from Tsukuba, Japan to the world

NIMS NOW International

National Institute for Materials Science

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Special Features

Nanotechnology/Materials Research Supporting the Creation of a Sustainable Society

New Developments in Cobalt Oxide Hydrate Superconductor

—Relationship between Superconductivity and Magnetism—

Eiji Takayama-Muromachi
New Materials Group
Superconducting Materials Center (SMC)

The cobalt oxide hydrate superconductor is a new superconductor which was discovered at NIMS. The first report on this material, which was published in *Nature* 422, 53 (2003), has already been cited more than 250 times. Since this discovery, much new knowledge has been obtained thanks to the energetic efforts of researchers around the world, and our understanding of this superconductor is continuing to grow. The NIMS research team has also made an important contribution to this work.

The cobalt oxide hydrate superconductor can be synthesized using only a soft chemical technique. Recent research at NIMS has revealed that the proper composition of the superconductor is $Na_x(H_3O)_z(H_2O)_yCoO_2$ ($x \approx 0.35$, $z \approx 0.24$, $y \approx 1.19$), and some sites which should be occupied by Na^+ are replaced by oxonium ions (H_3O^+). As a result, the valence of Co is considerably smaller than the value calculated using only the Na content. The meaning of this fact cannot be ignored, as the valence of Co is a key parameter in the theoretical treatment of the superconductor.

In reality, oxonium ions do not simply affect the valence of Co, but also play an extremely large role in controlling the physical properties of the system. The **accompanying figure** shows a phase diagram of the system using the resonance frequency of the nuclear quadropole resonance (NQR) of Co as a parameter. According to this phase diagram, the superconductivity transition temperature (T_c) increases with the resonance frequency. However, when the resonance frequency exceeds a certain limit, superconductivity is lost and a magnetic phase appears in its place. While this finding strongly suggests a close relationship between superconductivity and magnetism and an unconventional mechanism for the manifestation of superconductivity, in actuality, the fact that the oxonium ion concentration is an essential parameter governing the appearance of the magnetic phase was discovered only very recently. < Continued on p.3

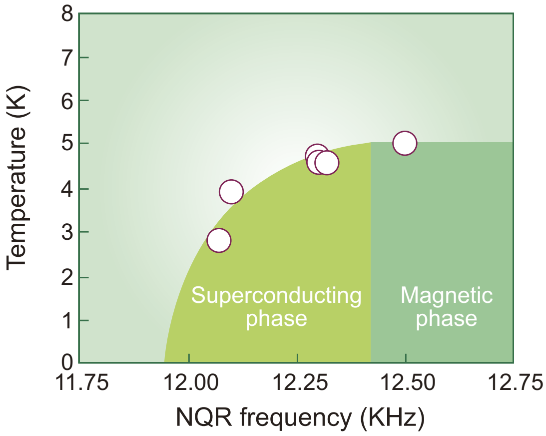

Fig. Phase diagram of cobalt oxide hydrate using the NQR frequency as a parameter. The white circles are experimental results. The NQR frequency was found to increase with the concentration of oxonium ions; the abscissa shows the relationship with the oxonium ion concentration.

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Progress in Research and Development of MgB_2 Wires and Tapes

Hiroaki Kumakura
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Hitoshi Kitaguchi, Akiyoshi Matsumoto
Oxide Superconducting Wires Group
Superconducting Materials Center (SMC)

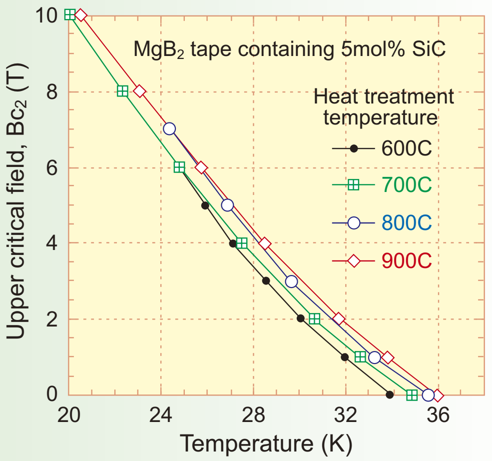

Fig. 1 Temperature dependence of upper critical field (Bc_2) of MgB_2 tape.

The MgB_2 superconductor, which was discovered in Japan 4 years ago, has several important features from the viewpoint of application. While MgB_2 is a metallic superconductor, it has a high superconductivity transition temperature (39 K) and thus operation is not limited to the temperature of liquid helium. Fabrication of wires and tapes is also simple, and raw material prices are low. Considering these facts, high expectations have been placed on MgB_2 as a promising new superconductor, and active research on the production of MgB_2 wires and tapes is underway worldwide. In particular, with recent improvements in cryocooler performance, MgB_2 is considered a promising material for various types of superconducting magnets which can be used at temperatures of around 20 K and do not require a coolant.

