GREEN

Research Center for
Energy and Environmental Materials (GREEN)

National Institute for Materials Science
Research Center for Energy and Environmental Materials (GREEN)

Director/Deputy Director/Fellow/Specially Appointed Researcher/Administrative Office Chief

Director

Takuya Masuda

Deputy Director

Koji Kamiya

Fellow

Kazunori Takada

Specially Appointed Researcher

Hitoshi Kitaguchi

Administrative Office Chief

Yoshikazu Shinohara

Research Field

Battery and Cell Materials Field

Field Director
Takuya MASUDA

- Solid-State Battery Group
- Battery Interface Control Group
- Battery Materials Analysis Group
- Photovoltaic Materials Group
- Rechargeable Battery Materials Group
- Solid State Battery Ionics Group
- Environment-Controlled Microscopy Group
- Automated Electrochemical Experiments Team
- Functional Electrolyte Synthesis Team

Hydrogen Technology Materials Field

Field Director
Koji KAMIYA

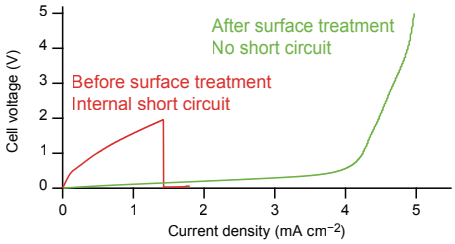
- Magnetic Refrigeration System Group
- Superconducting System Group
- Hydrogen Production Catalyst Materials Group
- Advanced Superconducting Wire Group
- Hydrogen Ion Materials Group
- Electrochemical Energy Conversion Team

Solid-State Battery Group

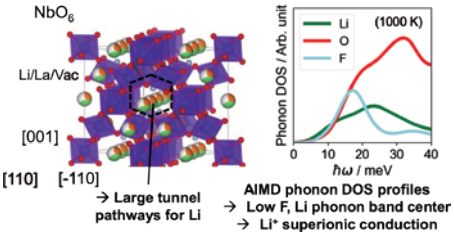
Group Leader
Kazunori Takada

Principal Researcher
Randy Jalem

Topics **Toward high-performance solid-state battery**



Suppression of internal short-circuit by the surface treatment of solid electrolyte
[ACS Appl. Energy Mater., 7 (2024) 5321.]



Pyrochlore-type $Li_{2-x}La_{(1+x)/3}Nb_2O_6F$ solid electrolyte
[J. Mater. Chem. A, 12 (2024) 33099]

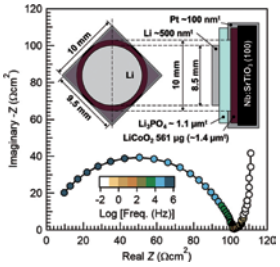
Rechargeable batteries with high reliability are required to promote electric vehicles and renewable energy. Research of this group is aiming at realizing high-performance solid-state batteries through studies on interfacial phenomena between ion-conducting solids and elucidation of super-ionic conduction mechanism by atomistic-level simulations and data science methods.

Battery Interface Control Group

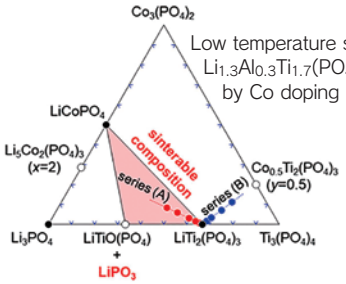
Group Leader
Tsuyoshi Ohnishi

Senior Researcher
Shogo Miyoshi

Topics **Development of Oxide-type All Solid-State Battery**



Interface resistance free thin film battery
[ACS Omega, 7 (2022) 21199.]



