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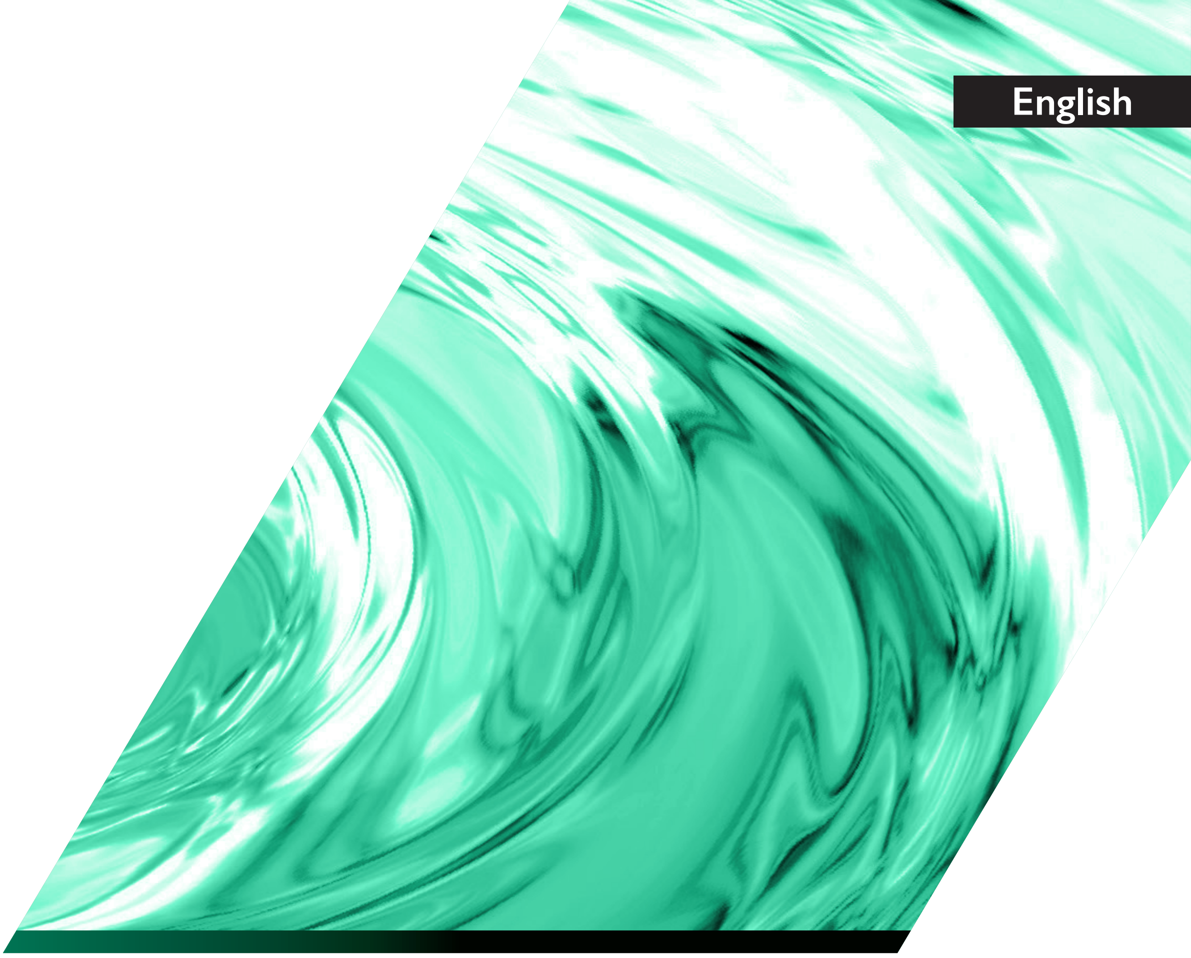
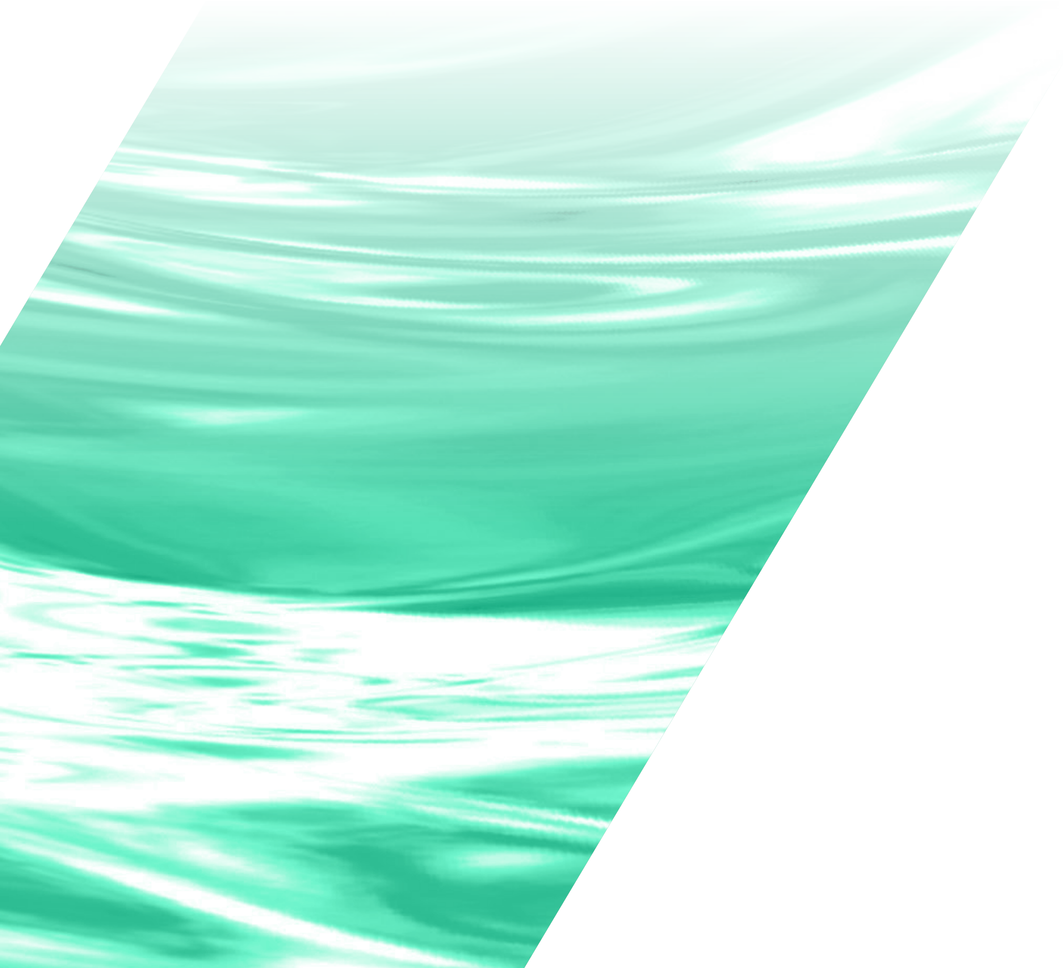


TIA

A platform for open innovation



TIA

About TIA

A platform for open innovation

TIA is an open innovation hub operated by six public organizations: 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 and Tohoku University. To drive innovation in Japan, these six 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. From 2020, TIA 3rd period started under the new vision "TIA to open up the future by expansion and deepening".