To date, we have mainly been engaged in the development of MgB_2 wires and tapes by the powder-in-tube (PIT) process, in which a mixture of raw material powders packed in a metal tube is processed and heat treated. Recently, improved superconducting properties have been realized in MgB_2 wires and tapes fabricated by this process, heightening the possibility of practical application. One superconducting property which is important for practical application is the upper critical field (Bc_2). Because Bc_2 represents the highest magnetic field in which a superconducting state can be maintained when a superconductor is exposed to an external magnetic field, it is a very important parameter when a superconductor is to be used in superconducting magnets. **Figure 1** shows the temperature dependence of Bc_2 in MgB_2 tape with 5 mol% addition of SiC. Bc_2 increases as the temperature decreases, reaching 10 T at 20 K. The Bc_2 at 20 K of this MgB_2 tape is comparable to the Bc_2 at the temperature of liquid helium (4.2 K) of practical Nb-Ti superconducting wires, which are the most widely used superconducting wires at present. This means that operation in the vicinity of 20 K using a cryocooler will be possible if the Nb-Ti superconducting magnets which are currently operated using liquid He are converted to MgB_2 magnets.

In other recent work, in cooperation with the Central Japan Railway Company and Hitachi Ltd., we fabricated a long-length wire exceeding 100 m and test-produced a small coil using this wire. An example of a test MgB_2 solenoid coil is shown in **Fig. 2**. Although this coil is quite small, having an outer diameter of 48 mm and height of 50 mm, promising results have been obtained, in that a field exceeding 1 T was successfully generated at a temperature of 20 K. In the future, we plan to further develop the results obtained to date, in particular, by improving superconducting properties and producing longer-length wires and tapes.

Fig. 2 Test-produced MgB_2 solenoid coil.

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

NIMS Signs MOU with University of Sherbrooke, Canada

(September 26, Canada) -- The NIMS Advanced Materials Laboratory (AML) signed a Memorandum of Understanding (MOU) on "Advanced Nanoceramics Plasma Processing" with the Research Centre for Energy, Plasma and Electrochemistry (CREPE), University of Sherbrooke, Quebec, Canada. The aim of this agreement is to promote a cooperative research relationship for creation of nanostructured materials through the exchanges of personnel and information about the development of advanced materials processing. The University of Sherbrooke is a leading research institute in the field of science and technology of thermal plasma processing, and AML has been carrying out cooperative research with Plasma Technology Research Centre (CRTP), which expanded its field of research to become CREPE last year. Taking advantage of this opportunity, the two Institutes will cooperate with each other more closely in order to advance new plasma chemistry frontiers through joint work on the synthesis of functional nano-size particles and nanostructured coatings.

Dr. Edwin Bourget, Vice-President of Research, University of Sherbrooke, and Dr. Ishigaki, Associate Director, Plasma Processing Group, AML.

Nb_3Al Wires Approaching Practical Application

—For Nuclear Fusion, High Energy Particle Accelerators, and High Resolution NMR Uses—

Takao Takeuchi, Yasuo Iijima, Akihiro Kikuchi, Nobuya Banno
Metal Superconducting Wires Group
Superconducting Materials Center (SMC)

Superconducting Nb_3Al wires are capable of carrying a higher current density while maintaining superconductivity up to high magnetic fields in comparison with the conventional Nb_3Sn wires, and also retain satisfactory transport current characteristics under mechanical strain. In view on these advantages, Nb_3Al wires have been developed for large superconducting coils for applications such as nuclear fusion reactors and high energy particle accelerators, which require huge electromagnetic force, and high resolution NMR, which operate in high magnetic fields exceeding 20 T.

For practical application of Nb_3Al wires, the following have been developed: (1) a technique to produce long-length precursor wires which are a composite of Nb and Al, (2) a technique to produce an $Nb(Al)_{ss}$ (**Fig. 1**) supersaturated solid solution containing up to 25 at% of Al homogeneously dissolved in Nb by ohmic heating of the precursor to approximately 1900 ℃, followed by rapid quenching, and (3) a heat treatment technique to cause a uniform massive transformation of an Nb-Al compound from this at a comparatively low temperature. Thus, while preventing coarsening of the grain size, these techniques have also solved the phase diagram problem of compositional deviations from stoichiometry. Recently, we performed hydrostatic extrusion of large billets and succeeded in drawing continuous precursor wires with a unit length of 2.6 km and diameters as small as 1.35 mm. For a wire-diameter of 0.7 mm, which is considered necessary for nuclear fusion reactors and accelerator applications, this billet size corresponds to roughly 10 km of length. A large-scale apparatus enabling rapid heating/rapid quenching of the obtained long-length precursor wire was also introduced, test operation was performed over lengths of several 100 m, and no serious problem was found. In the transformation heat treatment, we succeeded in suppressing the variation in superconducting properties originating from local deviations in the heating-up rate by positively introducing plastic strain in $Nb(Al)_{ss}$, which is a ductile material. This made it possible to secure homogeneous superconducting properties in the coil as a whole, in spite of the local delays in heating-up which inevitably occur in large coils.

