from Tsukuba, Japan to the world

NIMS NOW International

National Institute for Materials Science

Vol.3 No.5 May, 2005

Special Features

Interdisciplinary Research and Development II "Technical Innovation in Nano-IT Fields"

Introduction

—On publication of this special issue on "Technical Innovation in Nano-IT Fields"—

Masakazu Aono
Director-General
Nanomaterials Laboratory (NML)

Nano-Week (February 21-25), which is the world's largest comprehensive event devoted to nanotechnology was held recently at the Tokyo Big Sight International Exhibition Center. NIMS was proud to play a central role in holding this very active and deeply significant week, which included a variety of forums and exhibitions sponsored or cosponsored by Japanese industry, academic, and governmental institutes and organizations, together with events sponsored by many of the world's countries, visits by study missions to related research institutes, gatherings for exchanges at several embassies. More than 300 companies and groups presented exhibitions, and close to one-third of these were from foreign countries. The event was clear evidence of the high interest in nanotechnology around the world, as well as the intense attention that foreign countries have focused on Japan as either a partner or competitor in this important field.

Thus, it is particularly timely that we include this Special Feature, entitled "Technical Innovation in Nano-IT Fields," in *NIMS NOW International*. IT (information technology) is inseparable from nanotechnology, and without nanotechnology, there would be no prospects for progress in IT or the creation of an advanced information society, which is one of Japan's goals. Nanotechnology is a universal technology which spurs innovation in many fields, including IT, biotechnology, energy, and the environment. However, it would be no exaggeration to say that the greatest objective for nanotechnology is innovation in IT. < Continued on p.5

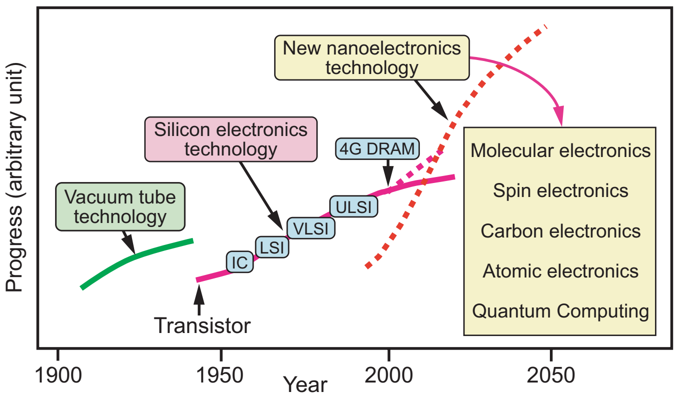

Fig. 1 Progress in electronic devices.

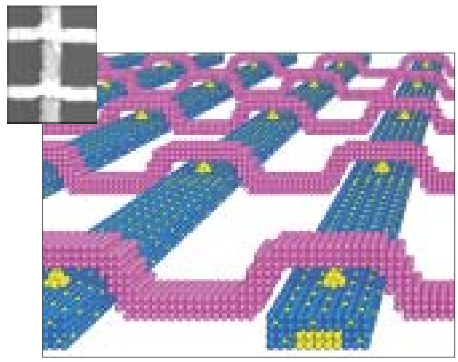

Fig. 2 Schematic diagram of integrated Atomic Switches. Upper left: Electron microscope image of 2 integrated Atomic Switches.

in this issue

NIMS News

Start of International Joint Graduate School with Poland's Warsaw University of Technology

From left to right, Prof. Wolański, Deputy Rector of WUT, Prof. Kishi, President of NIMS, Dr. Rybicki, Ambassador of Poland in Japan, Prof. Mańkowski, Rector of WUT, Mr. Sato, Director of Office for Material Research and Development, MEXT. < Continued on p.6

Search for Metal Gate Materials and Work Function Control in Next-Generation Integrated Circuits

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Nanomaterials Assembly Group
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—Fabrication and Work Function Measurement of Compositionally-Gradient Metal Thin Films—

Progressively higher integration in integrated circuits demands techniques for further miniaturization and suitable new materials. Among several important tasks, the most urgently requirements are a next-generation gate oxide film material and metal gate material. In the area of gate oxide films, based on recent research, there is a nearly complete agreement that HfO_2 oxides represent the direction of the future, but where gate materials are concerned, no clear direction can yet be seen. The threshold voltage V_{th} which controls On-Off operation of the metal oxide semiconductor field effect transistor (MOSFET) is controlled by the work function of the gate material. However, because it is necessary to use materials with different work functions in pMOS and nMOS, the possibility of controlling the work function using metal materials has become a topic of discussion.

