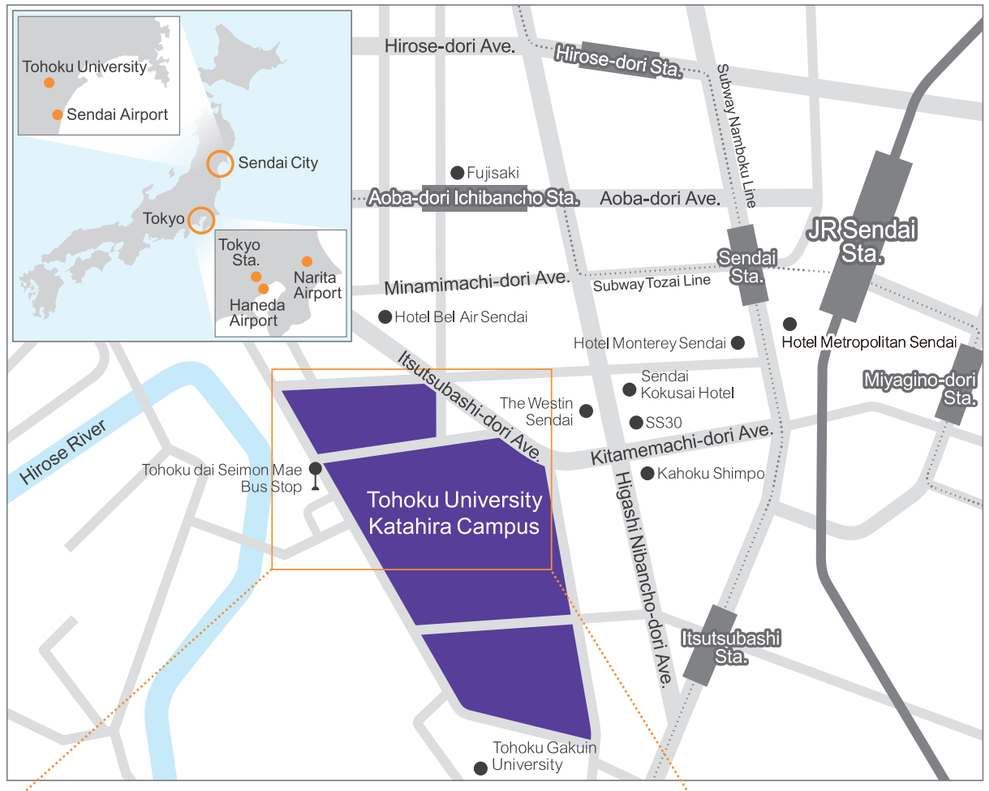

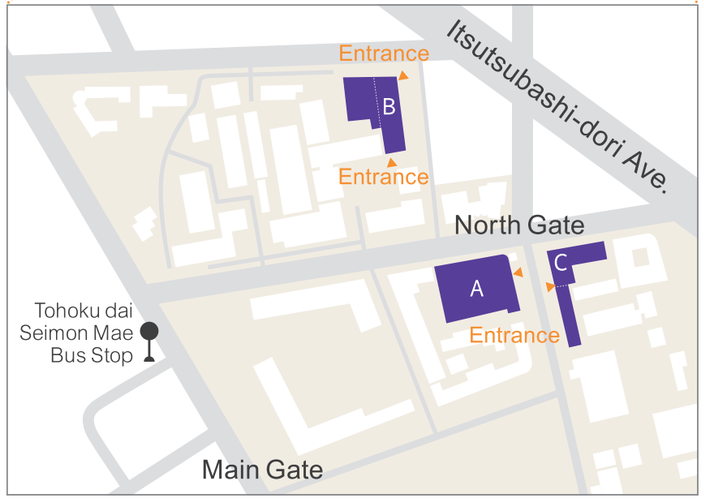

A AIMR Main Building
B AIMR Laboratory Building
C AIMR Annex Building

- **On foot**
  About 15 mins walk from the West Exit of Sendai Sta.
- **By subway**
  Take the Tozai Line from Sendai Sta. to Aoba-dori Ichibancho Sta., or take the Namboku Line from Sendai Sta. to Itsutsubashi Sta. Walk from either of the stations to Katahira Campus about 10 mins.
- **By taxi**
  About 10 mins by taxi from Sendai Sta. to the North Gate of Katahira Campus.
- **By bus**
  Take a city bus bound for either Yagiyama-Dobutsu-Koen, Midorigaoka-3-chome or Nishi-Koukou-Iriguchi via Otamaya-bashi at Sendai Sta. and get off at Tohoku-dai-Seimon-Mae.