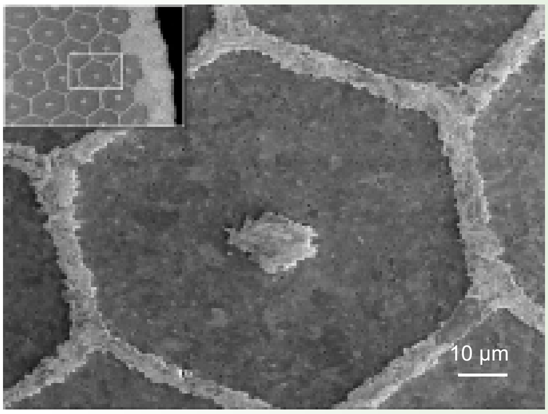

Fig. 1 Enlarged cross section of Nb_3Al wire.

Next, we will review the techniques used to incorporate the stabilizer, which is the most crucial problem for practical application of Nb_3Al wires. Since a flat-wire produced continuously by cladding Cu on the as-quenched Nb_3Al wire (**Fig. 2a**) is suitable for generating a homogenous magnetic field, we are attempting to apply this wire to NMR. This Cu clad-Nb_3Al flat wire has an actual production record of 800 m, and thus is the wire which is closest to practical application. On the other hand, in fusion reactors and high energy particle accelerators, stabilized composite wires with a round shape are required. We succeeded in substantially improving the interfacial adhesion between the Cu stabilizer and the wire by applying a combination of a reel-to-reel Cu ion plating process and Cu electroplating (**Fig. 2b**). Taking advantage of the fact that silver does not react with Nb at high temperatures, we also succeeded in fabrication of a wire containing an internal Ag stabilizer in the wire cross section from the start of fabrication (**Fig. 2c**) and trial-produced a high-current conductor using this as the strand. Future plans include comprehensive performance tests of long length/stabilized wires by energizing the coils wound with them.

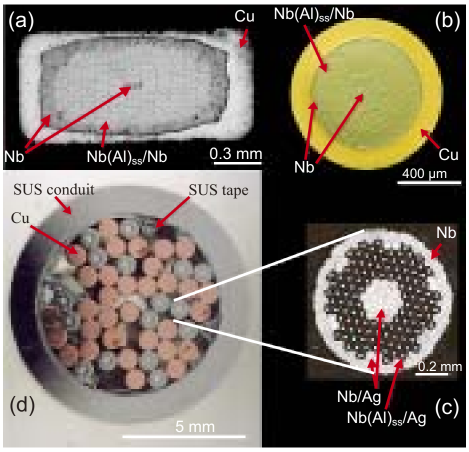

Fig. 2 Cross sections of various Nb_3Al wire composites with stabilizers. The space (d) is a coolant flow path.

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

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New Developments in Cobalt Oxide Hydrate Superconductors

Because there is a presentiment that the cobalt oxide hydrate superconductor may hold the key to a deep understanding of superconductivity, we look forward to further progress in research in the future, in both the physical and chemical aspects. This paper, which is presented under the responsibility of the author, summarizes joint work done with a large number of researchers. In particular, the results related to NQR are based on joint work with Prof. Ishida, Prof. Yoshimura, and other members of the Faculty of Science, Kyoto University.

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

Control of Flux Lines by Introduction of Nanosized Defects

Shuuichi Ooi, Takashi Mochiku, Kazuto Hirata
Thin Films and Single Crystals Group
Superconducting Materials Center (SMC)

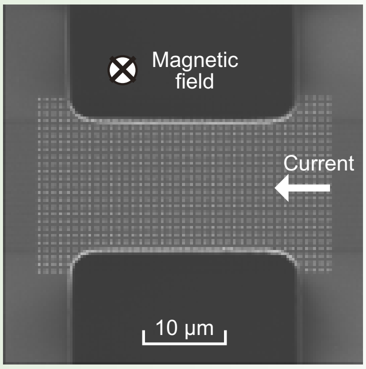

Fig. 1 Electron microscope image of the lattice-shaped arrangement of nanosized holes in a Bi-based superconductor formed by a focused ion beam.