Several guiding principles are applied in material selection. First, in order to control the work function, one aim is control of a wide range of values by combining materials with large and small work functions. However, in these metal materials, it is necessary to select substances which have low reactivity with the gate oxide film. Moreover, from the viewpoint of continuous composition control, it is also necessary to consider a combination of materials with a small intermediate layer. Here, Pt and W were selected as materials which satisfy these conditions, and the possibility of controlling the work function using these materials was investigated.

In specimen fabrication, a combinatorial method combined with the ion beam sputtering method was used. 5 keV Ar ions with an ion current of 20 μA was used for sputtering. A continuous compositionally-gradient film of Pt-W with a film thickness of 20 nm was fabricated by this method, and the composition and work function at various points in the specimen were investigated by X-ray photoelectron spectroscopy (XPS).

The **figure** shows a schematic diagram of the specimen, an optical image, and the composition change and work function values in the specimen. It can be understood that the composition changes gradually from Pt through the W region. The work function values change from 5.5 eV to 4.7 eV. Because the work function control which is actually required covers the range from 5.5 eV to 4.4 eV, this combination basically satisfies the necessary condition, making it possible to control the threshold voltage.

In a separate experiment, it was also found that the work function of a thin film closely approaches the value of the bulk at film thicknesses of 10 nm or more. This suggests that it will be possible to fabricate MOSFET using metal gates in integrated circuits in the 45 nm-32 nm gate length generation.

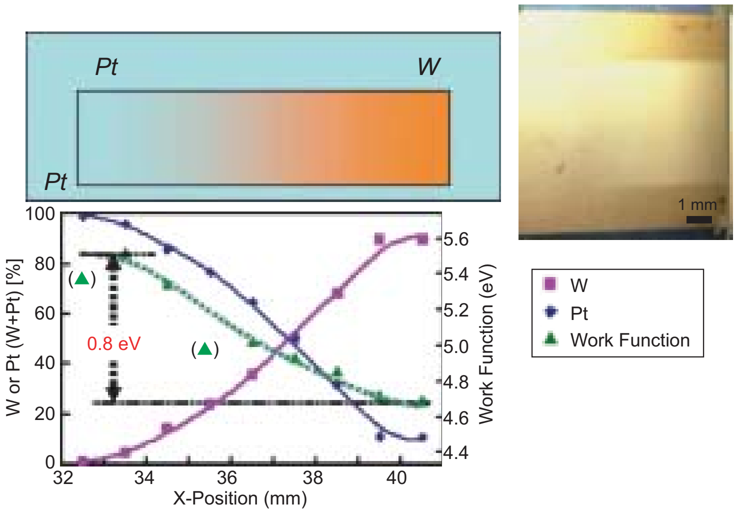

Fig. Pt-W compositionally-gradient specimen fabricated by combinatorial method and its work functions.

For more details: http://www.nims.go.jp/nanomat_lab/index_e.htm

Superconducting Diamond Film Synthesized by Chemical Vapor Deposition

Yoshihiko Takano, Masanori Nagao
Nano Quantum Electronics Group
Nanomaterials Laboratory (NML)

—A First Step toward Diamond Superconducting Devices—

As the king of precious stones, diamonds have always fascinated humankind, but the distinctive features of diamonds are not limited to their beauty. As almost everyone knows, diamonds are the hardest material, and although they are an electrical insulator, they are among the best thermal conductors. In general, materials with good thermal conduction are also good conductors of electricity. This is because free electrons conduct heat. However, diamonds are an insulator, and what characteristic of the diamond carries heat? In actuality, diamonds has extremely high frequency lattice vibration, and this conducts heat. On the other hand, superconductivity is the phenomenon in which electrical resistance becomes zero at low temperatures. Superconductivity is basically considered to be caused by the correlation between lattice vibration and the carrier. We therefore thought that superconductivity could be achieved if it were possible to introduce a carrier which would make the diamond a good electrical conductor.

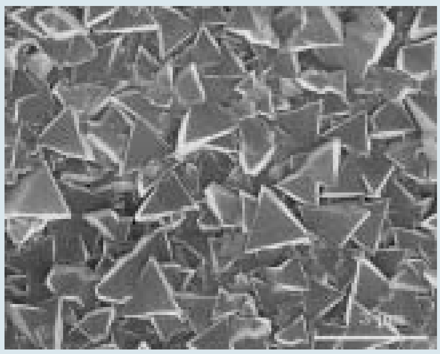

Fig. 1 SEM image of diamond film.