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

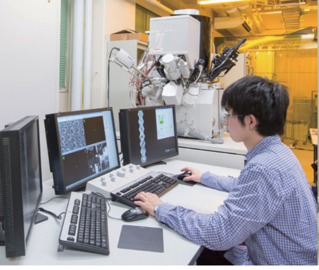
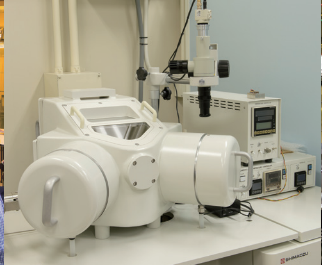
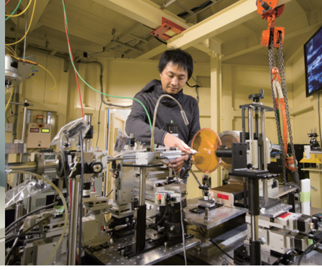
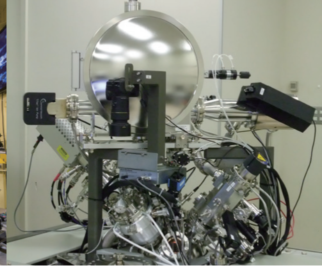
Human resource development

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 collaboration center


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.

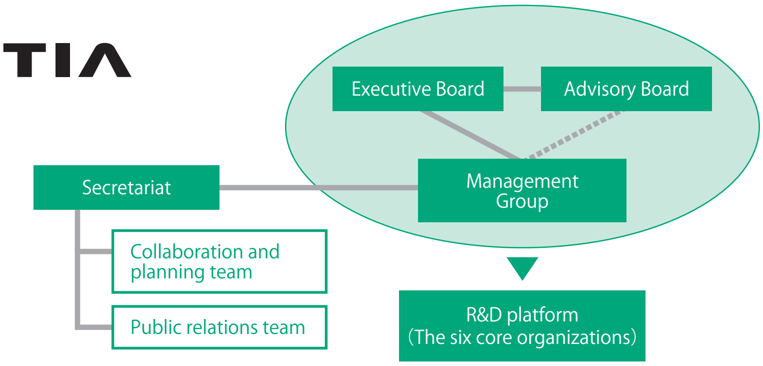
2019 TIA 10th anniversary symposium held

2020 The third phase of TIA started Tohoku University joined TIA

Governance structure

TIA is collaboratively operated by six 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 nine members: the respective heads of the six 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 six core organizations, to ensure smooth functioning of the TIA R&D platforms.

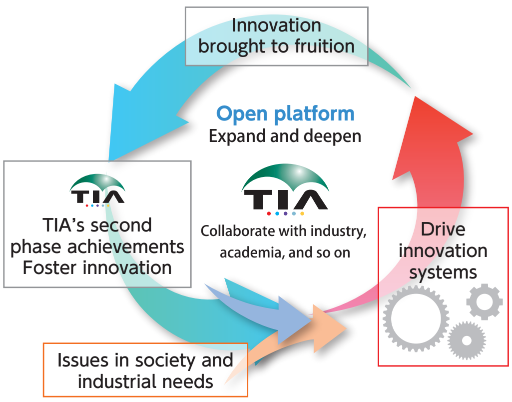


TIA Vision 2020–2024

TIA has led and performed open innovation in Japan over the last 10 years and made numerous noteworthy research achievements. The TIA Vision for 2020–2024 drives an open innovation system focused around the "Kakehashi" project.

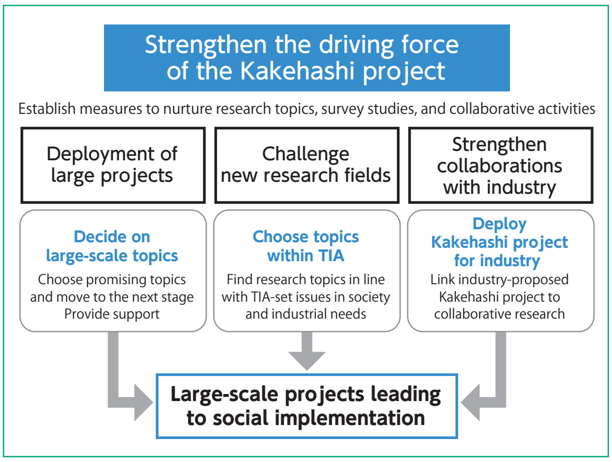
● Driving an open innovation system focused around the Kakehashi project

In the third phase, TIA drives open innovation systems from the creation of knowledge to their application in industry. Important issues in society and strong industrial needs will be extracted and incorporated into such systems to expand and deepen each system and clarify the innovation viewpoint. Collaboration with external organizations will also be enhanced.



● Enrichment of the Kakehashi project

Kakehashi, a new project to foster seeds with an innovation system mindset, is creating increased collaboration with external organizations. The driving force of this project will be strengthened by undertaking new measures.



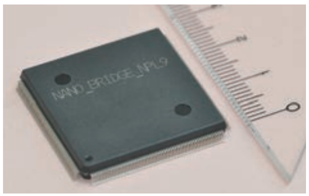
TIA's results – practical application and commercialization –

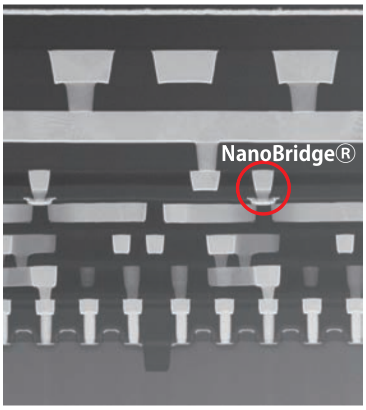
The six organizations comprising TIA boast world-leading facilities and equipment, outstanding researchers and engineers, and distinguished technological expertise. TIA's long-term activities performed using these resources have led to many achievements, including published scientific papers and intellectual property. Some of these research accomplishments have been commercialized and used for mass production, while others have led to the development of products for practical use or were the foundation of venture companies that became independent entities.

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.

