Masao Horiba Awards
堀場雅夫賞

2022

About the Masao Horiba Awards

Atsushi Horiba

Award Director of the Masao Horiba Awards
Chairman & Group CEO
HORIBA, Ltd.

The Masao Horiba Awards were established in 2003 to highlight innovative work in analytical and measurement technologies. Elucidating the composition and properties of a substance, and understanding the meaning and influences of various phenomena—these are the first steps in science and the basic approach to scientific and technological advancement and industrial development. For scientific and technological exploration and innovation, analytical and measurement technologies are indispensable. I hope that the Masao Horiba Awards, named after the founder of HORIBA, Ltd., will contribute to illuminating the achievements of researchers who are working hard in the field of analytical and measurement technologies, as well as the importance of these technologies.

Greeting

Masayuki Adachi

Chief of the Organizing Committee for the 2022 Masao Horiba Awards
President & COO
HORIBA, Ltd.

Thank you for taking time out of your busy schedule to attend the 2022 Masao Horiba Awards Commemorative Seminar and Award Ceremony. The theme for the 2022 Masao Horiba Awards is ”Analytical and measurement technologies that contribute to the use of hydrogen for a decarbonized society.” In recent years, in addition to further improving the efficiency of energy use, the adoption of new energy sources such as hydrogen has been progressing globally. However, to put such sources to practical use, the industrial world must tackle numerous challenges such as manufacturing cost reduction. This year, we received many entries from researchers and engineers in Japan and overseas, who are enthusiastically engaged in original research and development from an analytical and measurement perspective, to address these social needs. I hope all who attend today will deepen their understanding of the award-winning research from their respective positions. I believe this will be a great encouragement and support for the award-winners, leading to the further development of their research. I thank everyone who made the 2022 Masao Horiba Awards Ceremony possible, and I wish for your continued success.

2022 Masao Horiba Awards Ceremony Program

Date: Tuesday, October 18, 2022
Venue: Symposium Hall, International Science Innovation Building, Kyoto University (Yoshida Campus)

■ Commemorative Seminar (14:30-16:30)

1. Opening remarks: ***Masayuki Adachi,*** Chief of the Organizing Committee for the 2022 Masao Horiba Awards

2. Winner presentations

[Masao Horiba Awards]

Dr. Katsutoshi Sato
Designated Associated Professor
Department of Chemical Systems, Graduate School of Engineering, Nagoya University

Research theme: "Design of novel nitrogen reduction site led by atomic resolution electron microscopy analysis"

Dr. Yasufumi Takahashi
Professor
Department of Electronics, Graduate School of Engineering, Nagoya University

Research theme: "Development of scanning electrochemical cell microscopy for real space catalytic imaging"

Dr. Takashi Nakamura
Associate Professor
Institute of Multidisciplinary Research for Advanced Materials, Tohoku University

Research theme: "Development of electrochemical techniques for defect engineering on advanced energy materials"

[Honorable Mention]

Dr. Yukina Takahashi
Associate Professor
International Institute for Carbon-Neutral Energy Research, Kyushu University

Research theme: "Development of Highly Efficient Hydrogen Generation System by Plasmon-Induced Charge Separation Using Sunlight as an Energy Source"

Dr. Helge Sören Stein
Tenure Track Professor
Institute for Physical Chemistry (IPC) & Helmholtz Institute Ulm (HIU), Karlsruhe Institute of Technology (KIT)

"Research theme: Data driven acceleration of materials discovery and upscaling through correlative spectroscopy and lab-scale manufacturing"

< Break >

3. Special presentation: ***Dr. Kazunari Sasaki***, Senior Vice President, Distinguished Professor, Kyushu University; Director, International Research Center for Hydrogen Energy

Presentation title: "Current Status and Future Prospects of Hydrogen Energy"

< Coffee Break >

4. Poster session: Poster presentation on award-winning research

■ Award Ceremony (16:30-17:15)

1. Introduction of award-winning research
2. Presentation ceremony
   Screening Committee's comments: ***Prof. Kenji Yamaji***, Chairperson, Screening Committee for the 2022 Masao Horiba Awards; President, Research Institute of Technology for the Earth (RITE)
   Presenter: ***Atsushi Horiba***, Award Director of the Masao Horiba Awards
3. Introduction of guests
4. Closing remarks: ***Atsushi Horiba***, Award Director of the Masao Horiba Awards

2022 Masao Horiba Awards Theme:

Analytical and measurement technologies that contribute to the use of hydrogen for a decarbonized society

Winner

Dr. Katsutoshi Sato

Designated Associate Professor
Department of Chemical Systems,
Graduate School of Engineering,
Nagoya University

Winning research

Design of novel nitrogen reduction site led by atomic resolution electron microscopy analysis

