CONTENTS

3 Greetings from the President

4 AIST’s Vision and Fundamental Policies for the Fourth Medium-to Long-term Plan

5 Organization Chart

[ Seven Domains ]

6 Department of Energy and Environment

8 Department of Life Science and Biotechnology

10 Department of Information Technology and Human Factors

12 Department of Materials and Chemistry

14 Department of Electronics and Manufacturing

16 Geological Survey of Japan

18 National Metrology Institute of Japan

[ Open Innovation Platforms ]

20 Fukushima Renewable Energy Institute, AIST (FREA)

22 TIA

24 AIST Tokyo Waterfront, Bio and IT Fusion Research Base

26 Open Innovation Laboratories

27 Cooperative Research Laboratories

28 Regional Research Bases and Roles

31 Commercialization Support and International Collaboration

33 Human Resources Development

35 Highlights of Research Achievements

36 Directory
The National Institute of Advanced Industrial Science and Technology (AIST) was designated as a designated national research and development institute under a Special Measures Act October 2016. We take this designation as signifying strong Japanese government expectations for us, and we will continue to take a leadership role in Japan’s research and development (R&D), to contribute to industry and society. To meet these expectations, AIST must maintain R&D levels befitting a world-class research institute. Gaining an international reputation will enable us to enhance interaction and collaboration with research institutes and universities around the world, creating a virtuous circle for research enrichment and development.

As a public research institute, AIST has a mission to provide research results to industry, and return them to Japanese society. We therefore need not only to enrich basic and applied research, but also to conduct R&D activities with clearly defined goals.

AIST is pursuing activities focusing on the bridging of technology under the Fourth Medium- to Long-term Plan. At AIST’s research sites, we are promoting the establishment of cooperative research laboratories, bearing partner company names. Collaboration between AIST’s researchers and companies’ engineers will promote effective and efficient R&D, responding to social needs. AIST has already established cooperative research laboratories with ten companies, and begun collaborative research.

At the same time, over the last fiscal year, AIST has begun to establish open innovation laboratories (OILs) on university campuses, collaborative research hubs between AIST and universities. OILs will integrate the strengths of both AIST and the universities, with basic and applied research, development, and demonstration continuously conducted to accelerate research. AIST has thus far established OILs at seven universities, and commenced related activities.

In parallel with strengthening our collaboration with outside partners, AIST is considerably expanding the number of its innovation coordinators, full-time personnel who play a role in the bridging of technology. We recruit a variety of human resources from companies and public prefectural research organizations, and approach industry with marketing ideas not found in conventional public research institutes.

AIST has activity bases throughout Japan, because one of its important roles is to contribute to local industries and economies. Many technologies have been developed through collaborative development, and commercialized by local companies. Such technologies have created new industries and services; therefore, we must ensure a more stable flow of development. AIST is not only increasing the number of points of contact for companies, but also actively advancing collaboration with public research organizations and universities in each region, to enhance contact with industry. In the last fiscal year, we established new collaboration sites in Ishikawa and Fukui Prefectures, to develop a system to provide more detailed responses to industry needs. Please feel free to consult with a nearby AIST regional research base. We also provide telephone and email consultations. Our staff will make every effort to solve your problems.

We look forward to your continued understanding and support.

President,
National Institute of Advanced Industrial Science and Technology (AIST)

Ryoji Chubachi
AIST’s Vision and Fundamental Policies for the Fourth Medium- to Long-term Plan

In order to build a sustainable society, we are called to deliver solutions to 21st century issues, such as global warming, the energy problem, and a rapidly aging society. AIST conducts research in line with its principle of “Technology to Society.” During the Fourth Medium- to Long-term Plan (duration of 5 years) which started in April 2015, AIST aims to realize the principle by enforcing the three pillars of its activities. Specifically, we strengthen goal-oriented basic research which forms the basis of innovation, bridge its outcomes and industry, and utilize and nurture human resources who will create future innovation.

AIST’s subject of research is wide covering almost all industrial technologies of Japan. In order for the state of the art research outcomes to be widely used, we realigned our research organization into seven domains for the fourth period. We are aiming for maximum results by setting research institutes and research centers in each domain. The research institutes undertake goal-oriented basic research and applied research to practical research to bridge the gap between research and industry in an integrated manner. The research centers focus on practical, commercialization research in response to the needs of industry and society.

Moreover, we are actively tackling close collaboration with small and medium-sized enterprises with our 7 regional research bases. We are also establishing a system by which TIA, Fukushima Renewable Energy Institute, and even AIST Tokyo Waterfront can be used by universities, other research institutes, and private companies as open innovation platforms. Thus, we will make the platforms places for international research and development.

From fiscal 2016, we are establishing AIST labs (open innovation laboratories) on university campuses, to conduct end-to-end research from basic, applied, to demonstration and practical research through collaboration with universities and industry. We are also establishing cooperative research laboratories bearing partner companies’ names within AIST to promote closer collaboration with companies committed to commercialization of research results.

In addition, we have established a technology marketing section and will significantly increase the number of innovation coordinators to fundamentally strengthen our bridging function of technology. We will support the development of innovative products and production processes of regional companies by closely collaborating with the public research organizations of the regions.

AIST has been specified as a designated national research and development institute from October 2016. We will tackle world class research and development and human resource development suitable of such an institute, in order to respond to expectations as a core institute that powerfully drives the national innovation system.
Organization Chart

As of October 1, 2018

President
Management Steering Committee
Auditor

Board

Human Resource Committee
Committee of Research and Cooperation Strategies

Compliance Headquarters
Audit Office
Evaluation Department

TIA Central Office

Department of Energy and Environment
- Research Institute of Energy Frontier
- Research Institute of Electrochemical Energy
- Research Institute for Energy Conservation
- Environmental Management Research Institute
- Research Institute of Science for Safety and Sustainability
- Research Center for Photovoltaics
- Renewable Energy Research Center
- Advanced Power Electronics Research Center

Department of Life Science and Biotechnology
- Biotechnology Research Institute for Drug Discovery
- Biomedical Research Institute
- Health Research Institute
- Bioproduction Research Institute
- Molecular Profiling Research Center for Drug Discovery

Department of Information Technology and Human Factors
- Information Technology Research Institute
- Human Informatics Research Institute
- Intelligent Systems Research Institute
- Automotive Human Factors Research Center
- Robot Innovation Research Center
- Artificial Intelligence Research Center

Department of Materials and Chemistry
- Research Institute for Sustainable Chemistry
- Research Institute for Chemical Process Technology
- Nanomaterials Research Institute
- Inorganic Functional Materials Research Institute
- Structural Materials Research Institute
- Interdisciplinary Research Center for Catalytic Chemistry
- CNT-Application Research Center
- Research Center for Computational Design of Advanced Functional Materials
- Magnetic Powder Metallurgy Research Center

Department of Electronics and Manufacturing
- Nanoelectronics Research Institute
- Electronics and Photonics Research Institute
- Advanced Manufacturing Research Institute
- Spintronics Research Center
- Flexible Electronics Research Center
- Advanced Coating Technology Research Center
- Research Center for Ubiquitous MEMS and Micro Engineering

Geological Survey of Japan
- Research Institute of Earthquake and Volcano Geology
- Research Institute for Geo-Resources and Environment
- Research Institute of Geology and Geoinformation
- Geoinformation Service Center

National Metrology Institute of Japan
- Research Institute for Engineering Measurement
- Research Institute for Physical Measurement
- Research Institute for Material and Chemical Measurement
- Research Institute for Measurement and Analytical Instrumentation
- Center for Quality Management of Metrology

Planning Headquarters
Research and Innovation Promotion Headquarters
Environment and Safety Headquarters
General Affairs Headquarters

AIST Tokyo Headquarters
AIST Tsukuba
Fukushima Renewable Energy Institute, AIST
AIST Tokyo Waterfront
AIST Hokkaido
AIST Tohoku
AIST Chubu
AIST Kansai
AIST Chugoku
AIST Shikoku
AIST Kyushu
In order to promote green innovations toward solutions to energy and environmental issues growing on a global scale, the Department of Energy and Environment pursues the following development: 1) Technology to accelerate introduction of new energy, including renewable energy, to enable reduced greenhouse gas emissions, 2) Technology to store energy in high density, 3) Technology to convert and exploit energy efficiently and achieve an energy-conserving society, 4) Technology to use new energy resources such as methane hydrate effectively, and 5) Technology to evaluate and reduce environmental risks in order to achieve a society where industry and environment coexist.

