NIMS Award 2018 Goes to
Dr. Masato Sagawa and Dr. Terunobu Miyazaki

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National Institute for Materials Science (NIMS)

Overview

National Institute for Materials Science (NIMS) (Kazuhito Hashimoto, President) has selected the following scientists as the winners of the NIMS Award 2018.

Dr. Masato Sagawa
(Advisor for Daido Steel Co., Ltd.)

Terunobu Miyazaki
(Professor Emeritus at Tohoku University)

NIMS Award 2018 will be given to two scientists who have made epoch-making achievements in the area of "magnetic and spintronic materials". Dr. Masato Sagawa invented the world's strongest neodymium permanent magnets and played the leading role in the commercialization of the material. Dr. Terunobu Miyazaki developed the tunneling magnetoresistance device that exhibits giant magnetoresistance at room temperature. Their research accomplishments have made a significant impact on the society through their implementation to various industrial products such as electric vehicles, hard disk drives and magnetoresistive random access memory (MRAM).

The award ceremony and the NIMS Award symposium will take place at the Tokyo International Forum on October 15 as part of the NIMS WEEK 2018.

[NIMS Award]

Since 2007, the NIMS Award has been given to researchers around the world in recognition of their outstanding achievements in materials science and technology. This year's recipients were selected by the selection committee comprised of the staff members at NIMS and scientists from other organizations based on the nominations from the top scientists in the area of "magnetic and spintronics materials".

[NIMS WEEK]

NIMS WEEK is an annual event hosted by NIMS consisting of the Academic Symposium, the Business Showcase and the Open Laboratory. The participants can encounter "cutting edge materials research" through a variety of activities, such as the NIMS Award symposium to honor the award recipients and the exhibitions of the latest materials research at the NIMS Business Showcase. The largest ever "NIMS Open Laboratory"—

which is mainly targeted towards industrial engineers and academic researchers including graduate students and faculty members—will be held on the final day of the NIMS WEEK to publicize the NIMS' research activities and may provide opportunities for collaborations, employment of graduate students and administrative staff members.

NIMS WEEK 2018
2018 NIMS Award Winners

Awardee 1: **Dr. Masato Sagawa** (Advisor for Daido Steel Co., Ltd.)
Awardee 2: **Dr. Terunobu Miyazaki** (Professor Emeritus at Tohoku University)

Awardee 1
Dr. Masato Sagawa (Advisor for Daido Steel Co., Ltd.)

[Research field] Permanent magnet materials
[Research achievement title] Invention and practical application of neodymium magnets

[Research summary]

Dr. Sagawa invented neodymium (Nd) magnets—the world's strongest magnets—and led the industrialization of anisotropic neodymium magnets through a powder metallurgy process. The use of these magnets enabled the development of various electronic devices, such as hard disk drives, hybrid and electric vehicles. Dr. Sagawa independently discovered Nd-Fe-B-based magnetic alloys as a promising permanent magnet material. Immediately after joining Sumitomo Special Metals Inc., Dr. Sagawa developed the world's strongest Nd-Fe-B-based magnet. He then applied for a patent under the name of Sumitomo Special Metals in 1982 and published the approved patent in 1983. The development of Nd sintered magnets was revolutionary not only because their magnetic fields were stronger than those of the previously strongest Sm-Co-based permanent magnets, but also because they are composed mainly of Fe, which is abundant in nature, and Nd, which is a relatively abundant rare-earth element. The discovery of neodymium magnets was also groundbreaking because it defied the common belief that cobalt is a requisite ingredient in permanent magnets and completely resolved the issue of the limited availability of Co resources. Nd magnets remain the world's strongest 35 years after their invention, and their applications, which now include electric vehicles and robotics, continue to grow.

[Impact on the academic and industrial sectors]

Dr. Sagawa not only invented the anisotropic neodymium magnet, but also promoted basic research on the neodymium magnets by supplying samples to academic researchers around the world. This effort greatly contributed to advances in materials science of permanent magnets. Sumitomo Special Metals began commercial production of the Nd-Fe-B sintered magnet product NEOMAX in 1985. Production of NEOMAX—the most powerful permanent magnet in the world which can be manufactured using inexpensive raw materials—rapidly increased as the range of its applications expanded. Approximately 70,000 tons of NEOMAX were estimated to have been produced worldwide in 2015. Used in hard disk spindle motors and head actuators, neodymium magnets have become indispensable components of modern data storage technologies. More recently, Nd magnets have been used in the motors and generators of hybrid and electric vehicles, wind power generation, energy-efficient air conditioners and the drive units of robots. The use of these magnets for these purposes is expected to continue growing. Thus, society has benefited immensely from the neodymium magnets. For this contribution to the society, Dr. Sagawa received many prestegous awards like Osaka Science Award, James C. McGroddy Prize for New

Materials, Asahi Prize, Honda Memorial Award and Japan Prize.