Quantum Dot Technology for Generation of Single Photons in Optical Communications Waveband

Yoshiki Sakuma
Optoelectronic Nanomaterials Group
Nanomaterials Laboratory (NML)

Quantum mechanics is a scientific discipline which was established in the first half of the 20th century to describe the puzzling behavior of electrons and light, and makes it possible to understand all of the basic properties of substances and materials. Recently, however, there has been heightened interest in developing useful applications for quantum mechanics in ordinary life by artificial manipulation of these quantum properties. The new technology called "quantum communications," which includes the quantum computer and quantum cryptography, is a typical examples of this trend. Among these, because quantum cryptography is an extremely secure encryption technology which is absolute safe from eavesdropping by third parties, its early realization is strongly desired as society becomes increasingly convenient through linkage by information networks. Visible light actually consists of particles called photons. Quantum cryptography is a completely new technology which encrypts coded information on single light particles. However, single photon devices capable of generating and detecting single photons are necessary and indispensable condition for realizing this. The key to success is a fabrication technology for the quantum dots which are the basis for devices of this type.

The quantum dot is an extremely small, artificially produced semiconductor nanostructure with a size of no more than several tens of nanometers. Because quantum dots have properties similar to atoms, when electrons or holes are confined in this small region, it is possible to generate single photons using a basic principle of quantum mechanics called the Pauli exclusion principle. We have already succeeded in developing high quality quantum dots which display extremely strong photoluminescence (PL) in the 1.3-1.55 μm band, which is important for optical communications, enabling use of the extensive optical fiber communications network already in place. Employing the crystal growth technology called MOCVD, we developed a technology for fabricating quantum dots of indium arsenide (InAs) on a substrate of indium phosphide (InP). **Fig. 1** is a transmission electron microscope (TEM) image of the cross section of one quantum dot fabricated by this process. Planarization of the upper and lower hetrojunction interface between the InP and InAs at the atomic level was also possible, an accomplishment which is unprecedented in examples of research reported to date. Furthermore, in a detailed investigation of PL from this quantum dot, it was found that the newly-developed quantum dot causes generation of single photons as expected. This confirmed generation of single photons in the communications waveband is also a world's first. As shown in **Fig. 2**, a wavelength control technology called the double-capping method, which allows arbitrary control of the height of the quantum dot, was also realized at the same time. Using this outstanding quantum dot technology, we have begun joint research with the University of Tokyo and private-sector companies for practical application of single photon devices.

Fig. 1 TEM image of cross section of an InAs quantum dot fabricated on InP (001) substrate.

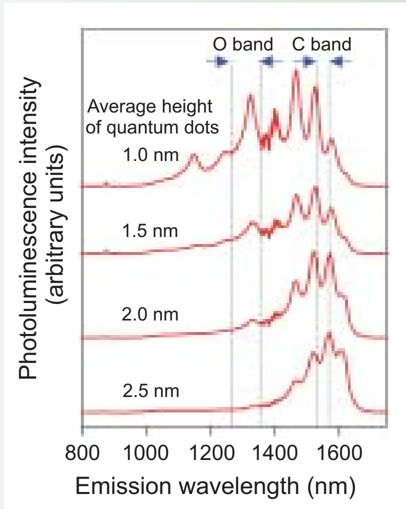

Fig. 2 Height of quantum dot by double-capping method and PL wavelength at 77 K.

For more details: http://www.nims.go.jp/nanomat_lab/index_e.htm

About 20 years ago, the chemical vapor deposition (CVD) method of synthesizing diamonds from methane, ethanol, etc. was developed. It is known that semiconducting diamonds can be obtained by mixing a small amount of gas containing boron during preparation of the sample, and these are expected to play a role in the development of next-generation devices. However, what would happen if a large quantity of boron were introduced? Using the CVD method, we prepared diamond thin films introducing a high concentration of boron. **Fig. 1** shows an scanning electron microscope (SEM) image of the obtained sample. Triangular diamond crystals can be observed. This is a crystal which has grown in the <111> direction, and corresponds to a dice cube as seen from an edge. **Fig. 2** shows the results of measurements of electrical resistance down to liquid herium temperature. The diamond becomes a good conductor, allowing electricity to pass easily. It was found that the sample reached at zero resistivity state and becomes a superconductor at around an absolute temperature of 7.4 K. At temperatures lower than this, electrical resistivity disappears and absolutely no heat is generated when an electric current is passed. The superconducting transition temperature appeared at a temperature more than three times higher than with samples produced by high-pressure synthesis.

Taking advantage of this feature, development of novel environment-friendly devices with low heat generation is expected. This research was carried out jointly with Prof. Hiroshi Kawarada of Waseda University.