- CIGS solar cells, composed of copper (Cu), indium (In), gallium (Ga), and selenium (Se), have attracted attention as lightweight and flexible solar cells with high conversion efficiency.
- We are developing technology to produce natural gas economically from methane hydrate, which is widely distributed offshore of Japan, and which is expected to be a new energy resource.
- Technology development that enhances recovery rates of rare metals collected from electrical and electronic hardware wastes (urban mine). In the future, the technology is expected to boost economic growth and preservation of the earth’s environment.
The field of storage batteries for electric vehicles is pursuing the development of secondary batteries which have higher capacity and safety compared to lithium ion batteries (LIBs) currently in use. In addition to being non-flammable, all-solid-state batteries using solid electrolytes are expected to have a high voltage reaching 5 V; a voltage level which is difficult to achieve with the current organic solvents. AIST has engaged in the development of all-solid-state LIBs using sulfide solid electrolytes, and has succeeded in the operation of a prototype laminate-type battery (see photo). Furthermore, with the discovery of metal polysulfide cathode materials that show high capacities—an achievement in materials development—we are working on the development of an all-solid-state battery employing a highly-safe oxide solid electrolyte. Material synthesis, electrode fabrication and battery fabrication technologies constitute the initiatives for device development. R&D efforts will aim for the early practical implementation of high performance all-solid-state LIBs that are highly safe.

We promote technology development that brings innovation to the future of power electronics, utilizing new semiconductors that are superior in material characteristics, such as silicon carbide (SiC). Tsukuba Power Electronics Constellations (TPEC), a new-type joint research alliance utilizing the vitality of the private sector, was organized in collaboration with many companies and universities at TIA, our open innovation platform of industrial technology development. It pursues manufacturing at practical mass-production levels for successive fabrication processes from wafers to devices, modules, and systems. Participating members encompass a wide range of industry segments: material manufacturers, electronics manufacturers, apparatus manufacturers, and applied systems companies, and TPEC supports mutual collaborations. A scheme for flexible use of intellectual property (IP) and know-how is in place, so IP and know-how developed individually at TIA can be used among participating members at no charge.
Department of Life Science and Biotechnology

Department of Life Science and Biotechnology implements advanced research that contributes to Life Innovation and Green Innovation for healthy longevity in society through a healthy and secure daily life, and for a sustainable society that minimizes the burden to the environment. Specific efforts include the following: 1) Fundamental drug discovery technologies that enable rapid, highly successful and cost effective ways; 2) Health care technologies ranging from stem-cell treatments for regenerative medicine to bio-devices for handy and precise measurement of health conditions; 3) Bioproduction to efficiently produce useful substances like starting materials for pharmaceuticals by enhancing substance productivity of microorganisms, plants and animals, with transgenic technology.

1. World’s first closed-type transgenic plant factory developed at AIST, where the transgenic strawberries for canine gingivitis were developed (left). The animal drug made from the strawberries was approved and is now commercially available as veterinary pharmaceuticals (right).

2. Electron microscopy image of a living bacteria at 30,000X magnification captured using the "TRANSEM" technology developed at AIST, which enables observation of living cells and other particles in liquid suspension at resolutions up to 10nm without staining, freezing or slicing.

3. World’s first early diagnosis of hepatic cancer by a blood test using a sugar-chain biomarker, which can reduce processing time and burdens on patients in comparison to conventional biopsy methods.
In the context of reduction of genome sequencing cost, rapid development of IT technologies, and availability of convenient genome manipulation techniques, AIST is working on full utilization of animals, plants, and microorganisms’ potential by designing and modifying their genomes for additional functions and material production at low environmental cost.

We implemented a genome editing technology to chicken for the first time, which can be applied to mass production of valuable proteins in eggs. For plants, we are working on developing “super plants,” including those which contribute to the fixation of CO₂ or can survive under harsh environments, by manipulating transcription factors and other genes. Moreover, to draw out the vast and wide ranges of potential of microbial species, technologies to treat and analyze masses of biological omics data, including transcriptomes, proteomes and metabolomes, are being developed, which can allow to design and modify metabolic pathways in the species for high production of materials and so on.

For realization of health and well-being, we are developing technologies to dynamically reduce the drug discovery processes and to readily evaluate health conditions, such as the handy fast qPCR equipment for detection of various pathogens causing such conditions as viral infection and food poisoning, and the humanoid robot “Mahoro” for reliable operations of biotechnological experiments. These technologies realize more efficient and convenient processes in drug discoveries, medical services and diagnosis. The stealth RNA vector developed at AIST enables us to introduce multiple objective genes into cells without damage of chromosomes, which can largely contribute to safe and effective preparation of iPS cells in clinical use.
In the Department of Information Technology and Human Factors, R&D concentrates on interactions between information science and ergonomics, and aims for enhanced industrial competitiveness and a plentiful and comfortable society. Development efforts include the following: 1) Artificial intelligence technology that creates value from big data, 2) Cloud technology that creates new value from people, things, and services and security technology for safe Internet use, 3) Measurement and evaluation technology of human activities, like driving an automobile, that elucidates human factors such as physiological, cognitive, and physical functions, and 4) Practical implementation technology for robots used in various fields such as caregiving, daily-life assistance, and manufacturing lines, and fundamental technology for autonomous work of robots that withstand environmental changes.

1. We perform measurement and evaluation of various human activities including the state of driving an automobile in order to elucidate human physiological, cognitive, and physical functions, and achieve safe and comfortable living in society.
2. Technology development pursues practical application of robots in various industries such as caregiving, mobility assistance, and manufacturing. The photo shows a two-armed robot lining up parts.
3. We aim to build systems that contribute to advancement of industry and social systems by integrating information gathered from people, things, and services.
In order to solve issues by people working together with artificial intelligence, it is necessary to have artificial intelligence with a high affinity to human intelligence. AIST conducts research focused on the following two areas. 1) Research of brain-like artificial intelligence: Bringing forth a computer system that performs flexible and agile information processing, like neural circuits and neurons of the brain process information, through engineering studies of the mechanism of expressing human intelligence by the human brain. 2) Research of data/knowledge integration-type artificial intelligence: Complex decisions and explanations of decision processes are made possible by natural integration of machine learning technology that learns regularity from vast data, semantic comprehension technology for understanding knowledge accumulated by human society, and inferential technology that applies knowledge. For these fundamental research themes, we set specific, clear applications in real society, and promote continuing research.

