds of progress are sown by those adventurous enough to discuss bold, new topics and explore off the beaten track.

Among his many accomplishments, Dr. Hiroyuki Sakaki has pioneered studies on electron behavior in semiconducting nanostructures and developed the new field of "nanoelectronics". His rich international experience and involvement in numerous research projects prompted us to ask him about how MANA became a world-leading research center and the requisite environment for opening new doors.

Interviewer: Akio Etori, NIMS publishing adviser

Astonishing treasures buried in mature fields

——President Clinton's message in 2000 roused a great deal of interest in nanotechnology. Is that motivation still alive?

Japan had already accumulated a good number of nanotechnologies by that time, and President Clinton's message encouraged further progress. But the power and sparkle of catchwords fade over the years, so we must keep writing fresh original stories and developing the front line.

We must also be careful, because astonishing treasures are sometimes discovered even in mature research fields if we dig deep enough. For example, a phenomenon that is believed to be 95% understood but not the remaining 5% – this is because the overall understanding is incorrect. A jigsaw puzzle cannot be completed if there is even only one mistake in it. We may be overlooking the potential for discoveries and inventions.

——So, researchers must take a broad view?

Yes. I studied MOS transistors for my graduation thesis. After I proceeded to the doctoral course, I saw an interesting field between electronics and materials science. It began with the superlattice proposed by Dr. Leona Esaki. In a superlattice, barrier layers are piled up in a certain cycle. The idea occurred to me to insert lattice barriers at specific intervals within the thin conducting layers of MOS transistors to control the movement and wave patterns of electrons. I summarized my research in 1975, after which the studies advanced and provided opportunities to open the door to the new world of quantum wires and dots. In 1980, I published a paper on quantum wire field-effect transistors and in 1982, a paper on quantum wire and quantum dot lasers. Fortunately, related research developed rapidly, including a study published in 1991 by Prof. Sumio Iijima on carbon nanotubes, which is quantum wire.

——Will researchers themselves lead the research strategies?

Researchers at all levels should play complementary roles to ensure the best research results. Young researchers devote their energies to studies, leading researchers serve as the central axis of well-balanced team work, and senior researchers provide wisdom and a broad prospective cultivated over many years of experience. The three groups have bonded well and demonstrated their strength at the Bell Telephone Laboratory and the Watson Research Center of IBM.

——Are there institutes in Japan similar to the Bell Telephone Laboratory?

Not in a strict sense, but in the field of electronics, the NTT laboratory is similar. NTT has a 100-year history of government-supported R&D

and has produced excellent results. National institutes, such as NIMS, AIST and RIKEN, have become more flexible over the years, encouraging energetic efforts and increased research power. One of the roles of these independent administrative institutions is to continue with research that they themselves judge to be worthy regardless of external academic trends and combine that with a good proportion of intensive study projects for which there is strong social demand.

Get rid of the demerit system and promote discussions on bold, new topics

——How should NIMS be?

One of the advantages at NIMS is that both scientific and engineering research is conducted. For each study product, it is important to identify whether the main objective is technological gain or scientific understanding and to maintain a complementary coexistence. Recently, the institute successfully created open organizations, such as Nanonet, for the purpose of inviting researchers from all over Japan to come and conduct joint research. If NIMS provides excellent research instruments and collaborative partners, scientists from universities need not buy their own tools, which will promote mutual inspiration among researchers.

——At NIMS, what should be done to develop MANA into one of the world's top research centers?

As shown by the success of ICYS, for a research institute to attract outstanding young researchers from Japan and abroad, it must be a place where young researchers can exchange information with many top-class researchers. Compared to Europe and North America, the institutes in Japan lag behind somewhat on this point. In research, it is important to work diligently on experiments from morning till night, but the seeds of rapid progress also come from fruitful discussions. Thus, we should cultivate the habit of devoting 20 to 30% of working hours to discussions. In Ezaki's group at the IBM Research Center, I was greatly inspired by the atmosphere of the Center where discussions could be enjoyed at any time. Of course, for experienced scientists to be free to talk with young fellows at any time, they should have less work to do (laugh).

——That's right! (laugh) It is actually the opposite of the real world.

For that reason, I believe that superior researchers should not be committed to large projects, but instead be able to continue meaningful studies with medium-level research funds. During the research process, we frequently find purposes and possibilities different from those initially planned. In such a case, the room for exploring detours is restricted in larger projects. The real pleasure of research is making an unexpected discovery in the middle of the original route, which should in fact be the primary mission.

——Why hasn't the culture of discussions developed in Japan?