For more details: http://www.nims.go.jp/nanomat_lab/index_e.htm

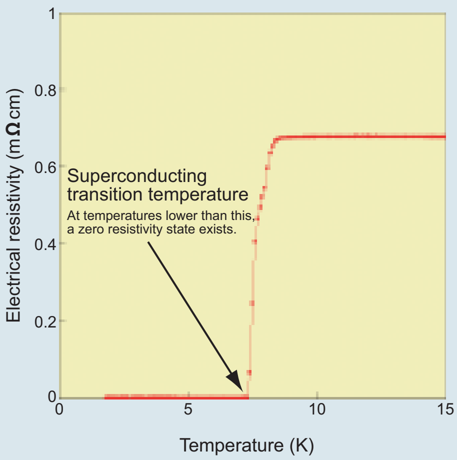

Fig. 2 Temperature dependence of electrical resistivity in superconducting diamond film.

Quest for Optical Quantum Computation using Semiconductor Nanostructure

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Because semiconductor microparticles (quantum dots) with sizes of several 10 nm have outstanding optical properties, active research aiming at application to lasers and other devices is underway. Electrons and holes (positively charged electron empty shell) can be confined in quantum dots by light irradiation or current injection. Single photon is generated when electrons and holes recombine and are extinguished, and the energy of the photon can be controlled by the size of the quantum dot. Using two laser pulses, it is possible to form one or two groups of electron/hole pairs in a quantum dot (**Fig. 1**). The possibility of realizing a basic processing element (controlled NOT gate) of quantum computers by employing this phenomenon has been demonstrated theoretically.

Conventional research has adopted a method in which the average values of optical properties are evaluated for a large number of quantum dots with size deviations. However, because this method is unsuitable for precise design of the quantum dots and evaluation of their properties, development of an evaluation method for individual quantum dots had been desired.

We therefore developed a low-noise, high-reliability evaluation device by assembling a measurement device combining a microscope and laser light source, and introducing an automatic adjustment mechanism for the microscope focal point using a piezoelectric element. **Fig. 2 (left)** shows a photoemission spectrum measured with this device. The several sharp photoemission lines which can be observed here are the respective photoemissions from quantum dots of different sizes.

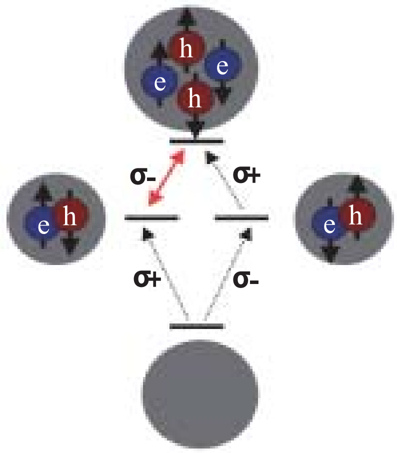

Fig. 1 Schematic diagram of controlled NOT gate using optical excitation of electron-hole (e-h) pair.

Although the width of photoemission lines is an important factor in optical characteristics, it is difficult to evaluate line width due to the inadequate resolution of the spectrometers ordinarily used. To solve this problem, we produced a device called a Michelson interferometer and observed the interference phenomena of photons generated from single quantum dot (phenomenon of self-interference of photons). From the data obtained, the line width was determined to be 30 μeV. **Fig. 2 (right)** shows the output of the interferometer and represents a condition in which photon interference is lost as the time difference increases. The measured values (red circles) and theoretical values (blue line) show good agreement.

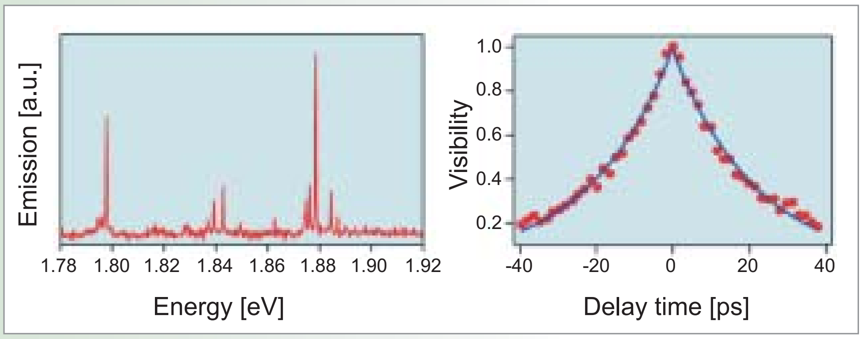

Fig. 2 Left: photoemission spectrum of single quantum dots; right: interference of single photons.

Based on the results of this research, we plan to demonstrate the principle of optical quantum computation, as shown in **Fig. 1**. This will be a significant development, as high expectations are placed on the quantum computer as an ultra-high speed computer of the future.

For more details: http://www.nims.go.jp/nanomat_lab/index_e.htm

MOU with Automation Creations, Inc. in the U.S.