Realizing innovation through robotic technology means that development of the robot alone is insufficient. Upstream processes, such as analysis of the target work, determination of service to provide in order to improve operations, and the estimation of investment efficiency, are important. For that, we establish the analysis method for the target work of robotic technology and the calculation method of investment efficiency, benefit and safety evaluation protocols supporting design specifications of the robot, and acquisition and analysis technology of log data in order to evaluate operational benefit. Building on these, we aim to spur innovation in relevant industries through the realization in society of robot services that implement the following: provide support to those receiving care; reduce the burden of care givers; support independent mobility of the elderly both indoors and outdoors; apply emerging AI technologies to industrial robots and manufacturing processes; and support new transportation systems revitalizing regional areas based on autonomous driving technologies.

How to reach us   Information Technology and Human Factors
☎️ +81-29-862-6028   ⚡ ith-contact-ml@aist.go.jp   ☑️ www.aist.go.jp/aist_e/dept/en_dithf.html
Department of Materials and Chemistry

In the Department of Materials and Chemistry, we aim to provide technology to create innovative components and primary materials, keys to product competitiveness, by synergy of materials and chemistry research fields. We promote green sustainable chemistry and chemical process innovation, and we develop nano-materials such as nano-carbon materials as well as their application technologies. The development of inorganic functional materials is also our focus to drive manufacturing technology and advanced structural materials contributing to establishment of energy-conserving technology. The efforts provide opportunities to create new added value for the materials and chemical industries.

The development of high-speed-fabrication technique for large-area films of nano-carbon materials such as graphene, which has high electrical and thermal conductivity, and search for their potential applications towards various optical and electrical devices

Development of technique for compositing of cellulose nano-fibers, a new lightweight material with high strength and low expansion coefficient made from woody biomass, with versatile materials such as resin and rubber (the inset figure: a prototype of an instrument panel of cars for audio equipment)

Development of high-performance devices through various simulation technologies for electrochemical interfaces, which are developed and used at research sites of industry, academia, and government

Development of high-performance magnets which do not need rare metal (dysprosium: Dy) and are riskless from issues of significant price escalation and unsecured supply
High-functional organosilicon components are expected to be materials that can be utilized widely: next-generation LED sealants, organic EL sealants, and solar cells, and wind-power generation components, for instance. AIST develops technology to manufacture organosilicon intermediate materials of these components through an energy-saving process from sand, which has few resource constraints. Furthermore, AIST conducts development of processes using non-metallic catalysts as substitutes for precious metal catalysts such as platinum with limited reserves. We are also aiming to develop new processes that can manufacture high functional components from intermediate materials. This effort aims to solve issues on natural resources and environment while ensuring competitive advantages of catalyst technology of Japan.

Our aim is commercializing highly crystalline, long single-walled CNTs, which were originally discovered in Japan, and expanding their use in the market. For this purpose we are developing low-cost mass production technology targeting yields greater than 10 times those obtained previously by applying the super growth method that boasts the world’s highest efficiency for synthesis. In addition, following the development of fundamental synthetic technology of CNTs, which surpass metal and carbon fibers in dynamic, electrical, and thermal properties, we develop technology to create composite material of CNTs with various materials by utilizing coating, lithographic processing, and printing technologies. We aim for application to LSI writing and parts in automobiles and motors. Single-walled CNTs obtained from the super growth method are expected to be applied in new functional materials and next-generation devices. We are pursuing development of mass-production technology and composite technology as industrial use approaches.
In the Department of Electronics and Manufacturing, AIST engages in development of devices that possess world-class performance for enabling both considerable energy-saving and high performance in IT equipment, and targets development of innovative manufacturing technology to achieve industrial activities that save energy, resources and money. Eyeing the arrival of the Internet of Things (IoT) connecting appliances other than information devices to the Internet, we develop super-efficient manufacturing systems and contribute to reinforcement of Japan’s industrial competitiveness by tying advanced sensing technology to acquire information from “things” together with innovative manufacturing technology.

1. Ultraviolet excitation V-trench biosensor
2. Electrochemical-based sensor for hormones in blood of livestock
3. 512-pixel superconducting tunnel junction array detector module
4. “Minimal Fab,” a novel integrated circuit manufacturing system

1. A V-trench biosensor that uses a sensor chip having a V-shaped microfluidic channel coated with an aluminum layer for surface plasmon resonance excitation. The sensor can detect fluorescent-labeled biological substances with high sensitivity.
2. An Electrochemical-based sensor, equipped with micro-structures of pyramid-shaped electrode arrays, enables efficient reproduction and breeding of livestock through accurate detection of hormone molecules in blood.
3. Superconducting tunnel junction array soft X-ray detectors exhibit a high energy resolution of 5-10 eV in full width at half maximum, which is exceedingly better than that of conventional semiconductor detectors. Analytical instruments equipped with the superconducting tunnel junction array soft X-ray detector can obtain unrevealed material information.
4. Meeting high-mix, low-volume production by using an innovative semiconductor manufacturing system with half-inch wafers as the manufacture substrate unit
We have been studying topological properties emerging from chalcogenide materials and its superlattices. Among them, we have developed a low dimensional electron control technique by external electric fields at room temperature, using Ge$_2$Te$_2$/Sb$_2$Te$_3$ chalcogenide superlattices. We are going to apply the technology with multi functionalities to ultra-low energy nonvolatile memories, a universal memory equipped with spin properties, reconfigurable logic switches, neural networking circuits, and a THz-optical switch controlling open/close of a band gap due to a Dirac cone.

Innovation Technology for Two Dimensional Multiferroic Functional Devices using Chalcogenide Superlattices with Topological Phase Transition

Differences in the switching mechanism between a conventional phase change memory and a superlattice phase change memory

Room Temperature Ceramic Coating by the Aerosol Deposition Method

The aerosol deposition (AD) method is a new coating technology developed by AIST, which can produce a robust ceramic film simply by spraying powder without sintering. The ceramic film is formed on a metal or resin base material not having heat resistance by the impact of the collision of blowing the mixtures of fine particles and gas at room temperature. The film is not only very ultra hard but also chemically stable. Therefore, the AD method has already been commercialized for parts of semiconductor manufacturing equipment, and supports the manufacture of semiconductor chips in the world. Also, the ceramic coating by the AD method can impart various surface functions to the member surface such as electrical, optical, abrasion resistance, corrosion resistance and heat resistance. It is expected to expand applications in a wide range of fields such as electronics, automobiles and aircraft, energy and medical related members.

Room Temperature Ceramic Coating by the Aerosol Deposition Method

How to reach us
Research Promotion Division of Electronics and Manufacturing

☎ +81-29-862-6592  rpd-eleman-ml@aist.go.jp  www.aist.go.jp/aist_e/dept/en_delma.html
Geological knowledge is considered to be “information with a time axis,” crucial in predicting the future of the earth by understanding its history. It is fundamental knowledge for building a safe and secure society particularly in Japan, which sits on a tectonically active belt. With an abundance of knowledge in geology, the Geological Survey of Japan (GSJ) pursues technology development to solve various issues related to mitigation of geological disaster, environmental protection and others. In addition, through resource potential assessment and the studies and surveys on the usage and maintenance of geo-environment to facilitate resource and energy policy planning and sustainable industrial development, we contribute to the advancement of a geo-friendly and sustainable society that uses resources and energy effectively.

