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Oct. 2010

CONVERGENCE

Resources are limited, but there are no limits to creativity

—— Masuo AIZAWA

Taking advantage of MANA forte field to extend

—— Kohei UOSAKI

MANA's Research Outcome

- Functionalized semiconductor silicon and germanium nanowires——Naoki FUKATA
- Crystal assemblies with a new philosophy of togetherness——Ujjal K. GAUTAM
- Starting with bulk, toward Nanoarchitectonics——Naoki OHASHI
- Evolution of nanotechnology using multiple-scanning-probe microscopes——Tomonobu NAKAYAMA

wpi

International Center for Materials Nanoarchitectonics (MANA)

Masuo AIZAWA

Graduated from the School of Engineering, Yokohama National University (1966), Ph.D. in Science, Tokyo Institute of Technology (1971), Adjunct of Chemical Resources Laboratory, Tokyo Institute of Technology (1971), Post-doctoral Fellow of Lehigh University (USA) (1974-1975), Associate Professor of Materials Engineering, University of Tsukuba (1980), Professor of the School of Engineering, Tokyo Institute of Technology (1986), Dean of the School of Bioscience and Biotechnology, Tokyo Institute of Technology (1994), President of the Tokyo Institute of Technology (2001), Chairman of the Japan Association of National Universities (2005-2007), Full-time Member of the Council for Science and Technology Policy (2007), Professor Emeritus of the Tokyo Institute of Technology (2007).

As a leading expert in biotechnology and bioelectronics research and through positions as the President of the Tokyo Institute of Technology, Chairman of the Japan Association of National Universities, and a full-time member of the Council for Science and Technology Policy, Masuo Aizawa has been advising on graduate education reform and science and technology policy in Japan.

Resources are limited, but there are no limits to creativity

❖Interviewer: Akio ETORI, NIMS publishing adviser

WPI convergence initiative to strengthen fundamental research

—Dr. Aizawa, you have been involved with WPI since its founding, and how have you viewed WPI program framework?

I always wanted to raise fundamental research in Japan to the top level internationally. I think doing that consists of two parts, which are centering on university research capability and strengthening the fundamental research capability of the research organizations of independent administrative institutions. In contrast to the 21st century COE program at the time, we started by trying to strengthen fundamental research capability. But rather than try to strengthen it blindly, the concept, as expressed by the title in this newsletter, was convergence. In other words, rather than proceeding by specializing in a narrow specialty, the dynamism from a diversity of fields and areas would be utilized to strive for new creations. That is what I mean when I say open up to the world. This has the feature of bringing many minds together to create new knowledge. Japanese tend to seclude themselves in a field or organization. This is a very bad characteristic of Japan. I want to overcome this somehow.

Only MANA operates in an independent administrative institution but other WPI centers are organizations completely housed in universities. This is a distinct organization from conventional graduate schools in that although it is located in universities, it is treated specially and is out of the authority of the university president, to give an extreme example. This means it was created with the concept of allowing the head of a WPI center to make discretionary decisions. In reality, however, the organization is located on the university premises, so it must be supported with special treatment to allow it to obtain its objectives. I think this is a very delicate matter. In the case of MANA as well, it operates in NIMS, but in some cases the authority of the NIMS President should be executed by the MANA Director. At the least, it is handled specially, and in terms of treatment as well, sometimes only it is allowed the special handling.

— Another objective of WPI seems to be nurturing excellent young researchers.

Although there was no clear policy when WPI was established, my personal opinion is that Japan is being alienated from international intellectual circles. The top level universities in the world attract excellent students from around the world, educate them, and then send them out to contribute. These people contribute on the international stage, and so they enjoy ever more intellectual interaction. It is the university that plays a very important role in this cycle. I think this is the role that should be played by world-class universities.