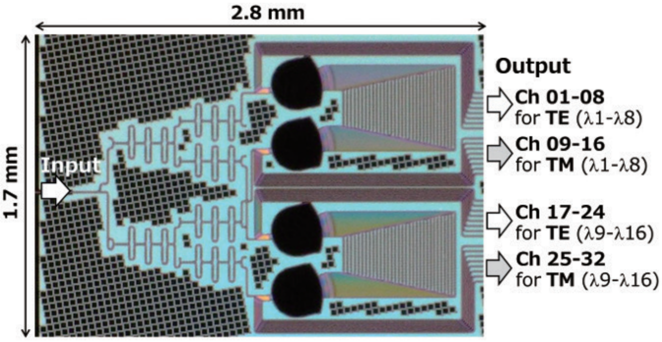




Development of 10-Tbps integrated photonics-electronics interposer

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

Data center and high-end computer demand low-power-consumption, high speed, and wide bandwidth optical transmission technology for data communication among the LSIs in the server or among the servers themselves. Photonics Electronics Technology Research Association (PETRA) developed the world's smallest, fingertip-size optical transceivers (optical I/O cores), a small and low-power-consumption 50-Gbps SiGe electrical absorption modulator, and a 16-wavelength Si multiplexer/demultiplexer for the next-generation 800-Gbps ethernet, based on fundamental photonics-electronics integration technology nurtured in TIA-SCR. PETRA established the AIO Core Co., Ltd. to commercialize the optical I/O cores in April 2017. Furthermore, PETRA has been developing a 10-Tbps photonics-electronics interposer composed of silicon photonics chips integrated with the established technologies.



16-wavelength Si multiplexer/demultiplexer

Minimal Fab

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
Nanocarbon application project for a low carbon society (FY 2014-FY 2016)(*)
CNT Alliance Consortium/Team of Application for Carbon Nanotubes Composites (2017-)

AIST and the Zeon Corporation jointly promoted the development of a fundamental mass production technique based on the super-growth (SG) method, which 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. 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 started to supply SGCNTs and took steps to commercialize products applying SGCNT. Sales of the heat-resistant O-ring "SGOINT™" started in 2018 from Sunarrow Limited.

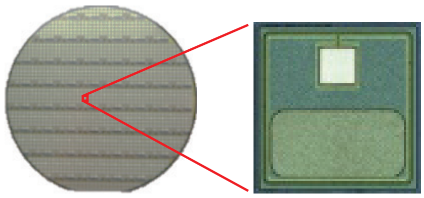
Heat/Pressure resistant O-ring "SGOINT™" reinforced by SGCNT

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. SiC power semiconductor modules developed for trains are installed and play active roles in new train cars for Shinkansen, as well as in conventional trains and subways.

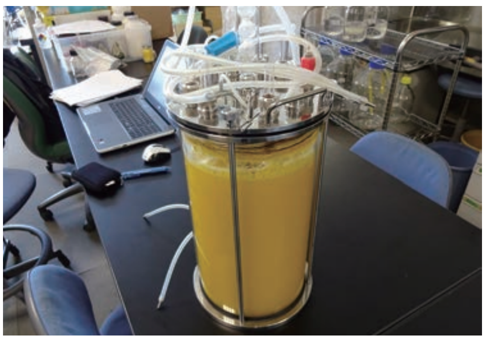

Fuji Electric's SiC device plant in operation (2013)


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)

Algal Bio Co., Ltd was established upon more than 20 years of scientific research at the University of Tokyo in March 2018. "Algal" in the company name symbolizes their mission to cultivate algae's potential for a better future with their unique scientific capabilities. Anticipating the advent of the "age of self-medication," the company, together with partner companies, develops functional ingredients derived from microalgae for nutraceuticals, beauty personal care products, food tech etc. that contribute to human health, which are required in modern society. TIA Kakehashi research group performed functionality assays on microalgae in collaboration with participating organizations, and the results were applied to accelerate the development of products for the advancement of a new market for functional biomass.


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)

*Incorporated using research achievements from a Strategic Basic Research Program (JST-CREST) and a Program for Creating Startups from Advanced Research and Technology (JST-START) at the Laboratory of Plant Life Science, Graduate School of Frontier Sciences, University of Tokyo.
Patents: one on carotenoids and one on long-chain polyunsaturated fatty acids, with exclusive licensing contracts

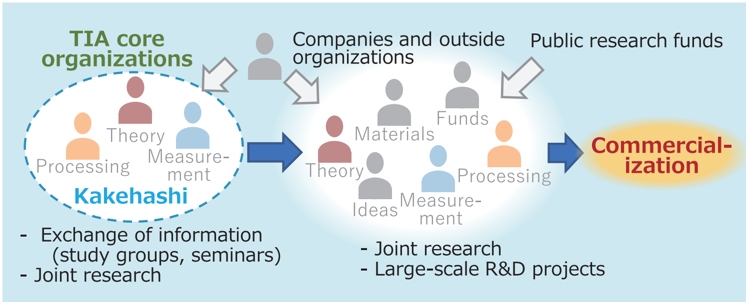
かけはし

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

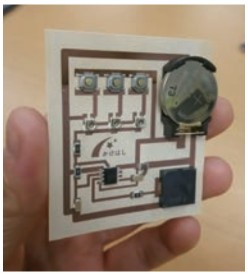
1) Integration of different fields or technology
2) Spread of technology seeds
3) Application and commercialization of technology seeds
4) Matching of technology seeds with company needs



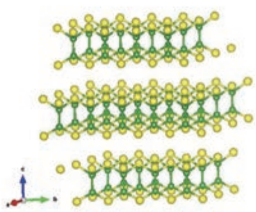
Discovery of the seeds of research for commercialization

Kakehashi projects establish a research system around the ideas of initiating research, which is difficult to undertake by a single researcher, through the formation of diverse collaborations that are not limited to a specific academic field. The technology seeds of the six core organizations are fused and fostered toward project deployment and commercialization.

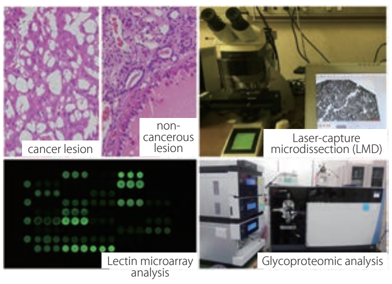
A paper device prototype with interactive elements was built for many people to enjoy touching, seeing, and hearing. The aim was to disseminate copper wiring technologies using printing that shows high affinity to paper, and device design technologies that take advantage of the features of paper through exhibition events. Some examples of devices include paper instruments that can be played, art exhibition tickets that start an audio guide when touched, paper media that talks when traced by a finger, and posters that have different touch sensations depending on the description.


Paper music instrument

Rhombohedral boron sulfide (r-BS) crystalized with a two-dimensional structure was synthesized under high pressure using a belt-type high-pressure apparatus at NIMS. The two-dimensional r-BS exfoliated using scotch-tape was evaluated its thickness using an atomic force microscope at the University of Tsukuba. The boron sulfide is expected to control the band gap over a wide range by a change in the two-dimensional structure. The lightweight and flexible r-BS indicating a particular tunable electro conductivity can be **applicable to wearable electronic devices**.