From left to right, Dr. Yagi, Director-General of MITS, Dr. Kipp, Director of MatWeb, Dr. Yamazaki, Group Leader of Materials Database Group, MITS.

(March 16, Tokyo) -- The Materials Information Technology Station (MITS) signed a memorandum of understanding (MOU) on mutual links of materials databases (DBs) with Automation Creations, Inc., which provides the world's largest database on practical materials on the web (MatWeb). In order to create materials DB which allow designers to select the optimum materials when designing products, NIMS and Automation Creations agreed to implement a system which makes the most of each organization's distinctive features, beginning with structural materials (creep and fatigue) and polymeric materials data. In the future, the two sides plan to cooperate in system development for materials databases and study of related business models.

Construction of Practical Logic Circuit using Ultimate Nanodevice "Atomic Switch"

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Nanomaterials Laboratory (NML)

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Semiconductor devices are used in all types of modern electronic equipment, from cellular phones to computers. However, the evolution of these semiconductor devices, which have contributed so much to the creation of today's information society, is now approaching its economic and physical limits. Thus, the development of new nanodevices, with which further progress can be expected, as a substitute for semiconductor devices has become an urgent task for realizing a more advanced information society.

Because electronic devices such as computers are actually an assemblage of an enormous number of electrical switches, the development of new nanodevices for this equipment means nothing other than the development of new switches. We have developed an ultimate nanodevice called the "Atomic Switch" which controls the movement of atoms, and is therefore in principle different from conventional semiconductor devices which control the movement of electrons. At present, we are engaged in research for practical application.

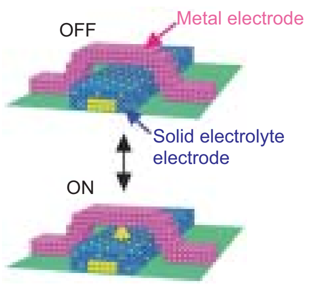

Fig. 1 Structure and operating principle of Atomic Switch.

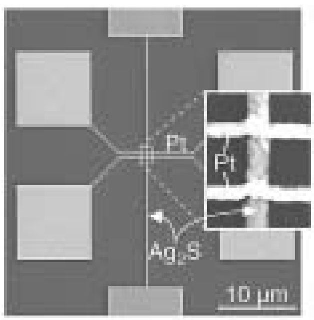

Fig. 2 Electron microscope image of Atomic Switch.

The Atomic Switch consists of an opposing solid electrolyte electrode and metal electrode separated by a gap of approximately 1 nm. In operation, depending on the polarity of the voltage applied to the two electrodes, the device switches ON, when metal atoms are precipitated from the solid electrolyte and bridge the gap, or switches OFF when the atoms are redissolved into the solid electrolyte and extinguished, causing the gap to reform (**Fig. 1**). This Atomic Switch has a number of advantages in comparison with conventional semiconductor devices, including smaller dimensions, lower power consumption, low resistance when ON, and nonvolatility, and thus offers a single solution to the various problems associated with semiconductor devices.

We recently established an integration technology for the Atomic Switch, fabricated memory and logic circuits using this technology, and succeeded in verifying their excellent operating characteristics.

Fig. 2 shows an electron microscope image of two integrated Atomic Switches fabricated using the newly-developed technology. The solid electrolyte is silver sulfide (Ag_2S) and the metal is platinum (Pt). The Atomic Switch is formed at the intersection between their wiring (width: 100 nm).

Basic logic circuits (AND, OR, NOT) were constructed using either two or one Atomic Switch. **Fig. 3** shows a schematic diagram of the AND circuit, together with its excellent operational results.

These results demonstrate that immediate practical application of the Atomic Switch is possible, and furthermore, the arithmetic circuits and memory circuits necessary in computers can be constructed using only Atomic Switches.

In the future, it can be expected that Atomic Switches will be used in virtually all electronic devices, and will make an important contribution to the sustained development of an advanced information society.

In closing, it may also be noted that these results have been reported in the British science journal *Nature* (January 6, 2005), and in numerous Japanese newspapers, including the *Asahi*, *Yomiuri*, *Mainichi*, *Sankei*, *Nikkei*, and others.

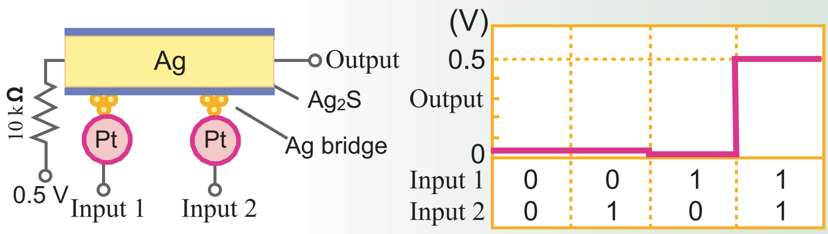

Fig. 3 Schematic diagram and operating results of logic circuit (AND gate).