The young generation in Japan today tends to seclude itself within the country and is not anxious to go abroad. It is difficult in particular to be aware of the international activities of researchers. Once the domestic environment was not good, so there were no choice but to go abroad and do our best in a difficult competitive environment, which resulted in our being active internationally later on. It is very important for people to move around internationally and be stimulated by different ways of thinking and cultures while proceeding to create new knowledge.

What is most important for science and technology is creative ability. There are limits to resources. But there is no limit to creative ability. Rather than WPI just simply nurturing young people, the place of research called WPI must have great expectations in the creative ability of young people. I think that is the true source of research capability. WPI is not a university, so it focuses on advancing top-level researches. Young people interact with top-level people and strive in a top-level atmosphere. In that situation they flourish while taking on the various missions, which develops them and prepares them for the next stage. This activity becomes the research results of WPI and completes the cycle. So I think WPI needs to create such a place. It is the duty of the people who head the centers to voluntarily take on this mission and manage the research and research organizations to motivate the people gathering to the center to increase their creativity.

People refined by a difficult environment and diversity

—That is a wonderful idea, but what was it that got you to think like that?

I spent my post-doctoral time at Lehigh University in Pennsylvania, USA. At the time, universities were excited about developing a new research field. The environment wasn't just as simple as what I wanted to learn or what I could have them teach me. They didn't have the field I had been researching and I was expected to utilize my background to produce new results from the day I arrived. My associate professor was the same age as me, and he was very competitive and wanted to reach the top, so just wanting to proceed with certain research resulted in a fierce discussion, but in the end I think that was beneficial. I could produce the great results from the interaction with the other people from various countries as well as him.

At the time, it was the desire of top-level researchers to attend the Gordon Research Conference in the US. The conference was held during summer vacation and used the dormitories of the college in New Hampshire where researchers, including Nobel Laureates, would gather to stay for a week and discuss one theme. The proceedings were not officially reported because that would make it difficult to exchange frank opinions. The attendees wore leisure clothing and the atmosphere was one where really hot data were exchanged.

Although I had just arrived from Japan, my professor asked me to hold discussions with different people to get a whiff of which institution was doing what research and how far it had progressed before it was published in a paper. I had to talk to get such information out of them, but if I talked too much they would get suspicious. Offering a presentation was also very difficult, but in the end it was all good training for me. It is that type of environment that develops people.

Just as they say there are no borders to science and technology, there really are no walls to research either. I think it is very important to get new ideas by exchanging completely different ideas with people who have completely different cultural backgrounds. In that sense, I think that "using other people's brains" might be one of my fortes.

—Japan is often said to be a science and technology nation, but listening to your talks makes me think that maybe we should call it a brain nation.

That's right. I focus on the importance of developing people. Brain power is really Japan's sales point. I often say, "Resources are limited but there are no limits to creativity." Creativity is Japan's true strength.

Breaking through the next barrier is the "mission of MANA"

—The Japanese young generation seems to be turning its back on science and technology because the negative part of it appeared in the spotlight.

Actually, this year's study by the Cabinet Office showed that interest in science, which had been on a decline, has made an abrupt turnaround. It appears that people again have hope that science and technology will be useful in solving the issues we face.

All issues, however, are too complex to be solved by just one technology. In its study of environmental and energy policy, the United States is holding workshops and conducting screenings about what issues should be resolved. In the energy field in particular, there is a very large role to be played by nanotechnology ultimately. So I think it would be very effective to raise nanotechnology, which has been undergoing research and development, to the level where it can be used to resolve issues.

MANA provides a very strong foundation for nanotechnology, but if the role of WPI is to facilitate new creativity by pursuing diversity from throughout the world, so I think that just pursuing nanotechnology as it is will not lead to the next issue. The huge potential of nanotechnology will lead to a variety of other developments. For this reason, I think it is wonderful that MANA is pursuing research under the keyword of "convergence."

