from Tsukuba, Japan to the world

NIMS NOW International

National Institute for Materials Science

Vol.4 No.3 March, 2006

Special Features

NIMS-Originated Ventures
- Contributing to the Creation of a Sustainable Society

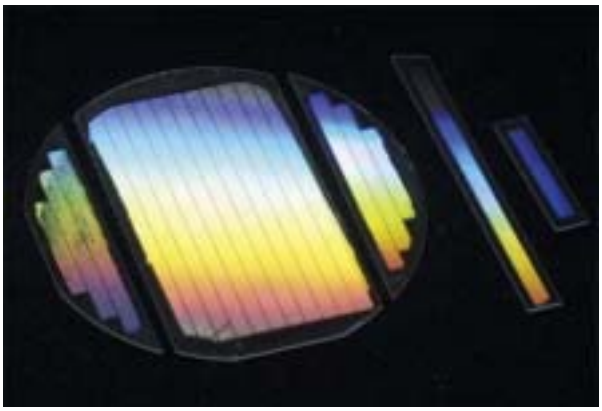
SWING Ltd.

- Development of Practical Applications and Feedback to Fundamental/Basic Research -

Kenji Kitamura, Shunji Takekawa
Opto-Single Crystal Group
Advanced Materials Laboratory (AML)
(Concurrently Directors of SWING Ltd.)

Even when we were announcing the results of research on wavelength conversion devices at NIMS, we received inquiries from companies and universities asking that we provide prototype devices on a paid basis, but we were unable to respond until now because business cooperation with a view to commercialization is by nature different from joint research with a national laboratory.

Against this background, in May 2003, a limited responsibility company called SWING, which provides prototype wavelength conversion devices, single crystals for use in holograms, and other devices/materials on paid basis was established to encourage practical application of materials and devices developed at NIMS. SWING is a venture company which was launched with personal funding by members of the NIMS Opto-Single Crystal Group, and was the first NIMS-licensed venture based on support measures for use of research products. Subsequently, the company's capitalization was increased, again with personal funding, and in July 2005, its organization was changed from a limited responsibility company to a stock company (capitalized at ¥20 million as of the end of 2005). Fortunately, the project proposed by SWING was selected as a funded project by the Ministry of Economy, Trade and Industry (METI) in fiscal 2004 and as a project in the Regional New Consortium R&D Project in fiscal 2005. At present, as we continue to search for good matches with corporate partners, SWING is in the takeoff stage from incubation to independence.



Example of product: Periodically-poled stoichiometric LT (SLT) substrate manufactured by SWING Ltd. (2-inch diameter substrate for use in 488 nm SHG)

In a transition of this type, there is an extremely large gap between the results of advanced research and commercialization, and there is a real feeling that what can bridge this gap is fundamental and basic research.

In development aiming at practical application of devices, we discovered a large difference in thermal conductivity in conventional materials and defect-controlled, or so-called stoichiometric materials. This was measured in response to a client's request, but a difference of more than 2 times became apparent in the measurements. This was the starting point for development into extremely interesting calculations of wavelength conversion efficiency with different thermal conductivity. Measured data were also collected in line with these calculations.

< Continued on p.4

in this issue

NIMS-Originated Ventures
- Contributing to the Creation of a Sustainable Society

NIMS News

NIMS Forum 2006

(February 15-16, Tokyo) -- The NIMS Forum 2006 was held at the Tokyo International Forum to publicly announce research achievements under the 1st Mid-Term Program and reveal the new 2nd Mid-Term Program starting from FY 2006.

< Continued on p.3

Progress of OXIDE Corporation
- The First Five Years -

Yasunori Furukawa
President and CEO, OXIDE Corporation
(Former member of Opto-Single Crystal Group, Advanced Materials Laboratory (AML))

OXIDE Corporation was established in October 2000 based on technologies in the field of single crystal materials for optical applications which were developed as research products at NIMS. OXIDE's mission is to support the growth of photonic technology in Japan through functional optical OXIDE single crystals developed by NIMS, and thereby create a more abundant living environment, and to continually send to market high function optical oxide single crystals as a key material for ensuring that Japan leads the world in photonic technology in the coming age of photonics.