1. East-southeastern view of Nishinoshima

Nishinoshima in the Ogasawara (Bonin) Islands (June 2014). Eruption began in 2013, paused in 2016, and resumed from April 2017. AIST offers information for the assessment and prediction of its volcanic activity based on field study and analyses of volcanic products.

2. Providing scientific evidence relating to continental shelf extension

In 2012, the United Nations recommended the extension of Japan’s continental shelf limits. AIST assumed the central role in the marine geological survey, and contributed to the filing of the application to the UN and handling of the review together with other related organizations.

3. Geological map viewer showing the Kumamoto region

AIST promotes the online distribution of its geological research outcomes as open data. The portal map viewer can display many geologic maps and data overlaying each other. The figure represents the epicenters of aftershocks of the Kumamoto Earthquake and active faults, shown with the geologic maps.

4. Peeled sample of tsunami deposit of the Jogan Earthquake

Peeled sample of tsunami deposits. An AIST study used geological evidence of unusually large tsunamis to estimate the recurrence intervals and inundation extent of past tsunamis in an effort to better prepare the Japanese coastline for future events.
Diversification of energy resources is one of the most important and urgent issues for Japan in the days when unpredictable international situations and energy and environmental issues need to be considered. Methane hydrates beneath the seafloor around Japan are expected to be a new energy resource. AIST has conducted geological surveys using various methods to assess the distribution and characteristics of shallow-type methane hydrate under consignment of the national government, and has estimated the resource amount in some areas off the Joetsu region. Responding to the result, the government has started the research on collecting the shallow-type methane hydrate. AIST also promotes basic research and development on geo-environmental utilization and protection, as well as translational research through collaboration especially with various industries and others. One of the recent hot topics is the first discovery of an underground microorganism (methanogen) which can produce methane directly from methoxylated aromatic compounds in a variety of coal types.

Survey on Potential of Submarine Mineral Resources

Toward the utilization of the offshore around Japan, AIST has discovered several active hydrothermal areas on the seafloor taking advantage of its experience and earth scientific knowledge. The “United Nations Convention on the Law of the Sea” recognizes the sovereign rights of coastal countries to explore and exploit natural resources in its continental shelf zone. Substantial resources such as rare metals and unknown resources are expected to exist within the exclusive economic zone (EEZ) of Japan. Marine geological survey is very important to accurately identify the distribution of these resources and to determine potential areas of mineral deposits. In addition, AIST promotes the research and development of efficient exploration techniques for inactive hydrothermal deposits. AIST is also engaged in the development of survey methods conducted with the private sector, the transfer of exploration and analysis technologies to the private sector to enhance commercialization, and the support of human resource development.

How to reach us | Research Promotion Division for Geological Survey of Japan
☎️ +81-29-861-3540 🌐 gweb@gsj.jp 🌐 www.aist.go.jp/aist_e/dept/en_gsj.html
National Metrology Institute of Japan

Development of the measurement standards such as length, time, and mass is a vital mission of AIST. The National Metrology Institute of Japan (NMIJ) develops and maintains measurement standards of physical quantities for seven base units and numerous combinations of those base units, and disseminate these standards to society. NMIJ advances the development of measurement technologies associated with the measurement standards, and undertakes the development of infrastructure underpinning cutting-edge manufacturing as well as the safety and security of our society. Four Research Institutes and the Center for Quality Management of Metrology are organically connected and cooperate closely to disseminate measurement standards, conduct legal metrology services, and enhance personnel training.

Measurement standards support the spectrum from daily life to advanced industry

1️⃣ The one and only torque standard machine in the world using electromagnetic force

The world’s first torque standard machine based on the watt balance method was developed, in which the torque is generated using electromagnetic force and is traceable to the International System of Units (SI). The standard machine is expected to be used for microscopic torque measurements that are difficult to be realized by torque standard machines based on a moment arm deadweight system using gravity.

2️⃣ The world’s first standard LED covering the full visible light

The world’s first standard LED covering the full visible light, which is indispensable for the quality evaluation of LED products, was developed in collaboration with an LED manufacturer so as to improve the quality and the consumer confidence regarding LED products.

3️⃣ Dissemination of certified reference materials for chemical measurements

Certified reference materials, which are necessary for calibrating analytical instruments and evaluating analytical methods, are widely disseminated domestically and internationally.

4️⃣ Nondestructive vacancy-inspection system for characterizing steel materials

In collaboration with a private enterprise, we developed a commercial desktop-type vacancy-inspection system for characterizing atomic vacancies inducing metal fatigue of structural materials such as the frame of automobiles. This system, based on the positron annihilation lifetime technique, allows nonexperts to measure materials nondestructively as well as easily.
Among the base units of the SI which are widely used as units to express physical quantities, worldwide preparations for the shift towards the new definitions planning in 2018 are underway for mass, temperature, electric current, and amount of substance. AIST participates in the International Avogadro Coordination project aiming to redefine the kilogram, and is also developing new realization methods based on the elementary charge and Boltzmann constant for electric current and temperature, respectively. Moreover, the development is proceeding for an optical lattice clock that may realize ultra-precision of the order of $10^{-18}$ (a deviation of one second every 13.7 billion years) and leads to a new definition of the second in the future. Those research approaches here are also expected to be applied to new measurement technologies such as micromass and microcurrent measurements.

Since many infrastructures in Japan were built more than 50 years ago, we have to develop techniques for securing their structural integrity. NMIJ has been developing non-destructive inspection techniques for maintaining these aging structures. For example, we have developed a novel digital image processing technique with Moiré fringes to evaluate the deflection of bridges in service. Moreover, we have developed a battery-driven compact high energy X-ray source that is capable of inspecting corrosion in chemical plant pipelines by being installed in an inspection robot. NMIJ’s specialists on measurement and instrumentation help resolve technical problems confronting companies and universities through cooperative schemes such as collaborative research and technical consulting.

How to reach us   NMIJ Public Relations Office, Center for Quality Management of Metrology
Towards early introduction of renewable energy at scale

Fukushima Renewable Energy Institute, AIST (FREA)

From Fukushima, we promote renewable energy R&D and deployment internationally, and contribute to the activation of the area affected by the disaster through developing new industrial clusters.

After receiving the government’s “Basic Guidelines for Reconstruction in response to the Great East Japan Earthquake” (issued in July 2011), AIST established the Fukushima Renewable Energy Institute, AIST (FREA) in Koriyama, Fukushima Pref. in April 2014. FREA has two missions: the promotion of R&D of renewable energy internationally, and the contribution to reconstruction through developing new industrial clusters in this area. In order to introduce renewable energy on a large scale, it is necessary to solve issues that include large fluctuations and high costs in power generation, and selection of appropriate technologies by location. Thus, in collaboration with domestic and foreign research organizations, universities, and companies, FREA promotes innovative technology development and its demonstration and commercialization and also contributes to development of regional industry and human resource development.
Main Research Themes

- Research and verification of advanced integration of renewable energy source (Photo ①)
  In order to develop and demonstrate a system that can use renewable energy maximally, we engage in R&D of energy management and peripheral technology that make full use of storage and control technology.

- Production and utilization technology of hydrogen energy carrier (Photo ②)
  We engage in R&D of hydrogen energy carrier production and application to store and transport large amount of fluctuating renewable energy.

- Advanced technology for wind power generation (Photo ③)
  We develop sophisticated wind-condition forecast technology, and apply it to improve windmill efficiency and lifetime.