Strategic Public Relations Office
Advanced Institute for Materials Research (AIMR), Tohoku University
2-1-1 Katahira, Aoba-ku, Sendai, 980-8577 Japan
Phone. +81-22-217-6146 Mail. aimr-outreach@grp.tohoku.ac.jp

AIMR, Tohoku University Search

https://www.wpi-aimr.tohoku.ac.jp/en/

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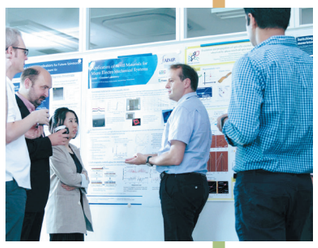
AIMR

Advanced Institute for Materials Research, Tohoku University

Materials Physics

Mathematical Science

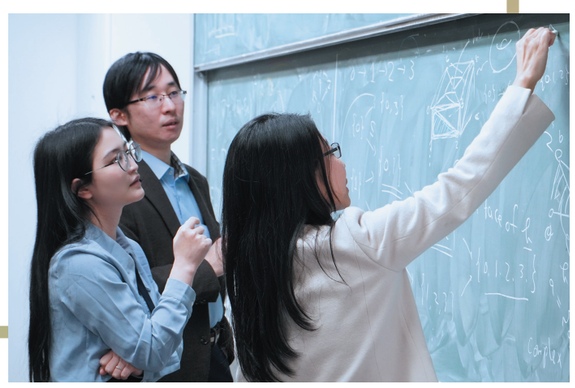
Non-equilibrium Materials



Devices/Systems

Bringing Advanced Materials Science to the World

Soft Materials



TOHOKU UNIVERSITY

wpi

AIMR

Overview of AIMR

The Advanced Institute for Materials Research (AIMR) at Tohoku University was launched as one of the centers established by the World Premier International Research Center Initiative (WPI) with the support of the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT), aimed at developing world-class research bases in Japan. After its establishment in 2007, AIMR has advanced the WPI's four basic objectives: advancing top-level research, creating interdisciplinary domains, establishing international research environments, and reforming research organizations. As a result, it has established a research center for materials science that attracts outstanding researchers from all over the world. In 2017, AIMR became a member of the WPI Academy. It has maintained world-class research standards as it promotes efforts to accelerate and expand the global circulation of the world's best brains.

Main Characteristics

- Collaboration between materials science and mathematics at the research institute level, which is the first such attempt in the world
- An international research environment with researchers coming from around the world; over 50 percent of the researchers are from overseas
- Comprehensive English language support, including for administrative procedures
- Provision of an ideal research environment in all areas, including research equipment and grants

Message from the Director

A wide array of materials including metals, semiconductors, ceramics, and polymers contribute to modern technologies in every field from energy to ICT, medicine, healthcare, and high-speed transport, and many technological domains have developed together with the creation of advanced materials. Progress in materials science will continue to be essential as an academic platform for acceleration of such materials creation.

With support from the World Premier International Research Center Initiative (WPI), the Advanced Institute for Materials Research (AIMR) aims to contribute to society through the creation of innovative materials. Founded in 2007, AIMR brings together international researchers in materials science, physics, chemistry, mathematics, and other fields. Since its establishment, AIMR has advanced top-level research in each of its research fields and conducted interdisciplinary research. In 2012, AIMR appointed the mathematician Professor Motoko Kotani as director and started the collaboration between mathematics and materials science with a view to identifying universal principles common to different material systems. Working together under one roof, materials scientists and a wide range of mathematicians spanning pure and applied mathematics have achieved major successes and continue to build new academic platforms for materials science based on predictions.

As well as further reinforcing AIMR's unique academic foundations as a WPI Academy member, by developing actual technological fields in concert with cutting-edge technologies in areas such as measurement, we will create materials that make a genuine contribution to society. Through such interdisciplinary research we will also develop young researchers from Japan and abroad who have diverse skills and promote multi-faceted international ties to provide powerful impetus to the global advanced materials science.

Considering that Tohoku University in 2022 marked the 115th year since its founding, AIMR at 17 years old is still relatively young. Since its establishment, a Director-led top-down decision-making approach was introduced, a basic WPI concept, and various system reforms have been carried out. AIMR has made many advanced efforts, such as the introduction of a new human resources system and provision of diverse support programs for international researchers. The sharing and utilization of AIMR accomplishments are helping to strengthen the globalization and research capabilities of the entire University. We intend to continue going ahead steadfastly as a part of Tohoku University.

