

TIA

A platform for open innovation



About TIA



● A platform for open innovation

TIA is an open innovation hub operated by five public organizations: the National Institute of Advanced Industrial Science and Technology (AIST), the National Institute for Materials Science (NIMS), the University of Tsukuba, the High Energy Accelerator Research Organization (KEK), and the University of Tokyo. To drive innovation in Japan, these five stellar organizations of TIA collaborate and compile their resources for R&D (e.g., researchers, facilities, and intellectual property) and support the creation of knowledge and its application in industry. TIA also fosters next-generation scientists and engineers.

TIA was first named the Tsukuba Innovation Arena for Nanotechnology (TIA-nano) in 2009, and then renamed to TIA in 2016. Since then, TIA has expanded its research focus from nanotechnology to biotechnology, healthcare, computer science, and the internet of things (IoT). In the same year, the TIA collaborative research program “Kakehashi” commenced. Kakehashi plays a role in fostering the seeds of research with the potential to spark innovation through close cooperation among the core organizations and matching these seeds to needs, and then developing the latter into large-scale R&D projects or enabling commercialization.

TIA continues to promote innovation by cooperating with industry and improving its one-stop services.

Five principles

1. Creation of global value
2. Under one roof
3. Independence/positive cycle
4. Networking for “win-win”
5. Education of next-generation scientists and engineers

Platform activities

Creating innovation using diverse technology seeds

● Research and development platforms

TIA provides organizations and companies both inside and outside TIA with an environment for R&D at the TIA platforms. At the core of these platforms are the Super cleanroom (SCR), the MEMS foundry, and the power electronics production lines among others. **TIA projects** and consortiums are the major R&D activities.



Nanoelectronics



Power electronics



MEMS



Nano-GREEN



Carbon nanotubes



Light/quantum measurement



Biotechnology and medical treatment

● Open research facilities

The five core organizations make their advanced research devices and facilities, including electron microscopes and synchrotron radiation facilities, available for shared use.



● Human resource development

TIA fosters excellent researchers and engineers by offering intensive summer school sessions and degree programs, taking advantage of outstanding TIA researchers and facilities.



● Creation of technology seeds and innovation acceleration

TIA provides venues for gathering researchers with different affiliations or expertise and accelerates innovation by conducting workshops, technical meetings, and other events, where technology seeds are created, fused, and matched with business needs.





TIA, a platform for open innovation

History

1970 The Tsukuba Science City Construction Act came into effect.

2009 Tsukuba Innovation Arena for Nanotechnology (TIA-nano) started.



2012 KEK joined TIA-nano.

2015 The second phase of TIA-nano started.

2016 TIA-nano changed its name to TIA. The University of Tokyo joined TIA.



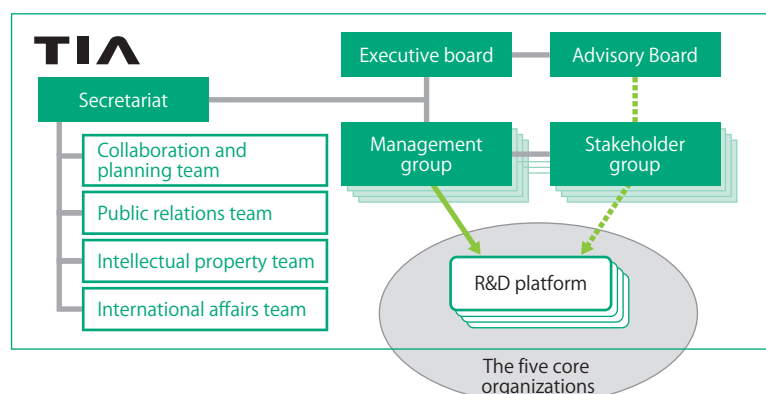
TIA collaborative research program "Kakehashi" started.



Governance structure

TIA is collaboratively operated by five core institutes and universities. In addition, with the aim of making Japan's industries more competitive, the Japan Business Federation (Keidanren) is taking part in its management. TIA also receives a wide range of support from administrative bodies including the Cabinet Office, the Ministry of Education, Culture, Sports, Science and Technology (MEXT), and the Ministry of Economy, Trade and Industry (METI).

TIA has an **Executive Board**, which is the highest decision-making body, consisting of eight members: the respective heads of the five core organizations, one representative from the industry, one independent expert, and the chairperson of the Advisory Board. The **Advisory Board** includes members from industry and is responsible for coordinating with industry players, who are the main users of TIA. The **Secretariat** is jointly run by the five core organizations, to ensure smooth functioning of the TIA R&D platforms.



TIA's results – practical application and commercialization –

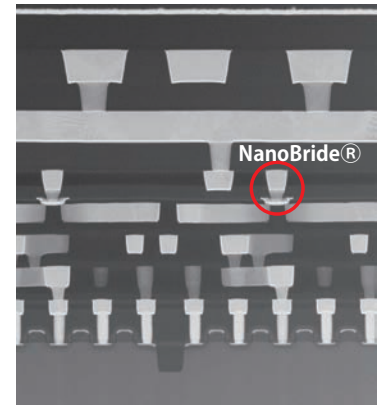
TIA boasts world-leading facilities and equipment, outstanding researchers and engineers, and distinguished technological expertise and intellectual property. TIA's long-term activities performed using these resources have led to diverse and visible results, such as mass production and commercialization, the development of products for practical use, and the laying of the foundation of venture companies, in addition to research outputs compiled as research papers, patents, and know-how.



Practical application of NanoBridge-FPGA devices

Ultra-Low-Voltage Device Project for Low-Carbon Society (FY 2010-FY 2014)(*)
Development of One Million LUT Atom Switch FPGA (FY 2016-FY 2018)(*)

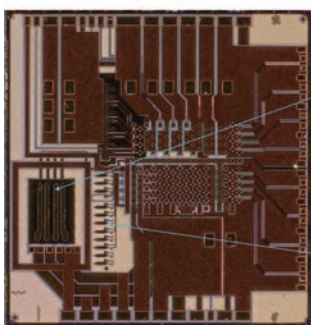
The NanoBridge-FPGA (Field Programmable Gate Array) has remarkably high radiation tolerance and power efficiency compared with conventional FPGAs based on static random-access memory (SRAM). Following the discovery of the principle of the NanoBridge-FPGA, which is called atom switch, and its fundamental research in NIMS, NEC and AIST have developed devices and circuits based on the principle. Their verification in and integration into large-scale LSI and reliability studies have been conducted in the AIST Super cleanroom (SCR), the TIA nanoelectronics platform, while considering 300-mm wafer-based commercialization. After the conduct of these studies, the resulting technology reached practical application. NEC will verify the practicality and reliability of the device aboard satellites and compile practical results. NEC will also expand the device's application for communication and IoT equipment in which low power performance is important.



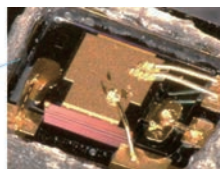
Practical application of optical I/O cores

Integrated Photonics-Electronics Convergence System
Technology (FY 2013-FY 2021)(*)

The Photonics Electronics Technology Research Association (PETRA) developed the world's smallest, fingertip-size optical transceivers (optical I/O cores), based on fundamental photonics-electronics integration technology nurtured in TIA-SCR. To commercialize the optical I/O cores, PETRA established the AIO Core Co., Ltd. in April 2017. The AIO Core Co., Ltd. provides optical interconnect solutions through state-of-the-art silicon photonics. Based on the technologies accumulated at PETRA, the AIO Core completed multimode fiber transmission capability for 50 m or farther distance on a 5-mm square chip at temperature ranging from -40 °C to 85 °C.



