from Tsukuba, Japan to the world

NIMS NOW International

National Institute for Materials Science

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Special Features

Manufacturing Frontier II

VENUS: A 3D Visualization System for Crystal Structures and Electron/Nuclear Densities

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Advanced Materials Laboratory (AML)

VENUS is a three-dimensional (3D) visualization system for

- crystal structures (stick, ball-and-stick, space-filling, wireframe, dot-surface, polyhedral, and thermal-ellipsoid models) and magnetic structures (magnetic moments);
- electron and nuclear densities, Patterson functions, and other physical quantities determined from X-ray and neutron diffraction data;
- electron densities, wave functions, electrostatic potentials, and other physical quantities obtained with programs for simulating electronic states.

Superposed display of a structural model with isosurfaces is also possible. VENUS runs best on a personal computer equipped with a video card supporting OpenGL acceleration.

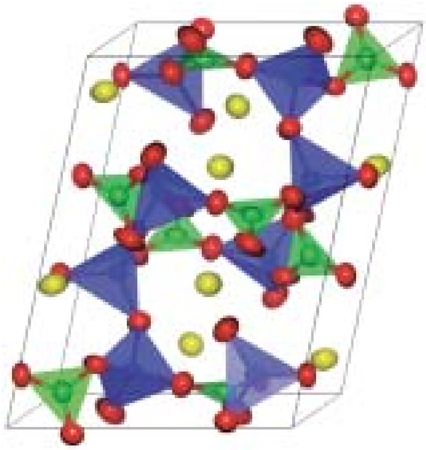

Fig. 1 Monoclinic unit cell for $Rb_2Al_2B_2O_7$ consisting of Rb atoms, AlO_4 tetrahedra, and BO_3 triangles. Each atom is represented by a thermal ellipsoid.

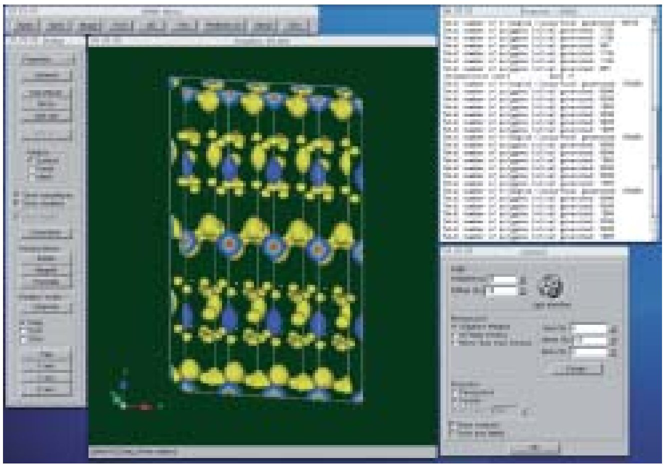

Fig. 2 3D display of electron densities obtained with PRIMA from synchrotron X-ray powder diffraction data of a superconducting Co oxide.

VENUS has superior features compared with existing commercial software. For example, VENUS can read in 23 kinds of crystal data files such as CIF and PDB, and can output 10 kinds of image files such as TIFF and EPS (including pixel or vector data) as exemplified in **Fig. 1**. VENUS has four rotation modes and automatic atom search features. It can display symmetry operations for each atom, interatomic distances, bond angles, distortion parameters for a coordination polyhedron, a bond valence sum, *etc*.

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Visit by Korean Students in Winter Institute Program

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X-Ray Absorption Fine Structure (XAFS) Microscope

Kenji Sakurai
X-Ray Physics Group
Materials Engineering Laboratory (MEL)

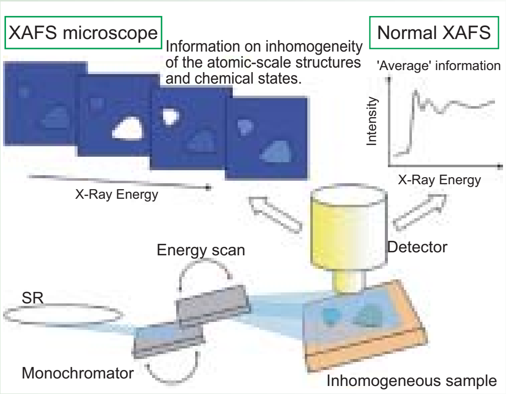


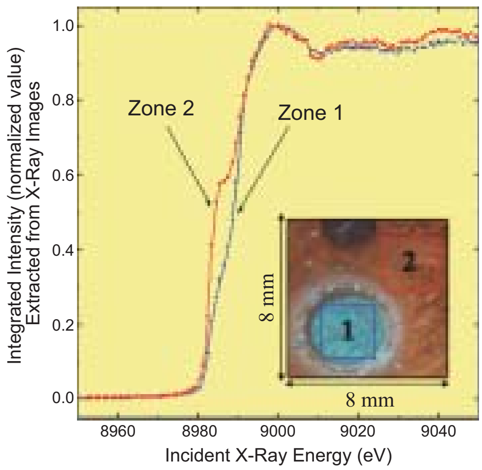
Fig. 1 Principle of XAFS microscope.