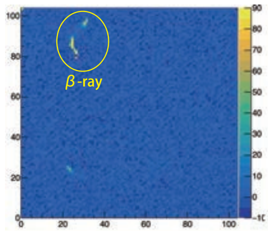

Crystal structure of two-dimensional r-BS synthesized under high pressure

Renal cell carcinoma (RCC) increases in end stage of renal disease (ESRD) patients on hemodialysis fifteen times as many as in patients without ESRD. There is no useful biomarkers to detect RCCs, and RCCs in hemodialysis patients are hard to be detected even TIA is conducting comprehensive analyses of RCC in ESRD, next generation sequencing (NGS), and glycomics in collaboration with AIST, to **identify a specific glycan-structure of RCC and establish a new biomarker for the diagnosis.**



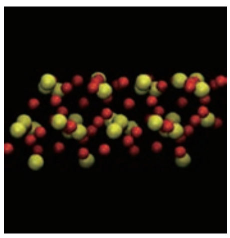
Tissue isolation and glycan structure analysis of RCC

Semiconductor quantum image sensors, where a typical example is particle detectors in high energy physics experiments, require complicated circuits that record a lot of information, e.g., particle hit position and time, at the pixel level. The pixel must be small to maintain spatial resolution. Therefore, a quantum image sensor using three-dimensional stacking technology that can stack circuits in a pixel was developed by KEK and AIST, the University of Tsukuba, and the University of Tokyo. An image sensor with approximately 10,000 × 20 μm-size pixels was used to observe β-ray tracks from ^{90}Sr with more than 99% bump yield.



Observation of β-ray tracks using a three-dimensional image sensor

Data assimilation analysis technologies combining measurements, calculations, and data science are attracting attention for understanding the structure and functionalities of materials and chemical reaction pathways. In Kakehashi, the University of Tokyo, NIMS, the University of Tsukuba, and KEK collaborated to develop new optimization technologies based on the data assimilation framework combining first-principles calculations, X-ray diffraction experiments, and machine learning. Development, public release, and promotion activities of materials science simulators generating high precision and quality data are also underway.

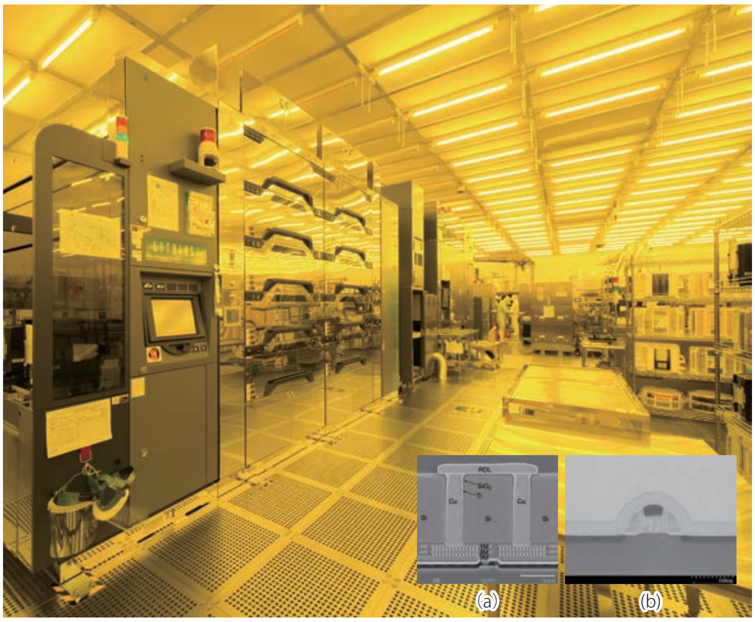

Crystal structure of coesite obtained by data assimilation

Nanoelectronics

Cutting-edge R&D in the nanoelectronics research domain includes device design technologies, nanofabrication and evaluation technologies, advanced memory and IoT devices, and the fusion of photonics and electronics. Most of these projects utilize research facilities such as AI Chip Design Center at the University of Tokyo, Center for Innovative Integrated Electronic Systems at Tohoku University, and the Super Cleanroom (SCR) and the High-Performance IoT Device R&D Hub at AIST. Many engineers and researchers from industry, universities, and research institutes work on a broad range of projects involving the development of devices, materials, and equipment, forming an open innovation hub to create new technologies and businesses. In addition, TIA provides a range of services related to common fundamental nanoelectronics technologies by highly skilled engineers to support projects.

Open-use clean room facility supporting high-performance IoT device R&D activities

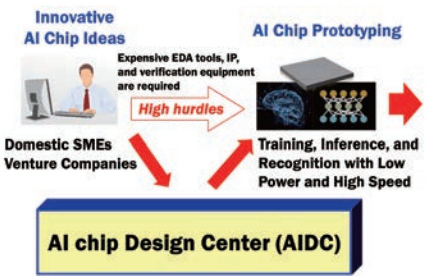
AIST has established R&D platform facilities including the SCR (3,000 m^2) and the High-Performance IoT Device R&D Hub (1,800 m^2) equipped with various process and evaluation tools capable with 300 mm Si wafer for nano-device and three-dimensional device stacking. Many R&D projects using these facilities achieved remarkable accomplishments in multiple fields, including advanced memory devices, three-dimensional device stacking and implementation technologies, and silicon photonics. The facilities are not only for nano-scaled device fabrication, but also for contributing to development of new materials or new process equipment for the device technologies.
(https://unit.aist.go.jp/tia-co/index_en.html).



SCR and cross-sectional views of prototype devices (a) Three-dimensional stacking device. (b)Nano-scaled MOSFET

AIST-UTokyo AI Chip Design Center

In order to provide design-development support aimed at achieving the practical application of ideas developed by SMEs and startups, AIST and the University of Tokyo are now establishing a research base with a development environment for design, evaluation, and verification, developing common technologies to promote chip development, and providing training to ensure personnel possess the knowledge and know-how necessary to utilize IoT and AI technologies.



Functions of AI Chip Design Center

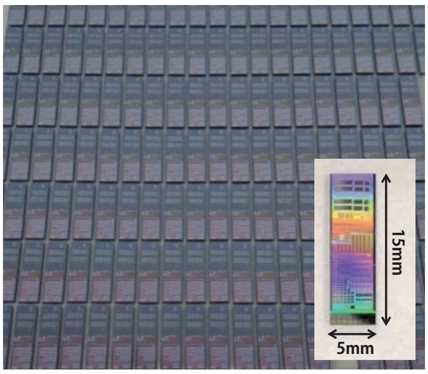
R&D center for innovative ultra-low- power semiconductors (IoT/AI processors, sensors, and so on)

Tohoku University has led the world in the field of ultra-low- power processors and memories for IoT and AI by integrating the spintronics technology that we have developed and the existing integrated circuit technology. We will continue to improve the R&D center to enhance the development capability from design to prototyping/verification and its convenience.

Center for Innovative Integrated Electronic Systems (CIES), Tohoku University

Leading R&D center for silicon photonics

Aiming to promote next-generation ultra-low-power information and communication technologies and their ecosystems, we have established and are operating an R&D center for silicon photonics that offers R&D-oriented multi-project wafer services for a wide range of users to utilize the world-leading silicon photonics technology developed by AIST.