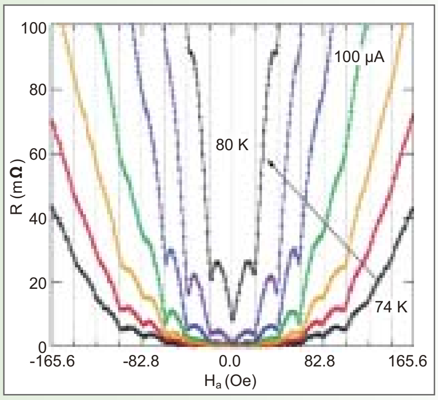

Fig. 2 Results of resistance-temperature measurements of a specimen with a lattice-shaped hole arrangement. Dips in resistance can be observed in a magnetic field at integral multiples of a 20.7 Oe field when a flux line enters each hole.

Because superconductors have electrical resistance infinitely close to zero, they are used in superconducting magnets and power transmission lines where large currents are necessary. When a current passes through a superconductor, a magnetic field is introduced as a result of a self-field, forming quantized flux lines. Due to forces caused by the current, these flux lines migrate in the superconductor, generating resistance. Reducing flux-line migration is an important issue for application of superconducting materials. "Pins" which prevent flux-line movement are introduced for this purpose. Although various pinning methods have been proposed, the positioning, form, and other properties of pins cannot necessarily be controlled. Therefore, one objective of our research is to identify a pinning method which is suitable for practical applications by introducing a pinning center which can be controlled artificially.

Figure 1 shows an electron microscope image of holes 300 nm in diameter arranged in a lattice form in a Bi-based superconducting single-crystal thin film using a focused ion beam. These pits are separated by a distance of 1 μm. The field when one flux line enters each of these holes is equivalent to 20.7 Oe. As shown in **Fig. 1**, when a magnetic field is applied to the specimen and a current is passed, the flux lines move by the Lorentz force, generating resistance. The measured results of this resistance are shown in **Fig. 2**. Dips in resistance can be seen precisely at integral multiples of 20.7 Oe. These dips can also be clearly observed when the temperature of the specimen is increased from -199 ℃ (74 K) to -193 ℃ (80 K). This shows that the flux lines in the superconductor are regularly distributed in accordance with the lattice-shaped hole arrangement.

Figure 3 shows a schematic phase diagram of flux lines in a Bi-based superconductor. It is known that flux lines, as a multibody system, shift from a solid to a liquid state in this temperature region. However, by introducing a lattice-shaped hole arrangement, a regular arrangement of flux lines, like that in the solid state, can be realized even in the temperature region where flux lines normally shift to the liquid state.

Based on the fact that it is possible to control the properties of superconductors by nanosized processing, as illustrated here, we are searching for novel phenomena, aiming at future applications of superconductors.

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

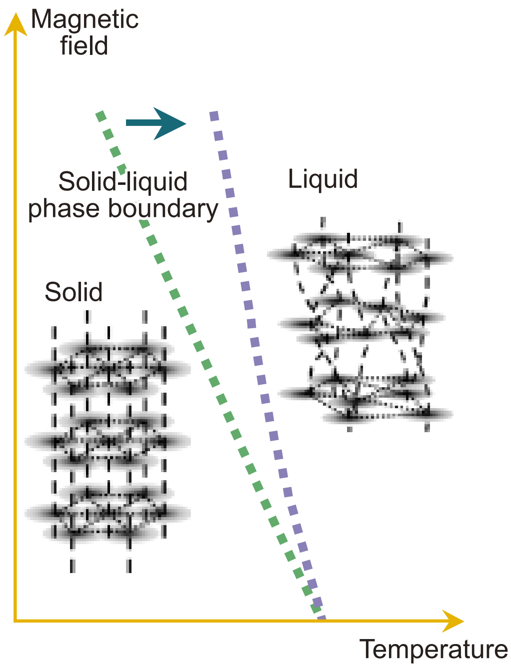

Fig. 3 Phase diagram of flux lines in a Bi-based high temperature superconductor. The solid-liquid phase boundary shifts to the high field/high temperature side due to the lattice-shaped arrangement of nanosized holes. (green → purple dotted line)

NIMS News

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Doctoral Program in NIMS

The Doctoral Program in Materials Science and Engineering will hold an additional entrance exam in February 2006, scheduled as below. The program is managed by NIMS in cooperation with the University of Tsukuba. Selected NIMS scientists have joined the program as graduate school faculty members and supervise students' thesis research. We believe that this course offers one of the most exciting, supportive, and intellectually challenging programs in materials science and engineering in the world today.