Awardee 2

Dr. Terunobu Miyazaki (Professor Emeritus at Tohoku University

[Research field] Spintronics, magnetic materials
[Research achievement title] Development of tunneling magnetoresistance elements capable of generating giant magnetoresistance at room temperature and application thereof to spintronics devices

[Research summary]

A magnetic tunnel junction (MTJ) is a tri-layer structure composed of two ferromagnetic layers sandwiching an insulating layer. Tunnel magnetoresistance in MTJ changes in response to differences in magnetic orientation between the two ferromagnetic layers, i.e., the tunneling magnetoresistance (TMR) effect. Although the TMR effect was first reported as early as the 1960s, observations prior to Dr. Miyazaki's pioneering research on TMR devices at Tohoku University were limited to the detection of subtle TMR at extremely low temperatures. In 1995, Dr. Miyazaki observed a giant TMR effect at room temperature for the first time using tri-layer (Fe/alumina/Fe) magnetic tunnel junction. This success triggered the interest in the practical application of TMR devices. After demonstrating the successful operation of TMR device at room temperature, Dr. Miyazaki continued his research by collaborating with worldwide academic and industrial researchers. His contributions were crucial in the development of spintronics. TMR is now used as read sensors of high capacity hard disk drives, magnetic random access memories and other magnetic sensors. Dr. Miyazaki' greatly contributed to society by advancing the applications of TMR devices in data storage, nonvolatile magnetic memories and magnetic sensors.

[Impact on the academic and industrial sectors]

Dr. Miyazaki's observation of a magnetoresistance effect at room temperature using TMR devices had a profound impact on the academic and industrial sectors. TMR devices were put into practical use in high-sensitivity read heads for hard disk drives (HDDs), which were commercialized in 2001 and still in use today. The improved performance of TMR read heads enabled an increase in HDD recording density, from tens of Gbit/in^2 before 2001 to 1 Tbit/in^2 today, greatly increasing the storage capacity of HDDs, which now serve as vital infrastructure for our advanced information society. TMR elements are also used as memory cells in MRAM devices, a promising candidate for next-generation non-volatile memory. The global R&D effort to develop these technologies has its roots in Dr. Miyazaki's discovery. The room temperature TMR effect has been applied in a wide variety of engineering and scientific research projects, such as exploration of high spin polarization materials and magnetically anisotropic materials and spin torque generated by spin transport. These research projects were highly valued by academic and industrial groups and won many awards, including the Asahi Prize, the JSAP (Japan Society of Applied Physics) Award and the American Physical Society Award. As a longtime faculty member at Tohoku University, Dr. Miyazaki has educated many students and young researchers in the magnetism and spintronics field. He has contributed greatly to maintaining Japan's high research standards in this field.

(Reference) NIMS Award winners of the past five years and their achievements

2013 **Prof. Hideo Hosono** (Professor at Tokyo Institute of Technology, Japan)
"Discovery of iron-based superconductors and invention of IGZO-TFT"

2014 **Prof. Krzysztof Matyjaszewski** (Professor at Carnegie Mellon University, USA)
"Development of atom transfer radical polymerization (ATRP)"
Prof. Mitsuo Sawamoto (Professor at Kyoto University, Japan)
"Precision polymerization and precision synthesis of functional polymers"

2015 **Prof. Harald Rose** (Professor at the University of Ulm, Germany)
Prof. Maximilian Haider (Professor at Karlsruhe Institute for Technology / Cofunder of the Corrected Electron Optical Systems GmbH, Germany)
Prof. Knut Wolf Urban (Professor, Research Centre Juelich, Germany)
"Development of aberration corrector for electron microscopes"

2016 **Dr. Koichi Mizushima** (Executive Fellow, Toshiba Research Consulting Corporation, Japan)
Dr. Akira Yoshino (Adviser for Asahi Kasei Corporation / President at the Lithium Ion Battery Technology and Evaluation Center / Visiting Professor at the Research and Education Center for Advanced Energy Materials, Devices, and Systems, Kyushu University, Japan)
"Discovery of anode material for the lithium ion battery ($LiCoO_2$) and development of the lithium ion battery"

2017 **Prof. John Ågren** (Professor at the Royal Institute of Technology, Sweden)
"Development of kinetic simulation packages for computational thermodynamics"
Prof. Bo Sundman (Professor at the Royal Institute of Technology, Sweden)
"Development of thermodynamic calculation packages for computational thermodynamics"
Prof. Kiyohito Ishida (Professor Emeritus at Tohoku University, Japan)
"Alloy design and development of structural materials based on thermodynamics of phase diagrams and microstructures"

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