As Galileo once said, "Observation is the origin of sciences", and so various kind of microscopes have been used as a fundamental research tool. An optical microscope, which is one of the most popular instruments, allows us to look at any specific parts of the object, and gives an image sensitive to the optical properties, i.e., color and shape of the surface. For many years, scientists have been waiting for further advanced microscopes that can see chemical composition, oxidation states and crystal structures, etc. Recently, the NIMS developed a new powerful microscope which observes the X-ray absorption fine structure (XAFS), which provides images of the chemical state (valence numbers, etc.) and the atomic-scale structures (the inter-atomic distances and the numbers of neighboring atoms) around the specific elements.

The XAFS is a promising method for nano-sciences and technologies, because it can analyze amorphous materials, nano-crystals, ultrafine particles, clusters etc., besides normal bulk crystals. As the technique measures basically X-ray absorption spectra, it requires a uniform sample. In the materials research, however, inhomogeneous samples are most likely. This is a reason why a microscope instead of a normal spectrometer for XAFS has been strongly demanded as essential.

The new XAFS microscope (**Fig. 1**: based on NIMS X-ray imaging technique (Japanese Patent No. 3049313)) observes about 1cm^2 area of a sample as a 1000 x 1000 (one million) pixels image, and acquires a set of images as a movie during the X-ray energy scan at a time, in just 10-30 minutes. So far, for such imaging, one had to perform the point-by-point analysis using an X-ray microbeam, and the measuring time becomes many hours or more when the number of pixels increases.

Fig. 2 shows the XAFS microscopic observation of corrosion (Zone1, patina) on the surface of a copper plate. In the XAFS spectra extracted from a set of images, one can see chemical shift of absorption edge between Zones 1 and 2, which corresponds to the increases in the valence number of copper. Since the present microscope is suitable for looking at inhomogeneous samples efficiently, the application to the screening of so called combinatorial materials, which have a huge number of different samples prepared as an array on a single substrate for finding promising materials.



X-ray images detected difference in the valence numbers between metallic and corrosion parts.

Fig. 2 Example of chemical state imaging using chemical shift of absorption edge.

For more details: http://www.nims.go.jp/xray/lab/

Appointment of New Vice President

(Jan. 1, 2005) -- Dr. Mamoru Watanabe, who had been serving as Director-General of Advanced Materials Laboratory (AML), was appointed as a new Vice President of NIMS, replacing an outgoing Vice President, Dr. Mutsukazu Kamo.

Dr. Mamoru Watanabe

Biography

Doctor of Science. Completed doctoral course in Department of Inorganic and Physical Chemistry, Graduate School of Science, Osaka University (1974). Joined the National Institute for Research in Inorganic Materials (NIRIM) of Science and Technology Agency as Researcher in 1974 and became the Senior Researcher in 1980. Served as Guest researcher at Massachusetts Institute of Technology (MIT), U.S. in 1982 and became the General Researcher in 1994. Appointed as Director-General of AML in 2001, and this time, named as the Vice President.

For more details: http://www.nims.go.jp/eng/about/executive/vicepresi3.html

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Visit by Korean Students in Winter Institute Program

(January 7, 2005) -- 40 Korean graduate students visited NIMS as an activity of the Winter Institute Program. After receiving a briefing of NIMS, they visited the High Magnetic Field Center and the High Voltage Electron Microscopy Station.

The program invites Korean graduate students in science and technology to Japanese national research institutes for about two months. The objective is to give them a closer understanding of the approach and methodology of Japanese researchers, thus encouraging exchanges and cooperation between Japan and Korea in science and technology in the future. NIMS has invited one or two students every year, and two students stayed at NIMS this year.

Development of Photocathode Type Electron Beam Source of High Intensity

Takayoshi Kimoto
Materials Physics Group
Materials Engineering Laboratory (MEL)

—For breakthrough from "TEM like a magnifying glass"—

An optical microscope removes spherical aberration by combining convex and concave lenses so that the image resolution is at a level of the wavelength of light, which is the theoretical resolution. On the other hand, a transmission electron microscope (TEM) cannot remove spherical aberration because the magnetic concave lens required is not available in practice, and so the image resolution is worse by hundred times than the electron wavelength. As a result, there is criticism that compared with the case of optical microscope, "TEM is like a magnifying glass". If a hologram with sufficiently good quality can be attained by applying an ultrahigh luminance and high interference electron beam source to TEM, the image-reproduction step with optical concave lenses can remove the aberration of the magnetic convex optical lenses in TEM, thus overcoming the resolution problem of TEM (Method by D. Gabor).

When the tip of the cathode is coated by a substance having high quantum efficiency (the ratio of electrons emitted by photoelectric effect), and when visible laser beam is irradiated, the quantity of emitted electrons becomes several ten thousand times that of existing thermal electron emissions and field emission electron beam sources. The existing electron beam sources emit electrons in all directions. The photocathode type high luminance electron beam source emits low-speed electrons almost in only one direction, which finely focuses the electrons, and thus an ultrahigh luminance electron beam source of this type should be feasible. Application to accelerators and X-ray generators is also expected.