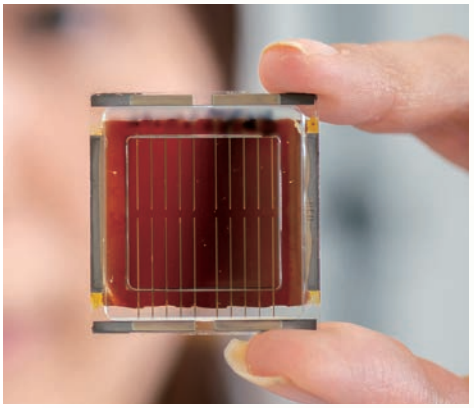
[ACS Appl. Energy Mater., 5 (2022) 7515.]

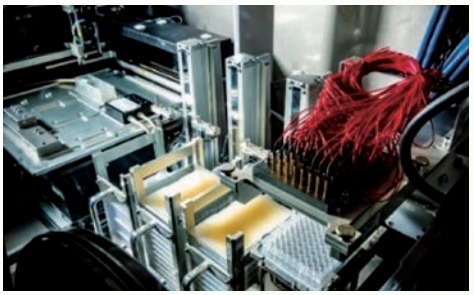
High-performance rechargeable batteries are expected to contribute realizing an environment-friendly society. Battery Interface Control Group aims for the realization of solid-state batteries with high reliability by improving the interface performance of batteries.

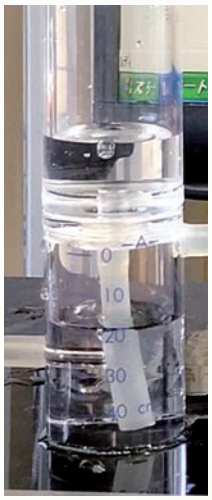
Aiming to become the world's leading research center on energy and environmental materials

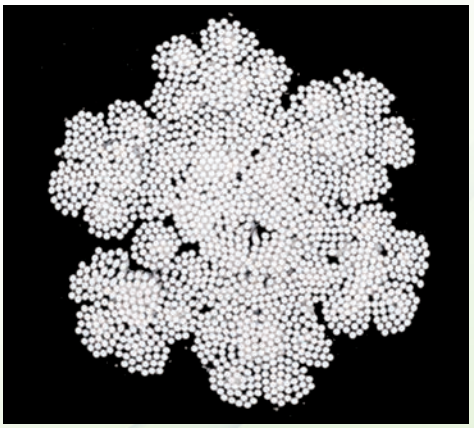
The Research Center for Energy and Environmental Materials (GREEN) conducts research and development on energy conversion and storage materials for next-generation rechargeable batteries, solar cells, fuel cells, hydrogen production, and storage systems to achieve carbon neutrality. We utilize cutting-edge characterization techniques and computational approaches to understand reaction mechanisms and design new materials. Our automated robotic experimental system speeds up material exploration, and we collaborate with diverse industries to address social issues.

Director **Takuya Masuda**









Major Projects

Materealize	Establishment of Process Science for realizing All-solid-state Batteries	PL: Kazunori Takada
JST MIRAI	Development of Advanced Hydrogen Liquefaction System by Using Magnetic Refrigeration Technology	PL: Nobuyuki Nishimiya
COI-NEXT	Advanced Battery Collaboration	PL: Kiyoshi Kanamura
GteX	Research Platform Integrated with Advanced Characterization and Digital Transformation Techniques for Batteries and Hydrogen Technologies	PL: Takuya Masuda
K Program	Development of Oxide-based Solid-state Batteries Applicable to Isolated and Extreme Environments	PL: Kazunori Takada

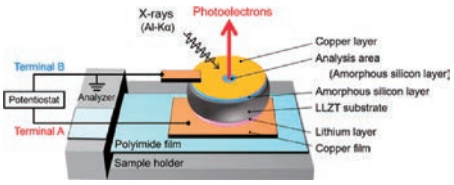
Battery Materials Analysis Group



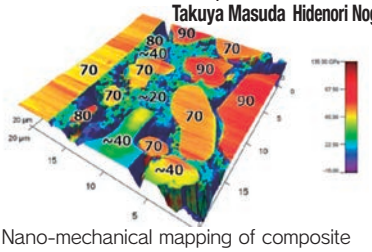



Group Leader **Takuya Masuda** | Chief Researcher **Hidenori Noguchi** | Principal Researcher **Kunie Ishioka** | Principal Researcher **Kimihiko Ito** | Senior Researcher **Kei Kubota** | Senior Researcher **Hisao Kiuchi**

Topics **Multiscale Analysis of Battery Reactions**



Operando reaction analysis by XPS
[J. Phys. Chem. Lett., 11 (2020) 6649.]