- High-performance PV modules with crystalline silicon solar cells (Photos ④・⑤)
  We are continuing R&D of thin-wafer based crystalline silicon solar cells to reduce cost through high efficiency and high reliability. Smart stack technology is also being developed to achieve ultra-high efficiency at low cost.

- Technologies for the effective and sustainable use of geothermal resources (Photo ⑥)
  We engage in R&D to overcome problems such as subsurface uncertainty, cost effectiveness, co-existence with hot spring spas, and sustainability, and to advance proper geothermal resource development and utilization that meet the underground conditions and demand.

- Suitability assessment of ground-source heat pump system and its system optimization technology (Photo ⑦)
  In order to promote ground-source heat pump systems, we develop suitability maps that reflect hydrogeological data of the region, and are pursuing R&D for high performance and cost-effective systems to be used according to hydrogeological conditions.

Collaboration Activities

- Support of the industry in the disaster area
  We support commercialization of technologies and know-how related to renewable energy held by companies located in the three prefectures of Fukushima, Miyagi, and Iwate affected by the Great East Japan Earthquake (107 cases as of end of March 2018).

- Human resource development in renewable energy fields
  We accept students from local universities, and train them through joint research with universities as future human resource in renewable energy fields.

- Active alliances with domestic and international organizations
  We are actively working on strategic alliances with local universities, domestic and foreign research organizations in technology development, human resource development, and international standardization.

Experiment Building

- This single-story building with blocks of large space can be arranged flexibly depending on usage, and is currently used for research and development of high-performance thin-wafer based crystalline silicon solar cells and hydrogen carriers.

Demonstration Field

- Equipped with solar power generation, wind power generation, storage battery, hydrogen carrier production/storage/utilization systems, and the energy management system that controls these, the field demonstrates the integration of large-scale power generation, energy storage and utilization technologies and is used for performance evaluations.

Smart System Research Facility (started operations in April 2016) (Photos ⑧・⑨)

- This facility offers the world’s top level in testing and R&D of advanced power electronics equipment, such as a full-size power conditioner (PCS) that is indispensable for renewable energy and storage battery installations.

How to reach us

Fukushima Renewable Energy Institute, AIST

☎ +81-24-963-0813  frea-info-ml@aist.go.jp  www.aist.go.jp/fukushima/en/
We disclose the results of our cutting-edge research, provide R&D facilities and equipment for open use, and promote open innovation.

Expanding from Tsukuba city, to Tokyo, TIA, is Japan’s largest center for open innovation operated by five public research organizations* with the support of the Japan Business Federation (Keidanren).

Since establishment in 2009, TIA has been creating various core technologies, including SiC power devices, single-walled carbon nanotubes (the super growth method) and composite materials, and super-low power consumption wireless sensor terminals, some of which have already reached mass-production and commercialization.

In phase 2 (FY 2015-2019), TIA improves user convenience with one-stop services in collaboration contracts, open access of facilities, and human resource development, undertakes project planning and marketing in collaboration with public investors, and establishes a global brand with international alliances.

*Five core organizations that constitute TIA:
- National Institute of Advanced Industrial Science and Technology (AIST)
- National Institute for Materials Science (NIMS)
- University of Tsukuba
- High Energy Accelerator Research Organization (KEK)
- The University of Tokyo
R&D in Various Fields

- Nanoelectronics: Various R&D projects related to silicon (Si) devices and photonic devices are conducted using the Super Cleanroom (Photo ①②③④).
- Power electronics: R&D of silicon carbide (SiC) power electronics and super conductivity is conducted by joint projects and consortiums. (Photo ⑤⑥)
- MEMS (micro electronic mechanical system): Using microfabrication and measurement facilities, R&D projects are conducted for devices and systems such as sensor networks. (Photo ⑦⑧)
- Carbon nanotubes (CNTs): Development of composite materials and safety research of CNTs are conducted. (Photo ⑨)

TIA Collaborative Research Program “Kakehashi”

The program, started in FY2016, is a collaborative framework for researchers among the five core organizations to explore research themes with potential to spark innovation in various fields such as biotechnology, computational materials science, big data analysis, and IoT.

Open Use of Facilities

- Nanotechnology facilities belonging to the five core organizations are available to external users. We provide them with one-stop services through accessible tools such as the database for open research facilities in Tsukuba.
- AIST offers seven open platforms to external users, including the Super Cleanroom, MEMS foundry, Nano-Processing Facility (NPF), etc. (photo ⑥⑧⑩⑪)

Human Resource Development Using the Facilities

- Nanotechnology facilities belonging to the five core organizations are available to external users. We provide them with one-stop services through accessible tools such as the database for open research facilities in Tsukuba.
- AIST offers seven open platforms to external users, including the Super Cleanroom, MEMS foundry, Nano-Processing Facility (NPF), etc. (photo ⑥⑧⑩⑪)

Nanotech Career Up Alliance (Nanotech CUPAL) (see page 34).
- As part of lectures and summer schools that use advanced facilities of TIA led by the University of Tsukuba, AIST offers classes and short courses in nanoelectronics, power electronics, and MEMS. (photo ②)
- Under the guidance of AIST staff, internships offer experience in practical research together with corporate researchers. With the support of private companies, endowed courses on power electronics are held at the University of Tsukuba.
We promote open innovation toward the attainment of a super smart society, and healthy and safe living afforded by information and life technologies

As a base of integrated bio and IT research, AIST Tokyo Waterfront engages principally in research associated with the departments of Life Science and Biotechnology, and Information Technology and Human Factors, and intends to become an open innovation platform of this integrated research. Specifically, we promote cutting-edge R&D with an emphasis on integrated bio and IT: for instance, the medical application of genomic data, optimization of drug discovery by robotics and mathematical analysis technology, drug discovery screening by creating a library of natural products, measurement and digital modeling of human functions and behaviors, artificial intelligence technology that creates value from big data, and advanced cryptography to handle information safely.

In addition, by taking advantage of the convenient location of the research base at Tokyo Waterfront, AIST drives activities such as technology transfer, personnel exchange, and human resource development through joint research and collaboration among companies and universities, development of next-generation human resources, and public exhibitions of research results.

■ Main Research Themes

- Identification of targets of lead compounds (Photo ①)
  Using ultra-sensitive mass spectrometry and a robotic sampling system with high reproducibility, we analyze interactions of lead compounds and intracellular proteins. These results will be used for analysis of drug efficacy and side effect mechanisms, and linked to clinical research.

- Natural product library (Photo ②)
  Using the world’s largest library of natural products of approximately 270,000 samples, we support the actualization of efficient, effective drug discovery by screening that targets various diseases, including tumors and central nervous system diseases.

- Kids design industry support based on injury prevention engineering (Photo ③)
  We are developing injury prevention engineering, including databases of physical and behavioral characteristics of children and injury simulation technology for children, in order to reduce injuries and fatal accidents of children, and are creating an infrastructure of kids design industry based on data.

- Cryptography with advanced functionality (Photo ④)
  We are developing high-performance cryptographic technology to meet sophisticated needs, including data processing of encrypted data, simple setting of users that are allowed to decrypt each encrypted document, and user verification enabling privacy protection of users.

- Digital human model for product design (Photo ⑤)
  To design industrial products with more ease of use and safety, we are developing technologies to measure body geometry and motion, technologies to create digital human models with individual differences after analyzing measured data statistically and mechanically, and technology to evaluate compatibility of human models and products by computing interaction.