In order to develop the ultrahigh luminance photocathode type electron beam source, I had to solve various key issues. Generally, the quantum efficiency of high quantum efficiency substances (photoemissive materials) such as Cs_3Sb decreases when they are exposed to even trace quantities of oxygen. I therefore fabricated an apparatus in which the tip of the cathode is coated with a high quantum efficiency substance, and the cathode unit is taken out from the coating device without exposure to oxygen, then mounted to the electron beam source. The effectiveness of the apparatus was experimentally confirmed. Even in a high vacuum environment, the quantum efficiency of Cs_3Sb, etc. rapidly decreases with increase in temperature. To counter this, we fabricated an anode which can be locally cooled at the tip by Peltier cooling (See **Fig. 1** and **Fig. 2**). Local cooling was applied so that the tip of the cathode reached -42 ℃ while cooling also the peripheral area of the tip. It was also proved that the low temperature was maintained even under continuous focused irradiation of visible laser, thus paving the way for practical application of the technology.

Furthermore, by placing a plate having a small hole (aperture) between the tip of the cathode and the vapor deposition port, we successfully conducted vacuum vapor deposition of Cs_3Sb in a fine area at the tip of the cathode (**Fig. 3**). If the hole is opened using a focused ion beam, the vapor deposition area and the electron emission area can be decreased to 10 nm, and the shape and number of electron beam can be freely controlled. I have acquired three patents and applied for a further three. I plan to continue development toward commercialization of the product.

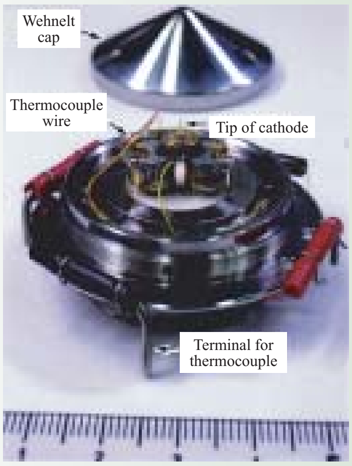

Fig. 1 Photograph of cathode unit fabricated for high luminance photoelectric effect electron beam source.

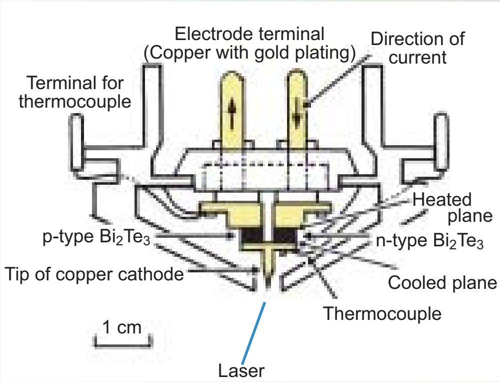

Fig. 2 Schematic drawing of local cooling at the tip of the cathode.

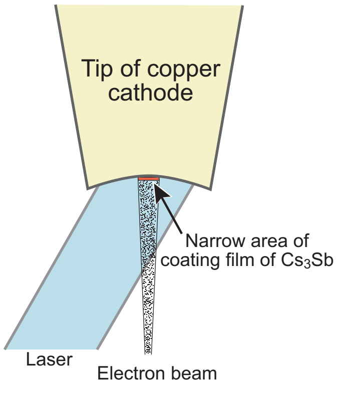

Fig. 3 Electron emissions from narrow area of coating film of Cs_3Sb.

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

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VENUS: A 3D Visualization System for Crystal Structures and Electron/Nuclear Densities

Furthermore, VENUS contains a maximum entropy method (MEM) program, PRIMA. PRIMA executes MEM analysis of X-ray and neutron diffraction data several-tens times faster than a preceding program. By linking a multi-purpose pattern-fitting system, RIETAN-2000, with VENUS, we can easily modify a structural model in Rietveld analysis and determine electron and nuclear density distribution (**Fig. 2**).

VENUS will contribute to many studies as a tool for understanding the crystal and electronic structures of materials in three dimensions, thus enhancing the creativity of researchers. Because VENUS is free software (distributed at http://homepage.mac.com/fujioizumi/), it is ideal for education of the structures of various compounds.

Development of Production Method for Fine Spherical Metallic Powder of Uniform Size

Kazumi Minagawa
Eco-Circulation Processing Group
Ecomaterials Center (EMC)

There is increasing demand for fine spherical powder with uniform particle size applicable to advanced powder metallurgy such as metal injection molding, solder for electronics parts joining, and conductive inks. These applications are, however, very difficult to achieve with the powders produced by conventional powder-making methods. We have therefore developed a hybrid atomization as a new powder-making method.