Nano-mechanical mapping of composite electrodes by bimodal AFM
[J. Power Sources, 413 (2019) 29.]

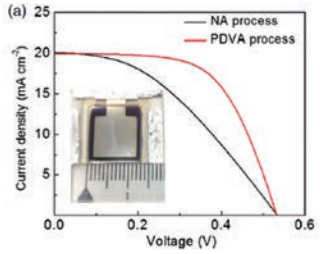
We are working toward the development of novel in situ analysis technique and its application to actual batteries in order to observe various physicochemical phenomena taking place in a state wherein heat, stress, substances, and other components are unevenly distributed in a narrow space inside a battery filled with various substances (e.g., active materials, binders, conductive additives, and electrolytes).

Photovoltaic Materials Group

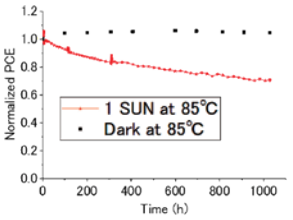


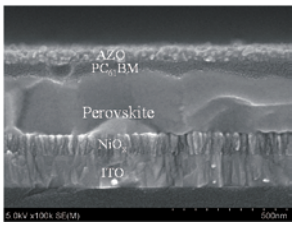

Group Leader **Yasuhiro Shirai** | Chief Researcher **Ashraful Islam** | Principal Researcher **Masatoshi Yanagida** | Senior Researcher **Dhruba B. Khadka**

Topics **Development of next generation photovoltaic devices**



Lead-free 1 cm² perovskite solar cells
[Solar RRL., 3 (2019) 1900245.]





Lead perovskite solar cells with excellent durability.
[Sol. Energy Mater. Sol. Cells, 195 (2019) 323.]

We focus on the development of next-generation solar cells that realize low cost and high efficiency, based on the development of materials and devices and understanding of power generation mechanisms.

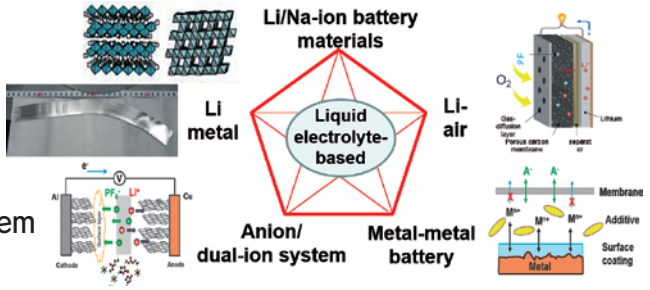
Rechargeable Battery Materials Group



Group Leader **Denis Yu** | Principal Researcher **Kei Nishikawa** | Senior Researcher **Akihiro Nomura**

Topics **Development of liquid-electrolyte-based batteries**

Research topics:
- Li/Na-ion battery materials
- Li metal
- Li-air battery
- Anion/dual-ion system
- Metal-metal battery

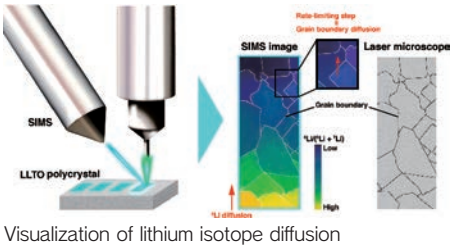


Our group develops active materials and electrolyte and understands factors affecting ion transport in electrodes/electrolyte to increase energy density, power, stability and reduce cost for future battery applications.