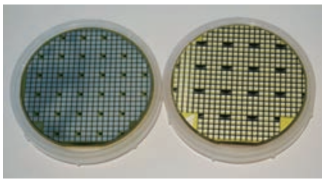
Silicon photonics chips from an R&D multi-project wafer

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

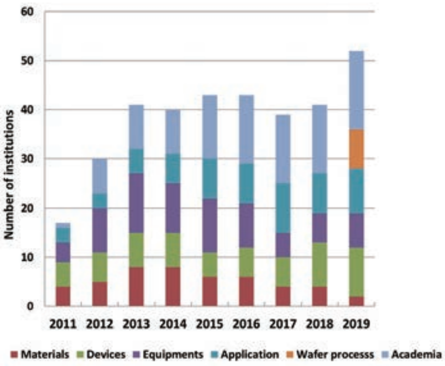
AIST, which has a large cleanroom for producing SiC prototype devices, has been working to establish evaluation technologies through accumulation of various data concerning wafers and devices and to increase the efficiency of the manufacturing process. At TIA, AIST and universities conduct a wide range 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. Research and development is promoted in which automobile, materials, processing, and device manufacturers collaborate closely over the entire process in, for example, silicon carbide large diameter wafer manufacturing, high-breakdown voltage device manufacturing, and gallium nitride device development.


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.



Number of TPEC member organizations by year

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.


ISS2019

MEMS

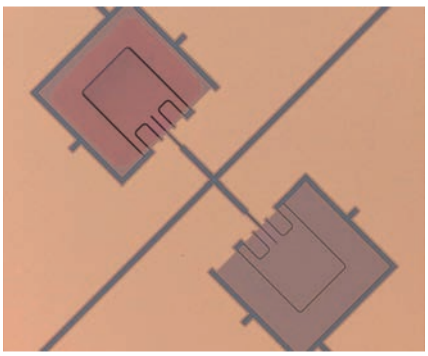
We have established a MEMS (micro-electro-mechanical system) production line that processes 200/300-mm wafers and facilities for integrations and packaging on the premises of AIST Tsukuba East, and are providing a venue to promote open innovation through joint research and/or demonstrative development 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*

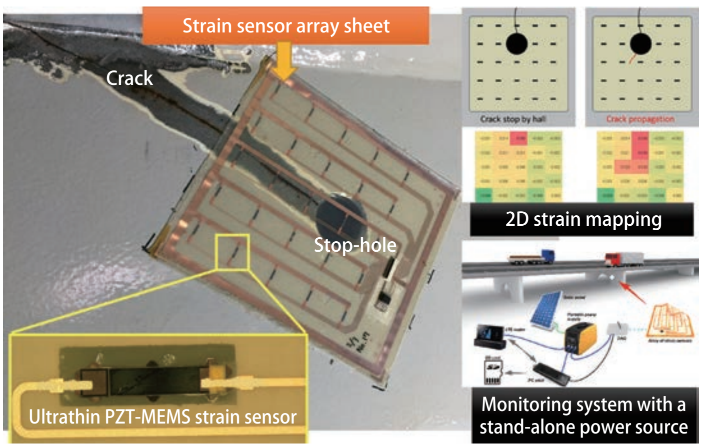
A gyro sensor using a high-sensitivity pressure sensor that measures inertial force of fluid in a circular channel is robust against noise induced by vibration, etc. An infrared sensor using nanopillars fabricated by MEMS processing can vary its sensing wavelength over a broad range. Spatial perception 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 developed a system to monitor cracks by measuring the bridges' strain distribution. 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.



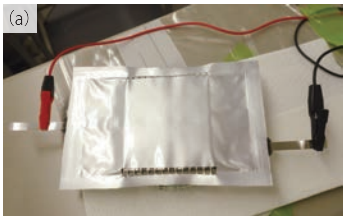
* Result of NEDO project "AI-enabled Innovative Recognition System for Spatial Mobile Robots (AIRs)" (FY 2017-FY 2018)
** Result of NEDO project "Research and Development of Sensing System for Road Infrastructure Monitoring System" (FY 2014-FY 2018)

Nano-GREEN

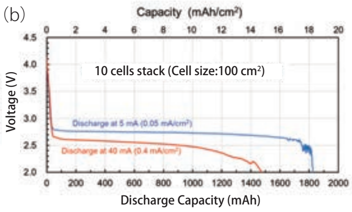
National Institute for Materials Science (NIMS) is playing a central role in providing a platform for collaborative research with industries to create environmental and energy technologies utilizing nanotechnology, in coordination with academia including TIA core institutes. In particular, we are developing materials for solar cells, rechargeable batteries, hydrogen production systems, thermoelectric devices and others, which will play key roles in clean energy systems. We are also working on electrode catalysts as common materials for energy devices. We are trying to accelerate materials development by computational science and materials informatics for material design and mechanism elucidation.

Research themes taking advantage of NIMS-developed materials and technologies

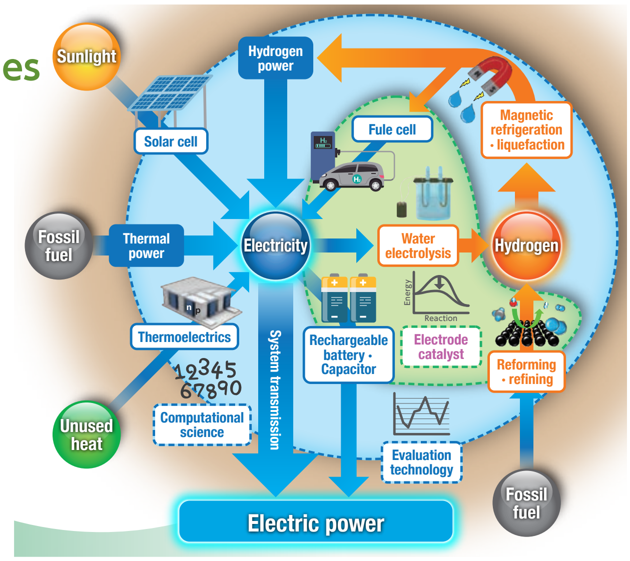
In order to develop a sustainable society, we are promoting basic R&D of materials and technologies in the areas of environment and energy. Especially, we focus on common technical issues on solar cells, rechargeable batteries, fuel batteries related to solar energy flow and take a basic research and development on these issues in scope. In particular, we are making major efforts for the studies on lithium-air batteries, all solid-state batteries and producing results.