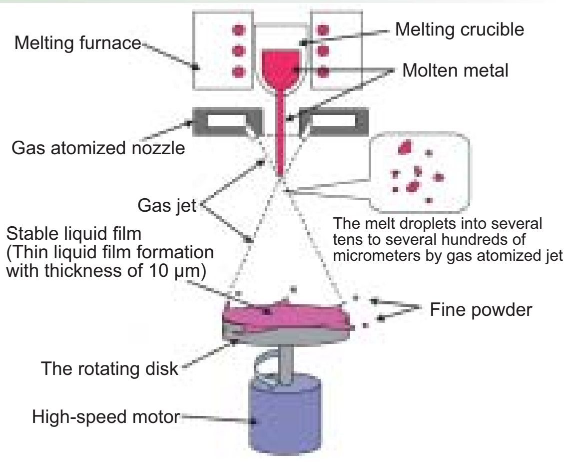

Fig. 1 Schematic diagram of hybrid atomization procedure.

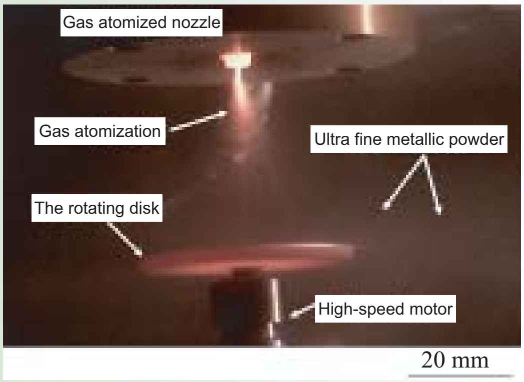

Fig. 2 Production of Powder by hybrid atomization.

In recent years, the uses of metal powder have widened from general sintered machine parts to metal injection molding, metal coating, functionally gradient materials, 3-D laminated shaping, and miniature electronic substrate joining.

On the other hand, there is increasing demand for high-quality powders having low oxygen content, fine spherical shape, and uniform size suitable for advanced technologies. However, conventional technologies cannot easily produce powders that satisfy such requirements, and so a new powder production technology is needed.

We studied and developed the world's first powder production method, the hybrid atomization, which can easily produce powder having 10 μm or smaller spherical particles, with uniform size and low oxygen content. Such powders cannot be produced by conventional powder production technology.

The hybrid atomization (**Fig. 1**) efficiently combines the gas atomization with the centrifugal atomization. The gas atomization breaks molten metal into pieces of several tens to several hundreds of micrometers in size using a gas jet. A rotating disk located beneath the spray is driven at high speed (5,000 to 66,000 rpm), and the molten metal is spread uniformly over the rotating disk using a gas spray flow, thereby forming a thin liquid film of 10 μm thickness or less. Then, the fine droplets are scattered from the edge of the rotating disk to obtain fine spherical powder. **Fig. 2** shows a photograph of powder production. As can be seen, the powder is formed in a smoke pattern, producing a very fine powder.

With the method, the powder particle size, particle size distribution, powder shape, and other characteristics can be easily controlled by detailed investigation of the relation between the metal physical properties (viscosity, surface tension, density) and the rotational speed of the rotary disk. **Fig. 3** shows the particle size distribution of the powder of tin-zinc alloy produced by varying the rotational speed of the rotating disk. The produced powder becomes finer as the rotational speed increases, giving a very fine average particle size of 10.6 μm at 20,000 rpm. It was found that the particle size distribution has two peaks. That type of particle size distribution has a droplet-breaking mode as shown in the droplet breaking mode (**Fig. 4**) due to the centrifugal force. That is, the droplets grow while the centrifugal force is balanced against the surface tension of the molten metal, and when the surface tension of the molten metal can no longer withstand the centrifugal force, the molten metal breaks into droplets, thus providing two peaks in the particle size distribution, and major droplets having similar particle sizes and sub-droplets are formed due to breakage of the tail portion of the major droplets. The breaking mode was not achieved by using the conventional molten metal breaking mode, but by using the hybrid atomization for the first time in the world.

Fig. 5 shows an electron microscope photograph of individual powders produced by the hybrid atomization. Since the method produces powder while keeping the oxygen concentration in the spray chamber to 0.01 % (100 ppm) or below, the oxygen content in the powder is kept to a very low level. Accordingly, the produced powder has a beautiful spherical shape without irregular surface. Furthermore, the yield of the produced powder of 45 μm or smaller size is as high as about 95 wt% for a tin-lead alloy powder, 98 wt% for a tin-zinc alloy powder, 84 wt% for a copper powder, and 80 wt% for an aluminum powder.

The results were reported at academic societies inside and outside Japan, and received the First PM Research Promotion Encouragement Prize of the Japan Powder Metallurgy Association. The technology was highly evaluated by academic and industrial associations as a new powder production technology, and in this fiscal year acquired a basic patent (Patent No. 3511082) as a method of manufacturing fine metal powder. We are conducting joint research with several powder manufacturers on a license base.