For more details: http://www.nims.go.jp/nanomat_lab/index_e.htm

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Special Features

Introduction

The history of progress in the electronic devices which support IT and computer technology is shown schematically in **Fig. 1**. The semiconductor transistor was invented in 1947. About 10 years later, the concept of integration was introduced, and the half-century that followed has seen extraordinary progress realizing in high integration. This progress is known as Moore's Law, which proposes that four-fold integration is achieved every 3 years. Nevertheless, this progress will reach its limits in the near future because miniaturization of the field effect transistor (FET), which has played a central role to date, is approaching its theoretical limits. Thus, in order to sustain progress in computer electronics, we must actively develop new nanoelectronic devices and create a roadmap for practical application as quickly as possible. Several of these possibilities are shown in the lower right of the **Fig. 1** and **Fig. 2**.

In this Special Features issue, we will take up five topics related to the issues outlined above. The fifth topic (see **page 6**) is actually related to new metrology techniques, but is included here as this field of technology is expected to provide a powerful tool for the future development of nanoelectronic devices.

For more details: http://www.nims.go.jp/nanomat_lab/index_e.htm

Technical Innovation in Measurement of Signals Transmitted via Single Nanostructures

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Nanomaterials Laboratory (NML)

Fig. 1 Ultra-high vacuum multiple-scanning-probe microscope.

The nanoelectronic devices which will support next-generation information and telecommunication technologies will utilize nanostructures which possess atomic level precision. This will not only result in dramatic increases in integrated circuit density, but is also expected to realize a new class of functional devices such as quantum devices and ultra-high sensitivity nanosensors using quantum phenomena. As an example, NIMS researchers recently demonstrated the surprising characteristics of the Atomic Switch, which is a device based on an entirely new principle (see **page 5**). Furthermore, if the complex functional networks seen in living organisms can be constructed and controlled using nanotechnology, this may also open the way to realizing a neural-type computer featuring information processing with a high order of parallel processing and learning functions.

The establishment of a new basic technology for measuring signals at the nano-scale level will be necessary and indispensable for achieving this kind of progress in nanoelectronics and innovation in advanced information processing technology. Therefore, in order to measure signals transmitted via single nanostructures, we developed a multiple-scanning-probe microscope (MP-SPM) shown in **Fig. 1**.

Our MP-SPM is equipped with 2 to 4 independently-driven probes, the positions of which are controlled with atomic-level precision. By placing the necessary number of probes in contact with the structure or material to be measured, it is possible to clarify its physical properties and functions. We have already verified the excellent capabilities of MP-SPM through nano-scale measurement of electrical properties, as described in the following. For example, using the MP-SPM, one nanowire was selected arbitrarily as the object of measurement from the large number of nanowires on an Si (001) surface. Two independently-controlled probes were properly positioned in contact with this nanowire, and its electrical resistance was measured. By repeating the process a number of times, it was possible to measure the length dependence of electrical resistance in single nanowires. This important measurement was an unprecedented achievement which had not been possible until now.

It may also be noted that there is no theoretical upper limit on the number of probes which can be used with the MP-SPM. If a technology using a larger number of probes can be applied not only to inorganic nanostructures such as that described above, but also to complex biological materials such as proteins and cells, it will be useful in developing information processing technologies based on novel concepts. For example, research and development to elucidate and apply the high-order information processing systems realized in cells is important (see **Fig. 2**). Therefore, in parallel with nano-measurement of signal transmission in biomaterials using the current MP-SPM, we have also taken on the challenge of developing even more advanced measurement technologies.

Although the multiple-scanning-probe microscope was developed to measure signals transmitted via single nanostructures, we intend to contribute to progress in nanotechnology and information technology by further development of this groundbreaking device.

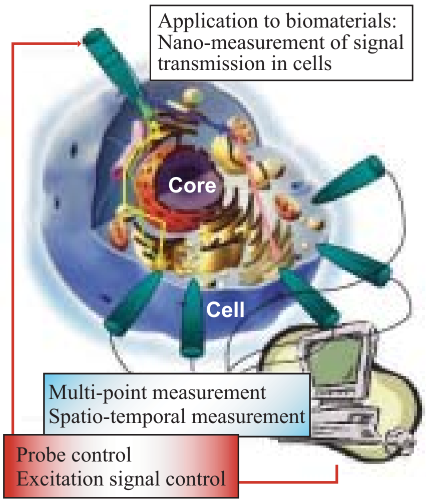

Fig. 2 Cell Odyssey: MP-SPM measurement of intracell signal transfer and transduction.