Schedule	Date
Application Period	January 4-6, 2006
Oral and Paper Examination	February 1-2, 2006
Announcement of Test Result	February 16, 2006
Enrollment	April 1 or August 1, 2006 (At student's option)

Contact:
Office for the Doctoral Program in Materials Science and Engineering
3-13 Sakura, Tsukuba, Ibaraki 305-0003 JAPAN
Phone: +81-29-863-5348 / Fax: +81-29-863-5394
E-mail: nims_admin@pas.tsukuba.ac.jp

For more details: http://www.nims.go.jp/graduate/english/

SQUID Probe Microscope

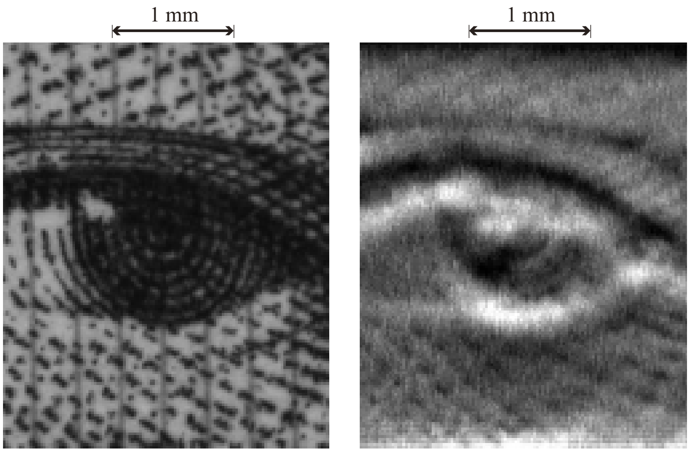
—Looking at the World of Micro Magnetism—

Hideo Itozaki, Tadayuki Hayashi, Huiwu Wang, Tomokatsu Ishikawa
SQUID Group, Superconducting Materials Center (SMC)

NIMS is currently developing a scanning SQUID probe microscope utilizing a superconducting quantum interference device (SQUID) with high magnetic sensitivity as a microscope for investigating the micro world of magnetism.

The SQUID is a magnetic sensor that is capable of detecting extremely weak magnetism as small as $1/10^8$ of earth magnetic field. A high temperature superconducting SQUID that can be used with relative ease has been developed using a liquid nitrogen coolant, and applied research is in progress. We developed a SQUID probe microscope using this high temperature superconducting SQUID (**Fig. 1**). Because the SQUID sensor is several mm in size, it is difficult to enhance its spatial resolution with respect to magnetism. We therefore conceived a method of using a sharpened needle of a material with high magnetic permeability as a probe in combination with the SQUID and succeeded for the first time in realizing micron-level spatial resolution with respect to magnetism. We also developed an image-processing program that gives a sharp image from the obtained magnetic data. **Figure 2** shows a comparison of optical microscope observation of part of the old ¥1,000 note and the same area as seen with the newly developed SQUID probe microscope. Because magnetic ink was used on the note, clear observation of the printed parts was possible by this magnetic technique.

Fig. 1 SQUID probe microscope.



a: Optical microscope image b: SQUID probe microscope image

Fig. 2 Observation by optical microscope and SQUID probe microscope. The images show the eye of Japanese novelist Natsume Soseki on the ¥1,000 note.

Although the SQUID probe microscope is expected to be an important tool for research on magnetic materials, its applications are not limited to this field. Because it can also capture magnetically the weak electrical currents in integrated circuits and other devices, application to nondestructive inspection of ICs is also conceivable.

Future work will include research to improve spatial resolution and various types of analysis of the micro magnetic world.

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

NIMS Ranks 4th in the World in Citations during the Past 5 Years

The results of an analysis based on the Essential Science Indicators database provided by Thomson Scientific revealed that NIMS ranked 4th in the world in the total number of citations of papers published in the field of materials science between January 2001 and August 2005. According to the same analysis, during the 5-year period from 1996 to 2000, before NIMS became an Independent Administrative Institution (IAI), the combined total of citations for its two predecessor organizations, the National Research Institute for Metals (NRIM) and National Institute for Research in Inorganic Materials (NIRIM), ranked 30th. Thus, this is clear evidence that NIMS has greatly increased its research achievements since becoming an IAI.