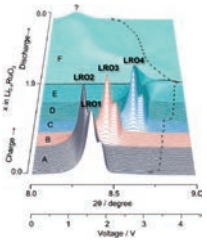
Solid-State Battery Ionics Group

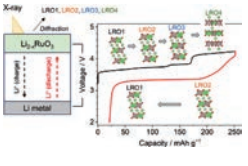

Group Leader **Naoaki Kuwata** | Researcher **Calpa Marcela**

Topics **Ion Dynamics Analysis of Battery Materials**



Visualization of lithium isotope diffusion
J. Mater. Chem. A, 12, 731 (2024).





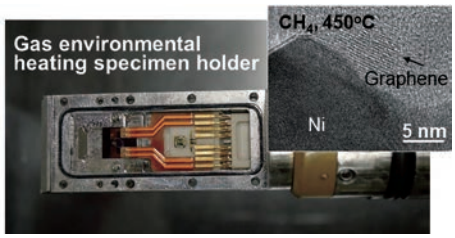
Operando XRD
Energy Storage Mater., 63, 103051 (2023).

We are working to elucidate ion dynamics of battery materials for the development of solid-state batteries with high energy density and long cycle life. Using our advanced analytical techniques such as SIMS, NMR, and XRD, we visualize the lithium ions diffusion and structural changes of battery materials. Based on these properties, we aim to apply them to solid-state batteries.

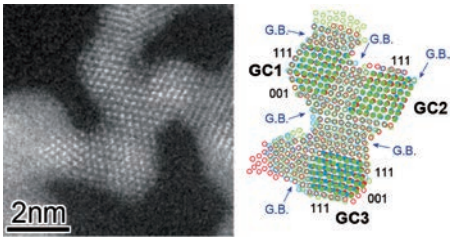
Environment-Controlled Microscopy Group


Group Leader **Ayako Hashimoto** Chief Researcher **Masaki Takeguchi**

Topics ***In-situ* and *operando* transmission electron microscopy**



Gas heating specimen holder and observation of graphene growth at 450℃ in CH_4 gas. [Microscopy 70 (2021) 545.]



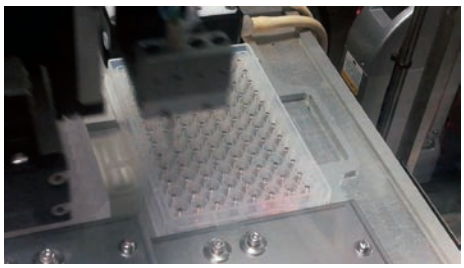
STEM observation of structural change of Pt nanowires in air [Nanomaterials 13 (2023) 2170.]

We develop *in-situ* and *operando* transmission electron microscopy techniques to observe energy conversion materials such as catalysts in gases and liquids using specimen holders. By capturing changes in their structures and compositions, we aim to elucidate the reaction and degradation mechanisms that are the key to higher efficiency, longer lifetime, and lower cost.

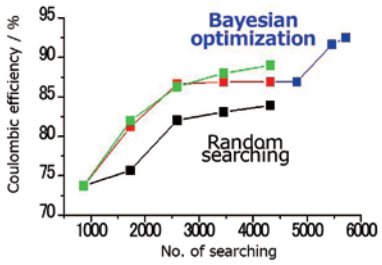
Automated Electrochemical Experiments Team

Team Leader **Shoichi Matsuda**

Topics **High throughput experiment for electrochemical materials**



High throughput electrochemical experiments [Scientific Reports, 9 (2019) 6211.]



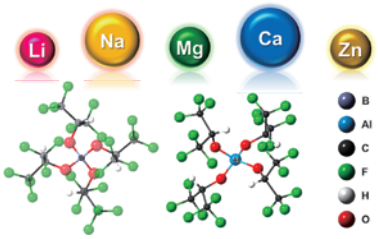
Material discovery with data scientific method [Cell Reports Phys Sci, 3 (2022) 100832.]

Automated robotic experimental system was developed. By applying data scientific methods for obtained series of experimental datasets, we are aiming the acceleration of discovery for novel electrochemical materials for rechargeable batteries and hydrogen production.