For more details: http://www.nims.go.jp/ele_nanochar_gr/

NIMS News

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Start of International Joint Graduate School with Poland's Warsaw University of Technology

(March 29, Tokyo) -- NIMS agreed to begin an international joint graduate school with Warsaw University of Technology (WUT) at a signing ceremony held at the Polish Embassy in Japan. Under the new program, NIMS will receive 5 students in doctoral courses from WUT each year to conduct research for doctoral dissertations under the guidance of NIMS researchers. The program will be implemented in the same manner as the programs with Charles University (Czech Republic) and five Australian universities which are already in progress. In addition to training young scientists, these programs also contribute to a higher level of activity in research work at NIMS by expanding cooperation to exchanges of researchers and joint research. As part of its effort to strengthen international cooperation, NIMS has been searching for new partners, and reached this agreement with WUT as the central presence in materials science in Poland, which is itself noted for producing a large number of outstanding young scientists.

Synthesis of Water-Soluble Silica-Based Material

—Rodlike Silicon Oxide with Higher-Ordered Nanostructure—

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Kagoshima University
(Former Research Fellow at NIMS)

Nobuo Iyi
Opto-Single Crystal Group
Advanced Materials Laboratory (AML)

Silica-based materials (silicon oxides) which consist of silicon (Si) atoms and oxygen (O) atoms, such as glass and silica gel, cannot dissolve in water. This is because the structure formed by chemical bonds of Si atoms and O atoms (siloxane bonds) is 3-dimensionally huge. Because these silica-based materials are nontoxic and also have high transparency, they are widely and generally used as desiccants (silica gel) and containers (glass) for foods. On the other hand, considering these desirable properties, hybridization with organic compounds having various functions has also been strongly desired in recent years. However, as mentioned above, because silica-based materials cannot dissolve in any solvents including water, the chemical reactions for hybridization in a homogeneous solution are impossible. Consequently, it is difficult to obtain homogeneous hybrid materials under the mild reaction conditions. It is conceivable that this problem can be solved by a water-soluble silica-based material.

We therefore polymerized (sol-gel reaction) an alkoxysilane raw material which converts to an ionic substituent during the reaction, and thereby succeeded in synthesizing a water-soluble silica-based material (**Fig. 1**). That is, when the sol-gel reaction was performed using an alkoxysilane molecule with an aminopropyl group, the network bonds consisting of Si and O grew only in a 1-dimensional direction, resulting in a rodlike silica-based material (**Fig. 2**). We assumed that the raw material was organized in the rodlike structure in the reaction solvent (water) due to the effect of the ionic substituent, and then polymerization occurred, leading to a rodlike silica-based material. In solid state, this material has a structure formed by regular stacking of the rodlike macromolecules with ca. 1-nm diameter. It shows water-solubility and dissolves in water to form a clear solution due to the hydrophilic ammonium ions on the surface of each rod (**Fig. 2**). We expect many types of inorganic-organic hybrid materials by combination of this water-soluble silica-based material with various functional organic compounds.

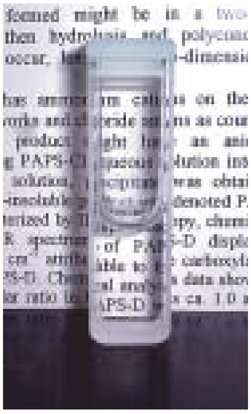

Fig. 1 Aqueous solution (20 wt%) of rodlike silica-based material.

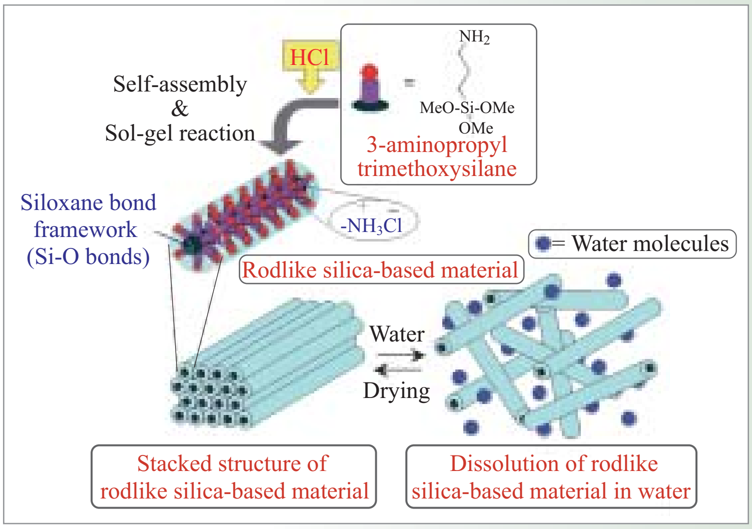

Fig. 2 Images of synthesis of rodlike silica-based material and its dissolution in water.