Top of view of TRx chip



LD mount



Optical coupling pins



Minimalfab

Development of an innovative fabrication process technology
(Minimal fab)(FY 2012–FY 2014)(*)

Minimal fab is a super-compact production system for semiconductors, targeting low-volume and high-variety markets. The AIST devised the concept, enabled its fundamental development, and in cooperation with about 150 companies, brought it into practical use. Minimal fab does not require a clean room because it is equipped with a locally clean transfer system. It has chemical solutions and can operate only by supply of electric power (AC 100 V), compressed air, and nitrogen. Power consumption is only 250 W per tool on average. The user interface (UI) for all tools is standardized, and dedicated operators are not required. Although a conventional prototype fabrication line performs only about two processes per day, Minimal fab can perform 20-30 processes per day, owing to the sophisticated and standardized UI and rapid 15-second vacuum loading time. Minimal fab has high development efficiency and has already been used for development of CMOS and MEMS sensors. Minimal fab tools are now commercially available.



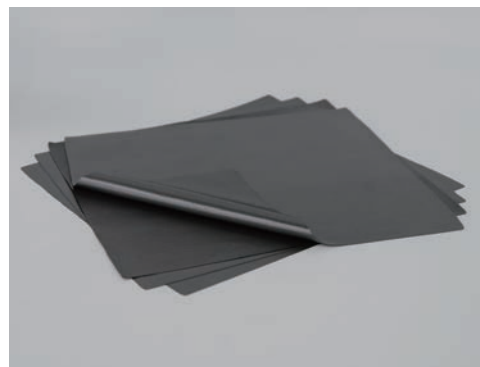
Projects marked with * were performed under New Energy and Industrial Technology Development Organization (NEDO).



CNT mass production plant and practical application of SGCNT

CNT mass production demonstration plant project
Innovative carbon nanotube composite materials project for a low-carbon society
(FY 2014-FY 2016)(*)

AIST and the Zeon Corporation jointly promoted the development of a fundamental mass production technique based on the super-growth (SG) method. The SG method is an innovative carbon nanotube synthesis method developed by Dr. Kenji Hata and AIST colleagues in 2004. A mass production demonstration plant was built and operated as a project under the FY 2009 supplementary budget of the Ministry of Economy, Trade and Industry (METI). Based on the results and techniques, the world's first mass production plant for SGCNTs, which are high-grade CNTs obtained via the SG method, was built and is currently operating at Zeon Corporation's Tokuyama Plant. The Zeon Corporation provides SGCNTs and promotes the commercialization of products that maximize SGCNT features, thereby bringing various materials, such as high-performance thermal interface materials (TIMs), into practical use.



Thermal interface materials (TIMs) using CNTs



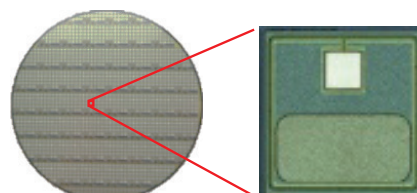
Mass production plant for SiC power device in operation

Tsukuba Power-Electronics Constellations (TPEC)(founded in April 2012)

Since April 2012, AIST has operated the Tsukuba Power-Electronics Constellations (TPEC) as a new industry-funded consortium, to promote open innovation in power electronics. Fuji Electric Co., Ltd., which is among the first and principal members of TPEC, developed the component technology necessary for the practical application of SiC power devices in TPEC. Fuji Electric also evaluated a practical device production using a mass-production line for prototypes at AIST Tsukuba West. Based on these results, Fuji Electric built 6-inch wafer process lines for the production of SiC power devices at Matsumoto Factory in Nagano Prefecture. This factory is the company's production base for power semiconductors and produces some of the most advanced SiC power devices.



Fuji Electric's SiC device plant in operation (2013)



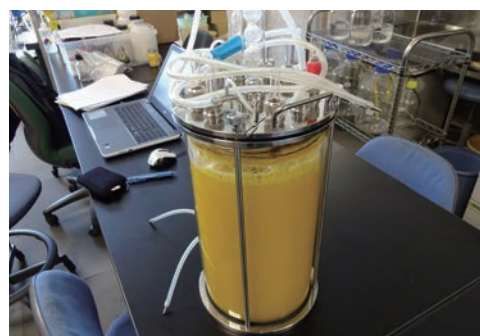
Six-inch wafer (left) and SiC trench gate MOSFET (right)



Algal Bio

Functional assays of 3,000 algal strains and development of new markets
in the age of self-medication (Kakehashi project in FY 2016)
Acceleration of functional assays of 3,000 microalgal strains and non-edible
biomass and development of new markets (Kakehashi project in FY 2017)

In March 2018, the Algal Bio Co., Ltd., a university-based venture business located in Kashiwa City, Chiba Prefecture, was established for R&D on algal biomass. Algal Bio's establishment aimed to expand and propagate the application of algae and microalgae. Specifically, it aims to put functional components (carotenoids, long-chain polyunsaturated fatty acids) produced by microalgae into practical use, based on research results from two separate projects of JST-CREST and JST-START. These projects were performed at the Laboratory of Plant Life Science of the Graduate School of Frontier Sciences, the University of Tokyo. In the TIA Kakehashi program, functional assays of microalgae were performed cooperatively by many researchers of member organizations. Based on the findings, an additional objective, that is "the development of a new market for functional biomass," was included in the business plan. The company will also provide health care products, which are necessary in this age of self-medication.



Mass production method for carotenoids
(Japanese Patent Application No. 2016-566380)



Seven-colored next-generation chlorella
(Japanese Patent Application No. 2016-566380, Method for mass production of carotenoids)



TIA's collaborative research program “Kakehashi”

Kakehashi is a program in which the TIA's five core organizations collaborate beyond their organizational boundaries and support research and collaborative activities to explore new fields. Kakehashi promotes the fusion of different professional techniques and the knowledge of the TIA core organizations. Further, it aims at facilitating large-scale collaborative research and projects by conducting open study groups, seminars, and exhibitions, and by utilizing external human resources, know-how, research resources, and research funding outside TIA.

Various styles of collaboration

1) Integration of different fields or technology

Create, integrate, and develop technology seeds by collaboration among the TIA organizations.

2) Spread of technology seeds

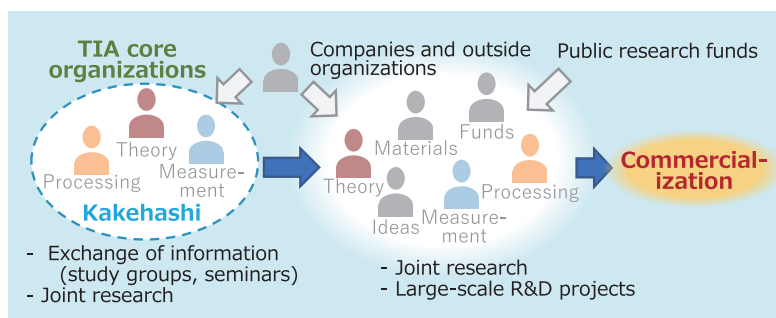
Disseminate technology seeds through activities, such as study groups, workshops, consortia, and exhibitions.