The problem is the demerit system. Originally, discussions involve creating one new positive idea out of a vast amount of useless talk. Therefore, discussions cannot take place without getting rid of the demerit system. Research is aimed at opening the doors to new frontiers and acquiring new concepts and knowledge. Thus, it is necessary to cultivate researchers who are fascinated by both the joys and setbacks of adventurous work. Researchers have no time or energy for discussions when they are pressured to quickly produce results and write papers in order to win a permanent post.

——That sounds like the actual situation in Japan.

It is very difficult, but when we find people who are likely to do splendid work in the future, we should trust and support them and not keep asking, "What are your results for this year?" I believe that this approach makes it easier for researchers to produce major results. For example, allowing researchers to use 70% of their working hours to fulfill their initial project responsibility and use the remaining 30% for adventurous research may facilitate the generation of unexpected results. In my case, I was working on the stable topic of microfilms and the risky topic of quantum wires when I won the Grant in Aid for Specially Promoted Research from the present Ministry of Education, Culture, Sports, Science and Technology in 1981. The studies, which were conducted jointly with then Associate Professor Yasuhiko Arakawa (present Professor) and other colleagues, resulted in the proposal of quantum dot lasers, which was never mentioned in the initial study plan. I had the good fortune to be able to freely conduct my research, which developed into the quantum wave project of ERATO (Exploratory Research for Advanced Technology). Thankfully, also in ERATO, I only needed to decide the direction of research and was given the freedom to conduct my studies.

Search for contributions beyond the borders of fields

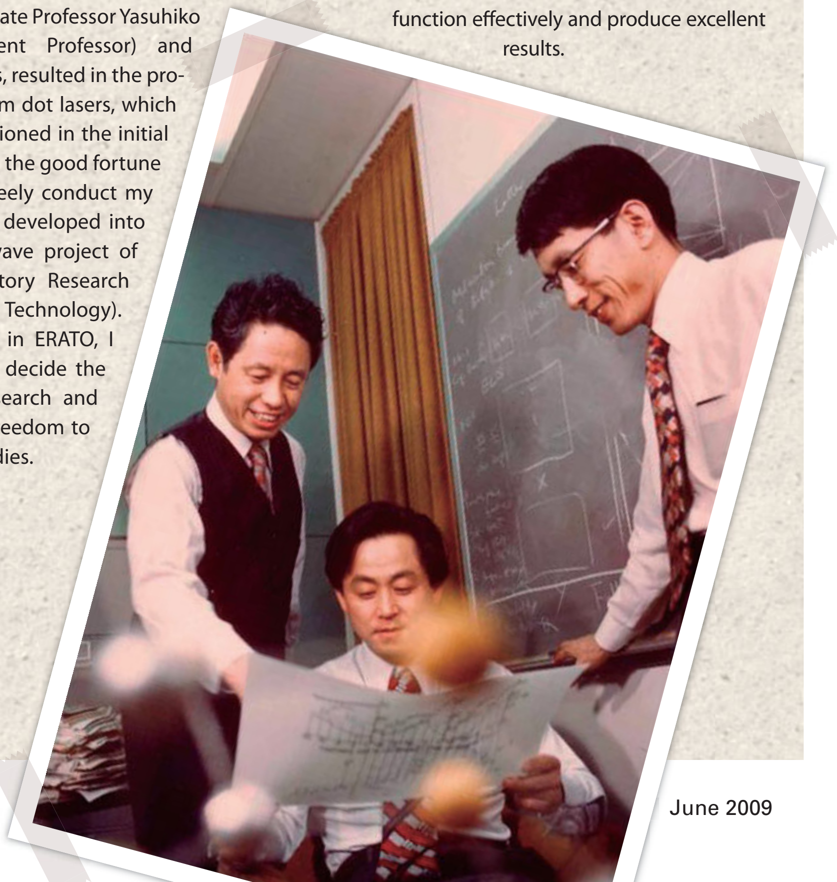
——We should organize MANA so as to allow active discussions as you have mentioned.

In an environment where researchers from different fields can engage in daily discussions, as at MANA, converged ideas from different fields can be born. It may provide opportunities and hints for turning the wheel away from the main course and going off the beaten path. New ideas that break through conventional technologies are in high demand, particularly in application fields. The probability of success may depend on the extent of discussions between those who have technological ideas and those who have deep scientific knowledge. People who are involved in MANA should also adopt the attitude of expecting the unexpected.

——In closing, do you have a message for young researchers?

The environment surrounding both scientific and engineering research has undergone many changes along with time. Today, Japan is empathetic to developing internationally competitive technologies and persons, and is also facing urgent global issues. Brain power is needed to protect the environment as well as to develop eminent engineering and industrial technologies. It may be difficult for a single researcher to answer both, but Japan as a whole can contribute to both issues by establishing scientific and technological policies and promoting outstanding research with full recognition of the expectations and restrictions of the era.