AIMR is striving to bring advanced materials science to the world. I look forward to your continued support for us.

Shin-ichi ORIMO
Director
Advanced Institute for
Materials Research (AIMR)
Tohoku University

What's WPI

Research institutes that are recognized as key centers in their fields of research are found around the world. These include Bio-X in Stanford University and the MIT Media Lab (Massachusetts Institute of Technology). Talented and capable human resources flow continuously into these global bases, bringing about further development, and giving rise to a cycle of ideal feedback.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) recognizes that the establishment of such global bases is vital to the future maintenance and improvement of science and technology standards in Japan. To that end, it initiated the World Premier International Research Center Initiative (WPI) in 2007. The research bases established under the WPI are known as "WPI centers." AIMR is one of the centers selected and established under its initiative.

Research Groups

See the website for details.
(https://www.wpi-aimr.tohoku.ac.jp/en/research/researcher/)

Materials Physics Group

Leader
Takafumi Sato
- Topological insulators and semimetals
- Unconventional superconductors with high Tc
- 2D materials with a few layer thickness

Gerrit E.-W. Bauer
- Theoretical solid state physics
- Spintronics and ferronics
- Nanomagnetism

Yong P. Chen
Purdue University/ Aarhus University
- 2D materials (including graphene)
- Topological quantum materials
- Spintronics, magnetism and superconductivity

Yuichi Ikuhara
The University of Tokyo
- Atomic resolution scanning transmission electron microscopy
- Crystal interface and grain boundary
- Grain boundary geometry and mathematics

Tomoki Ozawa
- Condensed matter theory of synthetic quantum matter
- Theory of atomic, molecular, and optical physics
- Universality of topological insulator physics

Eiji Saitoh
The University of Tokyo
- Spintronics
- Spin caloritronics
- Quantum AI

Alexander L. Shluger
University College London
- Insulating thin films and 2D materials
- Point defects and interfaces
- Theoretical modelling

Qikun Xue
Tsinghua University
- 2D materials and superconductivity
- Heterojunctions
- Low energy consumption electronics

Non-equilibrium Materials Group

A. Lindsay Greer
University of Cambridge
- The Glassy State
- Phase-change kinetics
- Record-breaking mechanical properties

Toshiaki Kato
- Synthesis of atomically precise 1D and 2D materials
- Integrated-quantum device
- Highly-transparent and ultra-lightweight solar cell

Hyoung Seop Kim
Pohang University of Science and Technology
- High entropy alloys
- Metal additive manufacturing and heterostructuring
- Computing &AI for metal thermo-mechanical behaviors

Dmitri Louzguine
- Liquid structure, fragility and crystallization
- Structural rejuvenation
- Ultrahigh-strength and bio-materials

Soft Materials Group

Leader
Tadafumi Adschiri
- Supercritical hydrothermal reaction
- Nano-catalysts
- Process science for nanomaterials

Ayumi Hirano-Iwata
- Artificial cell membrane sensors
- Reconstitution of neuronal network
- Nano-bio hybrid devices

Reiko Oda
CNRS/ University of Bordeaux
- Colloid/Supramolecular chemistry
- Molecular assembly
- Chirality

Thomas P. Russell
University of Massachusetts
- Interfacial assembly
- Structured liquids
- Wrinkling

Kazuo Takimiya
- Organic semiconductor
- Energy devices
- Molecular-crystal engineering

Device/System Group

Leader
Shigemi Mizukami
- Spintronics
- Ultrafast optics
- Terahertz wave

Shunsuke Fukami
- Functional spintronics material/device
- Electrical control of magnetization and its application
- Novel computing with spintronics

Michael Hirscher
Max Planck Institute for Intelligent Systems
- Hydrogen storage
- Porous materials
- Hydrogen isotope separation

Rana Mohtadi
Toyota Research Institute of North America
- Energy storage and hydrogen
- Beyond Li-ion batteries
- Energy conversion

Hirotomo Nishihara
- Nanoporous materials with single-graphene walls
- Force-responsive porous materials
- Energy storage and conversion

Shin-ichi Orimo
- Energy-related functions of metallic and inorganic hydrides
- Superionic-/super-conductivities of complex hydrides
- Multivalent ion batteries using advanced hydrides

Tomohiro Otsuka
- Quantum devices
- Semiconductor and nanostructures
- Condensed matter low temperature physics

Yuji Sutou
- Phase transformation-type smart materials
- Polymorphic-change memory
- Lightweight alloys with functionality

Magda Titirici
Imperial College London
- Hydrothermal carbonization
- Electrospinning
- Sustainable energy materials