3) Application and commercialization of technology seeds

Start-up R&D projects to advance technology seeds toward commercialization (acquire public budgets and launch joint development with private companies)

4) Matching of technology seeds with company needs

Conduct feasibility studies to start a joint research by matching technological challenges and company needs with TIA's technology seeds.

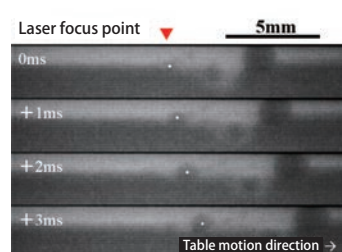


Integration and creation of technology seeds

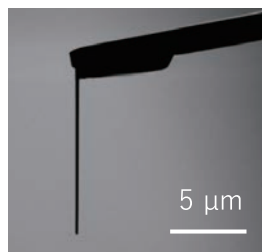
Metal 3D printing creates a three-dimensional metal shape by selectively melting and solidifying a metal powder bed using laser and by stacking one layer over another; the process results in several dozens of microns in thickness. Because powder undergoes complex phase changes, including melting, vaporization, and solidification during laser irradiation, in-situ observation is indispensable for understanding the phenomenon of these phase changes. In the Kakehashi project, researchers involved in additive manufacturing (AIST) and those in metal materials and evaluation technology (NIMS) worked collaboratively and observed successfully the melting and solidification of metal powder during processes similar to those under actual printing.

The selective isolation and analysis of intracellular vesicles from living cells is expected to become an effective technology for understanding the mechanism of intercellular communication. In particular, exosomes in multivesicular bodies in intracellular vesicles have received attention as a material for cancer diagnosis and are expected to lead to minimally invasive examination. The Kakehashi project has succeeded in selectively removing intracellular vesicles through a combination of techniques: tagging endosomes with fusion proteins developed by NIMS and an AFM cantilever nanoneedle technique developed by AIST.

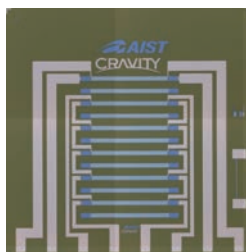
A fractional flux quantum proposed by AIST is an idea that involves splitting a quantum using phase-difference space. This process is expected to lead to increased memory capacity in low-power, high-speed superconducting computers and the foundation of quantum computers. The combination of superconducting devices fabricated at one of the TIA's open research facilities, namely, CRAVITY at AIST and quantum measurement techniques at NIMS, enabled the experimental formation and observation of a fractional flux quantum vortex.



In-situ observation of melting metal powder



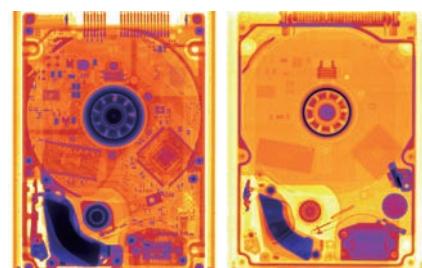
A nanoneedle



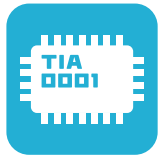
Fractional flux quantum device

Project development and commercialization

Recently, neutrons have become a well-known probe for a structural analysis of the advanced materials such as Hydrogen-fuels and lithium-ion batteries. However, to date, the use of neutrons has been limited only at large-scale experimental facilities such as nuclear reactors. A Kakehashi project has conducted a study to achieve a **portable neutron structural analysis**, which is available in small laboratories. This project has also launched the development of technology using a compact neutron source. As a starting point, the project succeeded in acquiring distinct neutron radiographs using a prototype of neutron flat panel detector. A collaboration network was established and gave rise to a project led by AIST, NIMS, KEK, and RIKEN. (NEDO project “Research and Development on Innovative Structural Materials”)



Radiographs of 2.5" HDD by X ray (left) and by neutron (right)



Nanoelectronics

Cutting-edge R&D in the nanoelectronics research domain focuses on nanodevices, IoT nanodevices, next-generation semiconductor nanofabrication and evaluation technologies, and fusion of photonics and electronics. Most of R&D projects have been conducted using the Super cleanroom (SCR) as the core research facility. A large number of researchers from industries, universities and research institutes work on a broad range of projects involving the development of devices, materials, and equipment. The SCR is a core of the open innovation platform for the researchers to explore new businesses and technologies. In addition, it provides a range of services related to common fundamental nanoelectronics technologies by highly skilled engineers supporting the projects.

Advanced device manufacturing facility with the Super cleanroom (SCR)

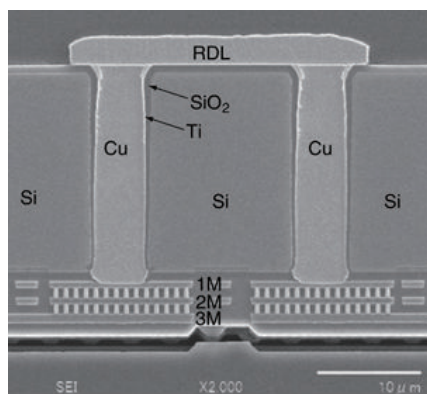
The 3,000 m² SCR is equipped with a set of nanodevice manufacturing machines compatible with 300 mm wafers. Many current projects aim to reduce the power consumption of LSI (large-scale integration) devices in the next IoT age. These projects include R&D of non-volatile memory devices (spintronics, atom switches, and phase change devices) that can be integrated into a low-voltage CMOS circuit, silicon photonics devices, and three-dimensional LSI devices. Numerous process and measurement equipment at the SCR is available to external users (<https://unit.aist.go.jp/tia-co/orp/index.html>).



Super cleanroom

The R&D center for three-dimensional integration and packaging technology

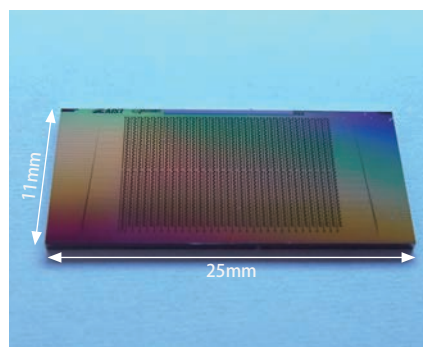
We aim to apply IoT to society by creating smaller, power-saving, and high-performance IoT devices. To achieve this, we are developing three-dimensional packaging technology using through-silicon vias (TSVs). It offers an alternative way to integrate semiconductor devices without relying on device miniaturization. (*)



Through-silicon via (TSV)

Leading R&D center for silicon photonics

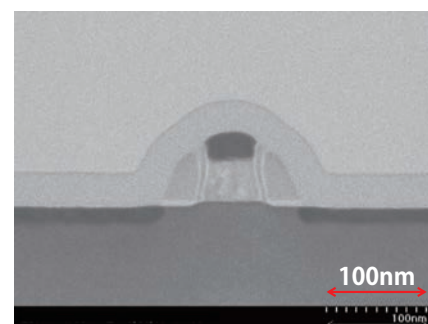
We are aiming to develop next-generation, ultra-low-power, information and communication systems and ecosystems. To this end, we are conducting research on innovative technology based on the fusion of photonics and electronics, such as highly integrated optical switches and highly efficient signal transmission technology.