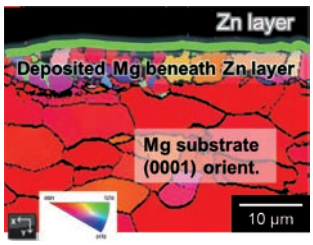
Functional Electrolyte Synthesis Team

Team Leader **Toshihiko Mandai**

Topics **Development of Functional Electrolyte and Interface**



Design and Synthesis of Electrolyte Materials [*ACS Appl. Mater. Interfaces* **2020**, *12*, 39135; *J. Phys. Chem. C* **2023**, *127*, 7987.]



Interfacial Regulation by Artificial Interface [*Energy Storage Mater.* **2024**, *67*, 103302]

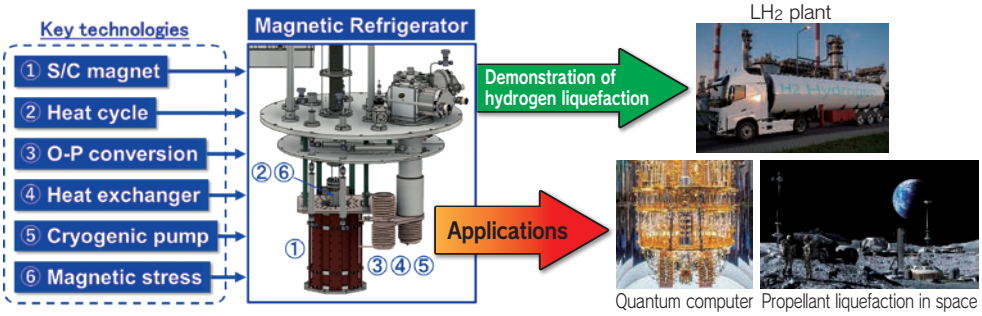
We are working on the development of functional electrolyte materials and artificial interface to achieve breakthrough toward materialization of next generation energy storage technologies. Based on the fundamental understanding of electro-, solution, and structural chemistry, the target materials will be realized by combining various synthetic methodologies including organic, inorganic, and nano scientific techniques.

Magnetic Refrigeration System Group



Group Leader **Koji Kamiya** Principal Researcher **Kyohei Natsume** Principal Researcher **XU Ya**

Topics **Development of highly efficient hydrogen liquefier**



The purpose of this group is to develop a highly efficient magnetic refrigerator that contributes to the realization of a hydrogen society. Magnetic refrigeration enables higher efficiency liquefaction compared to conventional methods. The magnetic refrigeration system, realized by integrating various development elements such as superconducting magnets, magnetic material coating, can be applied not only to hydrogen liquefaction plants but also to propellant liquefaction in space and quantum computers.

Superconducting System Group

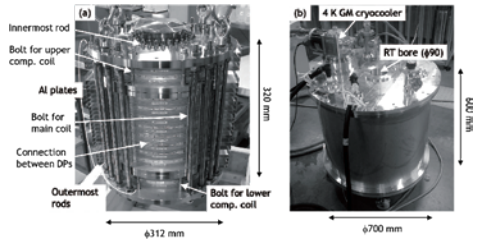

Group Leader
Gen Nishijima


Chief Researcher
Hiroki Fujii

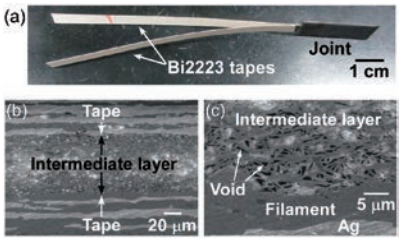

Chief Researcher
Akiyoshi Matsumoto


Researcher
Yasuaki Takeda

Topics **Development of superconducting devices used above LH_2 temperature**



High temperature superconducting magnet for magnetic refrigeration system
[IEEE Trans. Appl. Supercond., 33 (2023) 4602605]



Superconducting joint between high temperature superconductors
[Supercond. Sci. Technol., 35 (2022) 02LT02]

Superconducting materials, which can flow electric current with zero resistance, are the ultimate energy-saving materials as well as a promising solution to environmental and energy problems. We are developing superconducting devices and advanced superconducting wires that can be used above liquid hydrogen temperature.