- Artificial intelligence (AI) (Photo ⑥)
  In cooperation with universities and private enterprises, we conduct large-scale basic research and R&D of advanced core-AI technology modules, and construct devise technical foundations as Japan’s largest AI research platform. In addition, we return research results to society through human resource development and technology transfer.
Open Innovation Platform

- **International collaboration**
  As an international collaboration hub for bio and IT, the research base collaborates with China, India, Singapore, Finland, the U.K., Germany, the Netherlands, and the U.S., and engages in personnel exchanges.

- **Consortium for Evidence-based Health & Wellness Service**
  “Consortium for Evidence-based Health & Wellness Service” was established to implement seeds of healthcare service in the industry to public use. For promotion of evidence-based healthcare business, we will develop new measurement technologies for effective healthcare by conducting the following: promotion of standard creation, development of new effective measurement procedures, planning for appropriate substantiative experiments, differentiation of services in the market and promotion of international standardization. To facilitate evidence-based healthcare businesses in affiliated companies, we produce associated projects through conducting the following: disclosed or member-limited lecture meetings, tours of inspection on job-sites and survey studies.

- **Hub function of AI research**
  We gather domestic and foreign talents engaged in artificial intelligence (AI) research, engage in AI from basic research to practical application, and serve as a hub for AI research and as a platform.

- **Forum for government, industry and academia association in Tokyo Waterfront area**
  We produce an association forum gathering people who work in government, industry and academia in the Tokyo Waterfront area (Daiba, Aomi, Ariake and Toyosu) to promote interactive connections of people working in universities, companies and public research institutes. This association is hosted by AIST Tokyo Waterfront, Tokyo Metropolitan Industrial Technology Research Institute and Asia Startup Office MONO. We aim at creating open innovation to contribute to 2020 Tokyo Olympics and Paralympics by further promoting our collaboration.

How to reach us   AIST Tokyo Waterfront

📞+81-3-3599-8001 💌 sgk-wf-ml@aist.go.jp 🖥️ www.aist.go.jp/waterfront/index_en.html
Initiative for strengthening our bridging function—Cooperation with universities

Open Innovation Laboratories

Since FY 2016, as a part of the “Open Innovation Arena concept” promoted by the Ministry of Economy, Trade and Industry (METI), AIST has created the concept of “open innovation laboratories” (OILs), collaborative research bases located on university campuses, and has been engaged in their provision. We are planning to establish more than ten OILs by FY 2020.

〈Objectives of establishing OILs〉

1. Carrying out successive research and development from basic research to demonstration in a seamless manner.
2. Accelerating research with a cross-appointment system, in which professors of the universities can also work as AIST researchers.
3. Developing doctoral researchers with open-minded and practical visions, capable of playing active roles in industries.

AIST will merge the basic research carried out at universities, etc. with AIST’s goal-oriented basic research and applied technology development, and will promote bridging research and development and industry by the establishment of OILs.

〈Actual cases〉

AIST-Nagoya Univ. GaN Advanced Device Open Innovation Laboratory (GaN-OIL)
Based on the technology of blue LED which Japan realized first in the world, we aim at early practical application of power semiconductors using GaN (gallium nitride).

AIST-Univ. Tokyo Advanced Operando-Measurement Technology Open Innovation Laboratory (OPERANDO-OIL)
Operando-measurement technology will lead to elucidation of functional mechanisms and visualization of manufacture processes. The acceleration of development of materials, devices is expected.

AIST-Tohoku Univ. Mathematics for Advanced Materials Open Innovation Laboratory (MathAM-OIL)
We will systemize technology for materials modeling research by means of mathematical science, such as discrete geometric analysis, and computational materials science. We will clarify the principle of correlation among the structures, functions, and processes of materials, and will accelerate materials development.

AIST-Waseda Univ. Computational Bio Big-Data Open Innovation Laboratory (CBBD-OIL)
We are aiming at elucidating life phenomena and mechanisms of diseases and the creation of innovative drugs and supplements, by integrating biological big data and information infrastructure technology with technology for life information analysis.

AIST-Osaka Univ. Advanced Photonics and Biosensing Open Innovation Laboratory (PhotoBIO-OIL)
We will conduct research and development of biosensing technology to elucidate mechanisms of organisms and to realize epoch-making drug creation, drug effect, toxicity evaluation, and infectious disease diagnosis, by integrating nanophotonics technology and bidevice technology.

AIST-Tokyo Tech Real World Big-Data Computation Open Innovation Laboratory (RWBC-OIL)
Our mission is to advance the high-end processing and applications of big data in the real world, utilizing high performance, scalable computing as well as AI-based analysis technologies on world-leading computing infrastructures.

AIST-Kyoto Univ. Chemical Energy Materials Open Innovation Laboratory (ChemOIL)
By creating innovative materials based on new concepts and developing them into chemical energy devices, we will contribute to realizing a low carbon society by 2050 that is aimed at in the Energy and Environment Innovation Strategy.

“Comprehensive strategy for town, people, creation” project
AIST-Kyushu Univ. Hydrogen Materials Laboratory (HydroMate)
By developing materials for safe and economical utilization of hydrogen, we aim to expand utilization and application technology of hydrogen.

How to reach us
Planning Headquarters OIL Office ☏ +81-3-5501-0830 pl-oil-ml@aist.go.jp
In order to conduct research and development more closely related to strategies of companies, we have established collaborative research laboratories, bearing partner company names. Partner companies provide their researchers and funding, and AIST provides research resources, such as its researchers, research facilities, and intellectual property. The loaned researchers of companies and AIST researchers jointly conduct research and development.

〈Actual cases〉
- NEC–AIST AI Cooperative Research Laboratory
- SEI–AIST Cyber Security Cooperative Research Laboratory
- Zeon–AIST Nanotube Industrialization Cooperative Research Laboratory
- TICO–AIST Cooperative Research Laboratory for Advanced Logistics
- Panasonic–AIST Advanced AI Cooperative Research Laboratory
- NGK SPARK PLUG–AIST Healthcare • Materials Cooperative Research Laboratory
- TEL–AIST Cooperative Research Laboratory for Advanced Materials and Processes
- YAZAKI–AIST Next-generation Connecting Technology Cooperative Research Laboratory
- UACJ – AIST Cooperative Research Laboratory for Aluminum Advanced Technology
- Shimizu – AIST Zero Emission Hydrogen Town Cooperative Research Laboratory

Collaborative research with private companies
Based on the individual needs of private companies, AIST transfers technology.

How to reach us
Research and Innovation Promotion Headquarters Large-Scale Collaboration Office
+81-29-862-6026 lsco-general-ml@aist.go.jp
AIST united as a whole supports regional industry

Regional Research Bases and Roles

■ Research and development  
— Creating unique regional strength

To support competitiveness of a regional economy, we promote emphasized research according to the respective region’s industrial structure, available technological seeds, and needs, and advance the dissemination of achievements.

■ Promoting collaboration  
— Responding to regional needs

Aligning closely with public research institutions of the region, we provide technical advice services, develop human resources, provide equipment and research facilities, and implement joint proposals for public funds and various joint activities, and thus support regional companies.

■ Research Bases of AIST around Japan

■ AIST Hokkaido  
Emphasized research theme: Bio-manufacturing

The shipment value for the agricultural, fishery, and livestock industries of Hokkaido is the highest among prefectures in Japan, and the associated food industry is an important industry base. For further development of the food industry, AIST Hokkaido is promoting research and development of new substance production technology using biotechnology, as represented by the closed-type transgenic plant factory using artificial lamps only. Through this research and development, we contribute to efficient production of pharmaceuticals, and high added value to agricultural and marine products and food.