MANA is potentially capable of delivering leading research results regarding the global environment as well as strengthening industrial competitiveness with nanotechnologies. I expect that the diverse cultures contained in MANA will function effectively and produce excellent results.



Seeds of rapid progress are also born from fruitful discussions.
Enjoy discussions with anyone at any time.
(Photograph taken when working in Ezaki's group at the IBM Research Center)

Opening Up New Research Possibilities at MANA

Enrico TRAVERSA

- MANA Principal Investigator
- Specialty: Solid Oxide Fuel Cells
- Academic Degree: PhD, University of Rome "La Sapienza" (1986)

Choosing Japan over America

——Prof. Enrico Traversa, despite having had a large research group at the University of Rome Tor Vergata in Italy, you decided to join MANA as Principal Investigator at the beginning of 2009. Why did you choose to work in Japan and not in the U.S. ?

The situation in Italy had become difficult in terms of research funding and I always had set challenges in my research life. I was at the point where further challenges would have been difficult to achieve in Italy. Therefore, I started considering the idea of moving from Italy and starting up a new group elsewhere, provided I have good conditions available as to the moving and a high probability of successfully continuing my research. I do believe that this is the most creative moment of my research career until now, and it would have been difficult to fully exploit my ideas if I had remained in Italy. Fortunately, I had two opportunities for moving, another offer in the U.S. and the chance to work at MANA. Both were excellent opportunities and it was a tough choice for me. But I believed that it was more challenging for me, becoming one of the first Western researchers to directly enter a top-level position in Japan and contributing to Japan's internationalization process. Also because I had a long-lasting relationship with Japan, based upon 17 years of collaborations and friendships, this put me in the right track for the task.

——The cultures of Japan and Italy differ greatly. What is your personal interest in Japan ?

Japanese and Italian cultures are very different indeed, Japanese culture being "made of wood and paper" while Italian culture is "made of stone" – nonetheless, people's minds and souls are much closer than one might suspect from superficial analysis. When I am asked whether Japanese people are "really as strange in character as they look" from the perspective of the Italian people, my answer is that the Japanese look different from Europeans, but inside they are the same. On the other hand, American people look the same as Europeans, but inside they are different. Since I believe that understanding is very important in avoiding conflicts, I have always tried over the years to dig into the cultural differences that make Japanese behavior different from that of Westerners. Because after the first visit to Japan in 1992 I developed a strong interest for Japanese culture, and have read all types of books written by Japanese writers that have been translated into Italian language, I find this helpful in understanding the Japanese mind. However, I have learned about Japanese history by reading novels, from Murasaki Shikibu up to the contemporary writers, as I find history books difficult.

Going Multidisciplinary

——Your research specialty is Solid Oxide Fuel Cells. What kind of research will your new lab at MANA be doing ?

Since being discovered decades ago, many scientific and practical problems as to Solid Oxide Fuel Cells (SOFCs) remain to be solved upon realizing practical applications. The main goal of the new MANA lab's research is the development of a miniaturized SOFC device operating at low temperatures (below 450°C). To achieve this goal, first of all the study of the materials in thin film form is needed, and these investigations will be important also to elucidate properties that might be exploited in conventional, large SOFCs. In parallel, the developed materials will be assembled for the preparation of prototypes. However, during my career, I have published on many different topics, from corrosion to polymer composites in journals ranging from Fuel Cells to Stem Cells. I am curiosity-driven, and therefore I wish to explore different fields, provided that I have what I believe to be a good idea. This will be the case for example of new scaffolds for cardiac tissue engineering, where I believe we can have something interesting to study in the near future.

——What message would you like to give to young researchers at MANA ?

Mentoring young people has always been one of my priorities. I had dedicated lots of effort in Rome to start a new Ph.D. program in Materials for Health, Environment and Energy (the Health portion being added recently) with a strong international character, both to attract foreign students in Rome and to expose Italian students to an international environment. One of my major goal was trying to create a school, which should be a major aim for any professor, and the results show that I had some success in doing this. I wish to continue this kind of activity at MANA, trying to build up again a very international environment in my group. If there is a message I want to convey to young researchers it is enthusiasm, curiosity, and integrity. Being a researcher is a privilege, so this is a kind of job that intrinsically has to be fun and joyful.

Members of the Fuel Cell Nano-Materials Group at MANA
(from left to right): Dr. Emiliana Fabbri, Dr. Daniele Pergolesi, MANA PI Prof. Enrico Traversa and Dr. Edoardo Magnone.