(a) Li-air battery module



(b) Li-air battery discharge curves



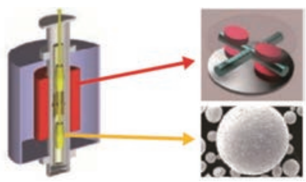
Research themes in Energy flow

Materials development of magnetic refrigeration for high efficiency liquid hydrogen production

Securing new, inexpensive and safe core energy is an extremely important theme. Hydrogen is attracting attention as one of the leading candidates for new energy carriers. We research and develop basic technologies for materials required to supply and use liquid hydrogen cheaply and safely among the technologies that support the realization of a society that consumes large amount of hydrogen.

Development of liquefaction and refrigeration technology using magnetic refrigeration

Basic Image of Magnetic Refrigeration



Research and Development Issues

Magnetic Refrigeration System
- Cooling Cycle (PAT.)
- AMR(Active Magnetic Regenerative)
- High-*Tc* Super Conducting Magnet

Magnetic Materilas
- Magnetcaloric Effect Materials
- Spherical Particles
- Surface technology and ortho-para conversion

Battery research platform

NIMS battery research platform is a world top-class unique facility for next-generation battery R&D covering everything from battery cell assembly to materials analysis. This innovative facility is available for external use and contribute to enhancement of competitiveness for battery technologies in our country.

R&D Support to solve common issues for next-generation batteries

Super-dry room 80m², Supplied dry air (DP< -90ºC)

Glove box and battery assemble equipments

FIB-SEM

TEM/STEM

HAXPES

TOF-SIMS(GCIB)

Carbon nanotubes

The commercialization of multi-walled carbon nanotubes (MWCNTs) is progressing; however, to accelerate the commercialization of single-walled carbon nanotubes (SWCNTs), drastic reductions in cost via the improvement of mass production technologies and increasing demand by broadening applications are required. Support for the creation of applied products is provided by developing dispersion evaluation technologies that elucidate the relationship between the characteristics of carbon nanotube composite materials and their dispersion. The goal is to contribute to the innovation of revolutionary products by applying the outstanding features of SWCNTs, which are 20 times stronger than steel, have 10 times higher heat conductivity than copper, contain half the density of aluminum, and have 10 times larger electron mobility than silicon.

Development of SWCNT mass production technology

We have made progress in developing SWCNT mass production technology using the super-growth method. Consequently, we achieved a continuously large area (500 mm by 500 mm) synthesis of an SWCNT forest (bulk), which led to the construction of the first global commercial-scale factory.

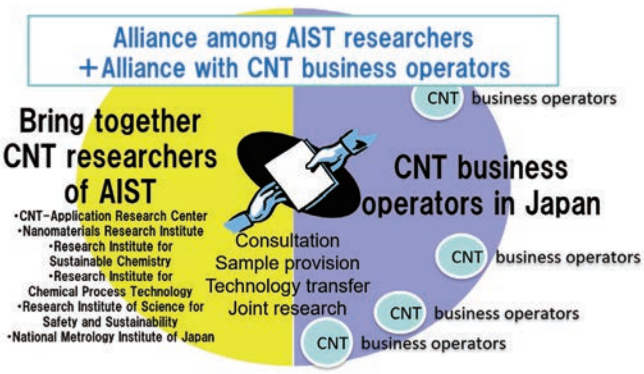
We aimed to further reduce the production costs to promote the development of applications, such as products utilizing composite materials. We are also working on developing a more cost-effective mass production technology via the development of novel processes.

CNT manufacturing plant (Tokuyama works, Zeon Corporation)

Carbon Nanotube (CNT) Alliance Consortium

Following the achievements of the 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 research and development on an open or closed platform as part of the innovation consortium-oriented joint research that the AIST is promoting. AIST researchers with various skills such as evaluation, processing, and safety of CNT materials participate in the consortium and work closely together.

The O-rings and PEEK/CNT, which are described in the right column, are accomplishments from the Team of Application for Carbon Nanotubes Composites, which is the first open platform collaborative research of the CNT Alliance Consortium. Private companies, AIST, and TIA work together to create CNT industries in Japan.

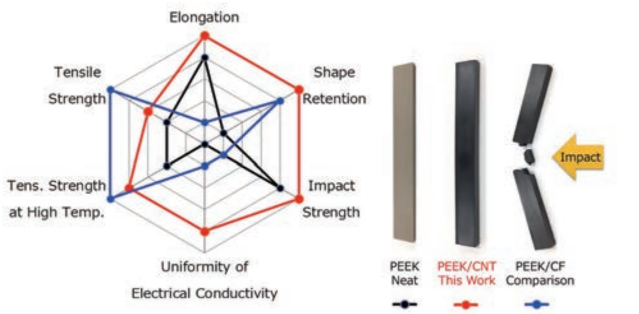


Sales start on products applying SWCNT composite materials

Heat-resistant O-rings containing SWCNTs based on the super-growth method were commercialized for the first time globally, and a collaborator is selling these under the name "SGOINT™." Its long-term sealing characteristics are far superior to competitive products, and these O-rings are suitable for high temperature and pressure environments.

Development of MWCNT resin composite materials resistant to heat and impact

The development of composite materials featuring the characteristics of MWCNTs are progressing in addition to materials using more costly SWCNTs. PEEK/CNT, a composite material containing polyether ether ketone that is a prototypical super engineering plastic with superior strength at high temperatures, was developed and has a uniform electric conductivity in the electrostatic dissipative range, high-temperature tensile strength and shape retention that are better than the matrix, and high impact strength.



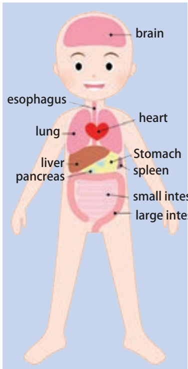
Light/quantum measurement

Pioneering fundamental science pursues the nature of life's materials and origins fully utilizes advanced light-quantum measurement technologies such as high energy beamline from large scale accelerators.
The TIA is actively collaborating on high energy beam research facilities and their advanced light-quantum measurement technologies. So creating new academic fields are to lead to the fostering of a breakthrough for the next generation.
This management group supports such activities linking TIA's R&D groups, which may directly contribute to industrial benefit in the future. For example, this R&D drives new ideas and breakthroughs, such as a higher performance with high precision and high resolution to measure it. And it will create further scientific studies on materials and biological mechanisms. So, the management group is to provide a suitable research environment through a collaborative network among TIA. Mission.

A collaboration of fundamental research

For example, a collaboration between high energy beamline and material R&D is an essential science activity. Such as processing "Technetium" for medical imaging use for cancer treatment and "Intelligent functional, structural material." Other examples that we are supporting are "Next-generation semiconductor materials" and "Environment-Energy materials." Those necessary scientific research activities are also in progress through TIA collaboration.