Hiroshi Yabu
- Biomimetic polymer materials
- Nanostructured particles
- Organic electrocatalysts

Miho Yamauchi
Kyushu University
- Nanomaterials
- Hydrogen induced nanofunctions
- Electrolysis

Mathematical Science Group

Leader
Hiroshi Suito
- Mathematical modeling
- Simulation and visualization techniques
- Coupled problems in multi-physics

Hiroyasu Ando
- Mathematics for computation harvesting
- IoT Vehicle data analysis
- Energy and mobility network

Hayato Chiba
- Infinite dimensional dynamical systems and its applications
- Synchronization phenomena
- Time-delay differential equations

Kazutoshi Inoue
- Geometry of grain boudaries and dislocations
- Analysis of crystalline interfaces
- Nonlinear elastoplasticity

Motoko Kotani
- Discrete geometric analysis
- Topological phase
- Multiscale analysis

Hao Li
- Catalysis and materials theory
- Data science for materials design
- Computational methodology development

Chris J. Pickard
University of Cambridge
- Structure prediction
- Density functional theory
- Interfaces and grain boundaries

Executive Research Coordinator
Motoko Kotani
Tohoku University Executive Vice President for Research

Research Adviser
Masaru Tsukada

Research Adviser
Yasumasa Nishiura

3 Advanced Target Projects

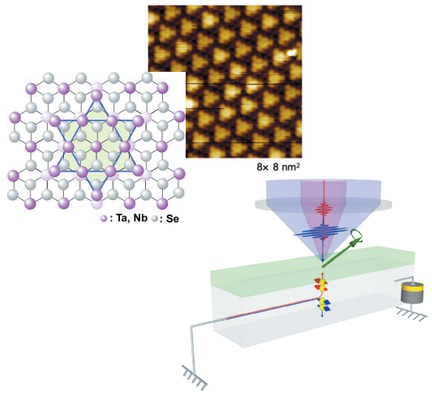
The ultimate goal of AIMR is to create materials based on a complete understanding and control of atoms and molecules — the smallest units for materials. To reach this goal, AIMR launched three new Advanced Target Projects (ATPs) in 2019. The ATPs aim to create materials that express new functions by connecting our understanding and ability to precisely control atoms and molecules to phenomena on the meso and macro scales.

ATP1 Local Structure Control in Topological Functional Materials

Advanced measurement and atomic control of local structures were established in TP2. To realize novel topological and quantum functional materials, a framework connecting "local" and "global" will be constructed by collaboration between materials science and mathematics.

Specific subjects of research

By developing field-effect ferromagnetic materials, topological insulators and spintronic materials, which are expected to be applied in next-generation electronics, we aim to create electronic and magnetic devices that contribute to the development of quantum computers.

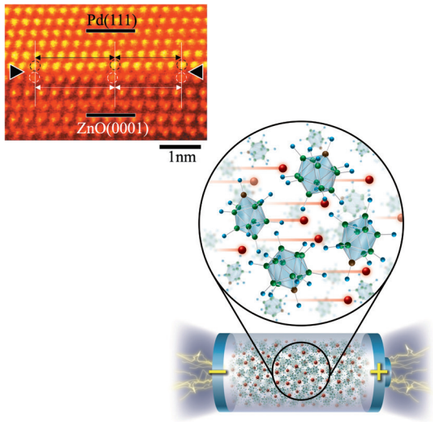


ATP2 Integrated Control of Bond Variation and its Time Evolution

Computational homology was utilized for characterization of static complex structures in TP1. To reveal temporal and spatial feature of dynamic systems by multi-modality approach, persistent homology is combined with advanced imaging and simulation techniques.

Specific subjects of research

By controlling the time evolution of bond variation and higher hydrogen function, we will develop high-speed ion conductive materials and superconducting materials, and aim to create devices that contribute to energy creation and storage.

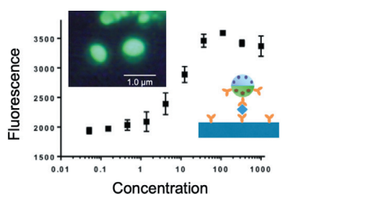


ATP3 Improvement of Self-Organization Technology and Control of Biological Response

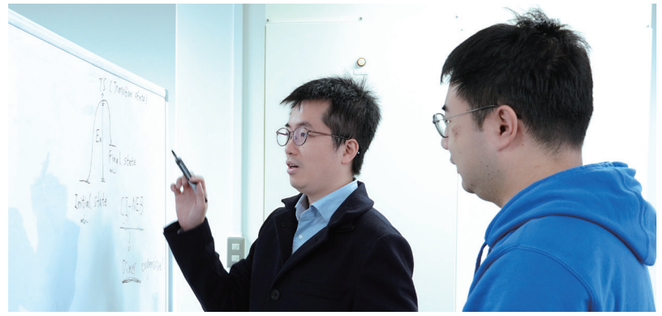
Universal description of hierarchical structures was studied in TP3. Such hierarchical structures have potential to become functional devices by controlling reactivity and response. Biological/non-biological interfaces and bio-networks are investigated to obtain a guiding principle in practical use of biological functions.