Unremitting attempts toward administrative reform

"IPMU* and MANA have made sound progress towards the goal of WPI Program, and can be seen as leading models for WPI research centers." MANA received such a high evaluation in the second WPI Follow-up Meeting (March 2009). This is a result of MANA's active reorganization and administrative reforms taken based on the advice of the previous year's follow-up. The actions are described below.

* IPMU: WPI Center of the University of Tokyo (Institute for the Physics and Mathematics of the Universe)

Deciding on missions

New missions were decided on to clarify the goals of MANA. MANA focuses on material development specializing in nanotechnologies based on its original study concept of Materials Nanoarchitectonics and aims to develop new materials and technologies for innovative applications.

Missions of MANA

- ◆Promote interdisciplinary research using Materials Nanoarchitectonics
- ◆Serve as a melting pot where top-level researchers gather from around the world
- ◆Secure and cultivate outstanding, innovative young scientists
- ◆Construct a network of nanotechnology centers throughout the world

Reformation of the research organization

When MANA was established in October 2007, a research organization was formed tailored to the five key technologies: "Controlled Self-Organization", "Chemical Nanomanipulation", "Field-induced Materials Control", "Atom/Molecule Novel Manipulation" and "Theoretical Modeling and Designing".

The organization was reformed in October 2008 into four research fields: "Nano-Materials", "Nano-System", "Nano-Green" and "Nano-Bio" to make the research at MANA more explicit and clarify its missions. The five key technologies of Nanoarchitectonics were converged into these four fields to promote fundamental studies on nanomaterials and nanosystem and clarify the direction of applications in environmental and life sciences, which will lead to new innovations.

Reformation of the management system

Instead of three vice directors, MANA now has a Chief Operating Officer (COO) under the Director General. The new system has reduced the management load of the Director General and has enabled efficient and fast decision-making. There are also field coordinators to promote research in each field, enhance coordination among fields and promote convergence studies.

Recruiting excellent Principal Investigators

Various activities have been performed to recruit excellent Principal Investigators from around the world. Today, there are 29 Principal Investigators, an increase of 7 from the time of establishment. The most remarkable was the successful headhunting of Prof. Traversa from the University of Rome in Italy, who specializes in Solid Oxide Fuel Cells (see the opposite page). We also invited Dr. Han (specializing in solar cells) from Sharp Corporation and Dr. Tsukagoshi (organic electronics) from the National Institute of Advanced Industrial Science and Technology (AIST). Professor Uosaki (Hokkaido University, specializing in catalysts) and Associate Prof. Tomishige (University of Tsukuba, biomass) have also joined us as Principal Investigators at satellite institutes.

Creating an attractive environment for researchers

Substantial research support systems have been established so that non-Japanese researchers can focus on their studies without any language barriers. Using the experience of welcoming researchers from abroad into the International Center for Young Scientists (ICYS) in the past five years, administrative and technological support is provided in English. Various documents, such as safety regulations and rules for purchasing goods and making business trips, have been translated into English. Newly arriving researchers are asked to participate in orientation and laboratory tour programs for thorough safety control, etc. Support is provided to non-Japanese researchers not only on research but also on personal aspects such as finding a place to live and a school for their children.

These activities for creating an attractive international research environment have resulted in a sharp rise in the number of non-Japanese researchers. There are 97 non-Japanese researchers from 19 countries working at MANA today, accounting for a percentage as high as 52% (see News & Topics).

Fostering young scientists

MANA is also committed to training young scientists. An original management system was established, in which MANA independent scientists (young scientists of NIMS in their 30s who work full-time for MANA) and ICYS-MANA researchers (postdoctoral fellows working at MANA) can conduct their own research independently. A unique training system called 3D is deployed, which will be described in detail in the following edition.