To contact for collaboration
☎ +81-11-857-8406  
✉ hokkaido-counselors-ml@aist.go.jp

■ AIST Tohoku  
Emphasized research theme: Chemical-manufacturing

AIST Tohoku merges technologies of chemical reaction, processes, and materials, and promotes research and development of chemical manufacturing that leads to innovation for chemical processes and materials. Through transfers of research achievements to industry, we aim for environmental load reduction in the chemical manufacturing industry and high added value for regional resources. At the same time, we contribute to the construction of a new industry base, reinforcement of international competitiveness, and recovery from the Great East Japan Earthquake.

To contact for collaboration
☎ +81-22-237-0936  
✉ tohoku-counselors-ml@aist.go.jp

Tamamushi lacquerware with nanocomposite coating (The technique of Claist(R) developed at AIST Tohoku is applied to the nanocomposite coating). Photo courtesy of Tohoku Kogei Co., Ltd.

Coating apparatus emitting reduced volatile organic compounds (VOCs) by using supercritical carbon dioxide.
The Chubu region is an industrial hub for the automotive, aircraft, and machine tools industries. Targeting mainly inorganic new materials, such as ceramics and metals relating to these industry clusters, AIST Chubu promotes research and development of various industrial components with outstanding environmental resistance and reliability, structural members contributing to lightweight transportation equipment, and thermal control structural materials suitable for various usage environments. Through these efforts, we contribute to the enhancement of international competitiveness in the field of materials.

AIST Chubu

Emphasized research theme: Functional materials

In order to meet the needs of the manufacturing industries such as batteries and medical equipment concentrated in the Kansai region, AIST Kansai puts emphasis on both advanced battery and medical technology that enable us to live a healthy and safe life. For the sake of supporting these two technologies, AIST Kansai is promoting research and development of material and information technologies. By creating technology that can solve problems of energy which is vital for industry and people's lives, and biotechnology that invents the future, AIST Kansai contributes to the realization of a new system of living.

AIST Kansai

Emphasized research themes: Battery technology/Medical technology

AIST Chugoku conducts research and development toward a sustainable society, with an emphasis on the chemical, bio- and material technologies to produce fundamental and functional chemicals with high efficiency and low environmental load from wood-based biomass resources abundant in the Chugoku region. We have been working toward innovation to activate regional industries in cooperation with METI Chugoku and public research institutions in the Chugoku region, and constructing the network between companies in the region.

AIST Chugoku

Emphasized research theme: Biomass conversion technology
AIST Shikoku

Emphasized research theme: Health care

The Shikoku region faces relatively high rates of life-style diseases, such as diabetes, and looks toward technology development that will lead to disease prevention and early diagnosis. AIST Shikoku is pursuing research and development for disease-predictive diagnosis that measures health conditions in people, and research and development for the removal and detoxification of health risk factors in living environments. Through the integration of advanced biotechnology and nanotechnology with technology for materials and systems, we contribute to healthy and comfortable daily life in our rapidly aging society.

AIST Kyushu

Emphasized research theme: Manufacturing plant diagnosis

The Kyushu region has a concentration of automobile-related and semiconductor-related plants. To contribute to productivity improvement at sites of industrial production, AIST Kyushu is promoting research and development for upgrading production technology and driving maintenance efficiency, new sensing technology, sensor network technology, and application technology for collected data. While “bridging” research and development achievements and companies, we contribute widely to industry through measurement and diagnostic system research councils to solve common challenges faced by regional companies.

Examples of “Bridging” Technology (Technology Transfer) to Regional Small and Medium-sized Enterprises

AIST satisfies extensive needs of regional businesses by its technological seeds and nationwide network.

- AIST supports new product development using its technological seeds
- LSI internal wiring uncovered by suction-type micro plasma etcher; no residue remains
- Collaboration with Sanyu Co., Ltd. (Ibaraki)

- AIST’s novel evaluation technologies distinguish newly developed products from their competitors.
- Quantitative measurement apparatus for gas volume in ultra-high vacuum
- Standard conductance element
- Molecular flow controller
- Collaboration with PURERON JAPAN CO., LTD. (Fukushima), and ULVAC, Inc. (Kanagawa)

- AIST provides technological support to regional companies in collaboration with municipal research institutes.
- Development of evaluation technology for static electricity free rope
- Electric discharge condition observed by a high sensitive camera
- Spherical shape electrode and earth (left) and a high sensitive camera (right)
- Collaboration with TAKAGI KOGYO CO., Ltd. (Kagawa), and Kagawa Prefectural Industrial Technology Research Center
Commercialization Support and International Collaboration

Through research at the highest global standards based on societal and industrial needs and “bridging” the achieved results and industry, AIST fulfills a central role in innovation and contributes to the attainment of a sustainable society.

Reinforcement of Technology Marketing Function

In order to upgrade our capability of “bridging” technology and industry, AIST has assigned innovation coordinators (including personnel who formerly worked at private companies and public research institutions) to its research bases around Japan. The coordinators are ready to respond to various needs of industry, society and their regions under the dictum to “Meet frequently, listen carefully, act promptly.” In addition, diverse solutions across planning, development, demonstration, and commercialization are available through technology consulting that leverages knowledge obtained from cutting-edge research and development.

Creation of AIST Start-ups

AIST engages in creating start-ups and supporting business ventures that create new markets and industries utilizing research achievements of AIST. In addition to AIST technological seeds, start-ups can be launched through incorporating technological seeds from universities or private companies.

Investment of IP and Facilities for Venture Companies

Since 2014, following the amendment of the Act for the Reinforcement of Research and Development Capability, AIST has been able to provide in-kind investment to venture companies that leverage AIST research achievements. By investing facilities, equipment, and intellectual property rights held by AIST, we can aid in the enhancement of the business foundation and credibility of venture companies.

IP that Companies can Flexibly Utilize

With respect to fundamental research achievements, AIST is promoting wide utilization of our intellectual property including jointly owned IP, in many domains and companies. On the other hand, regarding the applicable research results achieved through collaboration with companies, we make IP available in accordance with the intent of collaborating companies.
Accessibility to AIST Facilities and Equipment

When the research achievements of AIST are utilized, companies can use the state-of-the-art research facilities of AIST to produce and sell samples of their own products. Companies can reach commercialization seamlessly from the research stage in a shorter period of time.

Promotion of Strategic International Collaboration

Reflecting the characteristics of each partner organization or country, AIST develops strategic approaches toward international cooperation. The international activities include implementation of cutting-edge research in a joint laboratory, utilization of overseas resources, contribution to global issues, and promotion of measurement standards.

Collaboration with Fraunhofer

Joint researches have been conducted in partnership with Germany's Fraunhofer Institute for Laser Technology (ILT) on high-quality single crystal growth of new functional electronic and photonic materials using lasers, whose application in memory and power devices etc. is being anticipated. ILT is in charge of developing laser irradiation technologies, while AIST will develop single crystal growth technologies as well as evaluate the physical properties of single crystals.

Collaboration with India

A joint laboratory (DAILAB) was established with the Department of Biotechnology (DBT), Ministry of Science and Technology of India, within AIST, and is working on joint research toward development of anti-cancer drug reagents based on screening and imaging technology of AIST and India’s bio-resources. DAILAB actively hosts periodic seminars and personnel exchanges. In total, six DAILABs have been established in India and Sri Lanka.