Specific subjects of research

By developing nano-bio-hybrid materials and biomimetic materials by utilizing self-organization, bio-imitation, or dynamic biological response, we aim to create devices that contribute to regenerative medicine and infectious disease control.



Math-Materials Collaboration



— Collaboration between mathematics and materials science at the research institute level —

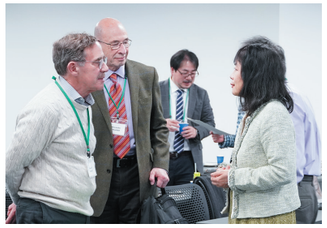
At AIMR, a mathematical viewpoint is taken in, to accelerate the fusion research over different fields. Mathematics can provide a common language to all the fields of science, and simplify complicated phenomena to extract principles from them. Mathematics, therefore, stimulates interdisciplinary fusion of various fields to create new materials science.

In 2012, AIMR hired six interface researchers to strengthen the organization of mathematics-materials science collaboration, and they have acted as a bridge between materials scientists and mathematicians. As a result of these efforts, material scientists and mathematicians could discuss directly without the need for an intermediary. In 2016, they evolved into the Mathematical Science Group consisting of mathematicians and theoretical researchers. In order to achieve the Advanced Target Projects, we are strongly promoting interdisciplinary research for the development of new materials and device creation by applying the advanced mathematics to the functionality issues in materials science.

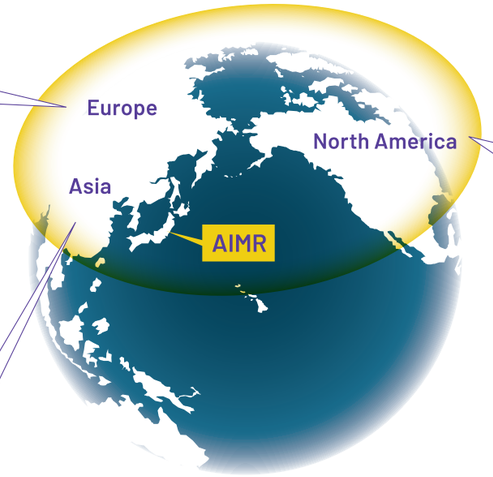
International Collaborations

Satellites and Partner Institutions

AIMR has concluded agreements with the three research institutes, which designate these institutes as Satellites for the implementation of bi-directional multidisciplinary exchange with AIMR. It has also utilized its network with the foreign PIs and adjunct professors to forge partnerships with frontline research institutions overseas, with the aim of conducting international joint research on materials science. There are currently seven international partner institutions.



- **University of Cambridge**
- University College London (UCL)
- Imperial College London
- Max Planck Institute for Intelligent Systems

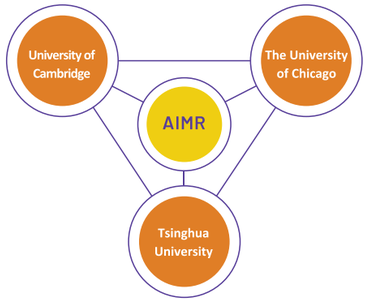


- **The University of Chicago**
- The University of Massachusetts Amherst
- University of California, Los Angeles (UCLA)
- Purdue University

- **Tsinghua University**
- Pohang University of Science and Technology (POSTECH)

AIMR Joint Research Center

AIMR has established AIMR Joint Research Centers, which function as research spaces at the Satellite institutes. Through these centers, AIMR aims to develop a system that places a particular focus on the implementation of joint research conducted together with leading materials research institutes in Europe, North America and Asia.