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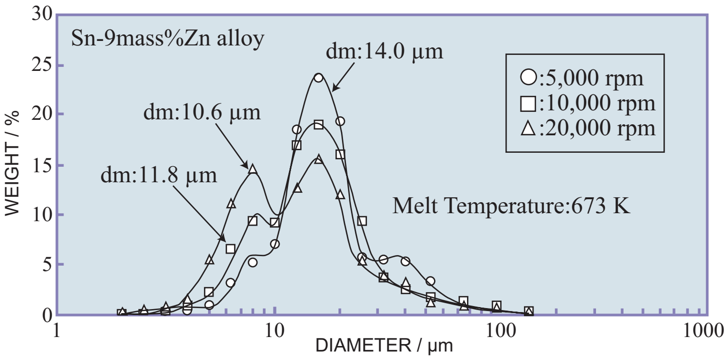

Fig. 3 Particle size distributions of powders under different disk rotation speeds and diameters.

Quasicrystal as a Promising Precursor for Catalysts

—A copper catalyst with high activity and high thermal stability—

An-Pang Tsai
Aperiodic Materials Group
Materials Engineering Laboratory (MEL)

Satoshi Kameoka
Institute of Multidisciplinary Research for Advanced Materials (IMRAM)
Tohoku University

Quasicrystal is a new matter which differs from crystalline and amorphous materials. Owing to the five fold symmetry which is forbidden in crystallography, the structure of quasicrystal is expected to exhibit novel physical properties. Quasicrystal, however, has no periodicity in the atomic arrangement, thus it is extremely brittle compared with ordinary metals, which is a significant drawback for a material. Nevertheless, this drawback is an advantage for materials which require high surface area. In recent years, the effectiveness of copper catalyst for steam reforming of methanol ($CH_3OH + H_2O \rightarrow 3H_2 + CO_2$), which has attracted attention as a reaction that could produce hydrogen for fuel cells and other products, has become important. Copper catalysts have, however, a problem of durability such as a tendency toward sintering between copper particles. Recently, we have found that an $Al_{63}Cu_{25}Fe_{12}$ quasicrystal treated by leaching in an aqueous alkali gives high activity, high selectivity, and high thermal stability over the steam reforming of methanol reaction.

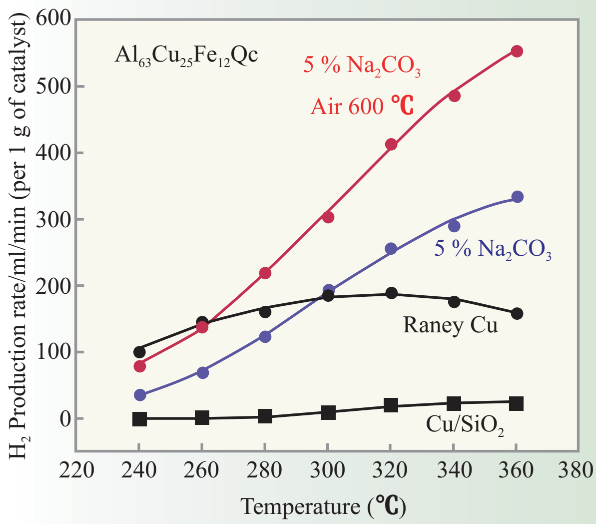

Fig. 1 Activity for quasicrystal (Qc) catalysts and of typical cupper catalysts over steam reforming of methanol.

As shown in **Fig. 1**, typical copper catalysts reveal much lower activity which further decreases at high temperatures (>300 ℃) due to sintering of Cu. In contrast, the activity for AlCuFe quasicrystal catalyst treated by leaching in aqueous Na_2CO_3 keeps increasing at high temperatures. For the quasicrystal catalyst further calcinated in air, the activity is significantly improved over the whole tested temperature range. **Fig. 2** is a bright-field image of transmission electron microscope showing a cross section of a quasicrystal particle after leaching and calcination treatments. From the inside (right) of the sample, there are quasicrystal (Qc), dense Al_2O_3 layer (A), and composite oxide layer containing Cu and Fe (B), while porous Al_2O_3 (C) exists at the outermost side. The calcination in air facilitated formation of the distinctive A layer and B layer, which are presumably improved the activity and thermal stability of the catalyst. Investigation of detailed mechanism is now in progress. By adjusting the conditions used for preparing the sample, high activity could be achieved even at low temperature (200 ℃), is another feature worth to indicate.

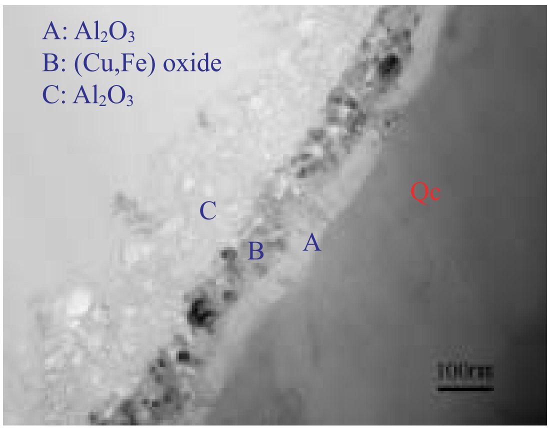

Fig. 2 TEM cross sectional micrography of an AlCuFe quasicrystal (Qc) particle after leaching and calcination treatment.