The products supplied by OXIDE are a type of high performance single crystal materials which were impossible to obtain in the past due to the difficulty of crystal growth. A novel production technology developed by NIMS made it possible to manufacture high quality, large-scale single crystals for the first time. During the 5 years since OXIDE was established, we developed this crystal growth technique to the level of a manufacturing technology and succeeded for the first time in the world in producing stoichiometric lithium tantalate (SLT) single crystals. We also achieved a dramatic improvement in yield. The SLN and SLT single crystals which OXIDE successfully commercialized have grown to become the company's mainstay products, currently accounting for approximately 60% of orders received. With SLN and SLT crystals, we are receiving orders for use as new single-crystal substrates without precedent in the world in a diverse range of photonic applications. OXIDE has been licensed by NIMS as a NIMS-originated venture company, and is also participating in the market for wavelength conversion devices using these crystals as a sales agent for SWING Ltd., which is also a NIMS-licensed venture company. In the coming year and thereafter, we intend to strengthen our business cooperation with SWING and expand our businesses, including possible M&A involving the existing businesses of other companies.

OXIDE Corporation's new building at Takekawa, Hokuto City, Yamanashi Pref.

With the aims of further upgrading our development system, strengthening manufacturing technology, and ensuring a stable supply of new products in order to respond even more effectively to customer requirements, OXIDE purchased a plant in Takekawa-cho, Hokuto City, Yamanashi Pref. in October 2004 and transferred all head office and plant operations to this location in May 2005. Since this move, more than 10 new single crystal-growing devices have been added, giving the company around 25 units and increasing its production capacity by 60-70%.

During the 5 years since OXIDE was established, we have devoted great effort to accumulating human resources, experience, and know-how in the functional oxide optical single crystal business, and we are now preparing to set our sights on becoming the world's top maker. In particular, our annual sales now exceed ¥300 million, and in 2005, OXIDE received the Tsukuba Venture Challenge Prize. We believe that the fact that we have grown this far as national laboratory-originated manufacturing venture in the materials production/sales business is proof that collaboration in research with NIMS is a sure approach.

While enhancing our strengths and making the leap to a truly excellent company, we intend to expand our business from R&D and applications to production of component materials and devices which can be incorporated in final products with the aim of further expanding our markets and product lineup.

For more details: http://www.opt-oxide.com/english/

NIMS News

Winter Institute Held at NIMS

Participants in the 2006 Winter Institute.

(January 16-February 17, NIMS) -- Six Korean graduate students visited NIMS and engaged in advanced materials research for a 1-month period. The Japan-Korea Industrial Technology Co-operation Foundation has sponsored these visits each year for 13 years under its Winter Institute Program. The objectives of the program are to give Korea graduate students in scientific and technical fields an opportunity to participate in research activities at research institutes in Japan and deepen their understanding of Japanese science and technology, and to contribute to the development of research cooperation between Japan and Korea in the future through exchanges with Japanese researchers.

Materials Design Technology Co., Ltd.

- Aiming at Popularization of Simulation Software -

Hidehiro Onodera
Director General
Materials Engineering Laboratory (MEL)
(Concurrently Director, Materials Design Technology Co., Ltd.)

Toshiyuki Koyama
Particle Simulation & Thermodynamics Group
Computational Materials Science Center (CMSC)
(Concurrently Director, Materials Design Technology Co., Ltd.)

Controlling of the internal microstructure of magnetic materials, lightweight high strength materials, and other advanced materials is indispensable for maximizing their properties and functions, and a material development and design system which makes it possible to predict the materials microstructure and properties on a computer is necessary for efficient development of new materials. For phase diagrams, which provide basic information for microstructure control, the CALPHAD (CALculation of PHAse Diagrams) method has been developed and the thermodynamic database has been expanded, enabling high accurate reproduction of the phase diagrams of real multi-component alloys. On the other hand, advances with the phase-field method, which can be used to describe dynamic behavior of microstructure changes, are continuing to establish quantitative description of the microstructure evolution process (see **figure**; The Fe-rich phase (red part) elongated along the external magnetic field is nucleated during thermomagnetic treatment (see the upper layer of the **figure**), then the lamellae shaped microstructure, where the Fe-rich phase is separated by the thin film of Cr-rich phase (green part), is developed with step aging (see the middle and lower layer of the **figure**)).

On September 12, 2003, the venture company Materials Design Technology Co., Ltd. was launched in order to carry out comprehensive development and marketing of thermodynamic databases for use in phase diagram calculations and a simulation system for microstructure design. The new company brought together researchers from Tohoku University, Kyushu Institute of Technology, and Japan's National Institute of Advanced Industrial Science and Technology (AIST), who had been involved in calculations and experiments related to phase diagrams and the development of thermodynamics databases for many years, researchers at NIMS, who developed a simulation method for microstructure evolutions using the phase-field modeling, and researchers at Interscience Co., Ltd., which is a software developer/marketer. During the same year, the company became a licensed venture company of NIMS and AIST.