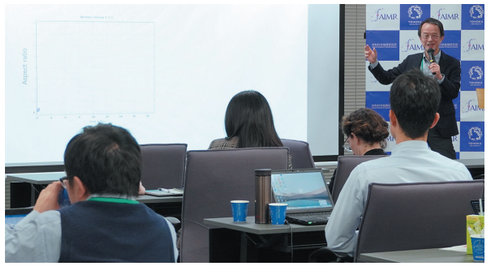
Global Intellectual Incubation and Integration Laboratory (GI³ Lab)

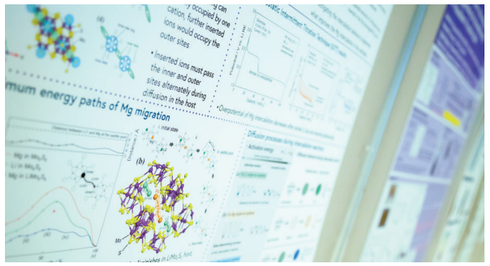
The Global Intellectual Incubation and Integration Laboratory (GI³ Lab) aims to strengthen international fusion/joint research with overseas institutes and construct a "worldwide visible center" by inviting excellent researchers and students (GI³ researchers) from all over the world. AIMR provides necessary measures to **(1) senior international researchers to be accepted by principal investigators (PIs) in Japan, (2) junior international researchers and students to be sent by PIs outside Japan, and (3) young researchers and students to be accepted or sent by AIMR PIs based on agreements with overseas satellites.**

Fusion Research & Tea Time

Promotion of Fusion Research

AIMR has injected particular effort into initiatives aimed at advancing research that is not restricted by the boundaries of existing research fields. Fusion research is an important approach in the creation of new scientific principles. The institute takes the following measures to promote such research activities.





AIMR Fusion Research Proposal

Every year, AIMR researchers submit proposals for fusion research projects to be implemented within AIMR, The Director, Director of the Research Support Division, and respective Group Leaders review the proposals submitted, and the Director makes the decision on whether or not to adopt the proposals. Research grants are allocated to selected projects.

Friday Tea Time

Weekly held Friday Tea Time is where AIMR researchers and staff members can relax and talk freely while drinking coffee. Expectations of stimulating conversation may arise among the researchers and leading to new research.

AIMR Seminars

Seminars are presented by AIMR researchers and visiting scientists who provide a wide range of hot topics from materials science to mathematics. The aims of the AIMR Seminar are to build up mutual understanding, communication, and discussions of each other's research fields.

Top Innovation based on Basic Science

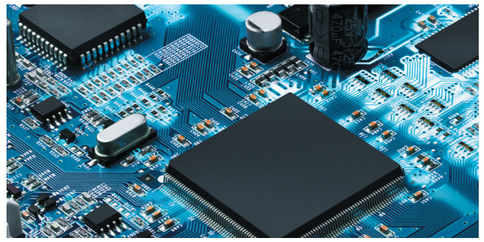
In promoting industry-academia collaboration, AIMR actively carries out joint research and commissioned research with research institutions and corporations at home and abroad. Below are sampling of projects that have been conducted.

Battery Industries

- Cathode materials for lithium-air batteries
- Synthetic processing of multicomponent substances for all-solid-state batteries

Hydrogen Industry

- Metal-based high-density hydrogen storage materials
- CO_2 emissions reduction: Novel chemical processes for hydrogen co-production



Semiconductor and Information Communication Industries

- New materials and measurement technologies for magnetoresistive non-volatile memory
- Photonic integrated circuits using synthetic dimensions and topological edge states

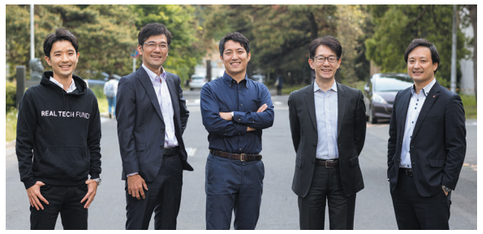
Resource Recycling Industry

- Highly efficient heat pump with natural refrigerants using nanoporous materials
- Chemical looping processes by low-temperature hydrocarbon reforming

Co-creation Research Center

The Co-creation Research Center is a liaison point between the university and companies that was established in the university and provides cross-departmental access to university researchers, knowledge, and facilities. This enables the planning and promotion of joint research, human resource development, and the promotion of a variety of collaborative activities, including partnerships with university-launched ventures.

SMM × Tohoku University GX Materials Science Co-Creation Research Center



3DC–Tohoku U Joint Research Laboratory: Transforming the World with GMS, a New Carbon Material

Open Innovation Center

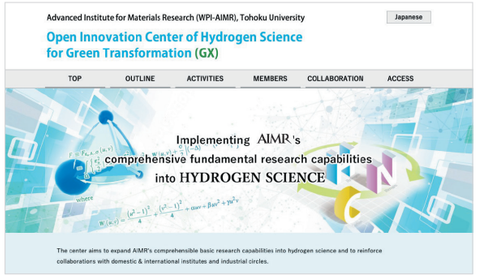
AIMR has an Open Innovation Center with the aim of applying and expanding AIMR's research achievements in industrial fields.