The achievement of high activity and high thermal stability using the inexpensive raw materials and the simple process suggests that catalyst materials could be developed using various intermetallic compounds as precursors including quasicrystals.

This study was in collaboration with Professor Masami Terauchi of the Institute of Multidisciplinary Research for Advanced Materials of Tohoku University as a part of JST-SORST.

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

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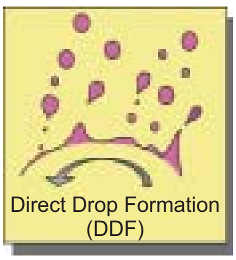


Fig. 4 Powder formation mode in centrifugal atomization.

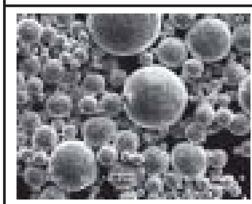
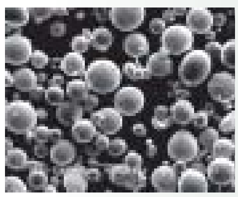
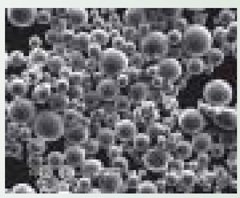
Tin-Lead alloy powders		Tin-Zinc alloy powders		Copper powders		Aluminum powders	
 10 µm		 20 µm		 20 µm		 20 µm	
Melting temperature	400 ℃	Melting temperature	400 ℃	Melting temperature	1400 ℃	Melting temperature	1200 ℃
Rotational speed	20,000 rpm	Rotational speed	20,000 rpm	Rotational speed	20,000 rpm	Rotational speed	60,000 rpm
Total Yield of -45 µm	95 %	Total Yield of -45 µm	98 %	Total Yield of -45 µm	84 %	Total Yield of -45 µm	80 %

Fig. 5 Production of Individual powders by hybrid atomization.

Solar-Blind Ultraviolet Sensor

Yasuo Koide
Super Diamond Group
Advanced Materials Laboratory (AML)

Our group conducts research on the industrial application of diamond semiconductors to ultraviolet (UV) sensors. As shown in **Fig. 1**, a UV portion of 190 to 280 nm wavelength of the total UV (wavelengths from 190 to 400 nm) in solar rays is absorbed by the ozone layer above the earth. The absorbed UV portion does not reach the earth, and is called "deep UV" light. An optical sensor which selectively detects the deep UV light is called a "solar-blind UV sensor".

The solar-blind UV sensor is expected to be applied as an optical sensor which detects flames having the same wavelength as that of deep UV and detects fluorescent spectra of harmful substances such as NO_x and CO_2 even in the presence of solar rays. In particular, if a miniature and thermally stable flame sensor as a practical solid device can be developed, it could be used for automatically controlling the internal combustion of engines. The ultimate such flame sensor would be a photonic device that has minimal impact on the environment and which enhances the development of next-generation engines.

As shown in **Fig. 2**, a sensor with metal/diamond/metal structure was fabricated on a boron-doped diamond epitaxial thin film grown by a chemical vapor deposition technique. A photocurrent due to an electron-hole pair generated by illuminating UV light having band-gap energy or higher energy flows between the metal electrodes of the sensor. The principle is the same as that of a solar cell. **Fig. 2** shows the photoresponse characteristics of the UV sensor, where the theoretical curve of the photosensitivity assuming a quantum efficiency of 100 % is also shown for comparison. As seen in **Fig. 2**, we have developed a solar-blind UV sensor that has a quantum efficiency of about 20 %, and a UV (220 nm)/visible light (400 nm) blind ratio (intensity ratio of photoelectric current at the wavelength) of about $10^{2.5}$. Commercially available silicon sensors cannot detect deep UV light of 260 nm or shorter wavelength without detecting visible light. We plan to improve the photosensitivity characteristics through the selection of electrode materials and the optimization of sensor structure.

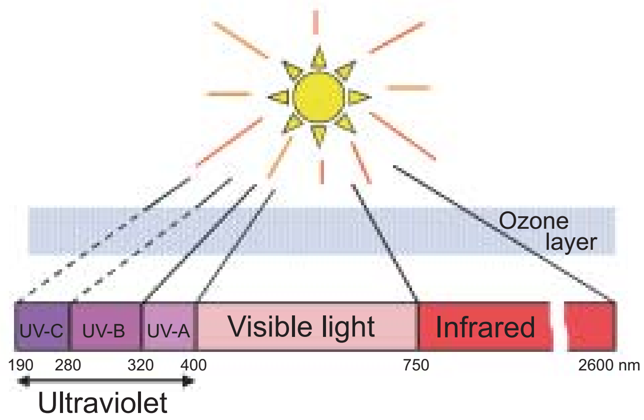


Fig. 1 Solar rays spectra on the earth.