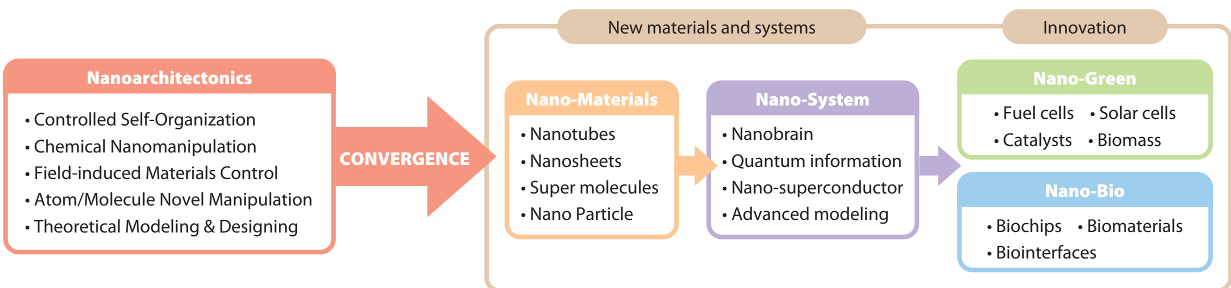
Establishing the MANA building

To assemble the researchers working for MANA into a single building as much as possible, the former Nano Biomaterials Research Building (13,000 m^2) was renamed as the "MANA Building", and the researchers' laboratories and offices were relocated to the building. The Melting Pot Cafe was opened in the lobby on the fifth floor of the building to encourage exchange and friendship among researchers. Every day, over 50 researchers enjoy having coffee and pleasant talks. To facilitate movement between the three areas of the Institute (Sengen, Namiki and Sakura), shuttle buses have been greatly increased to promote exchanges among researchers.

Today, there are over 150 researchers at MANA, who cannot all be accommodated at the MANA Building. Fortunately, the supplementary budget for fiscal 2009 was approved, and a second MANA building can be constructed.

MANA will continue reforming itself with the ultimate goal of developing into one of the world's top research centers, known for its excellent research environment, high-level research, and ability to attract leading researchers from around the world.

Materials Nanoarchitectonics and research fields



Nanosheets to create diverse functional materials

MANA Principal Investigator (PI)
Field Coordinator
Nano-Materials Field

Due to their laminated structure resulting from strong atomic binding chains in two-dimensional directions, layered materials, including graphite and mica as typical examples, exhibit characteristic behaviors such as mechanical cleavage and the intake of foreign substances between the layers (intercalation). In the present research, we are aiming to synthesize a novel nano-scale material called inorganic nanosheets, using a unique process of exfoliating the layered materials to single layers by inserting large organic ions between the layers like wedges, taking advantage of the intercalation reaction. We have already shown that various inorganic materials, including titanium oxide, can be modified into nanosheets.

Even though nanosheets are extremely thin, just a few atoms thick, their width is bulk size in the order of micrometers (Figure 1). Our various investigations on nanosheets have revealed several interesting properties, such as extremely intense optical absorption and abnormal thermal stability. These results suggest that an ultimate two-dimensional system with nano-scale thinness could have superior physical properties, so we are working to exploit the novel properties and phenomena of nanosheets. Another important research area is technologies for creating new materials by assembling nanosheets like building blocks. As nanosheets can be obtained as electrically charged colloids dispersed in a solution medium, they can be integrated and organized in various ways by the solution process. For instance, nanosheets can be deposited layer-by-layer on a substrate simply by using a beaker and tweezers, and hence ultrathin films with a thickness controlled in nanometers, as well as hollow structures with spherical shells made of such ultrathin films, can be synthesized. In addition, diverse nanocomposites and nanoporous materials can be synthesized because nanosheets reaggregate intercalating electrolytes when an electrolyte solution is added to the colloidal suspension. Since sophisticated nano-scale designs can be achieved by these simple and environment-friendly processes, we are now studying ways of creating photocatalysts, dielectrics, magnetic thin films, and other diverse functional materials using nanosheets.

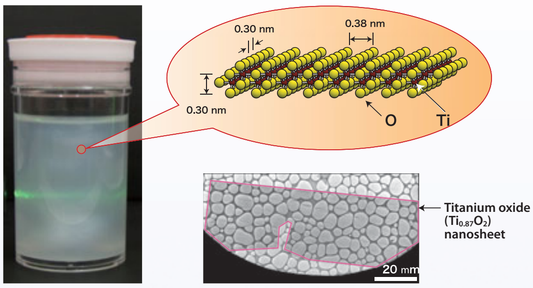


Figure 1
Colloidal suspension of titanium oxide nanosheets: The visible trace of a laser pointer beam entering the suspension proves that the nanosheets are dispersed within the solution.
Schematic diagram of the nanosheet structure: Note that on this scale, the nanosheets actually expand infinitely in the lateral direction.
Transmission electron microscope (TEM) image: Only a very low contrast image can be obtained due to the extreme thinness of the nanosheets. The outline is colored pink to enhance image legibility.