Malaria diagnosis technology

With the purpose to enable early diagnosis of malaria, which is one of the world’s three major infectious diseases, AIST independently developed a test apparatus using a cell chip. With this device, AIST has been conducting field tests together with overseas research organizations. AIST strives to gain the use of the device in malaria-infected areas in Africa and other regions in the future in cooperation with international organizations such as WHO.

How to reach us

Research and Innovation Promotion Planning Office
Research and Innovation Promotion Headquarters
☎️ +81-29-862-6040
✉️ raiso-general-ml@aist.go.jp

Collaboration Promotion and International Affairs Division
Research and Innovation Promotion Headquarters
☎️ +81-29-862-6144
✉️ cpiad-ml@aist.go.jp
AIST actively brings together diverse, superb technological seeds and human resources from domestic and foreign universities and regional public research organizations and companies. Our role of bridging becomes smoother through enhanced career mobility for advanced research personnel and higher AIST research potential. Richly varied curricula foster and form human resources who will lead the formulation of innovation in the future.

Deployment of the Cross-appointment System

As a core institution of “bridging” research and industry, AIST has established the cross-appointment system for researchers, who can have appointments at multiple institutions and take an active role as formal staff in any institution, in order to build a research structure that extends beyond the boundaries of an organization. Based on this system, advanced research personnel have an expanded area in which to take active roles. The increased mobility of human resources, and selection of superior technological seeds born from fundamental research at universities lead to expectations of an organization structured for bridging research and industry for commercialization.

How to reach us

Human Resources Division
General Affairs Headquarters
+81-29-862-6282
hrd-keikaku-ml@aist.go.jp

※ Example of engagement share
AIST accepts students, as well as researchers and engineers from companies, for certain periods. The program offers opportunities for technology trainees to learn cutting-edge testing and analysis technology at AIST. Such opportunities encourage those human resources to challenge themselves in new research and technology fields.

AIST has a program to hire graduate students as AIST Research Assistants. Graduate students hired under this program can concentrate on research activities without financial difficulties, and can participate in R&D projects implemented by AIST to gain practical research experience. They come to develop skills to carry out sophisticated research and improve research plans, and progressively apply research achievements to their degree theses.

### How to reach us

Collaboration Promotion and International Affairs Division Research and Innovation Promotion Headquarters

+81-29-862-6144  aist-ra-ml@aist.go.jp

### Innovation School

With the aim of developing doctoral talent that can perform across a broad range of fields in society, AIST hosts the Innovation School for postdoctoral researchers and PhD students with a curriculum to encourage broader perspective and reform of awareness.

Lectures and seminars bring instructors active in a variety of fields, and practical research work at AIST research sites and corporate internship programs (OJT) aim to develop human resources fit and ready for work. The teaching encompasses a synthetic research methodology that lets students consider research scenarios from an all-encompassing perspective, realize what skills they must acquire for the future, and work to develop communication skills.

Over 270 trainees have completed the Innovation School curriculum since its opening in 2008, with a growing human network. Many alumni work daily at the frontline of innovative development in companies, universities, and public research institutions today.

### How to reach us

Innovation School General Affairs Headquarters

+81-29-849-1600  school-jimukyoku-ml@aist.go.jp

### Nanotech CUPAL

Nanotech Career-up Alliance (Nanotech CUPAL) was established based on the subsidized project by MEXT “The Consortium Structuring Project to Foster Science and Technology Personnel” in FY 2014. To enhance the careers of nanotech researchers in Japan and to improve their career mobility, Nanotech CUPAL has enlisted TIA, a center for open innovation, and Kyoto University's Nanotechnology Hub, which are at the heart of developing the Nanotech Research Professional (NRP) and the Nanotech Innovation Professional (NIP).

### How to reach us

TIA Central Office Nanotech CUPAL Secretariat

+81-29-862-6123  nanotech-cupal-ml@aist.go.jp
Highlights of Research Achievements

Starting as the Geological Survey of Japan in 1882, followed by the era of its forerunner, the Agency of Industrial Science and Technology, and up until now, AIST has achieved numerous instances of breakthrough research and development that have left their mark in the annals of science history. We introduce here prime achievements spanning nearly 130 years from the 1880s until today.

**1880s**

**Geological map of Japan (1 : 3,000,000)**

The first complete geological map of Japan was published in 1889, a mere seven years after founding of the Geological Survey of Japan. Its history is closely linked to the development of geology, industry and mining in Japan, which began with instruction by foreign nationals at the beginning of the Meiji Period.

**TIEL method of ammonia synthesis**

The Provisional Laboratory of Nitrogen developed the first national ammonia synthesis technology using its original robust catalyst. It is the result of Japan's first large-scale project and is recognized worldwide as the “TIEL method of ammonia synthesis.”

**1920s**

**Transistor computer MARK-IV**

The Electrotechnical Laboratory completed Japan’s first transistor computer, the ETL Mark III, in 1956. It was then enhanced to create the Mark-IV and Mark-IV A, leading the way for commercialization of computers in Japan.

**1950s**

**PAN based carbon fiber**

In 1959, the Government Industrial Research Institute, Osaka, was the first in the world to develop lightweight and high strength carbon fiber from polycrylonitrile (PAN) fiber which came to be used in clothing and other products. Research aimed at its practical application was launched in the 1960s, and the material is now widely used in a multitude of products from fishing rods to airplanes.

**1960s**

**Production process for glucose isomerase used to make soft drink sweetener**

The Fermentation Research Institute developed a method for producing super sweet fructose by using glucose isomerase from glucose. It later signed license agreements with numerous companies in Japan, the US, and other countries, which resulted in its use all over the world.

**Production method for transparent conductive film (ITO = indium tin oxide)**

The Government Industrial Research Institute, Osaka, was the first in the world to develop technology for industrial production of indium tin oxide (ITO) transparent conductive film, which is indispensable to liquid crystal displays and solar cells. This film also aided in the industrialization of liquid crystal calculators and is now the source of a huge market.

**1980s**

**Catalytic action of gold nanoparticles**

Gold was considered to have no catalytic function, but in 1982 the Government Industrial Research Institute, Osaka, discovered specifically high catalytic activity of gold nanoparticles (3–4 nm) carried on metal oxide surfaces. The activity was outstanding even at low temperatures, and opened doors to commercial applications like deodorizing catalysts, detoxification of carbon monoxide, and gas sensors.

**Anode alloys as the foundation for nickel metal hydride batteries**

Research on the nickel metal hydride batteries used in hybrid cars began at the Government Industrial Research Institute, Osaka, in the 1970s. Around 1990, the first nickel metal hydride battery that had the same performance as lead batteries at half the weight was created. It is also garnering interest for use as a large stationary battery.

**2000s**

**High-performance MTJ device for HDD magnetic heads**

We developed high-performance magnetic tunnel junction (MTJ) devices with crystalline magnesium oxide (MgO) tunnel barrier for HDD read heads, which have more than doubled the recording density of HDD than before. Such high-performance MgO-TMR read heads are used in all HDDs manufactured today.
The latest research achievements, announcements, and various information for the general public, researchers and engineers, and industry associates can be found at these Internet sites.

**General inquiries**

**Collaboration and technical consultation**

**Research achievements**
- [www.aist.go.jp/aist_e/list/us_latest_research.html](http://www.aist.go.jp/aist_e/list/us_latest_research.html)