Center of Mathematical Sciences for Open Innovation

For inquiries on how to leverage in industrial fields the leading-edge mathematical science accomplishments of AIMR, contact the **Center of Mathematical Sciences for Open Innovation** (email math_oi_info@grp.tohoku.ac.jp).

Mathematical Sciences, AIMR Search

https://www.wpi-aimr.tohoku.ac.jp/cmsoi/



Open Innovation Center of Hydrogen Science for Green Transformation (GX)

For information on the industrial applications of hydrogen science and related GX research, contact the **Open Innovation Center of Hydrogen Science for Green Transformation (GX)**

Hydrogen Science, AIMR Search

https://www.wpi-aimr.tohoku.ac.jp/oic-hydrogen/index-e.html

To search for Tohoku University seeds or learn more about opportunities for collaboration with researchers, contact the **Industrial Liaison Division of the Head Office of Enterprise Partnerships, Tohoku University.**

RPIP, Tohoku University Search

https://www.rpip.tohoku.ac.jp/en/

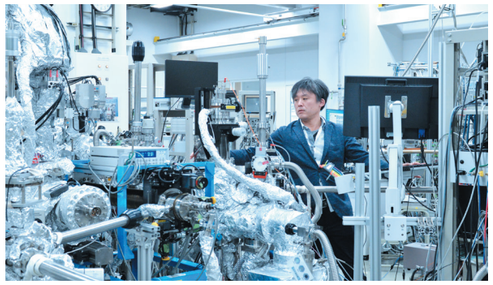
G-RIPS (Graduate-level Research in Industrial Projects for Students) Sendai

The G-RIPS (Graduate-level Research in Industrial Projects for Students) Sendai is held at AIMR. The event has been sponsored by industrial companies such as Toyota Motor Corporation, Fujitsu Laboratories Ltd., and NEC Corporation. The program, originally initiated by IPAM (Institute for Pure & Applied Mathematics), UCLA in the United States, has been running since 2001 and was held in Japan for the first time in 2018. The aim of this project is to bring together the next generation of young research leaders, foster industry-academia collaboration and strengthen cross-cultural exchange.
The eight-week program offers graduate students in mathematics and related disciplines the opportunity to work on industry-partnered research problems. Students from Japan and the U.S. work on cross-cultural teams on research problems designed by the industrial partners, and present the results of their work in a final report. The projects offer a stimulating challenge, and involve both analytic and computational skills.

Support System

World Class Research Environment and the Support System for Researchers

AIMR is proud of its full-scale support for its researchers so that they can concentrate on one's research using equipment at a world class facility. Also, since the majority of researchers at AIMR are young researchers under 40, various systems are formalized as a means to enhance support for their activities.



Support for International Researchers

Extensive and unique support is provided to international researchers at AIMR, i.e., various employment procedures necessary before and after their arrival in Japan, arrangements of Japanese language classes for the researcher and family, orientations, and rental goods. The main building of AIMR has a superb environment for international researchers with living quarters and speaking English as the official language to meet global standards.

Common Equipment Room

Dedicated technical coordinators manage common equipment and provide support for research technologies. They also create networks with internal and external research institutions pertaining to the joint use of experimentation equipment. The Unit carries out coordination work corresponding to the needs of researchers in order to ensure that researchers are also able to make use of equipment that is not available at the institute.

Major Equipments

- FE-SEM (Field-emission Scanning Electron Microscope); JEOL, JSM-7800F
- Sputtering System: ULVAC, QAM-4-S
- Laser Raman Spectrometer; HORIBA, LabRAM HR-800
- TG-DTA, DSC (Thermal Analysis Apparatus); RIGAKU, Thermo plus EvoII
- Xray Diffraction Measurement System (XRD); RIGAKU, SmartLab 9MTP
- Xray Diffraction Measurement System (Laue Camera); RIGAKU, RASCO 3M etc.