Fortunately, the venture's databases for Pb-free solder alloys and copper alloys for wiring the electric circuit on substrate coincided with corporate development targets, and as a result, these DB have been introduced by an increasing number of companies. The microstructure prediction simulation system has not yet reached the stage of actual software supply, because the user interface is still incomplete, but we have already received orders for consulting services on individual material systems and phenomena, and there is a definite vision that the potential demand in this field is enormous. A large expansion in popularization is also expected in the future, as adoption for educational use in universities and elsewhere by supply in software form is foreseen.

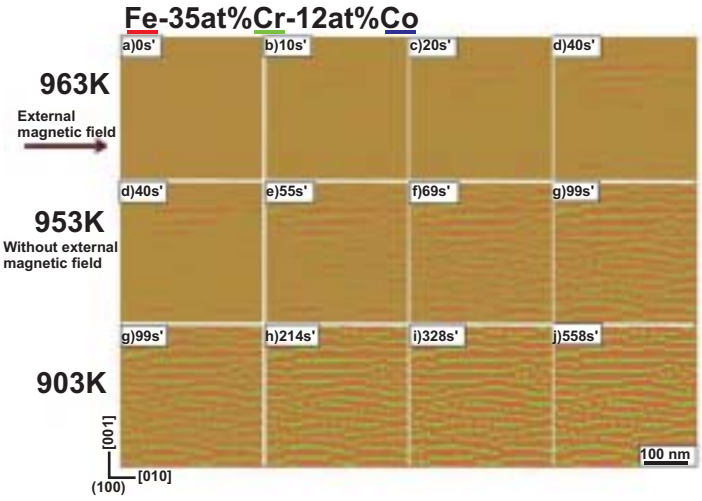


Fig. Quantitative prediction of the microstructure control process for Fe-Cr-Co magnetic alloy during thermomagnetic treatment and step aging by using the phase-field method.

For more details: http://www.materials-design.co.jp/indexE.htm

NIMS News

< Continued from p.1

NIMS Forum 2006

NIMS researchers reported on a wide range of research results, with all research units making oral presentations and virtually all research groups exhibiting 119 poster presentations on their research achievements during the last 5 years. At the end of the forum, a panel discussion entitled "Materials Research and Technology that Underlie the Development of Japan" was held with leading members from academia and industry. The number of visitors totaled 1,400 over the 2 day period.

NIMS Wave Inc. : A Venture Aiming at Creation of Devices using ZnO Single Crystals

- Development of a Novel Surface Treatment Technology for ZnO Single Crystals -

Hajime Haneda, Naoki Ohashi
Electroceramics Group
Advanced Materials Laboratory (AML)
(Concurrently Directors of NIMS Wave Inc.)

Zinc oxide (ZnO) is a ceramic material which has been used since antiquity. In recent years, rapid progress has been achieved in techniques for creating high quality thin films and growing large-scale single crystals of ZnO, resulting in what might be called a "ZnO renaissance." Thin film technology has made it possible to develop luminescent materials equal to gallium nitride, and thanks to large-scale single-crystal technology, development to electronic devices is no longer a dream. The technology described here is related to both.

Recently, it has become possible to grow ZnO single crystals exceeding 2 inches in diameter using a hydrothermal process which is effective in growing single crystals with high crystallinity. For practical application of these single crystals, an extremely clean, defect-free surface is necessary. However, because ZnO is prone to damage by mechanical polishing and also reacts easily with various solvents, it had been impossible to eliminate atomic order roughness (strain) (See **Fig. 1(a)**). We therefore developed a surface treatment technique which completely eliminates strain, as can be seen in **Fig. 1 (b)**, by applying a special heat treatment method to the polished surface.

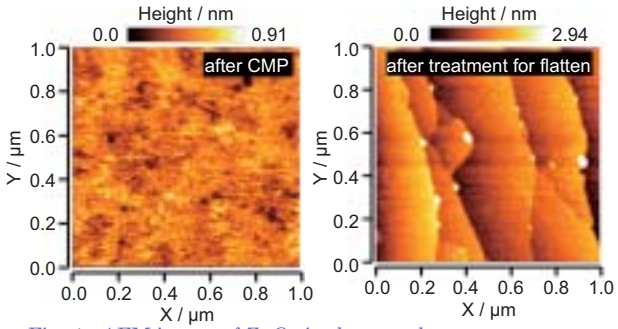


Fig. 1 AFM image of ZnO single crystal.
(a) Surface after mechanical polishing.
(b) Surface after newly-developed heat treatment.