Research summary

The synthesis catalysts and process of ammonia as a hydrogen carrier with excellent storage and transport properties for hydrogen have attracted attention as a means of effective use of renewable energy. In order to develop highly active catalysts, it is necessary to analyze the structure and chemical state of the active site and lead to a new design.
Dr. Sato established a method to directly analyze the active site of catalysts at the atomic level by combining observation and analysis techniques using aberration-corrected transmission electron microscopes and various spectroscopic detectors which require to be used without exposure to air in the development of catalysts. His research is extremely important as analytical and measurement techniques that lead to technological innovation in catalytic reaction processes. This method clarifies the structure and mechanism of nitrogen reduction sites (active site) required for highly active ammonia synthesis catalysts. Further it has achieved high activation and non-precious metallization, and developed world-class practical catalysts.
The analytical methods developed will also be applied to actual catalyst development (design), which will contribute to the establishment of a carbon-neutral society by expanding the use of ammonia as a hydrogen carrier and the construction of a hydrogen distribution network.

Winner

Dr. Yasufumi Takahashi

Professor
Department of Electronics,
Graduate School of Engineering,
Nagoya University

Winning research

Development of scanning electrochemical cell microscopy for real space catalytic imaging

Research summary

With increasing demand for hydrogen in recent years, catalysts have been developed to efficiently produce hydrogen instead of expensive precious metals such as platinum. Molybdenum disulfide (MoS_2), which is noted as one of the catalysts, is known to be an excellent catalyst for hydrogen generation by making it a nanosheet for one layer of atoms. Further enhancement of the catalytic capacity of MoS_2 requires understanding of what structure of the catalyst contributes to its activity, but the limitations of resolution in conventional Scanning Electrochemical Microscopy have not led to a detailed understanding of the principles that improve the catalytic capacity.
Dr. Takahashi has succeeded in developing the Scanning Electrochemical Cell Microscopy (SECCM), which has greatly improved the resolution from the previous tens of μm to 20 to 50 nm: the world's highest resolution, as an ideal evaluation device for understanding phenomena. In addition, the structure of MoS_2 has been elucidated by visualizing (electrochemical imaging) the catalytic active site using SECCM.
Since the SECCM can also be used to modify the catalyst, identify degraded sites, and evaluate catalysts other than the hydrogen generation reaction, it can be applied to various research projects such as photocatalysts and power storage materials, and will contribute to energy-related research in the future.

Winner

Dr. Takashi Nakamura

Associate Professor
Institute of Multidisciplinary Research
for Advanced Materials,
Tohoku University

Winning research

Development of electrochemical techniques for defect engineering on advanced energy materials

Research summary

Highly efficient energy storage and conversion technologies, such as next-generation batteries and fuel cells, are essential for realizing carbon neutrality. In energy materials, lattice defects* are regarded as a source of their functionalities, and therefore, understanding the true role of defect species is important. By applying coulometric titration* with an electrochemical cell* with a solid electrolyte, Dr. Nakamura established a methodology to evaluate the defect formation mechanism, and clarified how defect species are created and how they affect the functionality.
Furthermore, he has developed a defect control technique based on the above-mentioned technology to utilize defects actively in material development. For instance, he succeeded to dramatically mitigate the energy density degradation upon charge/discharge cycles by the introduction of oxygen defects into energy storage materials. The technique has great potential for the establishment of a new concept for the development of energy materials and innovations in energy storage and conversion technologies.

*Lattice defects: Disturbance of atomic arrangement in crystalline materials.
Typical examples include vacancies, substituted ions, and interstitial ions.

*Coulometric titration: A method to evaluate a target substance by generating ions through electrolysis and measuring the amount of electric quantity required to complete the reaction between the generated ions and the target substance.

*Electrochemical cell: An apparatus for electrochemical measurements consisting of an electrolyte, a cathode, an anode, and others.

Honorable Mention

Dr. Yukina Takahashi

Associate Professor
International Institute for Carbon-Neutral Energy Research,
Kyushu University

Winning research

Development of Highly Efficient Hydrogen Generation System by Plasmon-Induced Charge Separation Using Sunlight as Energy Source

Research summary

Dr. Takahashi is establishing a system using localized surface plasmon resonance (LSPR) and plasmon-induced charge separation (PICS). LSPR increases the density of solar energy. PICS occurs when metal nanoparticles and semiconductors are combined. The semiconductors need p-type semiconductors instead of conventional n-type semiconductors, which can improve stability and charge separation efficiency, and also improve the reaction selectivity by controlling the type of metals and crystal planes that make up the metal nanoparticles.
This research can contribute to solving the energy problems by converting light energy into various types such as electricity, power, and heat in a high efficiency and stable manner.

* Localized surface plasmon resonance (LSPR) :A phenomenon in which nanosized metal harvests the photoenergy of incident light in its nanospace on the surface beyond the diffraction limit. In theory, it can enhance the optical energy of incident light by tens to millions of times.

*Plasmon-induced charge separation (PICS): A phenomenon in which the charge of plasmonic metal nanoparticles is transferred to semiconductors under light irradiation at resonance wavelengths.