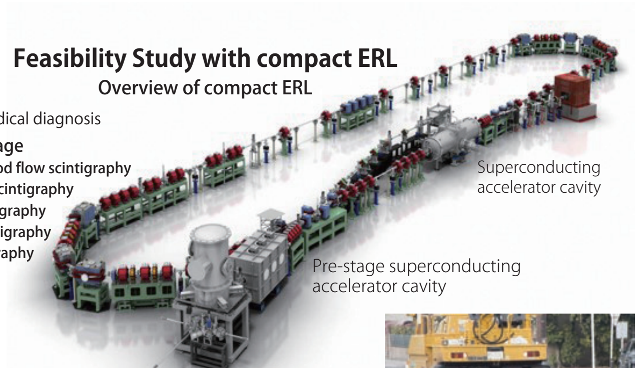
Example
Manufacture of technetium-99m for medical diagnosis



Medical image
- Cerebral blood flow scintigraphy
- Myocardial scintigraphy
- Kidney scintigraphy
- Thyroid scintigraphy
- Lung scintigraphy
- etc

©Rey Hori/KEK

Feasibility Study with compact ERL
Overview of compact ERL



Example
Longer life of asphalt

R&D and applications of light-quantum beams

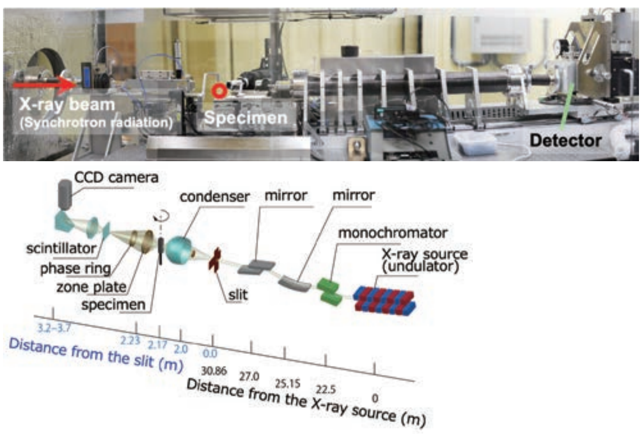
Processing several medium-size beam applications can be installed for scientific research, medical fields, and the industrial category. Compact beamline with high performance and saving energy type accelerators (known as cERL) have developed. And more to keeping more, high-power SiC semiconductor devices are an excellent candidate set in TIA. And many beam applications have developed these light-quantum beamlines, such as X-ray, neutron, and muon beams. They are contributing to innovative research areas, medical fields, and industrial applications. For instance, we developed an X-ray absorption fine structure-computed tomography (known as "XAFS-CT") equipment that has high energy X-ray beam, and it allows 3D mapping of the chemical state of material (electronic condition). This equipment has a unique feature, and you can observe less than 50nm high spatial resolution under applied pressure. One of the applications demonstrated is the in-situ analysis of the crack initiation-propagation of carbon fiber reinforced plastic (known as CFRP) material for airplanes' advanced structural material. It is crucial to understand and control the entire phenomenon from the formation of the degradation origin to propagation and fracture—basic research linked to industrial application.

Sensing with light-quantum beams and measurement technologies

We support the R&D activity of novel sensors, such as a superconducting type detector and SOI (known as silicon-on-insulator) type imaging detector.
Our management group supports innovative R&D on measurement/diagnostic technology with high energy beams generated by accelerators, and it can contribute fundamental scientific research/medical research and infrastructure diagnosis.

Crack observation using XAFS-CT

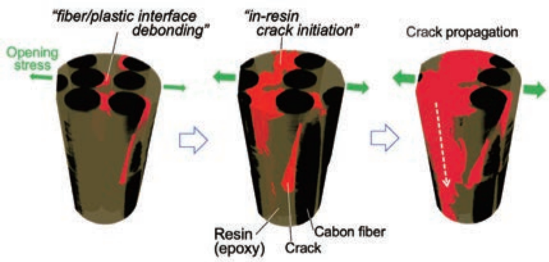
(a)



(b)

XAFS-CT equipment is (a) an X-ray microscope that uses synchrotron radiation and can perform three-dimensional non-destructive observation under stress at high spatial resolution (<50 nm). (b) Example of observation under the pressure of CFRP used in airplanes.
M. Kimura et al., Sci. Rep. **9**, 19300 (2019)
M. Watanabe et al., Comp. Sci. Techno. **197**, 108244 (2020)

(C)



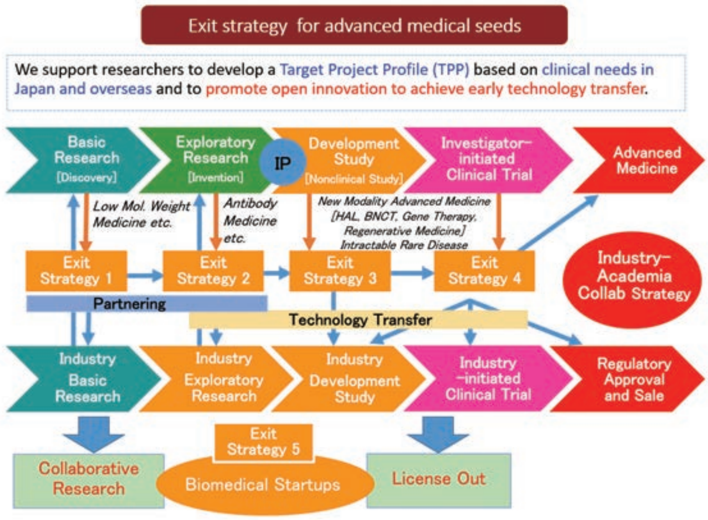
Biotechnology and medical treatment

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.

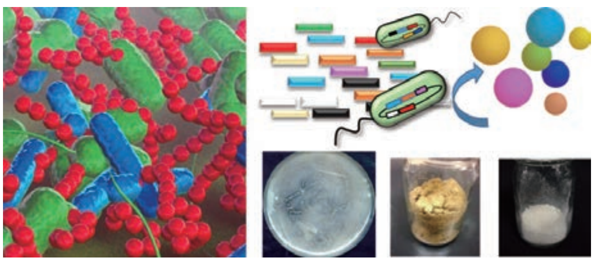
●Tsukuba Clinical Research & Development Organization (T-CReDO)
http://www.s.hosp.tsukuba.ac.jp/t-credo/



New technologies for microbial control and use

There are diverse microbial species and functions beyond human understanding. The Earth's ecosystems are protected by the relationships between microorganisms and animals, plants, and other microorganisms. However, most of the relationships remain unclear, even with cutting-edge science. This center is establishing new technologies for understanding uncovered microorganisms and their interactions with others, which protects water and soil, and the food and health of humankind. For example, molecule-level interactions between intestinal bacteria and humans, pathogenic bacteria and plants, and among microorganisms using proprietary microscopy are studied to undertake microbial control innovations for probiotics, the prevention of crop diseases, and the improvement of water treatment technologies. Studies also include the development of novel fermentation technologies for producing raw materials for biomass plastics, antioxidative amino acids for our health, functional materials.