Because ZnO is transparent and conductivity equal to that of metals can be imparted, use as a transparent conductive substrate is possible (**Fig. 2**). Moreover, as lattice mismatch with GaN is exceedingly small in comparison with sapphire single crystals, which are widely used at present, ZnO can be expected to provide a superior substrate. Based on the fact that there is an actual need for a substrate which can be used with the CVD process, this was also studied. The results are presented in **Fig. 3**, which shows that it was possible to form the highest level nitride film by applying our single crystal treatment technique.

As this is an indispensable technology, not only for simple application as a substrate, but also for development of the ZnO single crystal itself as a device, wide development is expected. Therefore, in May 2004, we launched a new venture called NIMS Wave Inc. aiming at wider application of this technology. We are also targeting further expansion of this business in the future.

For more details: http://www.nimswave.com/new_index2.html

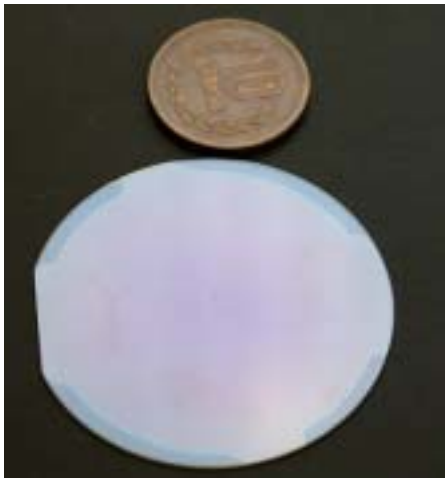


Fig. 2 ZnO substrate. (Above: A 10 yen coin with the diameter of 23.5 mm.)

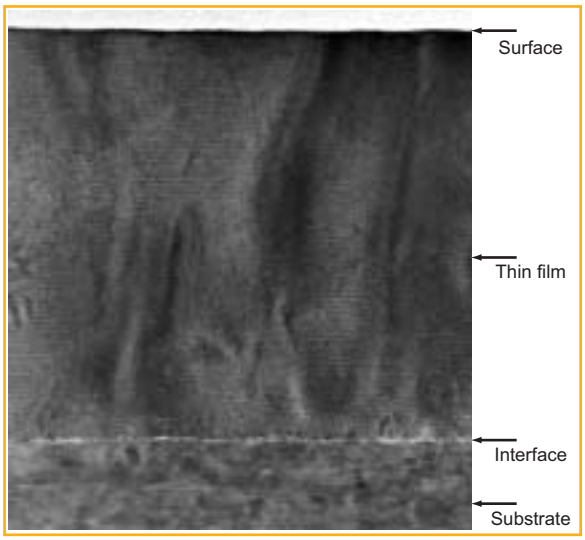


Fig. 3 Cross-sectional TEM image of InN grown using a ZnO single crystal as a substrate.

Special Features

< Continued from p.1

SWING Ltd.

- Development of Practical Applications and Feedback to Fundamental/Basic Research -

On the other hand, in order to obtain higher reliability and reproducibility in polarization reversal, which is the main technology in the device process, the necessity of an investigation of the mechanism of polarization reversal in ferroelectrics from the fundamental stage became an urgent matter.

If these tasks were carried out as part of a program aiming at practical application, they would be considered applied research, but in the context of science and technology, the respective topics can be called fundamental and basic research. Moreover, they also involve issues which can make a large academic contribution. This suggests that we must not overlook the fact that precisely when there is a difficult gap between advanced research and practical development, themes that can be fed back to the fundamental/basic research process also exist in profusion.

The research products which SWING is attempting to develop to the practical level were obtained through joint research and cooperation with a number of researchers inside and outside of Japan extending over many years. In particular, we would like to formally express our thanks to Dr. Sunao Kurimura and Dr. Masaru Nakamura of the Opto-Single Crystal Group, Advanced Materials Laboratory, and to Dr. Yasunori Furukawa, President and CEO of OXIDE Corporation.

For more details: http://www.opt-swing.com/

Adbic Inc.

- Development of Practical Health Care Chips for Home Health Diagnosis -

Yasuhiro Horiike
NIMS Fellow
(Concurrently Director of Adbic Inc.)

Hiroki Ogawa
Representative Director
Adbic Inc.