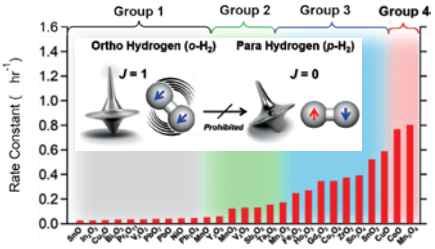
Hydrogen Production Catalyst Materials Group


Group Leader
Hideki Abe


Senior Researcher
Tetsuya Kako


Researcher
Shusaku Shoji

Topics **High-performance catalysts & systems for clean hydrogen**



Value-added Hydrogen:
Ortho/para H_2 conversion.

Explorations 20230040 (2024)
doi.org/10.1002/EXP.20230040

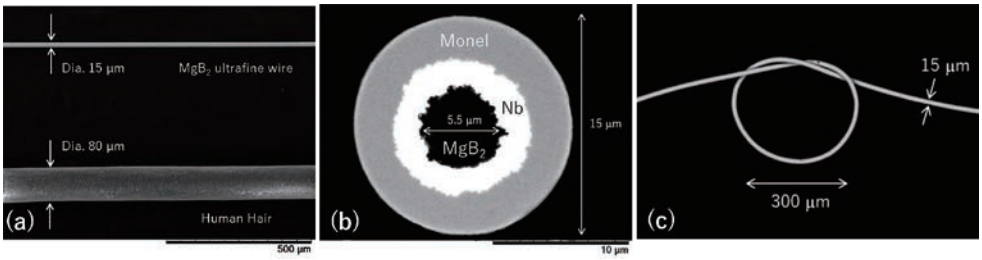
We are conducting research and development on high-performance catalyst materials and reaction systems for the inexpensive and large-scale production of hydrogen from various hydrogen sources such as hydrocarbons, without releasing carbon dioxide into the atmosphere (clean hydrogen production).

Advanced Superconducting Wire Group


Group Leader
Akihiro Kikuchi


Principal Researcher
Nobuya Banno

Topics **Flexible Ultrafine Superconducting Wires**



The world finest 15 μm MgB_2 superconducting wire. (a) Comparison to human hair. (b) Wire cross-section. (c) A small loop.

We are working on improving the performance of superconducting wires that contribute to application devices such as fusion reactors, high-energy particle accelerators, etc. We will also develop related technologies, e. g. superconducting joints. In addition, we will promote R&D of Ultrafine Superconducting Wires and Flexible Cables aimed at application to new electric aircraft and liquid hydrogen pumps that use cold heat of liquid.

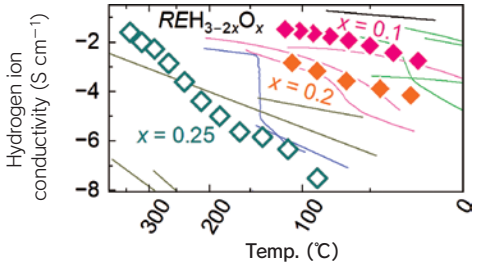
Hydrogen Ion Materials Group


Group Leader
Soshi Iimura

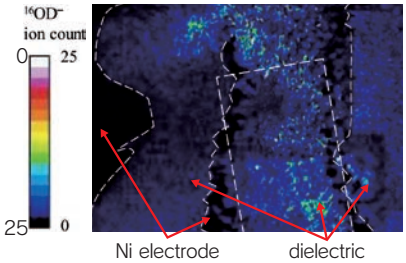

Chief Researcher
Taku Suzuki


Chief Researcher
Isao Sakaguchi

Topics **Development and elucidation of functionality in hydrogen-ion-active materials**



World record hydride ion conductivity of $LaH_{3-2x}O_x$ [JACS, (2022).]