Institutional Citation Ranking (materials science) of NIMS before/after becoming IAI

Ranking	Jan. 1996 ~ Dec. 2000 (No. of citations)		Jan. 2001 ~ Aug. 2005 (No. of citations)	
1	Max Planck Society	4,886	Chinese Academy of Sciences	10,201
2	Tohoku University	3,990	Max Planck Society	9,287
3	University of California, Santa Barbara	3,204	Tohoku University	7,915
4	MIT	3,095	NIMS	5,309
5	Russian Academy of Science	2,982	MIT	4,910
6	University of Cambridge	2,570	CSIC	4,633
7	Pennsylvania State University	2,517	Osaka University	4,464
8	Kyoto University	2,443	University of Tokyo	4,440
9	Osaka University	2,370	University of Cambridge	4,338
10	Sandia National Laboratory	2,260	University of California, Berkeley	4,204
•••	•••	•••		
30	NIMS*	1,570		

* Combined total of citations for NRIM and NIRIM.

Source: Rankings prepared based on the Essential Science Indicators database (Nov. 2005) of Thomson Scientific.

Research Frontier

Development of Cell Culture-System for a Fatigue Test

—Enables Durability Evaluations of Biomaterials in the Presence of Living Cells—

Norio Maruyama, Akiko Yamamoto
Reconstitution Materials Group
Biomaterials Center (BMC)

Metallic materials are used in artificial joints, jawbone reconstruction plates, and other parts for orthopedic surgery as they have high strength, toughness, rigidity, electrical conductivity, and other properties. Metallic materials are also used for the treatment of cardiovascular and digestive diseases. For example, metal tubes called stents are used to expand narrowed parts of blood vessels, the esophagus, and other organs. From the viewpoint of mechanical reliability, it is difficult to replace these metallic devices by other nonmetallic materials. For this reason, it is extremely important to evaluate the mechanical properties of metallic materials, such as fatigue strength, in the living body.

Until now, fatigue tests of metal biomaterials (bone plates, spinal fixing devices, etc.) were performed in simulated body fluid. However, it was impossible to make an accurate evaluation of the mechanical strength of metallic biomaterials in the biological environment due to the non-existence of cells, which are the main component of the living body.

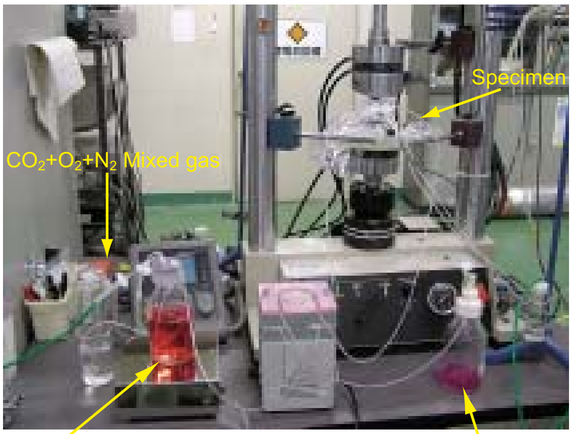
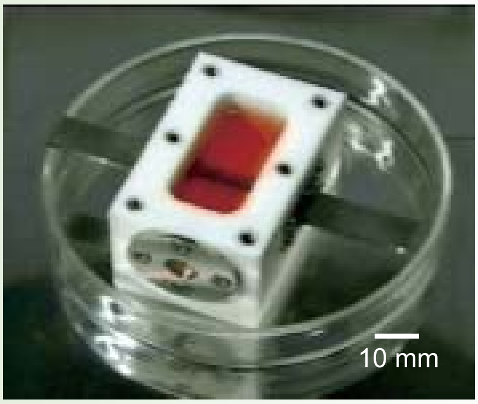


Fig. 1 Cell culture-system for a fatigue test.

We recently developed a system which enables measurement of the long-term fatigue properties of metallic biomaterials in a cell culture environment by inoculating cells on the specimen surface, placing it into a cell culture unit, and culturing cells in a culture medium by keeping its temperature constant in the range of 30 ℃-45 ℃.

The fresh cell culture medium is supplied into the cell culture unit at a controlled flow rate while recovering the used culture medium (**Fig. 1**). This method allows a wide range of the culture medium flow rates, and thus, enables fatigue testing of metallic materials in an environment closer to that in the living body (**Fig. 2**).

This device makes it possible to evaluate long-term fatigue properties of metallic biomaterials in the presence of living cells, improving the reliability of biomaterial durability data. It is expected to contribute to the confirmation of the design standards for biomedical devices, as well as to the establishment of clear guidelines for the development of new biomaterials with higher reliability and safety.