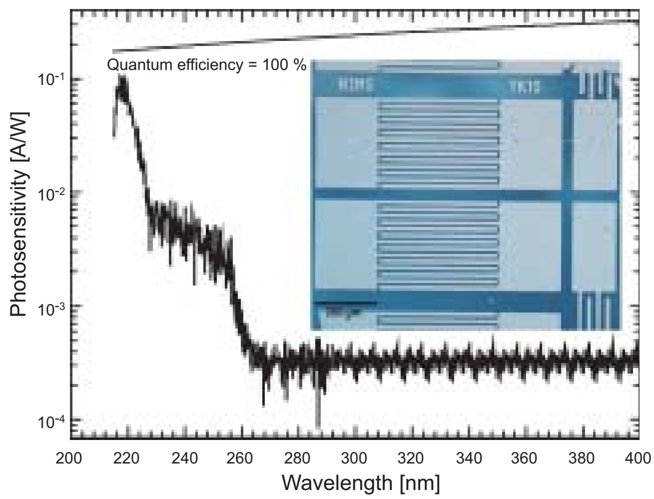


Fig. 2 Surface photograph and photoresponse characteristics of the developed diamond UV sensor.

For more details: http://www.nims.go.jp/superdiamond/index.html

Successful Generation of 37.9 Tesla, Breaking the Domestic Record for a Steady Magnetic Field

—Development of water-cooled insert magnet for hybrid magnet—

Toshihisa Asano
Magnet Development Group
High Magnetic Field Center (HMFC)

High magnetic field is an extremely useful means for investigating the properties of substances and materials. Efforts to increase the performance of electromagnets (abbreviated to "magnet") for generating high magnetic field are described. In view of the power of the generated magnetic field, a pulse magnet which instantaneously generates high magnetic field is advantageous. Stable generation of high magnetic field is achieved by placing a water-cooled copper magnet, which allows a large current to flow to the air core at room temperature through the directly-water-cooled normal conduction coil, in a superconducting magnet. With such a hybrid magnet we have achieved 37.3 T, while the world record is 45.1 T generated at the National High Magnetic Field Laboratory (NHMFL) of the U.S. < Continued on p.7

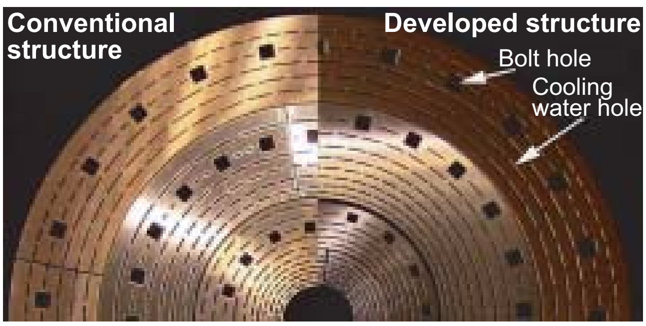


Fig. 1 Comparison of Bitter plate structures.

Internet Electron Microscope Enters the Education Field

—Interactive at anytime, anywhere, and for anyone—

Kazuo Furuya, Miyoko Tanaka, Akane Tameike
In-situ Characterization Group
High Voltage Electron Microscopy Station (HVEMS)

In view of the general aversion of the younger generation toward science, educational organizations are interested in using the Internet to allow scientific phenomena to be viewed interactively. Such interactive contents are expected to stimulate interest in science and technology through learning by investigation and discovery, rather than textbook-based passive learning.

We have developed an Internet electron microscope system which is attracting attention for its potential educational benefits. The system was developed to offer free access and manipulation of an electron microscope at NIMS via a web browser. The system was test-operated at the National Museum of Emerging Science and Innovation at Odaiba, Tokyo. The system has been delivered to two super-science high schools designated by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) (**Fig. 1**).

Fig. 1 High school students manipulating the Internet electron microscope.

The resolution of an electron microscope is several hundred to several thousand times that of an optical microscope, and is an essential tool for advanced experimental research. Introducing electron microscopes into ordinary education would help stimulate scientific curiosity, but since they are very expensive and require special knowledge for maintenance and operation, electron microscopes have not been available for general education. We have therefore built a network system that allows the electron microscope to be remotely operated. The system allows the users to manipulate the electron microscope safely and comfortably in a wide variety of network environments. Users can access the system merely with a personal computer and Internet connection, without the burden of an expensive facility and maintenance. The system allows the electron microscope to be used in general education, at home, and around the world at anytime, anywhere, and by anyone. (**Fig. 2**)

The new system is already being used in the classroom, club activities, and other fields. High school students send their test samples to NIMS, and they can then observe the samples with the electron microscope. The educational impact of using such an advanced facility is very high, and should be of great research benefit through science and technology education.