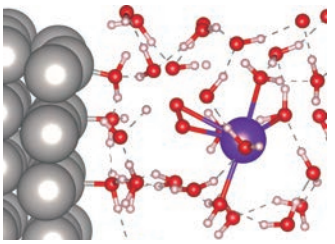
Observation of MLCC degradation by hydrogen incorporation using SIMS [JJAP, (2021).]

Hydrogen in materials can change its form from ions with positive and negative valence to atomic hydrogen, and is responsible for excellent chemical, diffusion, and electronic functions and so on. Our group focuses on hydrogen in bulk and on the surface to create new energy and environmental materials and to elucidate the role of hydrogen in material functionality.

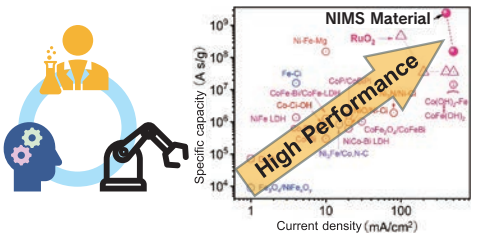
Electrochemical Energy Conversion Team

Team Leader
Ken Sakaushi

Topics **Electrochemical Research with Experiment/Theory/Data Science Collaboration**



Unveiling Microscopic Electrode Process at Solid-Liquid Interfaces
[*Angew. Chem. Int. Ed.*, 62 (2023) e202312841.]



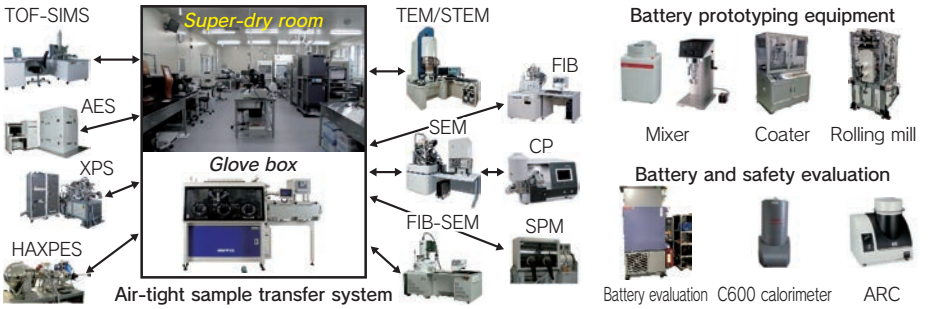
Accelerated Discovery of Electrochemical Materials by Human-Machine Collaboration
[*ACS Cent. Sci.*, 9 (2023) 2216.]

We conduct our research to solve modern energy issues through unveiling basic principles and synthesis of materials of electrochemistry towards fuel-cells and rechargeable batteries. We put special emphasis on researches in collaboration with experiments, theoretical calculations, and data science, focusing on the following two points: (1) uncovering reaction mechanisms by using model electrodes, and (2) design and synthesis of novel electrode materials.

Battery Research Platform

Platform Director
Hitoshi Ota

Topics **World-class research facility for next-generation batteries**

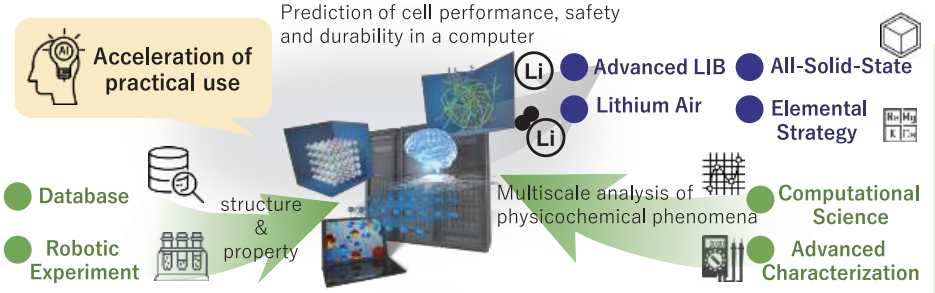


NIMS Battery Research Platform is equipped with state-of-the-art facilities supporting cutting-edge battery development. Our world-class research environment offers end-to-end support from cell prototyping and performance evaluation to detailed structural analysis at both the material and cell levels. We prioritize the JST GteX program, advancing next-generation battery research and development.