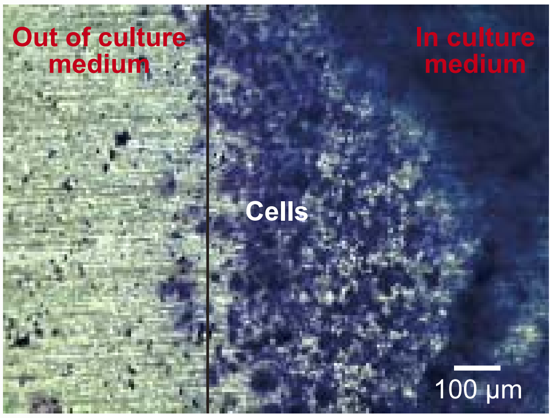


Fig. 2 Left: Cell culture unit and specimen; right: L929 cells (stained in blue) proliferating on the specimen surface during fatigue testing. Stress amplitude: 180 MPa. No. of cycles: 3.6 x 10^6 (3 weeks).

For more details: http://www.nims.go.jp/bmc/index_e.html

NIMS News

Workshop by NIMS and Germany's MPA-IfW

(September 6-7, Germany) -- The 5th IfW Darmstadt · MPA Stuttgart · NIMS workshop was held in Darmstadt, Germany. The subject was "Performance and Requirements of Structural Materials for Modern High Efficient Power Plants." Discussions concentrated on the issue of high temperature strength in high Cr heat-resistant steels, which has become a problem worldwide, including Germany and Japan. The workshop featured 11 presentations from the Japanese side and 10 from the European side. The next workshop in this series is scheduled for March 2007 at NIMS.
(MPA Stuttgart: Materials Testing Institute, University of Stuttgart, IfW Darmstadt: Materials Technology Institute, Darmstadt University of Technology)

Prof. Berger, Director of the IfW Darmstadt, delivers opening remarks.

World's First Protein Crystal Fabrication Experiment in a Laboratory Microgravity Environment

—Clarification of the Possibility of Obtaining High Quality Crystals—

Nobuko Wakayama
NMR & Chemistry Group
High Magnetic Field Center (HMFC)

Tsukasa Kiyoshi
Vice Director General
High Magnetic Field Center (HMFC)

A knowledge of the 3-dimensionsal structure of protein molecules such as enzyme, hormone and others is indispensable in the elucidation of life phenomena, development of new drugs, and research on new methods of treating disease. Although the structures of most proteins have now been obtained by X-ray structural analysis, production of high quality crystals remains a bottleneck for structural analysis. It is generally thought that crystals of good quality can be obtained in the outer space environment, which is unaffected by gravity. However, experiments in space require numerous preliminary and preparatory experiments and are also expensive, severely limiting the opportunities for research of this type.

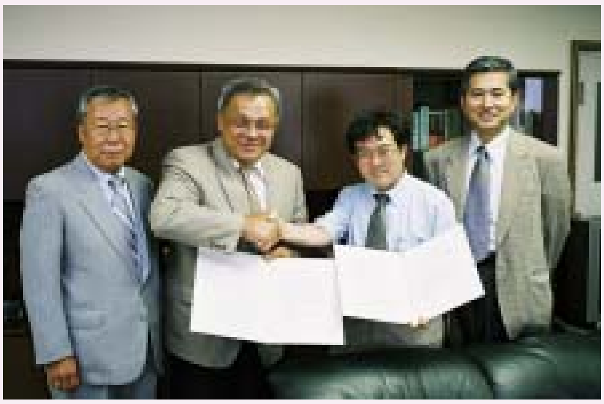
Minimal gravitational force exists in a space station because the earth's gravity is counterbalanced by the centrifugal force of orbital flight. Just as iron is attracted to a magnet, all substances are either attracted to or repulsed by magnets. However, most substances, including water and proteins, display a force which repels magnets (these are termed diamagnetic substances). Although this repulsive force is extremely weak, a microgravity environment like that in outer space can be produced in the laboratory by using a powerful superconducting magnet to apply an upward-directed magnetic force equal to the force of gravity.

NIMS, in cooperation with Prof. Yoshifumi Tanimoto of Hiroshima University and Dr. Kazuaki Harata of the National Institute of Advanced Industrial Science and Technology (AIST), carried out the world's first demonstration experiment to verify the effectiveness of a microgravity (μG) environment obtained using a superconducting magnet in the production of high quality protein crystals. The **figure** shows the superconducting magnet used in this experiment. A pseudo-microgravity environment was generated in the magnet in the part indicated by the arrow. Experiments in which protein crystals (orthorhombic lysozyme) were formed simultaneously in the microgravity environment in the superconducting magnet and outside the magnet were carried out a total of three times, and in each case, it was found that the crystals formed in the microgravity environment were of higher quality than those obtained in the normal gravitational field (1 G) outside of the magnet. Thus, this research demonstrated for the first time in the world that high quality protein crystals can be obtained using an easily-produced terrestrial microgravity field. In the future, we plan to confirm the effectiveness of terrestrial microgravity environments with a large number of other proteins.