When I was pioneering the frontier of bioelectronics, the difficult part for the researcher of determining the scientific and technical limits and whether these limits could be overcome was also what was the most interesting. Nanotechnology has progressed to where it is today because people challenged what were considered the limitations at the time. I think it would be good to look back on the position of nanotechnology at the time and go back to basics to some extent to continue to develop it without restricting ourselves to the so-called filed of nanotechnology in order to break through the next limitation.

Also, at the time I think the theorists did really well. I think the enthusiasm that burned within the theorists to see the unseen, and to seriously think about and predict a world that is beyond your senses is very important. I would like them not to limit themselves to the field of nanotechnology but to also make large contributions to resolving the issues we face.

Taking advantage of MANA forte field to extend

Kohei UOSAKI

- Principal Investigator
- Nano-Green Field
- Specialty: Surface physical chemistry

From educational institution to research institution

—— You came to MANA from Hokkaido University; what are the differences between a university and an independent administrative institution?

In terms of research, laboratories in universities are coordinated based on academic year, i.e., to coincide with the students' schedules, but here, research is more or less carried out on an individual pace. On the other hand, as far as research subjects are concerned, while the president or dean does not have any say in professors' research, top management seems to have a strong influence at independent administrative institutions such as NIMS. This is because factors such as internal funding and projects approved by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) come into play. Therefore, policy is easily determined and things tend to move faster. For example, things are probably moving faster with MANA than at other WPIs affiliated with the university. In the sense of action towards a certain objective, independent administrative institutions have a solid policy and things seem to get done quickly. In terms of administration, however, purchasing protocol is very strict and it takes more time to purchase goods than at universities.

A major object of a university is education and research is carried out to educate graduate students. One of the most important roles of the staffs of university research lab., for example, is to "educate graduate students" and "help them earn their doctorate degrees." For example, the first author of papers is very highly appreciated at NIMS but it is often given to students to be qualified for obtaining a doctorate degree. After all, universities are educational institutions, but NIMS is a research institution.

Future vision of the Nano-Green field

—— Nano-Green is an important field, and a lot is expected of you. What kind of research are you planning to undertake?

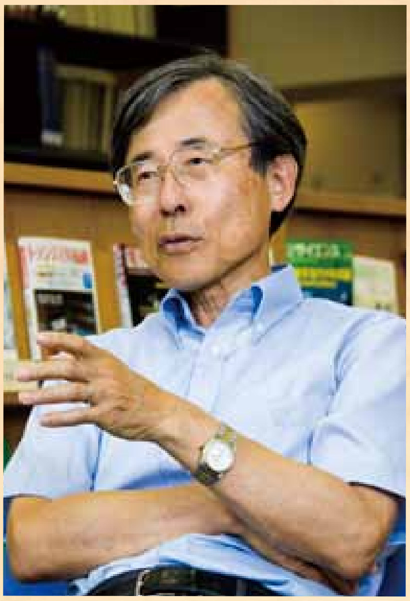
I have been involved in electrochemical research on "electron transfer at solid/liquid interfaces." This is what batteries, fuel cells and solar cells are based on. Nano-Green, or energy conversion, upon which it focuses, demands control and understanding of the electron transfer and material transformation reactions. At MANA, not many people are studying chemical reactions. I would like to contribute in that way. Inversely, we have a lot of people who specialize in material synthesis, so I would like to conduct joint research with them. Since two years ago, I have been involved in a project on "Strategic utilization of elements" MEXT and have been working on precious metal-free catalysts. The most important target is the inter-conversion between water and oxygen and hydrogen, which requires decomposition of water to hydrogen and oxygen and a reduction of oxygen by hydrogen to form water. One possible application would be fuel cells and another would be solar energy conversion. I would like to conduct fundamental research, which will have a greater impact in the future than the research close to application.

—— What sort of things are you thinking of that would be equal to an actual exit when you say you would like to produce something?