32 x 32 optical switch device

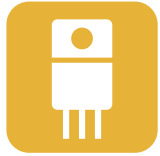
Semiconductor production platform with applications in high performance IoT devices

We provide advanced prototyping of semiconductor devices with 300 mm-diameter Si wafers. The development of patterning technology using next-generation lithography and that of prototyping processes for new materials and new structures suitable for IoT devices are conducted.



Transistor formed on a 300 mm-diameter Si wafer

* Results of the NEDO project "R&D Project for the Next Generation Smart Device" (FY2013–FY 2017)

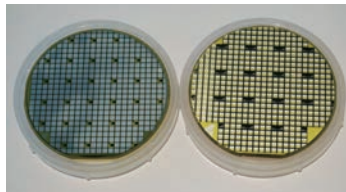


Power electronics

Power electronics is a field in which Japanese industry still maintains high competitiveness in the global market. The core technology is SiC (silicon carbide) power semiconductor devices, which are considered highly promising innovative devices that will contribute to creating a low-carbon society. Power electronics research domain of TIA is based on R&D on SiC crystal growth, wafer processing, epitaxial film growth and SiC device manufacturing which AIST has been the world leader in R&D of SiC for over 30 years. Companies, universities and research institutes have come together and are playing the central role in Japan's world-leading SiC R&D.

Building an SiC power device research environment and promoting state-of-the-art research

AIST, which has a large cleanroom for producing SiC prototype devices, has been working to establish evaluation technologies through accumulation of various data concerning wafers and devices and to increase the efficiency of the manufacturing process. At TIA, AIST and universities conduct a wide range of basic research (defect evaluation, study of new structural devices, simulation, etc.), and the results of such research are used for applied research that meets the needs of industry. Particular focus is placed on R&D for the manufacture of next-generation large-diameter wafers, high-breakdown voltage devices, etc. in which companies such as automobile, materials, processing and device manufacturers cooperate in an integrated manner.



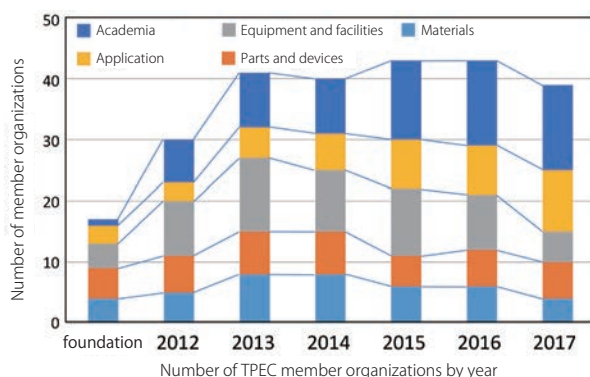
SiC devices prototype on 3-inch wafer



Cleanroom for producing SiC power device prototype

Tsukuba Power-Electronics Constellations (TPEC): an industry-funded open innovation consortium

Under the initiative of AIST, the Tsukuba Power-Electronics Constellations (TPEC) was founded in April 2012 as a unique industry-funded consortium for promoting open innovation in power electronics. TPEC operates in a self-sustaining manner, with power electronics-related companies integrating their own technological strength and sharing research costs. TPEC contributes to not only R&D for industrial applications but also the development of human resources who will lead the next generation in power electronics.



SiC power electronics line (SPEL)

In response to expectations in energy-saving technology using SiC power devices for hybrid cars and railway vehicles, full-fledged use of 6-inch-class SiC power semiconductor wafers has accelerated. At the TIA's power electronics R&D platform, new lines that are capable of mass producing SiC power semiconductor devices were built, in cooperation with industry, and brought into operation. This is the world's first open innovation platform for 6-inch-class wafer processing. The development and promotion of technologies for mass production, reliability evaluation, and quality evaluation for SiC power devices are anticipated.

ASCOT: a technology development consortium

A technology development consortium called the Applied Superconductivity Constellations of Tsukuba (ASCOT), established in May 2016, promotes open innovation toward application of superconducting technology for solving societal problems, and aims at creating new businesses, and developing human resources responsible for future generations. ASCOT established a task force that examines business models. It has accelerated its activity while holding monthly study groups for the creation of a new technology. In addition, ASCOT has held the International Symposium on Superconductivity (ISS) and a superconductivity school every year.



ISS2017



MEMS

We have established a MEMS (micro-electro-mechanical system) production line that processes 200/300-mm wafers and facilities for integrations and packaging on the premises of AIST Tsukuba East, and are providing a venue to promote open innovation through joint research and/or demonstrative development in collaboration with MEMS researchers from companies and universities. In addition to miniaturization, functionality enhancement, and strengthening industrial competitiveness of advanced MEMS devices, we promote R&D of application-oriented integration and systematization. Through these activities, we aim to develop technologies that will contribute to society in the areas of living environment, infrastructure, and energy saving. Moreover, in these MEMS production facilities, we provide various services of process and analysis for R&D, and foundry services such as prototype device production, to private companies, universities, and academic research institutes.

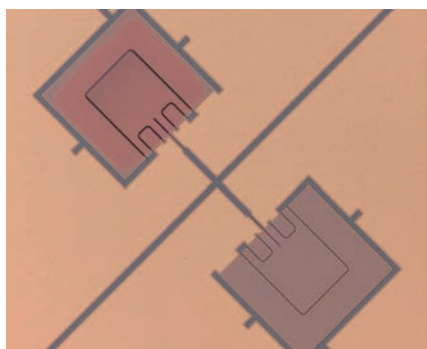
MEMS R&D Center that meets advanced research needs and provision of foundry services

We have established a MEMS foundry (TKB-812) to research and develop advanced integrated-MEMS and fabricate prototype devices using a large-diameter (200/300 mm) wafer process line. We conduct research, evaluation and demonstration of MEMS devices in collaboration with companies and universities. Also, given that the MEMS foundry is an open research facility, we offer various services, such as R&D support, various process and analysis services, and prototyping devices in coordination with MicroNano Open Innovation Center (MNOIC).



Development of innovative sensors based on new principles*

A gyro sensor using a high-sensitivity pressure sensor that measures inertial force of fluid in a circular channel is robust against noise induced by vibration, etc. An infrared sensor using nanopillars fabricated by MEMS processing can vary its sensing wavelength over a broad range. Spatial perception technology for robots and autonomous vehicles using these innovative sensors combined with artificial intelligence are now under development.