*n-type semiconductor: A semiconductor in which electrical conduction occurs by the movement of free electrons.

*p-type semiconductor: A semiconductor in which electrical conduction occurs by the transfer of holes.

Honorable Mention

Dr. Helge Sören Stein

Tenure Track Professor
Institute for Physical Chemistry (IPC) &
Helmholtz Institute Ulm (HIU),
Karlsruhe Institute of Technology (KIT)

Winning research

Data driven acceleration of materials discovery and upscaling through correlative spectroscopy and lab-scale manufacturing

Research summary

Dr. Stein aims to accelerate the development process of reliable and efficient materials used in batteries and electrolyte devices/apparatuses so that we can develop the technology necessary for a carbon-free energy infrastructure. Materials development requires exhaustive measurements, data correlation and experiment preparations to test hundreds of material combinations, leading to months-long material discovery times. Acceleration of the material discovery process is an important challenge. Dr. Stein has realized material research automation in the Platform for Accelerated Electrochemical Storage Research (PLACES/R). This platform uses data science to automate the material evaluation stage through the interconnection of analyzers (XRF, Raman, FTIR, XPS among others), data processing systems and robots. Artificial Intelligence (AI) adjusts testing parameters and objectives, while the researcher focuses on complex research planning and data interpretation.
The automation of materials discovery experiments achieved by Prof. Stein will opens up a new dimension to research of energy materials for the decarbonization across energy sectors.

■ *Special Lecture: "Current Status and Future Prospects of Hydrogen Energy"*

Dr. Kazunari Sasaki

Senior Vice President,
Distinguished Professor,
Kyushu University
Director, International
Research Center for
Hydrogen Energy

The recent trend toward carbon neutrality and decarbonization urges fundamental changes to the way energy should be. Along with electrification and CO_2 collection, the widespread use of hydrogen, a chemical energy carrier that does not emit carbon dioxide when used, is the key to green transformation (GX). This lecture discusses the current status of hydrogen as a secondary energy source for producing electricity and heat, representative hydrogen energy technologies, domestic and international trends and Japan's strategy regarding hydrogen energy, and the significance and future prospects of green hydrogen innovation, which is expected to be a major driver of the growth of the green industry. The lecture also covers how industry-academia-government collaboration and regional cooperation should develop, hydrogen's contribution to energy security, and policies and legal systems for future infrastructure development.

Born in Kyoto City in 1965. He graduated from Tokyo Institute of Technology School of Engineering in 1987, and completed his master's program at the Graduate School of Engineering in 1989. He received his Ph.D. in Engineering from the Swiss Federal Institute of Technology (ETH) in 1993. He became a Visiting Researcher at the Max-Planck-Institute for Solid State Research in Germany. After working in Europe for 10 years, he joined Kyushu University as an Associate Professor in 1999, becoming a Professor in 2005, a Distinguished Professor in 2011, and Senior Vice President in 2016. He engages in research on materials and processes of fuel cells, and leads Kyushu University's Hydrogen Project while promoting industry-academia-government collaboration with hydrogen-related companies, etc. He currently serves as Chairperson of the Hydrogen Policy Subcommittee and the Ammonia and Other Decarbonized Fuel Policy Subcommittee of the Advisory Committee for Natural Resources and Energy, a WG member of the Green Innovation Strategy Promotion Council, an expert member of the Environmental Energy Science and Technology Committee of the Council for Science and Technology, an Academic Advisory Board member for the International Federation of Automotive Engineering Societies (FISITA), an associate member of the Science Council of Japan, and a specially appointed fellow at the Japan Science and Technology Agency (JST).

2022 Screening Committee

Chairperson	***Prof. Kenji Yamaji***	President, Research Institute of Innovative Technology for the Earth (RITE), Professor Emeritus, The University of Tokyo Green Innovation Strategy Meeting
Judges	***Prof. Scott Samuelsen***	Mechanical and Aerospace Engineering, University of California, Irvine
	Prof. Osamu Ishitani	School of Science, Chemistry, Tokyo Institute of Technology Specially Appointed Professor, Department of Chemistry, Graduate School of Advanced Science and Engineering, Hiroshima University
	Prof. Tatsumi Ishihara	Deputy Director, International Institute for Carbon Neutral Energy, Kyushu University Principal Professor, Department of Applied Chemistry, Faculty of Engineering Department of Bioengineering, Kyushu University
	Prof. Shigeo Satokawa	Faculty of Science and Technology, Seikei University
	Prof. Scott Samuelsen	Mechanical and Aerospace Engineering, University of California, Irvine
	Yusuke Mizuno	Department Manager, Alternative Energy Conversion Department, Business Incubation Division, HORIBA, Ltd.
	Yasunari Hanaki	Manager, New Energy Technology, Alternative Energy Conversion Center, Business Incubation Division, HORIBA, Ltd.

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