A catalyst is needed to affect most chemical reactions. We used to use bulk metal as a catalyst, but have now reduced this to tiny nano particles. I would like to further reduce this to several atoms or a single molecule. With the catalysts used so far, in many cases only the outermost parts are used as a catalyst and the inside atoms are wasted. If we can use individual atoms as a catalyst, all atoms will be used effectively with no waste. The same can be said of molecules. I would therefore like to aim for this ultimate nanotechnology and develop a highly efficient catalyst. We are specialized in detailed investigations of reactions *in situ* in real time rather than in synthesizing materials. We will employ logical and rational approaches for catalyst design based on the above-mentioned investigation.

—— What is your future vision for MANA?

The Basic Plan for Science and Technology for the next period is said to focus on problem-solving research and also the main theme of the new growth strategy approved at the cabinet meeting towards the end of last year: "environment/energy major power strategies by means of green innovation." Concerning green innovation, the Innovative Center of Nanomaterials Science for Environment and Energy was already started at NIMS last year, and the Low Carbon Research Network Hub was established by the second supplementary budget of the last fiscal year. The Nano-Green field of MANA should also be naturally connected with green innovation, but I think it should play a unique role unlike that of any other organization. Because MANA is a group of researchers with the ability to "create new functions by manipulating atoms and molecules," i.e., nanoarchitechtonics, I think we can contribute by taking maximum advantage of that feature. The target of our research is not necessary limited to energy conversion. We will be able to create MANA's own, unique Nano-Green fields—taking advantage of the fact that we have many researchers with expertise in electronic materials.



The form of MANA is what made it possible to realize such a fastidious research support environment

The majority of researchers at MANA are foreigners, so a wide range of support, such as making English the official language, is provided so that not understanding Japanese does not hinder the research activities of the researchers. It is the research support that is the pride of MANA. The MANA Foundry, which is equipped with first-class facilities, is contained in the same building to support research of nanoarchitechtonics. Moreover, MANA has many shared facilities in addition to the MANA Foundry that are supported by a technical support staff (TSS) that is proficient in English.

—MANA Foundry supports research in many fields—

Facilities meant to be versatile

The MANA Foundry was started as a shared MANA facility in April 2009. Many researchers from various fields around the world gather to MANA. For this reason, the MANA Foundry has abundant research facilities that handle a wide range of substances and materials and Foundry technical experts provide fastidious support.

The MANA Foundry is equipped with a 235 m^2 clean room which is made up of the six areas of lithography and exposure area, dry process area, nano machining area, nano structure evaluation area, nano measurement area, and heat treatment area.

The major characteristic of the MANA Foundry is its ability to provide an integrated process from materials creation to structural observation and characteristics evaluation, including micromachining using nano gap electrode pattern formation utilizing electron beam lithography of a wide variety of structures, including nano dots, nano wires, and nano sheets, made of the wide range of materials that can be handled, such as organic, inorganic, metallic, semiconductor, magnetic, superconducting, and composite materials. In addition, the MANA Foundry shares the same building to allow contributions to be made in a short time.

Flexible operation for users

For the first time MANA researchers use the facility, it's necessary for them to attend a briefing session and go through registration procedures. Even after registration, for each new project, they receive consultation from experienced staff, and this not only provides the right support for the research but also is effective in getting the researchers to clearly envision their research.

The MANA Foundry operation system was changed starting with fiscal 2010. First of all, the clean room operation hours were extended from 7 to 9.5 hours and the staff's working hours were changed to a two-shift format to meet the requests of researchers. Also, a fixed charge billing system was implemented. This was done to prepare for future operation by having researchers share the cost of general consumables and supplies, one objective of which is to encourage them to conserve these resources. The organization is looking for its own unique operation system to realize a better research environment.

(Left) Focused Ion Beam equipment
This system accelerates gallium ions to form focused ion beam(FIB). The diameter of the beam can be less than 10 nm. By irradiating FIB, samples can be etched very precisely to form a wide variety of nano structures. The system can be applied to various materials including silicon.

(Right) Angular-Resolved X-Ray Photoelectron Spectroscopy equipment
This system can identify element and chemical bonding state of sample surface by analyzing kinetic energy of photoelectrons caused by X-ray irradiation with relatively lower energy.