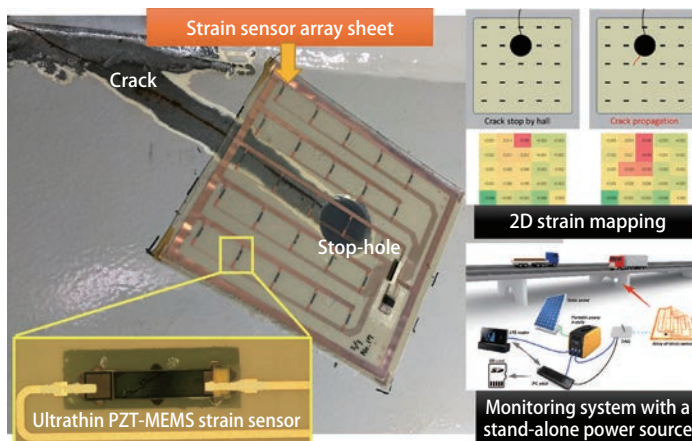


MEMS high-sensitivity pressure sensor

Road infrastructure monitoring with large-area flexible sensor sheets**

To maintain aging bridges, we are developing a system to monitor cracks by measuring the strain distribution in bridges. We have developed a large-area sensor sheet with an array of MEMS-based ultrathin piezoelectric strain sensors arranged on a flexible circuit substrate. This device can detect cracks by strain mapping. An onboard power system

using a solar cell and a wireless communication device enable the device stand-alone operation of strain measurement and communication. By attaching the sensor sheets on bridges, and then connecting these sensors to a wireless network, the system is expected to enable continual monitoring of bridges and inspection during times of disaster.



* Result of NEDO project "AI-enabled Innovative Recognition System for Spatial Mobile Robots (AIRs)" (FY 2017-FY 2018)

** Result of NEDO project "Research and Development of Sensing System for Road Infrastructure Monitoring System" (FY 2014-FY 2018)

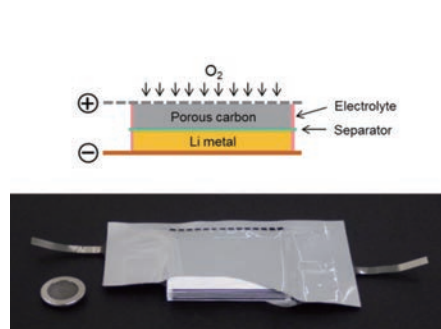


Nano-GREEN

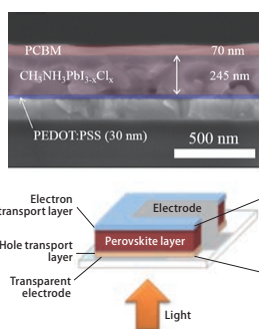
National Institute for Materials Science (NIMS) is playing a central role in coordination with academia, including TIA core institutes, in providing a venue for collaborative research with industries to create environmental and energy technologies using nanotechnology. We encourage a wide range of industrial partners both in Japan and abroad to participate in Nano-GREEN (Global Research Center for Environment and Energy based on Nanomaterials Science) to accelerate R&D in materials technologies. We arrange various forms of collaboration with companies according to their request. At Nano-GREEN, we aim to conduct efficient R&D through coordinated and integrated utilization of materials technologies developed by NIMS, advanced measurement technology, and computational science.

Research themes taking advantage of NIMS-developed materials and technologies

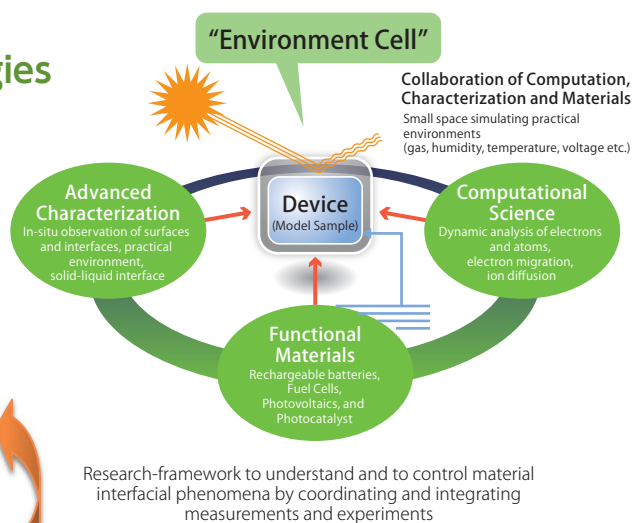
In order to develop a sustainable society, we are promoting basic R&D of materials and technologies in the areas of environment and energy. In particular, we are making major efforts for the studies on all solid-state rechargeable batteries, lithium-air rechargeable batteries, and on perovskite solar cells to address common technological issues with an all Japan formation of collaborations between industries, government and academia.



Schematic and 10-cell stack of lithium-air battery

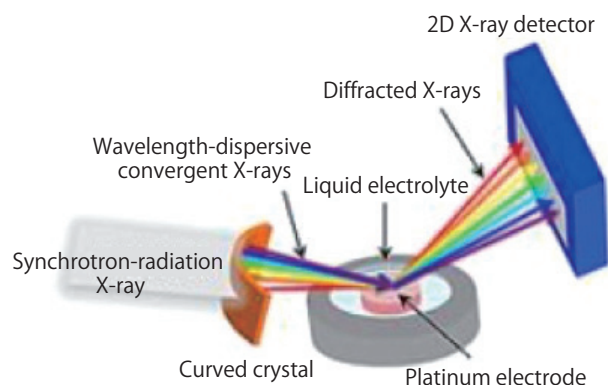


Schematic cross section of a low-temperature solution-processed perovskite solar cell and its elements



Advanced measurement technology enabling in-situ surface/interface analysis in the operating environment

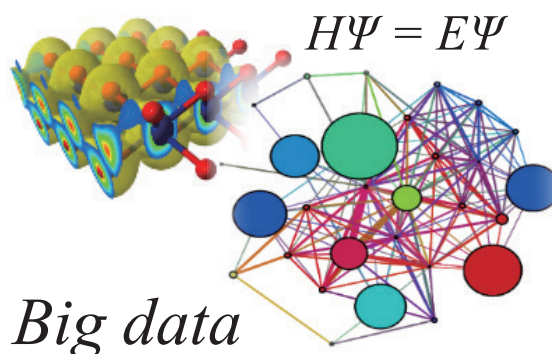
We will identify the basic mechanisms of the surface/interface phenomena which will be the key for the function of the relevant materials by making the best use of environment controlling technology developed by NIMS.



Real-time observation of atomic motion at solid-liquid interfaces

Computational science for dynamic analysis of electron/atom transfer, and ion diffusion, etc.

We aim to understand electron/atom dynamics at nanosurfaces/nanointerfaces, which form the basic principle of energy conversion, using a sophisticated computational scientific method. Based on the knowledge gained from those studies, we are also drawing up guidelines for designing new materials and functions.



Efficient research of new materials utilizing big data



Carbon nanotubes

The world's first factory to manufacture single-walled carbon nanotubes (SWCNTs) was built in Japan. To increase SWCNT business in the future, it is vital to expand the application of SWCNTs and increase their demand. It is also indispensable to develop more advanced technology to mass-produce SWCNTs and significantly reduce their production cost. To achieve these goals, we intend to develop a dispersion evaluation technique, which will make it possible to identify the relation between the characteristics of carbon nanotube (CNT) composite materials and the dispersion state of CNTs, and promote the development of products using the materials. In addition, we hope to develop revolutionary CNT-applied materials by making use of the outstanding properties of SWCNTs, which are 20 times stronger than steel, 10 times more thermally conductive than copper, 50% less dense than aluminum, and 10 times higher than silicon in terms of electron mobility. Such materials will contribute to the development of totally new "dream products." Regarding the health effects of nanocarbon materials, such as CNTs, in the workplace, we assist business operators in conducting voluntary management of such issues. In this effort, we have been developing and encouraging the use of inexpensive and simple emission and exposure assessment methods, and quick and easy hazard assessment protocols.