Atomic switch to produce multifunctional electronic devices and artificial intelligence

(Photo: Robert Cameron)

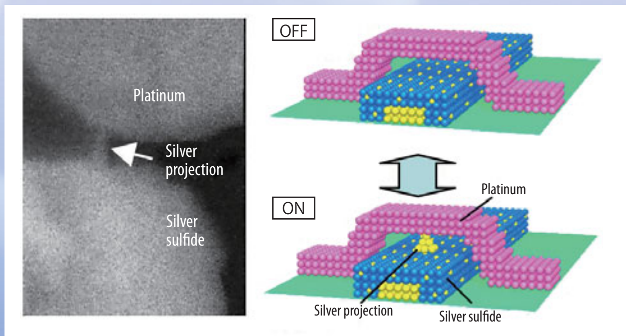
MANA Principal Investigator (PI)
Nano-System Field

An ultimate goal of microscopists was to be able to observe single atoms, which was made possible with the development of electron microscopes and scanning tunneling microscopes. Next, they wanted to be able to manipulate atoms freely, which was also made possible by the scanning tunneling microscope. This led to studies on creating an atomic switch.

Observations with a scanning tunneling microscope use electrons discharged from the tip of a pointed needle on an atomic scale. We conducted an experiment to discharge atoms from the tip of a pointed needle made of an ion conductor material. Inside the ion conductor, metal atoms move around as ions, and we tried to remove the atoms one by one from the needle tip. Although electrons reaching the surface of the specimen would go somewhere else, we considered that the atoms which remained where they were dropped could be placed at any arbitrary location. The experiment was a success, but the probe tip and the specimen became stuck together when about ten atoms were dropped at the same position. It was also found that the atoms which had come out later returned to the inside of the ion conductor when a voltage was applied in the direction opposite to that used for removing atoms. Thus, an atomic switch was developed.

Figure 1 shows a schematic diagram of the switching motion when using silver sulfide as the ion conductor, as well as an electron microscope image showing a silver projection which grew from the silver sulfide. By using the atomic switch, which is smaller than a semiconductor transistor and is nonvolatile (the on or off state doesn't change after the atomic switch has been turned off), it may be possible to develop an electronic device which uses only one chip and offers versatile functions. Research & Development on this possibility is now being conducted in collaboration with a private company.

The atomic switch has another unique property. The ease with which atoms enter and leave the ion conductor can be controlled by changing the materials and element structure. Using this property, an atomic switch which requires so-called learning, i.e., it is not activated unless multiple input signals are received, can be produced. It may also be feasible to develop an atomic switch which operates in response to light and smell. Using these new properties, the MANA Brain Project is currently developing artificial intelligence equipped with learning and sensor functions.



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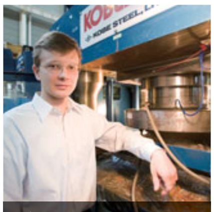


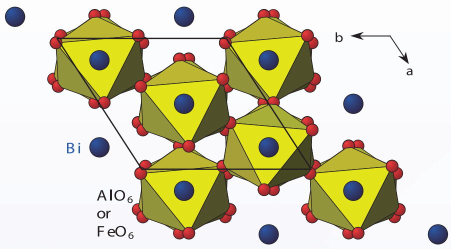
Ferroelectric and magnetic materials for memory applications

Alexei A. BELIK
アレクセイ・ベリク
MANA
Independent Scientist

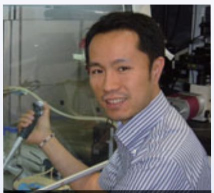
Many memory elements are based on the switchable electric polarization (in ferroelectrics) or switchable magnetic moments (in ferromagnets). Simply speaking electric polarization and magnetic moments have two states, up and down, corresponding to the 1 and 0 states required for binary memories. The first robust and stable ferroelectric ($BaTiO_3$) was discovered about 65 years ago. For a long time, ferroelectrics were used in capacitors, piezoelectric actuators, sonar detectors, and so on. After significant reduction of the size and development of thin-film ferroelectrics, they found applications in data storage media (non-volatile ferroelectric memories), mobile digital phones, and so on. Ferromagnetic materials are known from the ancient times (for example, magnetite). In our days, they are used in magnetic data storage (tapes and hard disks), transformer cores, and so forth.

In the so-called multiferroic materials, both electric and magnetic polarizations exist. A lot of ferroelectric and ferromagnetic materials are known. Surprisingly, multiferroics are scarce in nature. One can guess that multiferroics are quite interesting because they combine properties of both ferroelectric and ferromagnetic parent materials. We may have two- (or more)-in-one. Multiferroics allow control of electric properties by magnetic field and control of magnetic properties by electric field. Speaking about memories, the great advantages of multiferroics would be (1) the drastic reduction of the thermal power of a magnetic memory if magnetization were switched by electric field, (2) the replacement of slow magnetic writing process by a fast magnetization reversal trough electric poling, and (3) increase of the memory density. In other words, multiferroics allow electric-write magnetic-read memory devices that combine the best of ferroelectric and magnetic random-access memories.