— Technical Support Staff (TSS) team —

Veteran technician support

The MANA TSS Team has 5 technicians that can speak English, and a variety of other support is provided to allow researchers to focus on their research, such as equipment maintenance, laboratory cleaning, reagent support, safety measures, and technical studies, transport, and installation when purchasing equipment.

This includes the orientation, such as safety training, for researchers newly hired by MANA, and equipment support when starting up a laboratory. Actually, most of the TSS members are former researchers of NIMS, so they not only possess research knowledge, but their contacts within the NIMS are also very useful to newly employed foreign researchers. To prepare the environment for the researchers that have come to MANA, the TSS first starts with consultation. First they find out what kind of equipment will be needed from what the researchers tell them, Such as, "I want to create carbon nanotubes at low temperature," "I want to make nitrides," or "I want to do advanced analysis using X-rays." To select the optimum equipment, they conduct hearings about what kind of experiments the researchers want to perform and what are the objectives of the experiments, and then hold discussions with the researchers to clarify the required equipment specifications. Based on this, they introduce the researchers to the equipment available within NIMS and/or purchase suitable equipment and reagents. If the equipment is not commercially available, then they may also develop new equipment.

In addition, the TSS can also provide reassuring assistance as mentors to young foreign researchers in particular, such as providing advice for obtaining outside funding, handling accounting audits, and handling accidents.

Functionalized semiconductor silicon and germanium nanowires

Naoki FUKATA
深田　直樹
MANA Independent Scientist

Technical progress in silicon integrated circuits (Si VLSI) has, up to the present time, been driven by the miniaturization, or scaling, of gates, oxide layers, p-n junctions, substrates, and other elements in metal-oxide semiconductor field-effect transistors (MOSFETs), which are the building blocks of VLSI. However, advances in performance and integration through conventional scaling of device geometries are now reaching their practical limits in planar MOSFETs. To overcome the limiting factors in planar MOSFETs, vertical structural arrangements using semiconductor nanowires have been suggested as the basis for next-generation semiconductor devices. A considerable amount of work has been done regarding semiconductor nanowires. In particular, Si and germanium nanowires (SiNWs and GeNWs) have gained attention since NWs-based nanodevices are desirable for their compatibility with the present Si complementary metal-oxide semiconductors (Si CMOS) integrated circuit technology and for offering better scalability and leakage control.

Impurity doping is the most important technique to functionalize semiconductor nanowires. The crucial point is how the states of impurity atoms can be clarified. Recently, I established characterization methods to clarify the chemical bonding states and electrical activity of boron (B) and phosphorus (P) atoms in SiNWs and GeNWs by micro-Raman spectroscopy and electron spin resonance.[1),2)] By applying the methods, we could detect the local vibrational modes of B and P, the Fano resonance, and the ESR signal of conduction electrons experimentally for the first time. These results clearly proved that B and P atoms were electrically activated in the substitutional sites, demonstrating the formation of p-type and n-type SiNWs and GeNWs. These methods can be an significantly useful techniques for the characterization of semiconductor nanowire devices, resulting in the realization of next-generation vertical type MOSFETs.

References
1) N. Fukata, *Adv. Mater*. **21**, 2829-2832 (2009).
2) N. Fukata *et al.*, *ACS NANO* **4**, 3807 (2010).

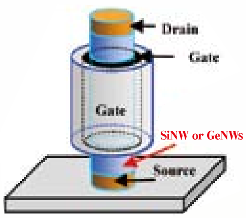
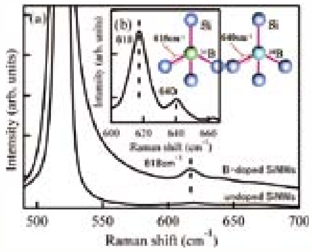
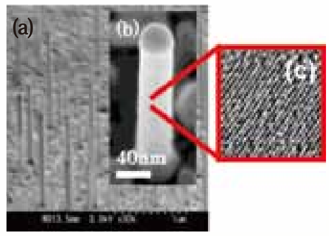


Illustration of vertical-type of MOSFETs.