Fig. Superconducting magnet used to obtain a microgravity environment.

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

MOU with the University of Texas at Dallas, U.S.



Left to right: Mr. Shimizu, UTD, Prof. Zakhidov, Deputy Director of the UTD NanoTech Institute, Dr. Chikyo, NML, and Prof. Koinuma, Vice President of NIMS.

(July 19, Tsukuba) -- The Nanomaterials Laboratory (NML) signed an MOU on research cooperation with the NanoTech Institute of the University of Texas at Dallas (UTD). The two institutes plan to conduct exchanges of researchers and research information and carry out joint research in fields related to combinatorial materials and material informatics. UTD has recently achieved important results in electronic materials development and nanomaterials research using organic molecules, which the university is carrying out with the support of local businesses. The school has now completed construction of a new laboratory building for research in these areas and is expected to realize research achievements using this facility.

Friendly People and Beautiful Nature of Japan

Mingxiang Xu (China)
Research Fellow (January 2001 - March 2006)
New Materials Group
Superconducting Materials Center (SMC)

[Enjoying yearly summer festival with my family, left]

I am very happy to write something about my research in NIMS and life in Japan through NIMS NOW. My name is Mingxiang Xu, from Zhejiang University in China. As a Research Fellow, I am now working in the New Materials Group of the Superconducting Materials Center (SMC) under the supervision of Dr. Muromachi. As an STA Fellow, I came to Tsukuba with my family in January 2001. Up to now, I have worked in three different research groups with different hosts in NIMS. This has broadened my scientific knowledge from nano-materials to nano-devices, and now to new materials. Fortunately, all of my host researchers and colleagues have been very kind and friendly. They give me much help, not only in my research but also in my daily life. With their help, my experimental research is going smoothly, and my experimental skills have improved greatly. Here, I would like to say, "Thank you, my warmhearted colleagues."

I have learned only a little bit about the Japanese culture and nature from my daily life and colleagues due to my busy research work and poor Japanese. However, the yearly summer festival and people with various kimono are strongly impressed in my memory. Certainly, scenes of enchanting beauty such as the sakura blossoms in spring, the red autumn leaves and hot springs, as well as the Shinkansen bullet train and Mt. Fuji, which I have experienced in Japan will stay in my mind forever. My research and life in Japan are happy and memorable.

Hello from Half-Metals at NIMS

Ammanabrolu Rajani Kanth (India)
University of Tsukuba Ph.D. Student/
NIMS Junior Researcher (September 2004 - present)
Metallic Nanostructure Group
Materials Engineering Laboratory (MEL)

[With colleagues, back right]

Hello. My name is A. Rajani Kanth, I came from India. I received my Master's degree in physics from the University of Hyderabad. Hyderabad is known as the software center of India. Now I am working at NIMS with Prof. Hono in the Doctoral Program in Materials Science and Engineering at the University of Tsukuba.

I have already spent one year in Tsukuba City. This city is calm and clean and has little pollution, which made me feel that it is the best place to stay healthy. NIMS has the kind of environment in which we can really see our thoughts and ideas becoming reality.

My doctoral work is to investigate the structural and magnetic properties of half-metallic materials. These materials are being used in spintronic devices, which in comparison with conventional electronics, utilize the spin as well as the charge of the electron. Structural and electrical characterization of the materials used for these devices is crucial; however, measurement of the spin polarization in ferromagnetic materials is a crucial experiment. We have set up a spin polarization measurement system using the point contact Andreev reflection method, which is the first of its kind in Japan.

In my one year at NIMS, I feel that I have had good exposure to instrumentation as well as basic science research. I am working in the Metallic Nanostructure Group, which is a multicultural group, and I enjoy working with my colleagues. Although initially I felt socially alone, now almost every moment with everyone I have fun. I have also visited various institutes such as Institute for Material Research (IMR) in Sendai, Nagoya University, and the University of Tokyo, and attended a conference at Shinshu University. I really enjoy exchanging my views with various people and doing collaborative work. For my one year work to be a consolidated one, Prof. Hono provided all the necessary equipment without any second question. I really feel blessed in this matter. The subject class education in the doctoral program at NIMS is yet to start for foreign students, which I hope will be structured in the future.

I hope that my remaining two year stay in Japan will turn out to be an exciting one, professionally as well as personally.

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