In MANA, we are focusing on searching for new ferroelectric and multiferroics materials. For searching, we are using advantages of the high-pressure synthesis (up to 60.000 atmosphere). With high-pressure, one can stabilize ions in unusual oxidation states, ions with unusual coordination numbers, high density compounds, metastable phases and new modifications of known compounds. Surprisingly, many compounds that require (moderate) high pressure for stabilization in bulk form can be stabilized (prepared) in thin-film form. This fact is very important for modern applications. We have found and/or investigated the following ferroelectric and multiferroics materials: $BiAlO_3$, $BiInO_3$, $BiScO_3$, $BiMnO_{3\pm\delta}$, $BiCrO_3$, $BiFeO_3$, $PbVO_3$, $InMnO_3$, and others. For example, $BiAlO_3$ is a new lead-free ferroelectric/piezoelectric material that shows a nice square ferroelectric hysteresis loop needed for memory applications; in addition, $BiAlO_3$ contains very cheap elements.



Crystal structure of ferroelectric $BiAlO_3$ and multiferroic $BiFeO_3$

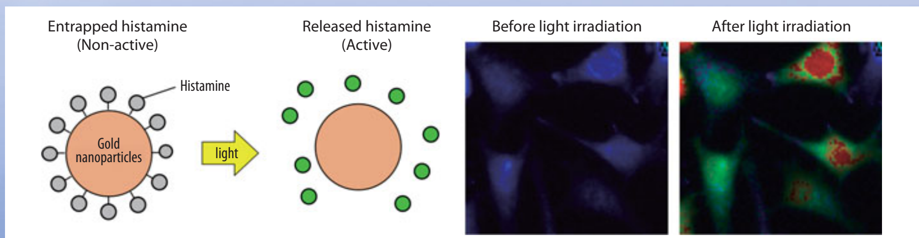


Nanoparticles which release biomolecules in response to light

Jun NAKANISHI
中西 淳
MANA
Independent Scientist

Countless biomolecules exist within living bodies, and their exchange of complex and entangled biosignals leads to bioresponses in accordance with various situations. To understand this mechanism, it is crucial to investigate the dynamic state of biomolecules using fluorescent probes such as GFP, as well as to reproduce the bioreactions using artificially produced biomolecules. Caged compounds are biomolecules whose bioactivity has been temporarily inhibited by modifying a photocleavable protecting group, and their original bioactivity is restored by photocleavage of the protecting group. Thus, biomolecular activity at local sites in a living body can be manipulated at any desired timing by adjusting the light irradiated to the biomolecules. Nevertheless, with conventional techniques, a precise biomolecular design for each target biomolecule was required in order to strictly switch the bioactivity depending on the existence of protecting groups, and the synthesis and refining processes were laborious. In this study, we developed a novel method for synthesizing caged compounds by designing gold nanoparticles to which a special surface modification was applied.

As the nanoparticles developed in this study possess succinimidyl ester through a photocleavable nitrobenzyl group, they entrap and release amine compounds in response to light irradiation (refer to the two schematic diagrams on the left in the figure). With this design, the biomolecular binding between the fixed amine and the intravital target biomolecules is inhibited by the nanoparticles, and so the biomolecules function as caged compounds. In addition, synthesis and refining are easier to perform because the nanoparticles themselves become the solid-phase support. After confirming by various surface analyses that the synthesized nanoparticles presented the intended functions, caged compounds of histamine, which is an amine involved in allergic reactions and neural transmission, were prepared. As a result of adding these nanoparticles to the extracellular fluid of HeLa cells to which a calcium fluorescent probe had been introduced, a rapid increase in the intracellular calcium concentration in response to light irradiation was observed (refer to the two images on the right in the figure), showing that the calcium concentration varied according to the amount of light irradiation. Meanwhile, when the nanoparticles were sprinkled onto the cells but light was not irradiated, no such calcium response was observed, confirming that these nanoparticles function as caged histamine. This caged histamine is useful for closely examining the involvement of histamine in neurotransmission. Furthermore, as many biomolecules such as peptides and proteins belong to amine compounds, it should be possible to synthesize caged compounds in a similar manner. Thus, our nanoparticles will be particularly useful for research on drug discovery and development, such as exploitation of novel target sites of medicines.



Control of cellular activity using histamine generated from photoresponsive nanoparticles

MANA Highly Evaluated by the Program Committee
—Results of Follow-up for Fiscal Year 2008—

Together with the WPI Research Center at the University of Tokyo, the International Center for Materials Nanoarchitectonics (MANA) was highly evaluated by the WPI Program Committee for its fiscal year 2008 activities including proper management as a WPI Research Center, number of foreign-national researchers exceeding 50%, and provision of substantial administrative support with English as the common language.