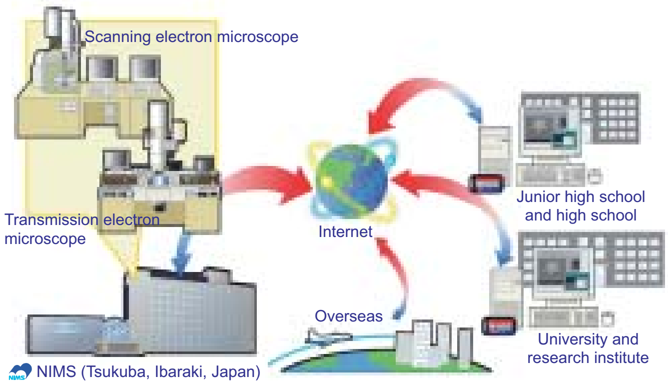


Fig. 2 Schematic drawing of the Internet electron microscope.

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

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Our water-cooled copper magnet is a Bitter coil fabricated by laminating a Bitter plate with an insulation film, as illustrated in **Fig. 1**. When generating high magnetic field, the water-cooled copper magnet generates heat and consumes much power, so the magnet requires a water passage inside the coil to directly cool the conductor with a large quantity of water. The high strength and high conductivity copper-silver alloy sheet developed by us significantly improves the magnetic field generated by the coil which receives electromagnetic force near its strength limit. To increase the high magnetic field generated by the magnet made using this developed material, we increased the number of divisions of coaxial elements of the magnet to raise the efficiency, and finely adjusted the power distribution and the current density on the Bitter plate within the allowable range of power, temperature, and electromagnetic force. Furthermore, the arrangement of tightening bolt holes and the cooling effect were improved. With this Bitter plate, the coil was fabricated to combine together as shown in **Fig. 2**. With hybrid operation, 37.9 T has been achieved within an area of effective inner diameter of 32 mm at room temperature. The power of the magnetic field was improved by 0.5 T or more, and the applied power was decreased from the conventional 14.33 MW to 13.35 MW, thus saving about 1 MW of power. The operation also generated the higher magnetic field for a longer period of time.

Currently, High Magnetic Field Center is inviting outside organizations to jointly use our various high-magnetic-field magnets, including the hybrid magnet. The magnet developed in this study can be used by other organizations.

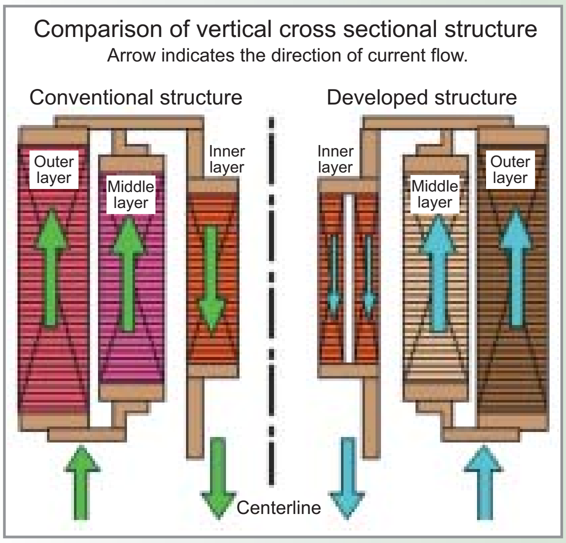

Fig. 2 Comparison of coaxial multilayer coil structures.

For more details: http://akahoshi.nims.go.jp/TML/english/develop.html

Japan's Hot Springs are Wonderful!

Shan Yu (China)
Research Fellow (Apr. 2002- present)
Films and Single Crystals Group
Superconducting Materials Center (SMC)

I am very happy to have this opportunity to meet all of our readers through NIMS NOW. My name is Shan Yu. I came to Japan from Beijing, China. After I got a PhD in applied physics at the Tokyo Institute of Technology, I was fortunate to have the chance to work as a Research Fellow at NIMS. I am engaged in research on the vortex physics of high temperature superconductors in the Thin Film Single Crystal Group. At first, I had a great deal of trouble because the research topic is a new field for me. But now, with the help of my colleagues, my experimental research goes smoothly and I have published several research results.

[With younger sister at the Urabandai highlands (left)]

[Kyushu Yufuin hot spring resort]

As a break from my busy research work, I visited my hometown Beijing after a long absence in the Golden Week holidays last year. While I was away, the thing I missed most, aside from my Japanese friends and healthy Japanese food, was the hot springs of Japan. Japan is known as a country with many volcanoes, but as one benefit of all this volcanic activity, a variety of natural hot springs are scattered across the country. The hot springs don't just make the skin smooth, they also take away fatigue and warm the body and mind. Ideas that help me advance my research come to me when I'm relaxing in a hot spring. Hot springs are also special after enjoying skiing with colleagues. Because there are several hot springs near Tsukuba City, where NIMS is located, it's easy to go on the weekend, even when busy with experiments. If you have a chance to visit NIMS, be sure to try the open-air bath at Yuri-no-Sato hot spring, which offers a panoramic view of Mt. Tsukuba. You may also get a good idea for your research there.

Photo by H. Okubo

Narcissus
February 24

Narcissus has started to bloom in Sengen Site.
The beautiful and fragrant flowers are telling us that spring has come to Tsukuba.

This seasonal photo section is exclusive for print version readers.
All the photos we have introduced are taken by our researchers who love sharing the beautiful changes of seasons of Japan with you.

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