For more details: http://www.nims.go.jp/osc/index_eng.html

NIMS Signs MOU with Institute of Materials for Electronics and Magnetism, Italy

(March 1, Italy) -- The Nanomaterials Laboratory (NML) signed an MOU on research cooperation with the Institute of Materials for Electronics and Magnetism (CNR-IMEM), located in Parma, Italy. The goal of this MOU is to further expand Italian-Japanese cooperative work in connection with the development and evaluation of semiconductor materials, which has been underway for the last 3 years. Under the agreement, the two sides will promote research cooperation on "Nanoscale characterization of defects and microstructures in semiconductors." Areas of research will include many types of materials not limited to semiconductors, but also encompassing superconductors, ceramics, nanomaterials, and others. Thus, in the future, the agreement is expected to enable wide-ranging research cooperation between the two institutes in fields other than semiconductors.

Dr. Zanotti (right), Director, CNR-IMEM, and Dr. Sekiguchi, Director, Optoelectronic Nanomaterials Group, NIMS.

■ Enjoying the Work and Smelling the Flowers ■

Yongzhao Yao (China, Sep. 2004 - Jul. 2007)
University of Tsukuba PhD Student/NIMS Junior Researcher
Optoelectronic Nanomaterials Group
Nanomaterials Laboratory (NML)

[With Nobel Laureate Dr. Heinrich Rohrer and NIMS researchers (front, third from right)]

It is with great pleasure that I say hello to *NIMS NOW* readers here. I am Yao from Beijing, China. I started my research as a PhD student in NIMS last September, just after I graduated from Tsinghua University, China. I am now working on MBE III-V nitride in the Optoelectronic Nanomaterials Group headed by Prof. Takashi Sekiguchi. Studying and living in Japan is a totally new and exciting experience for me. All of my colleagues are very kind and warmhearted, and they always help me in my work and daily life, even before I ask. That's why I like to regard our group as a big family. My scientific communication with my colleagues has not been frustrated by my poor Japanese, and this allows me to devote myself to the research. Thus, it is not only world-class research equipment that NIMS offers me, but also a good opportunity to work with and learn from so many outstanding researchers.

Besides work, I enjoy living in Japan very much. On holidays, I play soccer or go out for hiking, climbing, and shopping with friends. Here, in Tsukuba, I feel Japan and the Japanese with my heart. Last weekend, when I went to hanami (a party to enjoy viewing sakura blossoms) with my friends, I told myself this is my life, enjoying the work and smelling the flowers.

■ Hi Everybody! ■

Mohammad Kamal Hossain
(Bangladesh, Apr. 2004 - Mar. 2007)
University of Tsukuba PhD Student/NIMS Junior Researcher
Reaction & Excitation Dynamics Group
Materials Engineering Laboratory (MEL)

[Near Mt. Tsukuba with friends (second from left)]

I am Mohammad Kamal Hossain from Bangladesh. I am very glad to have this opportunity to introduce myself. I have received my M. Engg. from AIT (Asian Institute of Technology) in Thailand after graduating from KUET (Khulna University of Engineering and Technology) in Bangladesh. I started my work at NIMS under the supervision of Prof. Masahiro Kitajima (Reaction and Excitation Dynamics Group). At present, I am in the process of studying the dynamic properties of molecules absorbed on noble metal nanoparticles by the FS laser.

From the beginning, I was thirsty to do research and become familiar with state-of-the-art facilities. NIMS has given me this opportunity. There is no doubt that this program (doctoral program launched by NIMS) is one of the best programs for those who are really serious about their researches. I would like to express my heartfelt thanks to Kitajima-sensei for giving me this chance. And of course, I can't hide another very important person, Assoc. Prof. Kunie Ishioka, whose kind guidance is always leading me to the right way. I've found my all colleagues always helpful in all respects.

I like to enjoy natural scenery. But truly speaking, I rarely go out because of my busy schedule. Naturally, I am very emotional and I miss my parents and others very often. In that case, I try to make myself busy with my research, and if this is not possible, I sleep all the day and night. That's the life going on here in Tsukuba.

Doctoral Program in Materials Science and Engineering, Graduate School of Pure and Applied Sciences, University of Tsukuba

This program, which Mr. Yao and Mr. Hossain belong to, has been conducted jointly by the NIMS and the University of Tsukuba since 2004. Entrance exam for 2006 admission is scheduled in this August. For more details: **http://www.nims.go.jp/graduate/english/**

NIMS Public Relations Office
National Institute for Materials Science

PUBLISHER
Dr. Masatoshi Nihei

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