As a result, a subsidy of 125 million yen was announced, entitling us to receive a total subsidy of 1.475 billion yen for fiscal year 2009.

MANA Members Exceed 200
—Foreign-national Researchers Become the Majority—

The number of MANA members has increased steadily, reaching 218 as of April 2009, exceeding the initial goal of 200. Foreign-national researchers number 97, accounting for 52% of the total 186 researchers.

A significant feature is that 76 of 100 postdoctoral fellows and graduate students are foreign nationals, who provide vigor and excitement to the Center. The diverse backgrounds of our researchers and staff encompass 20 different countries including Japan, and this multinational gathering of members truly creates a "melting pot" environment, as intended.

MANA members (as of April 2009)

Position	Total number of members	Number of foreign nationals
Principal Investigators (PI)	29	9
Permanent researchers	57	12
Postdoctoral fellows	73	59
Graduate students	27	17
Staff	32	4
Total	218	101

Ratio of foreign-national researchers: 52% (97/186)

News & Topics

News release

March 28, 2009
Dr. Ajayan Vinu, a MANA Independent Scientist, received the Chemical Society of Japan (CSJ) Award for Young Chemists.

April 14, 2009
Dr. Minoru Osada, a MANA Scientist, received the Young Scientists' Prize awarded by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT).

May 8, 2009
Dr. Kazuhiro Hono, a MANA Principal Investigator, received the 6th Honda Frontier Award.

MANA International Symposium 2009

The 2nd MANA International Symposium was held from February 25 to 27, 2009 at the Tsukuba International Congress Center Epochal Tsukuba.

On the first day, Professor Emeritus Hiroo Imura of Kyoto University, who is Chairperson of the WPI Program Committee, and Professor Emeritus Toshio Kuroki of the University of Tokyo, who is WPI Program Director, greeted the participants, followed by a lecture delivered by Dr. Heinrich Rohrer, a Nobel Prize laureate in Physics and a MANA advisor.

Throughout the 3-day symposium, presentations were made by researchers covering the four research fields of MANA, i.e., Nano-Materials, Nano-System, Nano-Bio, and Nano-Green. Presentations included lectures delivered by eight guest lecturers from both Japan and overseas who are well-renowned in nanotechnology, Professors Anthony Cheetham (University of Cambridge), Kazuyuki Kuroda (Waseda University), Gerhard Wenz (Saarland University), Masashi Kawasaki (Tohoku University), Roland Wiesendanger (University of Hamburg), Nicola Marzari (Massachusetts Institute of Technology), Kazuhito Hashimoto (University of Tokyo), and Teruo Okano (Tokyo Women's Medical University), as well as 33 oral and 85 poster presentations by MANA Principal Investigators, MANA Scientists, MANA Independent Scientists, and ICYS Fellows.

Attended by over 300 participants, which surpasses the number for last year, this was a major international symposium, showing both the steady progress of MANA and the increasing global attention focused on MANA.

Joint Graduate School with the Moscow State University

On March 12, 2009, NIMS signed an agreement pertaining to the collaboration as sister institutions and for the Joint Graduate School with the Moscow State University (MSU) of Russia, to promote collaborative research and the exchange of human resources between the two institutions. This fall, MSU doctoral program students of the Departments of Materials Science, Physics, and Chemistry are scheduled to stay at NIMS for several months to conduct research under the supervision of MANA Principal Investigators.

Established in 1755, MSU is the most prestigious university in Rusia that has produced 11 of the 18 Nobel Prize laureates from Russia. As the only non-university institution among the five WPI Centers, MANA has been asked to accept graduate students by various means, resulting in the signing of this agreement.

NIMS President Professor Kishi shakes hands with MSU Vice-Rector Professor Khokhlov

Recruitment: Positions Available for Principal Investigators

The International Center for Materials Nanoarchitectonics (MANA) invites applicants to work as Principal Investigators in the research fields of Nano-Bio and Nano-Green. Researchers with globally recognized research achievements in these fields are invited to conduct research in our excellent international research environment.

Annual salary will range from 10 to 20 million Japanese yen, depending on each individual's competence and research achievements. Sufficient start-up research funds will be provided upon arrival. Applications from female scientists are highly encouraged. Applications must be submitted electronically no later than Friday, July 31, 2009. For further details, please visit our webpage:
http://www.nims.go.jp/mana/recruitment/

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"Convergence" is the keyword used to symbolically describe the entire project of MANA, where outstanding researchers from around the world assemble and converge in the "melting pot" research environment to bring together key technologies into nanoarchitechtonics for the creation and innovation of new functional materials.