(a) Raman spectra observed for B-doped SiNWs and undoped SiNWs. (b) The magnification of (a).



(a) SEM, (b) STEM, and (c) HRTEM images of SiNWs.

Crystal assemblies with a new philosophy of togetherness

Ujjal K. GAUTAM
ウジャル・ゴータム
ICYS-MANA Scientist

Crystal assemblies are omnipresent and are useful for devices. Nature too shows phenomenal control over bio-mineralization processes to produce exquisite looking crystal assemblies. Investigation of crystal-assemblies is crucial for mimicking Nature's way of crystal-growth, and for organizing nanometer size crystals for applications, as manipulation of small materials is an emerging challenge. We have discovered a new rule that governs formation of crystal assemblies of zinc oxide (ZnO) nanocrystals. The assemblies look like sea urchin, with many ZnO nanorods emanating from a central core.

This new rule is based on a special property of ZnO, polarity, meaning under certain conditions, the two ends of a ZnO rod develops positive and negative charges respectively. It was previously unknown that when ZnO rods form assembly, whether polarity is taken into consideration. We have now discovered that in an assembly, all rods grow along either the positive or the negative polar end, yielding two distinct assemblies. Thus, not the crystal axis alone, but also 'which side of crystal axis?' is an important parameter.

The two assemblies are related with a unique rule. If each rod in an assembly is rotated upside down, one assembly transforms to the other. Such relation in crystal assemblies was previously unknown, and can be compared only with molecular phenomena, such as enantiomers that are similar organic molecules but rotate light in opposite directions.

Despite similar appearances, these assemblies are entirely different in property due to opposite polarity. There are many challenges now, e. g. finding its origin, finding similar assembly of other materials etc. Since no parallels, expectations are there for novel applications. For instance, these are bio-friendly, can create a uni-polar and uni-charged surface without external electrical connections and could be used in biological systems, *in-vivo*, for sensing or chemical extraction purposes.

References
Gautam *et al.*, *Proc. Natl. Acad. Sci.* **107** (2010) 13588.

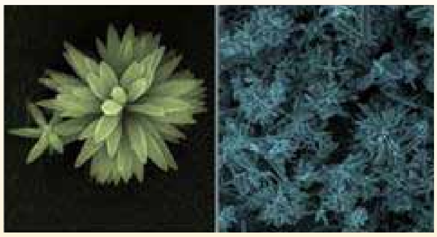


Figure 1: Images of the ZnO assemblies.

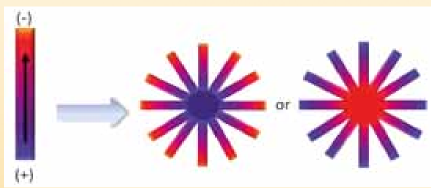


Figure 2: Schematic describing the new rule of assembly. A ZnO rod has a positive and a negative polar end, depicted in blue and red colors. Within an assembly, unipolar growth is maintained, i. e. the colors are arranged systematically, without intermixing.

Starting with bulk, toward Nanoarchitectonics

Naoki OHASHI
大橋　直樹
MANA Principal Investigator (PI)
Nano-Materials Field

Functions of solid-state devices are mostly originated in electronic phenomena at interfaces (junctions); thus, controlling of the interfacial structures in atomic scale is absolutely important for development of the solid state devices. Absolutely, arrangement and alignment of each nano-structures is also very important for fabrication of useful devices. From this viewpoint, platforms (substrates) available for organization of nano-structures are needed.

Currently, the most popular platform for nano-organization is silicon wafers, because of ultimately high purity, controllable conductivity, very flat surface, very high crystallinity and a lot of knowledge for nano-fabrication. However, it has relatively narrow bandgap causing absorption of visible light. Thus, we are considering application of wide bandgap semiconductor wafers, e.g., ZnO, for the platform of nano-organization. Actually, we have developed technology for bulk crystal growth of wide bandgap oxide semiconductors.