Center for Advanced Battery Collaboration

Directorr
Kiyoshi Kanamura

Topics **Protocols for cell analysis, design and development**

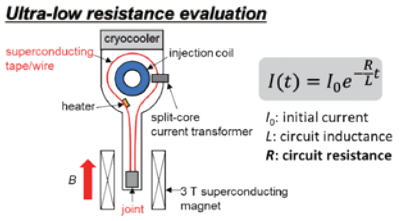


We accelerate the research and development of next generation rechargeable batteries by developing a protocol for cell analysis, design and development. We aim to realize a connected society by a wide variety of batteries, including advanced LIB, all-solid-state, lithium-air, elemental strategy batteries through the advancement of IoT, innovation of transportation & logistics and expansion of usage of renewable energy.

Applied Superconductivity R&D

Specially Appointed Researcher
Hitoshi Kitaguchi

Topics **Superconducting joint technology**



Superconducting joint technology is inevitable for NMR and MRI magnets. Research on joint-forming process to improve joint performance and development of ultra-low resistance (10^{-14}~$10^{-9}\Omega$) evaluation technology are being performed.

In order to promote applications of Bi-2223 high-temperature superconductor which was found in NIMS, R&D in the field of applied superconductivity, such as materials science of superconducting wires, magtet technologies, etc, are being performed.

History of GREEN

2009 (H21)	Foundation of GREEN (October)
2011 (H23)	GREEN became a core project of TIA Nano-Green.
2012 (H24)	Relocation to a new research building (May)
2013 (H25)	Inauguration of two Specially Promoted Research Teams (All Solid Battery, Lithium Air Battery) in GREEN (April)
2014 (H26)	Inauguration of ad hoc team of Perovskite PV Cells in GREEN (October)
	Foundation of Battery Research Platform (October)
2016 (H28)	**Foundation of Greater GREEN including GREEN and Battery Research Platform (April)**
	The 13th GREEN Symposium (June)
2017 (H29)	The 14th GREEN Symposium (February)
	International Workshop on Electrified Interfaces for Energy Conversions (May)
	The 15th GREEN Symposium (June)
	The 3rd Tohoku Univ. & GREEN Joint Symposium (December) (The 16th GREEN Symposium)
2018 (H30)	The 17th GREEN Symposium (January)
	The 18th GREEN Symposium (June)
2019 (H31)	The 19th GREEN Symposium (January)
	The 20th GREEN Symposium (February)
2020 (R2)	The 21st GREEN Symposium (March)
2021 (R3)	The 22nd GREEN Symposium（March）
	Foundation of Center for Advanced Battery Collaboration（June）
2022 (R4)	The 23rd GREEN Symposium（March）
2023 (R5)	The 24th GREEN Symposium（March）
	Renamed to "Research Center for Energy and Environmental Materials(GREEN)" (April)
2024 (R6)	The 25th Green Symposium (Feburary)

GREEN
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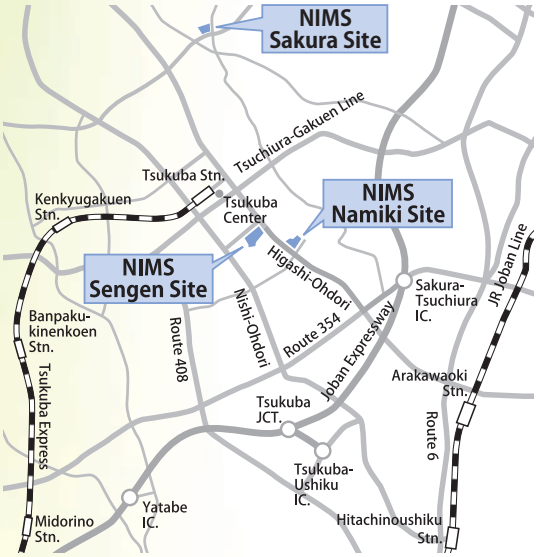

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