NIMS Award 2023 goes to Prof. Dierk Raabe

National Institute for Materials Science (NIMS)

Overview

The National Institute for Materials Science (NIMS) (Dr. Kazuhiro Hono, President) has selected the following scientist as the winner of the NIMS Award 2023.

This year's NIMS Award targeted basic research in the field of structural materials that has led to profound benefit for society and industry and created impactful results that have changed the world. Prof. Dierk Raabe's "Pioneering research on the sustainability and microstructure-based design of advanced metallic alloys" was selected to receive the NIMS Award 2023 as an outstanding global achievement.

The NIMS Award Ceremony and Commemorative Lecture will be held on Monday, November 6th at the Tsukuba International Congress Center as part of the "NIMS Award Symposium 2023".

Prof. Dierk Raabe
Director
Department Microstructure Physics and Alloy Design
Sustainable Synthesis of Materials
Max-Planck-Institut für Eisenforschung GmbH

[NIMS Award]

Since 2007, NIMS has been awarding the NIMS Award, an international award, to researchers who have made outstanding scientific and engineering achievements related to materials science and technology. As award topics in each year, NIMS has divided the related materials science topics in which it is particularly focused, along four major fields*, and the NIMS Award is presented each year in the order of the fields listed below. This year's NIMS Award targeted basic research in the field of structural materials that has led to profound benefit for society and industry and created impactful results that have changed the world. For selection of laureates, the top material scientists from around the world were asked to nominate candidates, and a committee of neutral experts conducted a strict selection process.

* Four award fields: 1. Environmental and Energy Materials, 2. Functional Materials, 3. Structural Materials, 4. Basic and Fundamental Technologies

[NIMS Award Symposium]

NIMS has been holding NIMS WEEK, a largest event organized by NIMS, once a year, and the NIMS Award Symposium was an academic event during this NIMS WEEK. Although the COVID-19 pandemic forced us to hold the symposium online, we held it in person at Tokyo International Forum for two days from November 14 to 15 last year. This year, the NIMS Award Symposium will be held at the Tsukuba International Congress Center in Tsukuba City. The NIMS Award ceremony, commemorative lectures, invited lectures and presentations by NIMS researchers will be held. In addition, there will be poster presentations by NIMS researchers and graduate students studying materials science at the venue of NIMS Award Symposium.

For details, please refer to the NIMS Award Symposium 2023 official website, which will be published at a later date.

* The National Institute for Materials Science has unified its abbreviation to 'NIMS'.

NIMS Award Symposium 2023
2023 NIMS Award laureate

NIMS Award laureate:
Prof. Dierk Raabe (Director, Max-Planck-Institut für Eisenforschung GmbH)

[Field of research]
Structural Metals, Sustainability, Metallurgy, Metal Physics, Computational Science

[Title of research achievement]
Pioneering research on the sustainability and microstructure-based design of advanced metallic alloys

[Outline of awarded research achievement]
Prof. Dierk Raabe has focused on the relation among lattice defects, their defect chemistry, mechanical properties and sustainable fabrication processes in structural metallic materials. Also, he has used state-of-the-art multiscale analysis techniques such as atom probe tomography [(1)], transmission electron microscopy, field ion microscopy [(1)], and machine learning [(2)] for correlative atomic-scale characterization of microstructure developments, such as dislocations and interfaces, and chemical properties due to phase transformation. He has then applied this approach to the trade-off problem between strength and ductility [(3)], controlling structural phase transformation by chemically adjusting thermomechanical stability, and has developed new materials with both high strength and durability.

[Ripple effects of achievements on academia and industry]
Prof. Dierk Raabe's research achievements to date have conspicuously contributed to the latest research that is identifying pathways for the sustainability of metallic materials. It is now globally recognized that the production and manufacturing of materials must become more sustainable, particularly the associated high carbon dioxide emissions must be urgently reduced. In this context, Raabe's work particularly addresses primary production with less carbon dioxide, high-performance alloys based on metal recycling, alloy design for enhanced scrap compatibility, improved impurity- and hydrogen-tolerance of alloys, green steel production by hydrogen plasma, direct reduction of iron ore by hydrogen etc., all contributions with highest urgency and benefit to academia and industry.

<Reference>

NIMS Award laureate of the past six years and their achievements (Affiliation is at the time of the award)

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

2018 **Dr. Masato Sagawa** (Daido Steel Co., Ltd., Japan)
"Invention and practical application of neodymium magnets"
Prof.Terunobu Miyazaki (Tohoku University, Japan)
"Development of tunneling magnetoresistance elements capable of generating giant magnetoresistance at room temperature and application thereof to spintronics devices"

2019 **Prof. Gerbrand Ceder** (University of California Berkeley, USA)
"Pioneering data-driven materials research based on the first-principles calculations"
Dr. Pierre Villars (Materials Phases Data System (MPDS), Switzerland) "Development of Pauling File, inorganic materials database"

2020 **Prof. Hiroshi Julian Goldsmid** (The University of New South Wales, Australia)
"Pioneer work on bismuth telluride thermoelectric material and its application for large-capacity optical communication systems using the Peltier cooling phenomenon"
Prof. Kunihito Koumoto (Nagoya University, Japan)
"Development of environmental-friendly inorganic thermoelectric materials"

2021 **Prof. Tsuneya Ando** (Tokyo Institute of Technology, Japan, University of Tokyo, Japan)
"Fundamental theoretical studies on quantum states of low-dimensional materials"
Prof. Allan H. MacDonald (University of Texas at Austin, USA)
Prof. Pablo Jarillo-Herrero (Massachusetts Institute of Technology, USA)
"Pioneering work of new quantum physics by twistronics"

2022 **Prof. Teruo Okano**（Tokyo Women's Medical University, JAPAN）
"Development of cell sheet engineering using temperature-responsive polymers and its application to regenerative medicine"
Prof. Kazuhiko Ishihara
（Osaka University, JAPAN）
"Pioneering work in the development of biomimetic polymer biomaterials and their medical applications"
Prof. Donald E. Ingber
(Wyss Institute for Biologically Inspired Engineering at Harvard University, USA)
"Proposal of the cellular tensegrity model and the invention of organ-on-a-chip technology"

[Glossary for technical terms]

(1) Atom probe tomography

An analytical technique in which atoms are ionized from the surface of the sample by applying laser pulses to the sample to which high voltage is applied, and the mass and position of the ions are simultaneously measured in three dimensions. Field ion microscope (also called field ion microscope) is an analytical instrument that uses the same principle to characterize the microstructure of samples quantitatively.
Reference: https://www.nims.go.jp/mmu/3daplab/tutorials_e.html

(2) Machine Learning

A technique that uses artificial intelligence (AI) to organize previously acquired data for further analysis.

(3) The Tradeoff problem between strength and ductility

It refers to the relationship between "strength" and "ductility," and has been regarded as the fate of metallic materials, which are difficult to improve simultaneously.
Reference: https://elements-strategy.jp/en/digest/p11

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