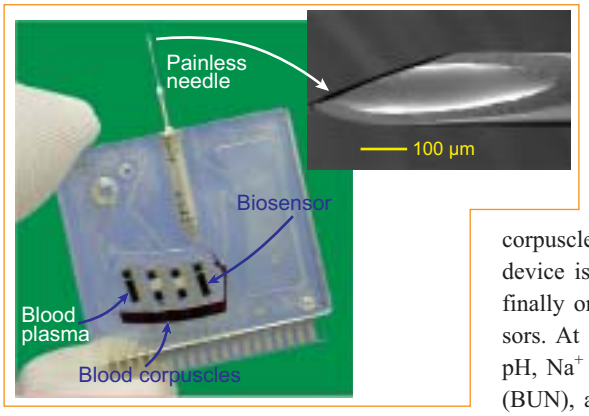


Fig. 1 Health care chip.

Prevention is important for leading a healthy everyday life. We are therefore developing health care chips which measure multiple health markers in the blood plasma extracted from a minute quantity of blood, which can be sampled in the home. In September 2004, the NIMS-licensed venture company Adbic Inc. was established to develop this technology to the practical level.

First, we developed a painless needle, as we believed that it is important that even untrained users be able to take blood samples at home without pain. Using a stainless steel tube with an outer diameter of only 0.15 mm, the rough inner wall which occurs during tube forming was given an ultra-smooth finish and the three faces at the tip were ground to an angle of 10°. This was followed by final electrolytic polishing (**Fig. 1**). Because the needle has a smooth inner wall surface, when it reaches a blood vessel, actual blood sampling requires only the user's own blood pressure. A visualization and detection system was developed to ensure that the needle follows the blood vessel. For visualization, infrared light, which easily passes through the body, is irradiated on the puncture area, allowing the user to confirm the position of the blood vessel from an image obtained with an infrared camera. It is also possible to confirm that the needle has reached a blood vessel by measuring the change in electric potential at this time. A blood sampling success rate of virtually 100% has been obtained thanks to this visualization and detection system. **Fig. 2** shows a user taking a blood sample while observing the screen, without looking at his own arm, and the needle assembly for blood sampling using the painless needle.

This blood sampling assembly is mounted on an integrated chip (**Fig. 1**) containing electrochemical biosensors. Blood is introduced into the biosensors by centrifugal force when the chip is rotated, and at the same time, the blood corpuscles and plasma are separated. The device is fractionized in such as way that finally only the plasma covers the biosensors. At present, it is possible to measure pH, Na^+ and K^+ ions, blood urea nitrogen (BUN), and glucose from this blood plasma using the prototype measuring device shown in **Fig. 3**. We are currently working to improve the stability and reliability of the sensors and reduce the cost and size of the measuring device.

Recently, we also trial-manufactured a colorimetric-type chip which obtains marker concentrations for object from changes in light absorbance when a reagent is mixed with blood plasma. In addition to the liver function diagnosis items of three enzymes represented by γ - GTP, GOT, and GPT, it is also possible to measure the three items total cholesterol, plasma lipids (neutral fat), and HDL cholesterol. Thus, the use of this series of health care chips is expected to be useful in preventing lifestyle diseases. At present, one of the authors has been diagnosed with hyperlipidemia in a health examination, and with the approval of a NIMS staff doctor, is investigating the curative process from changes in plasma lipids resulting from the prescribed medication with this chip over the 6-month period. Because the author is not particularly given to moderation, the values sometimes show considerable ups and downs, but the general tendency is toward improvement, suggesting that this device is extremely useful for self-diagnosis.

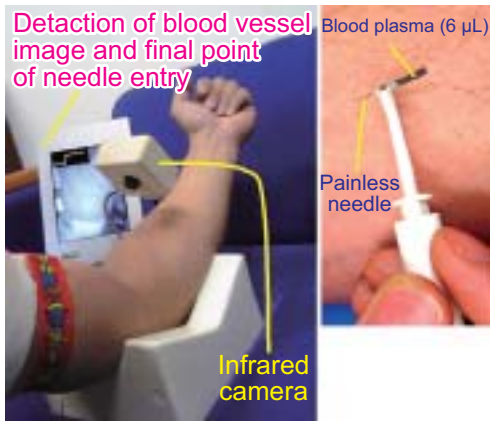


Fig. 2 Sampling of extremely small amount of blood from a vein with the painless needle, supported by the blood vessel visualization and detection system.