AIMR Advisory Board

(Surnames in alphabetical order)

Sadamichi Maekawa (Chair)
- Senior Advisor, Center for Emergent Matter Science (CEMS), RIKEN
- Professor Emeritus, Tohoku University

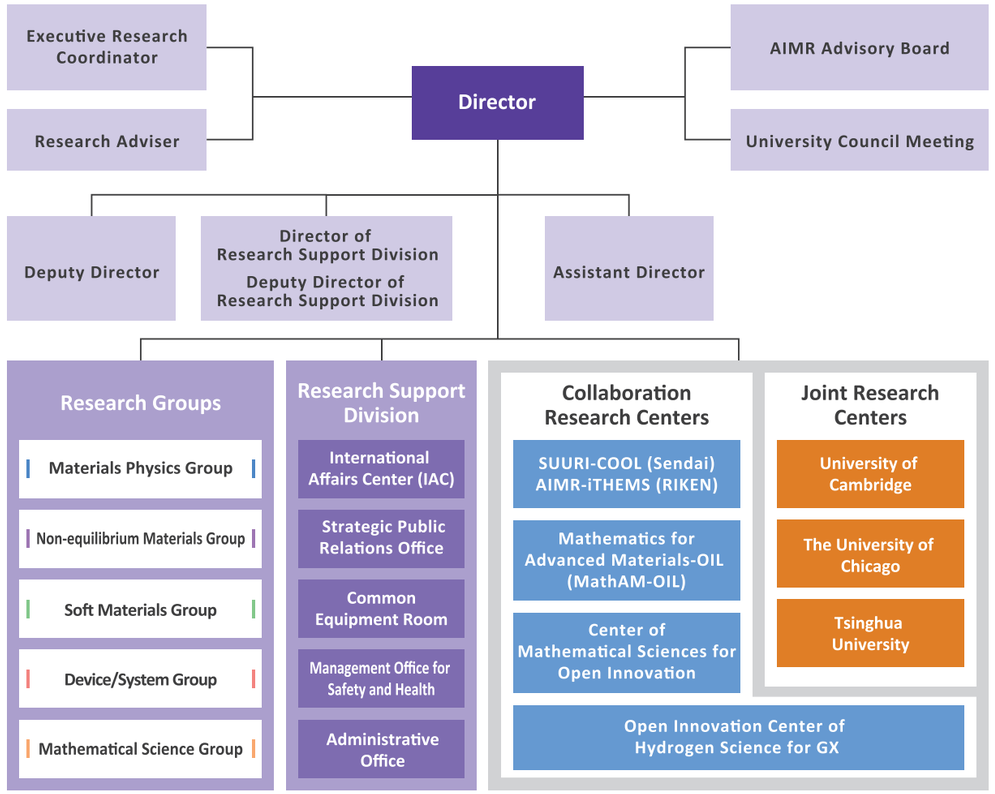
Giulia Galli
- Liew Family Professor, Pritzker School of Molecular Engineering, The University of Chicago

Hatsumi Mori
- Vice President, The University of Tokyo
- Professor, The Institute for Solid State Physics, The University of Tokyo

J. Georg Bednorz
- Dr
- IBM Fellow Emeritus
- 1987 Physics Nobel Laureate

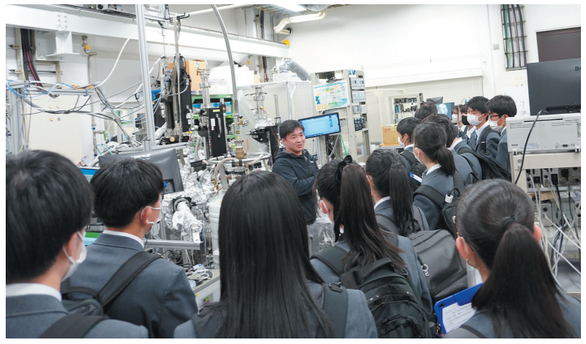
Masahiro Goto
- Professor, Department of Applied Chemistry, Graduate School of Engineering, Kyushu University

Organization Chart



PR & Outreach Activities

The Strategic Public Relations Office promotes worldwide awareness of AIMR as a top-level research institute, by putting out a wide range of information, including the latest research achievements, on the web, social networks and other media. It also engages in a variety of outreach activities aimed at promoting communication and mutual understanding with the general public. Events of various kinds are held jointly with the Japanese Ministry of Education, Culture, Sports, Science and Technology and with other WPI centers, offering middle- and high-school students and the general public opportunities to see leading-edge science up close. In addition, facility tours welcoming local Sendai high schools in the science and mathematics field, among others, help to build stronger community ties. Through talks by young scientists on future career paths, and visits to research laboratories in various fields, such activities convey messages to the youth who will be forging the future of science.



To promote broad understanding in the local community of the research and educational activities of Tohoku University, the “Katahira Festival” is held biannually at research institutes mainly on the Katahira Campus, inviting the public to see the AIMR facilities and holding events including science experiments. After a long absence due to the pandemic, the Katahira Festival was held on-site in 2023 with many visitors.