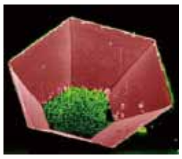
In this context, our first step is planarization of oxide surface without mechanical damage. As displayed, our student, Mr. Miyazaki, recently developed a state-of-the-art technology to obtain atomically flat surface of oxide wafers.

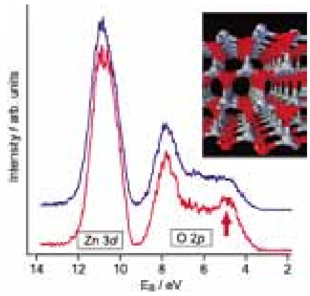
We are also interested in the crystalline anisotropy and spontaneous polarization of oxide semiconductors, because we consider that those surface activities can be triggers for self-organization. Thus, we are investigating the particular electronic structure of polar oxide surface and spontaneous formation of arranged structures on oxide surface.

We expects integration of those knowledge enables us to integrate many functions on the oxide crystalline platform.

Reference
Kobayashi *et al.*, *Cryst. Growth & Des.* **9** (2009) 1219.
Ohashi *et al.*, *Appl.phys. Lett.* **94** (2009) 122102.

Oxide semiconductor wafer and its "atomically-flat"surface.





Investigation of polar oxide surface with photoemission spectroscopy.

Evolution of nanotechnology using multiple-scanning-probe microscopes

Tomonobu NAKAYAMA
中山　知信
MANA Principal Investigator (PI)
Nano-System Field

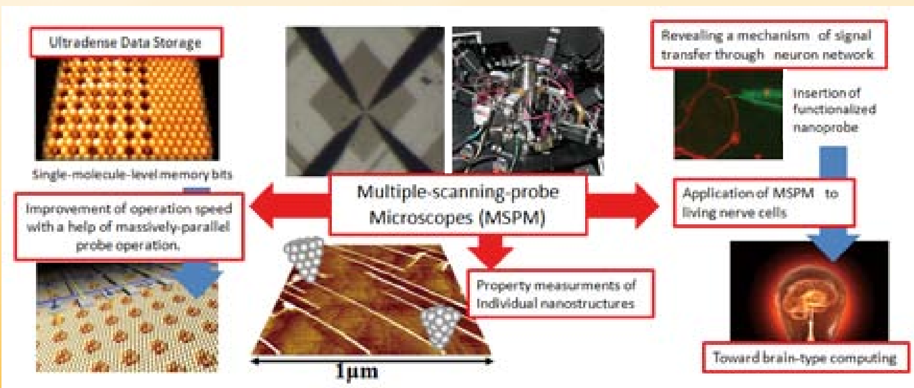
Establishing a methodology and a technology to combine nanoscale fabrication and characterization is essential for nanotechnology to be useful for practical applications. Therefore, we have developed multiple-scanning-probe microscopes (MSPMs) which realize nanofabrication, measurements of properties of individual nanostructures, and exploration of nanosystem functionalities.

Our MSPM has two to four independently-driven probes and each probe serves the same functions as those realized by conventional scanning tunneling microsocope (STM) and atomic force microscope. Using the MSPM, for example, we can observe nanowires grown on Si substrates and bring two probes in contact with a selected nanowire. Thus, the electrical property of the nanowire is measured as if we use an electrical tester. Such a novel nanoscale measurement enables us to investigate physical properties and feasible applications of individual nanostructures.

Recently, we found a new method for controlling inter-C_{60} molecules using a probe of STM and demonstrated how an ultrahigh density data storage is operated by single-molecule-level chemical reactions. The operation speed of such a device will be orders of magnitude increased by using MPSPM equipped with superparallel probes.