Development of SWCNT mass production technology

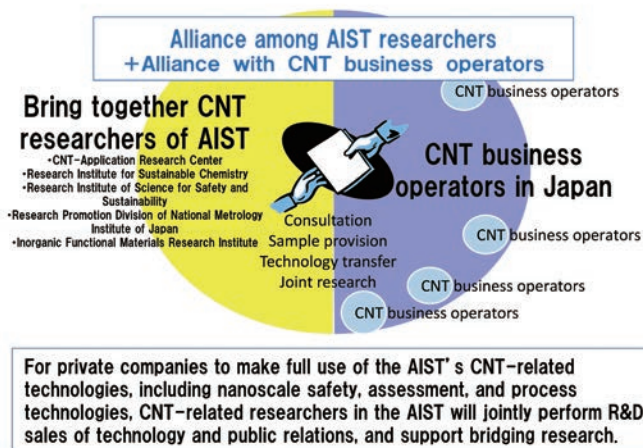
We have made progress in the development of SWCNT mass production technology using Super-growth method as a fundamental technique. Consequently, we were able to optimize the fabrication process and achieve a continuous large-area (500 mm by 500 mm) synthesis of an SWCNT forest (bulk), which led to the construction of a commercial-scale factory. Moreover, to expand SWCNT applications, we aim to further reduce production cost by developing a new fabrication process and mass production technology.



CNT manufacturing plant (Tokuyama works, Zeon Corporation)

Carbon nanotube alliance consortium

Following the achievements of a TIA project titled "Nanocarbon application project to realize a low carbon society," a new open platform, called the Carbon Nanotube (CNT) Alliance Consortium, was established. This consortium allows various companies involved in CNT research to conduct R&D on an open or closed platform, as part of the innovation consortium-oriented joint research that the AIST is promoting. The AIST's researchers, who manage safety, assessment, and process technologies for CNT materials that are in high demand by CNT-related business operators, participate in the consortium and unite themselves to serve as a bridge.



Conceptual illustration of the CNT Alliance Consortium

The Team of Application for Carbon Nanotubes Composites (TACC), which started in April 2017, is the first open platform-based joint research team in the CNT Alliance Consortium. TACC is based in AIST Tsukuba and consists of researchers on loan from the Zeon Corporation and Sunarrow Ltd. and researchers from AIST. TACC develops master batches of CNT and resin/rubber composite materials. It also conducts sales of technology for composites, product development, manufacturing process development using biaxial mixing or injection molding, and other research and development activities. The TACC's undertakings aim to bring CNT composite materials to the market within three years, thus creating the first Japanese CNT industry through cooperation between AIST and private companies.



TACC exhibit at the Nanotech 2018 (Zeon Corporation, Sunarrow Ltd., and AIST)



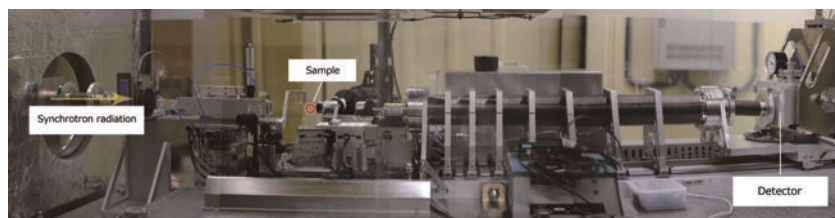
Light/quantum measurement

We pioneer academic research for elucidating the origins of the universe and the roots of substance and life using cutting-edge light/quantum measurement technologies, such as large accelerators.

Regarding light/quantum measurement, the TIA's five core organizations have combined their advanced light/quantum measurement technologies, with the aim of creating new science and industry. The platform aims at conducting the following: development of high-performance light/quantum beam generation technologies; development of high-sensitivity, high-precision, and high-resolution light/quantum detectors and advanced measurement technologies; and research on the origins of material functions and fundamental development of new functional materials using newly developed light/quantum measurement technologies.

Fundamental research for new materials

We promote fundamental physical property research on the origins of material functions through application of light/quantum beams. By directly linking research laboratories that use light/quantum beams and those that develop materials, fundamental research and development has accelerated in the field of structural materials, electronic materials, and environment and energy materials, where new world-leading materials are expected to emerge.



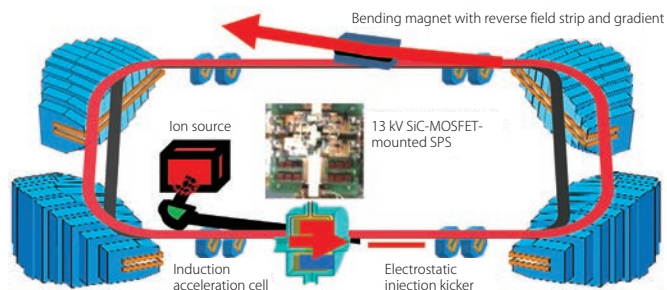
X-ray Absorption Fine Structure - Computed Tomography (XAFS-CT)



X-ray Absorption Fine Structure with a Superconducting Detector (SC-XAFS)

Research and development on light/quantum beam generation technologies

The development of a light/quantum beam source, which is compact, lightweight, and portable, is conducted in research and industrial settings. The aim is to create accelerators that show higher performance and are compact and energy-saving overall, by, among others, transferring the technology for development of large accelerators and adopting SiC power semiconductors. New tools were created for research and industrial settings, and the use of light/quantum beam sources, such as X-ray, neutron, and muon sources with compact accelerators, is expanding.



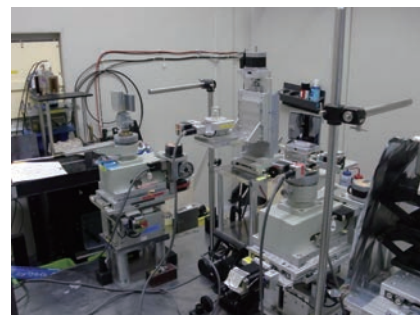
Induction Microtron for Giant Cluster Ions



Compact ERL

Light/quantum detection and innovative measurement technologies

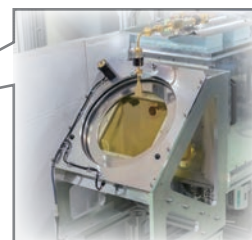
We developed new high-sensitivity and high-resolution detectors, such as superconductive and silicon-on-insulator (SOI) detectors. Innovation in measurement and diagnostic technologies in diverse fields has advanced. Such fields range from fundamental physics research and medical research, to infrastructure diagnosis, wherein cosmic rays, radiation, and quantum beams generated by accelerators are employed. Applied research, such as the application of cosmic microwave background radiation observation technology to meteorology and agriculture, has also been promoted in many fields.