●University of Tsukuba, The Microbiology Research Center for Sustainability
https://www.mics.tsukuba.ac.jp/en/

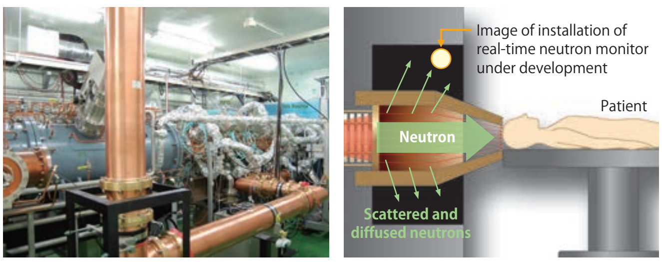


Convoluted microbial complex systems and applications for making things with microorganisms

Boron neutron capture therapy (BNCT)

BNCT has recently attracted attention as a radiation therapy combining neutrons and chemicals to treat refractory and recurrent cancer. The University of Tsukuba is collaborating with research organizations such as the High Energy Accelerator Research Organization (KEK), heavy industry manufacturers, Ibaraki Prefecture, and Tsukuba City on research and development of iBNCT, a BNCT device based on a compact accelerator that can be installed in a hospital.

Conducting BNCT requires technology that can measure the neutron beam irradiated on a patient at high precision and in real time. Therefore, the University of Tsukuba is collaborating with the National Metrology Institute of Japan in AIST on research and development of neutron measurement technologies for BNCT. Clinical studies of iBNCT and the development of neutron measurement devices that can be applied in medicine will be conducted for the practical use of these technologies in actual cancer treatment.



Developed and serviced device for BNCT: linear accelerator for iBNCT

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. The Nanotech Career-up Alliance (Nanotech CUPAL) is a project that fosters young 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.

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

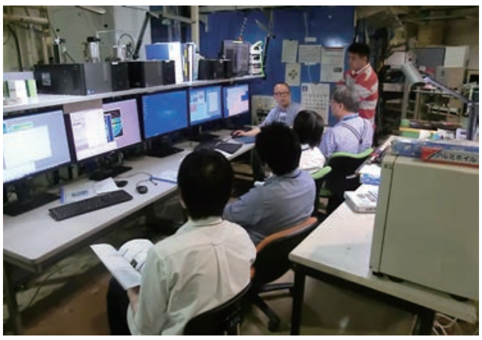
TIA Graduate School power electronics course

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/

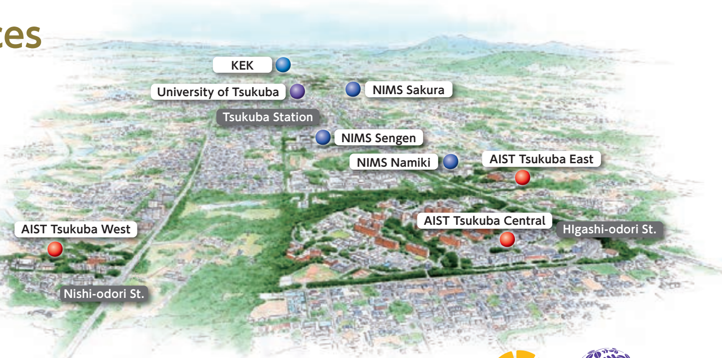
Open research facilities

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 and Tohoku University joined in FY2020.

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.

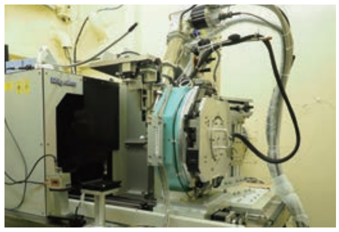


Microfabrication | Photolithography | Elemental analysis | Structural analysis | Thin film formation | Mass spectrometry | Surface analysis | High intensity synchrotron radiation | Device fabrication


i-Line stepper (AIST)


Atomic-resolution analytical electron microscope (NIMS)


1 MV Tandetron accelerator (the University of Tsukuba)


Multipurpose Weissenberg camera under extreme conditions (KEK)

Seminars and human resource development

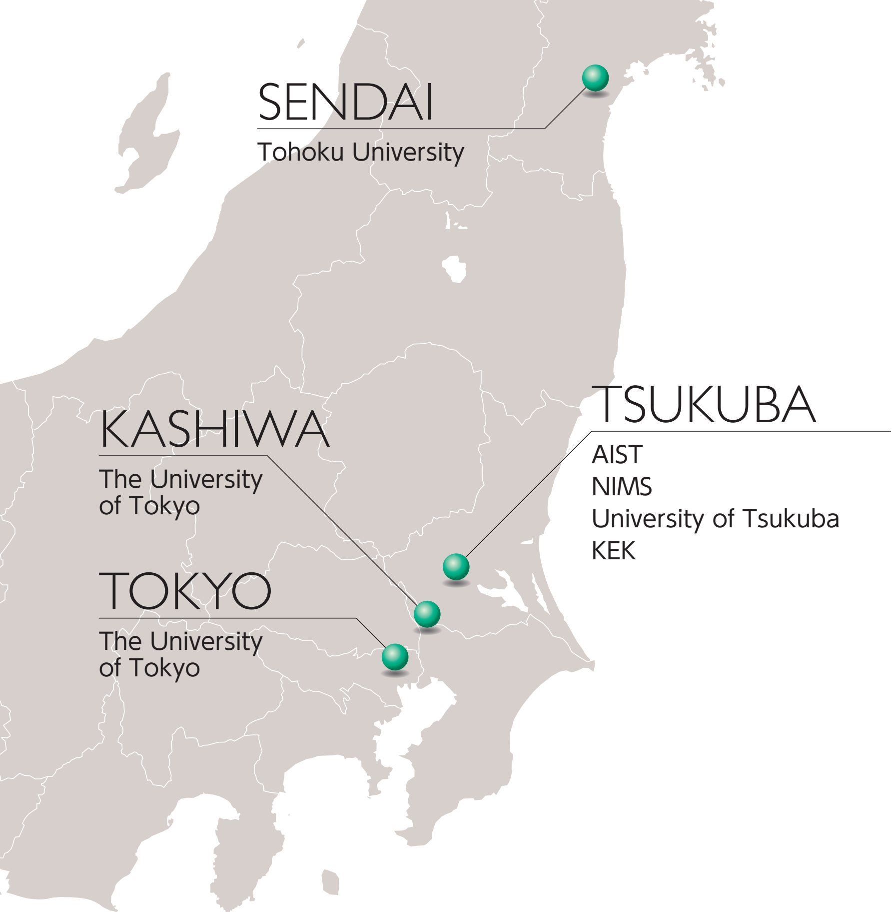
TIA offers various seminars, schools, and training courses to develop human resources. In this way, human resources are expected to play active roles in various fields, from academic research to the development of industrial technologies and R&D in cutting-edge nanoscale processing, measurement, and 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 TIA Open Research Facilities

https://www.tia-nano.jp/orf/

This database marks the registration of more than 680 units of shared use equipment belonging to the six core organizations of TIA (AIST, NIMS, University of Tsukuba, KEK, the University of Tokyo, and Tohoku University), 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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