The meachanism of signal transfer through living neuron networks can be studied by MSPM. For this aim, we developed nanoscale probes for detecting single molecules in liquid and those for measuring local ionic currents. MSPM equipped with such probes offers a new area of research toward a brain-type computers.

Reference
D.-K. Lim *et al. Appl. Phys. Lett*, 2008; **92**(20); 203114.
M. Nakaya *et al. Adv. Mater*, 2010; **22**(14);1622-1625.
S. Higuchi *et al. Rev. Sci. Instrum*, 2010; **81**(7); 073706.



MANA was Highly Evaluated –FY2009 WPI Program Follow-up Results–

The WPI Program Committee met on Wednesday, July 14, to evaluate scientific achievements and project implementations of the 5 WPI centers for their FY2009 activities. The International Center for Materials Nanoarchitectonics (MANA) received a high evaluation along with IPMU (the University of Tokyo) and iCeMS (Osaka University). MANA was favorably evaluated for having more than 50% foreign national researchers, appointing excellent Principal Investigators from Japan and abroad, and providing good administrative support for foreign researchers by using English as the common language. Mentioned future issues were clarifying the distinctive science undertaken by MANA, the need for a grand challenge for creating new material sciences, and strengthening nano-bio field.

New MOUs with Two Universities

MANA has signed a memorandum of understanding (MOU) with the Erlangen Catalysis Resource Center (ECRC), the University of Erlangen-Nürnberg, Germany, and has agreed to collaborate on research in the materials and catalyst fields (May 20, 2010).

From left: Dr. Vinu, MANA Independent Scientist
Prof. Schwieger, University of Erlangen-Nürnberg
and Prof. Hartmann, ECRC

MANA has signed a memorandum of understanding (MOU) with Department of Materials Science, Fudan University, China, to promote joint research in the fields of organic-inorganic nano hybrid materials for optoelectronic applications (June 23, 2010).

From left: Prof. Wu, Fudan University
and Prof. Bando, MANA COO

Awards

Received the FY2010 Commendation of Science and Technology by the Minister of Education, Culture, Sports, Science and Technology

On April 13, MANA Independent Scientist Katsunori Wakabayashi was awarded the Commendation of Science and Technology by the Minister of Education, Culture, Sports, Science and Technology (MEXT). He received the Young Scientists' Prize, which recognizes young researchers with advanced R&D ability, for his work on "Nano-scale Effect on Electronic Properties of Graphene."

MANA Independent Scientist
Katsunori Wakabayashi

Yoshio SAKKA
(Principal Investigator)
Japan Society of Powder and Powder Metallurgy, Award for Distinguished Achievements in Research, May 25, 2010

Kazuhiro HONO
(Principal Investigator)
Japanese Society of Microscopy, Best Paper Award, May 25, 2010

Yoshihiro TSUJIMOTO
(ICYS-MANA Researcher)
Japan Society of Powder and Powder Metallurgy, Award for Innovatory Research, May 25, 2010

Jin KAWAKITA
(MANA Scientist)
Japan Society of Corrosion Engineering, Encouragement Prize, May 13, 2010

Newly Appointed Researchers

Takao AOYAGI
Principal Investigator
Nano-Bio Field Coordinator
Hybrid Nano-Biomaterials Group
Appointed in September 2010

Tamaki NAGANUMA
MANA Scientist
Fuel Cell Nano-Materials Group
Appointed in July 2010

Mitsuhiro EBARA
MANA Scientist
Hybrid Nano-Biomaterials Group
Appointed in September 2010

Five new ICYS-MANA Researchers (postdocs) joined MANA.

Events

MANA International Symposium 2011

Dates: March 2 (Wed) to March 4 (Fri), 2011
Location: Tsukuba International Congress Center, 2-20-3 Takezono, Tsukuba-shi, Ibaragi-ken, Japan
Participation fee: Free
Registration and details will be available at Symposium website: http://www.nims.go.jp/mana_2011/
(Scheduled to open in late November)

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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.