Synchrotron Radiation X-ray Imaging for Medical Applications



Meteorological Application of CMB Technologies (KUMODES)





Biotechnology and medical treatment

Under the leadership of the University of Tsukuba, TIA has conducted R&D to apply its technology to not only advanced nanotechnology but also biotechnology and medical treatment. The participation of the University of Tokyo and commencement of the TIA collaborative research program “Kakehashi” have further expanded research areas and promoted collaboration, leading to practical application and commercialization of research results in those fields.

Nano-biotechnology

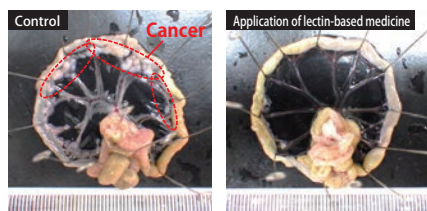
TIA's technologies and advanced systems are expected to be applied to nanobiotechnology, in a way that TIA can conduct every phase of R&D, from the creation of materials and their evaluation, to device fabrication, and even to systematization. The Tsukuba Clinical Research & Development Organization (T-CReDO) was established in the University of Tsukuba, where a system to support demonstrative and clinical trials for social implementation, which is important particularly for nanobiotechnology, has been put in place. In collaboration with T-CReDO, TIA aims to develop a nanobiotechnology platform, which enables the seamless execution of R&D steps, from basic research to the development of technology seeds and to the verification and implementation of clinical research. TIA also aims to create incubators for life innovation.

● Tsukuba Clinical Research & Development Organization (T-CReDO)
<http://www.s.hosp.tsukuba.ac.jp/t-credo/>



Medical application of glycan-targeted lectins

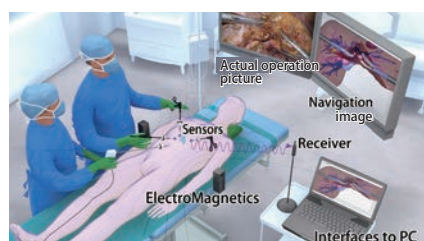
Lectins are proteins bound to sugars (glycans). Japan leads the world in the development of their application technology. Lectins vary widely in terms of properties and functions. They are expected to be applied to regenerative medicine and diagnostic agents, owing to the recent progress in recombinant construction and the development of glycan profiling technology. Based on the advanced glycan analysis technology, called the lectin microarray, which was developed by AIST, and other technologies, we promote the development of diagnostic agents and therapeutic methods for pancreatic cancer. In the development of these agents and methods, we use glycan-targeted lectins, in collaboration with the TIA core organizations and domestic companies. Moreover, through the Lectin application technology meeting, collaboration with overseas companies will be expanded, and human resource development will be promoted.



Anticancer effects of lectin-based medicine in a mouse model with pancreatic cancer and peritoneal metastasis

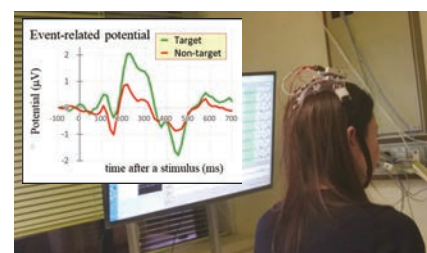
Real-time navigation system in the body

Using a real-time navigation system for laparoscopic hepatectomy surgery, a surgeon can understand on which part he/she is actually operating and how to proceed with the operation according to the navigation. This is a new system under development and is thus different from conventional surgery support systems. More specifically, the surgeon can receive a warning sign from sensors equipped in surgical tools if the incision is out of the cutting line or if there is a risk of tissue damage, thereby allowing the surgeon to correct the procedure. With the advancement in such surgery support systems, we will ensure further safety and accuracy of surgery and enhance education of next-generation surgeons in the improvement of their surgical skills.



A cognitive assessment system based on brain wave reading

Using the core technology of the “Neurocommunicator[®]” system, we are developing prototypes of a cognitive assessment system in which a brain wave component (event-related potential), which reflects a momentary increase in attention, is used as a biomarker. This system, which is among the technological seeds that AIST fostered, enables us to evaluate cognitive function, especially attention, quantitatively and independently of language and motor functions. It is expected to contribute to the development of various applications, such as regular monitoring of long-term bed-ridden persons with physical disabilities, detection of symptoms of dementia often observed in older persons, support for cognitive rehabilitation of patients affected by stroke, and rehabilitation of children with developmental disorders.



Brain wave measurement and event-related potential



Human resource development

We are establishing a TIA Graduate School system to develop human resources for the next generation. TIA Graduate School is educational infrastructure aiming to provide a higher level of education than any single university or research institute, taking advantage of outstanding TIA researchers and facilities. The system takes a variety of initiatives to develop skilled human resources. Nanotech Career-up Alliance (Nanotech CUPAL) is another project to foster young-generation researchers in the nanotechnology field. The project was launched in FY2014 with support from the grant-in-aid program for the development of human resources in science and technology, and is led by TIA and Kyoto University.

TIA Graduate School Summer Open Festival

TIA Graduate School Summer Open Festival provides students and young scientists with opportunities to gain up-to-date knowledge and skills in nanoscience/nanotechnology and to interact in an inter-organizational manner. During the event, lectures, practical training sessions, and facility tours are given by leading researchers and industrial technical experts from Japan and overseas. Students and company researchers around Japan can be qualified to participate in the event. In addition, participants can attend lectures provided in English by prestigious professors from overseas universities, and thus enjoy an international flavor in Tsukuba. Some of these educational activities are equivalent to first-term doctoral classes at the University of Tsukuba, therefore signifying the high educational quality of the event.



<https://tia-edu.jp>

TIA Graduate School power electronics course

Since graduate school education is provided through collaboration of industry, academia and government, a "TIA Graduate School power electronics course" was opened in April 2013, combining two endowed laboratories at the University of Tsukuba (the Toyota Motor-Denso power electronics endowed laboratory and the Fuji Electric power electronics endowed laboratory) and employing AIST researchers as instructors (Cooperative Graduate School System). Through systematically learning power electronics as an academic discipline and conducting collaborative research in close cooperation with company researchers, students of this course are expected to play in the future an active role in companies, and succeed and further develop Japan's advanced power electronics technologies. The human resource development undertaken in this course is implemented with the cooperation of an industry-funded consortium operated as a collaboration of industry, academia and government and based on the Tsukuba Power-Electronics Constellations (TPEC).



● Cooperative Graduate School System
A system at the University of Tsukuba to provide education at its graduate school by employing researchers from research institutes as professors at the University of Tsukuba while keeping their status as institute researchers, and also using the research environments of those research institutes.

Nanotech Career-up Alliance: Nanotech CUPAL

AIST, NIMS, KEK, and the University of Tsukuba from TIA, and Kyoto University, all of which are the centers of the industry-academia-government resonance fields in the area of nanotechnology, are taking charge of providing education and training to young scientists in the Nanotech Career-up Alliance (CUPAL). Supplemented by cutting-edge expertise and equipment, CUPAL offers Nanotech Research Professional (N.R.P.) courses, which form a joint research program aiming to foster professionals who will lead the creation of new understandings in nanotechnology. CUPAL also offers Nanotech Innovation Professional (N.I.P.) courses, which provide basic and practical training sessions for members to foster professionals who will lead innovative research in nanotechnology. Researchers and students from a wide range of industries, universities, and research institutes are also able to join the N.I.P. courses.