In the future, Adbic plans to develop new chips capable of measuring a larger number of items as a step toward realizing full-scale home diagnosis.

Fig. 3 Prototype measuring device.

NIMS News

MOU with the University of Virginia

From right to left, Prof. Howe, Prof. Gangloff (Chair), Dr. Nagai and Dr. Tsuzaki (SRC).

(January 12, Tsukuba) -- The Steel Research Center signed an MOU on research cooperation with the Department of Materials Science and Engineering (DMSE) of the University of Virginia. The two parties plan to conduct exchanges of researchers and research information, hold workshops, and carry out joint research on structural metals for high performance in severe environments. DMSE is a materials research base in the eastern United States. It is active in cooperative research involving industry, governmental agencies, and universities. Numerous research achievements in fields centering on structural materials can be expected as a result of cooperative research with this partner.

Hello from NIMS

NIMS - "The Paradise of Researchers"

Sarkarainadar Balamurugan (India)
Research Fellow (March 2004-March 2007)
New Materials Group
Superconducting Materials Center (SMC)

[Enjoying the snowfall with my family]

I am Balamurugan, and I am from the southern part of India (Tamilnadu/Tirunelveli). Although I had two foreign research opportunities (Japan and France), I preferred the Japan offer to pursue my post-doctoral research. I came to Japan (Kyoto) in October 2002 after completing my Ph.D. at I. I. T-Bombay, India. I worked as a post-doctoral fellow for one and half years (Oct. 2002 - Mar. 2004) at the Dept. of Electrical Engineering, Kyoto University. Kyoto is a very nice place. I enjoyed my research as well as my daily life in Kyoto. After completing my first post-doctoral research, I then joined NIMS under the supervision of Dr. E. Takayama-Muromachi. He gave me an opportunity to enter the NIMS nucleus, for which I am always very grateful to him. All my colleagues are kind and helpful, and I am delighted with my research work at NIMS. Since March 2004, I have been working on the synthesis (and characterization) of perovskite cobalt oxides and related materials under high pressure and high temperature (HPHT), and studying their structural, magnetic, and transport properties.

Life in Tsukuba is calm and safe. I am living with my family. Recently, we are blessed with a lovely child. We are enjoying life even more with our lovely son. Although I have not been able to learn more about Japanese culture and tradition due to the language problem, I wonder about agriculture in Japan. The soil is very soft, and it looks like manure. I hope that the farmers will get a 100% yield from their fertile land. Opposite my house, an old couple is living and they have their own field. In our spare time, we tend to watch and admire them and how they work actively even in their old age. Whenever they see us, they greet us and say "konnichiwa" with their smiling faces.

We learn a little bit about Japanese culture and tradition through their gestures. The further words of William Henry Davies come true through their habits and activities, "*what is this life if, full of care, we have no time to stand and stare.*" Life in Japan is very fast, and generally the Japanese people have no time to stand and chat. Their anxiety of working lies at the foundation of their further development.

The Japanese people are very calm and more reserved, and their calmness is shattered through the further nature in Japan. As Keats says "*truth is beauty, beauty is truth*". The very beauty is seen through the true nature in Japan. The poets were tempted to write poetry through the further divinity that is present in nature. Even Milton, the divine poet, gained his lost paradise through nature, and nature stood as a gateway for writing his great epic. Hence, the Japanese are blessed with a very heavenly shower through nature.

I love the cool weather in Japan. Every winter I enjoy the snowfall. The snow looks like cotton balls which were weaved from the heavenly mother. It is very beautiful to see, when the whole land seems to be wearing a white dress and appears as a heavenly angel after a snowfall. My visit to Japan has been memorable and will remain in my mind forever.

Photo by M. Sato

Beautiful spring has come earlier!

Believe it or not, cherry blossom forecast is included in the weather forecast in springtime of Japan. This year, after a warm February, Ibaraki had a March 31 forecast date, which is 10 days earlier than usual.

Photo by H. Okubo

NIMS Public Relations Office
National Institute for Materials Science

PUBLISHER
Dr. Masatoshi Nihei

NIMS NOW International is a monthly newsletter made for international readers to introduce our latest research activities and events. Our official website provides you with the back issue download as well as the news on most recent activities at
http://www.nims.go.jp/

To subscribe, contact:
Ms. Naoko Ichihara
Public Relations Office, NIMS
1-2-1 Sengen, Tsukuba, Ibaraki
305-0047 JAPAN
Phone: +81-29-859-2026
Fax: +81-29-859-2017
inquiry@nims.go.jp