<https://nanotechcupal.jp/nip/>



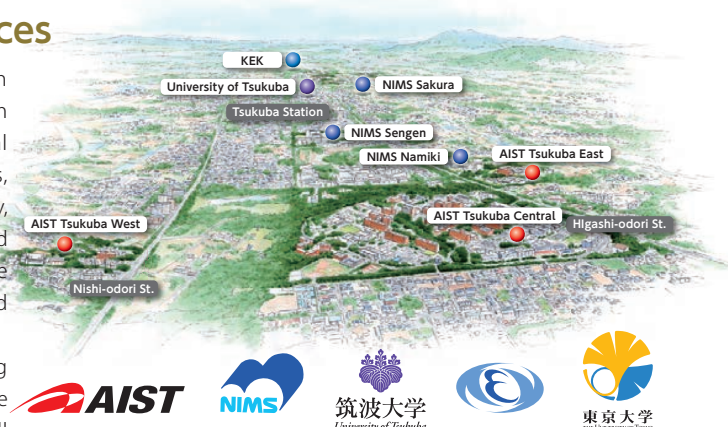
Open research facilities

In Tsukuba, Ibaraki Prefecture, 32 public research organizations account for approximately a third of all public research organizations in Japan. The TIA core organizations, namely, AIST, NIMS, University of Tsukuba, and KEK, have research facilities and equipment for a wide range of fields, including those developed uniquely in these organizations. In addition to their intended use for R&D, these innovative devices, equipment, and facilities are available for external use. They can be accessed for free or a fee through various services, such as technical surrogates in prototyping or measurement and under joint research. They form a network of TIA open research facilities, which the University of Tokyo joined in FY 2016.

Advanced equipment and forms of services

The four core organizations in Tsukuba lie in an oval-shaped area, which extends 15 km north to south. The area holds 15 open research facilities with approximately 500 devices in total. These devices range from fundamental equipment to special-purpose facilities, which can achieve diverse purposes, spanning from academic research to the development of industrial technology, including microfabrication processing equipment, advanced measurement and analysis equipment, experimental facilities using synchrotron radiation of the Photon Factory (PF), devices available to cosmic radiation tolerance test, and facilities for the syntheses of molecules and substances.

The open facilities are available through various forms of services, including technical consultation, technical surrogate, use of equipment, and collaborative research. They are available either free of charge, assuming that the results will be published, or for a fee, under a strict non-disclosure agreement that the results will not be published. The Photon Factory (PF) at the KEK offers shared use of the facility to university researchers for free. Some facilities are part of the MEXT Nanotechnology Platform Project, which promotes shared use.



Microfabrication	Photolithography	Elemental analysis	Structural analysis
Thin film formation	Mass spectrometry	Surface analysis	High intensity synchrotron radiation
Device fabrication			



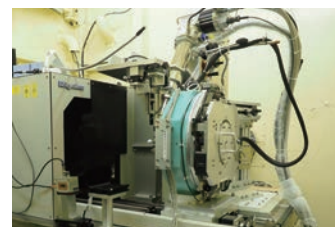
i-Line stepper (AIST)



Atomic-resolution analytical electron microscope (NIMS)



1 MV Tandem accelerator (the University of Tsukuba)



Multipurpose Weissenberg camera under extreme conditions (KEK)

Seminars and human resource development

TIA offers various seminars, schools, and training courses to develop human resources. In this way, human resources are expected to play active roles in various fields, from academic research to the development of industrial technologies and R&D in cutting-edge nanoscale processing, measurement, and analysis. Various courses showcase the advantages and distinctive features of each organization, such as a practical training using equipment in the SCR of AIST or the trial measurement and processing using ion beam (free of charge) offered by the University of Tsukuba.

Database of Open Research Facilities in Tsukuba

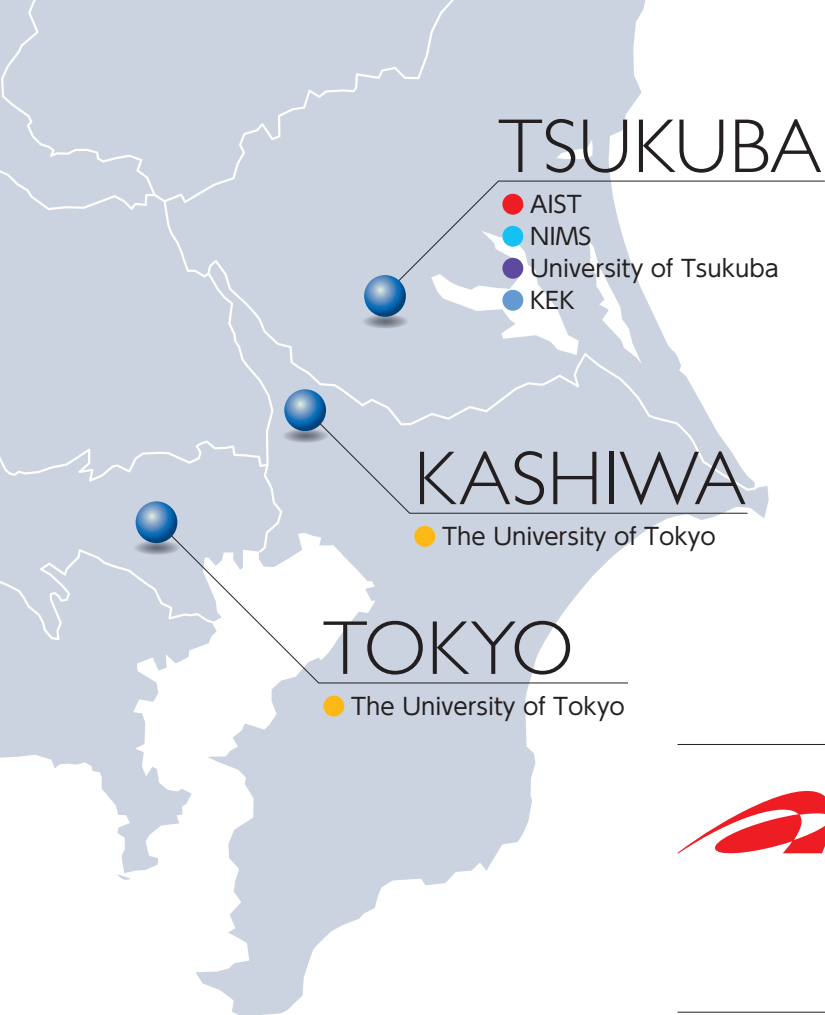
<http://oft.tsukuba-sogotokku.jp/>

This database was created in FY2013 as a part of the Tsukuba International Strategic Zone projects. Currently, the database marks the registration of more than 300 pieces of shared use equipment belonging to the four core organizations of TIA based in the Tsukuba area (AIST, NIMS, University of Tsukuba, and KEK), and researchers can search for equipment that meets their purposes. By conducting keyword search, users can find the locations and specifications of equipment, and how to apply to use it. The database can also be used to search for equipment in terms of what material will be analyzed, measured, or processed, and what method will be used.



Contact Please send an e-mail to tia-orf_info@tia-nano.jp for any inquiries.

For details about facilities and equipment, please refer to <https://www.tia-nano.jp>.



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