SANKEN
THE UNIVERSITY OF OSAKA

ANNUAL REPORT | 2025 |

Year ended March 31, 2025

We are aiming to contribute to society
by promoting state-of-the-art research
and solving environmental, energy, medical,
safety and security issues.

Quantum Beam

Laser-driven Particle Acceleration

Quantum Beam-driven Drug Discovery and Medical Application

Nanofabrication Materials

Device

Quantum Technology

Flexible Electronics

Flexible Spintronics Sensors

Molecular Chemistry

Photochemistry

Synthetic Molecular Systems

Drug Discovery

Chemical Biology

Information

Computer Vision

Spoken Dialogue Systems

Artificial Intelligence

Data Science

Biotechnology

Smell Digitization

Multidrug Resistant Bacteria

Bioluminescence

Singularity Biology

Material

Cellulose Nanofiber

Multi-Functional Materials

Advanced Batteries

Harnessing Untapped Infrared Solar Energy

Nanotechnology

Quantum Functional Oxides

Nanofabrication Process

Characterization of Nanomaterials

Computational Materials Science

Single-molecule Science

Organic Electronics

Director

Shun'ichi Kuroda

The Institute of Scientific and Industrial Research (SANKEN), was established in 1939 as part of Osaka Imperial University, the predecessor of today's the University of Osaka. Its founding was made possible through the strong support and passionate request of the Kansai business community, who called for the establishment of a research institute in Osaka dedicated to the basic and applied sciences necessary for industry. In 2025, SANKEN celebrates its 86th anniversary. Since its founding, our core philosophy has remained steadfast across the Showa, Heisei, and Reiwa eras. In response to evolving societal needs, we have continually advanced organizational reforms and expanded our research domains.

In 2009, SANKEN was reorganized into a four-division structure aimed at further promoting interdisciplinary research: the First Division (Information and Quantum Sciences), the Second Division (Materials and Beam Science), the Third Division (Biological and Molecular Sciences), and the Nanoscience and Nanotechnology Center. Furthermore, in 2010, we formed an alliance of five institutes: the Research Institute for Electronic Science, Hokkaido University; the Institute of Multidisciplinary Research for Advanced Materials, Tohoku University; the Laboratory for Chemistry and Life Science, Institute of Integrated Research Institute of Science Tokyo; and the Institute for Materials Chemistry and Engineering, Kyushu University. Since fiscal year 2022, this collaboration has been operating under the name "Crossover Alliance to Create the Future with People, Intelligence, and Materials," with SANKEN serving as the central hub for Japan's first network-type Joint Usage / "Network Joint Research Center for Materials and Devices." Through this alliance, we continue to foster collaboration with universities and companies nationwide and support the development of young researchers, contributing to the advancement of science and technology.

Despite the rapidly changing global socio-economic landscape, our foundational mission remains unchanged. SANKEN continues to identify emerging directions in science and technology and strongly promotes cutting-edge research and its implementation in society. For example, in the field of information science—now central to the deployment of generative AI—we had already established foundational research areas in the 1970s, contributing significantly to academic advancement. Building on this legacy, SANKEN established the AI Center in 2019 to integrate strengths in quantum, materials, beam, biological, molecular, and nanotechnology sciences. The center aims to develop the foundations of next-generation industrial science and implement innovative AI-driven solutions across society and industry. In 2024, SANKEN underwent further strategic reorganization under the University of Osaka's OU Master Plan Acceleration Initiative to enhance its research capabilities. Furthermore, in 2025, in response to the growing societal demand for the space sector in recent years, the Lunar Urban Development Research Center was established with the aim of applying the advanced technologies possessed by SANKEN to the space-related industries.

Moving forward, SANKEN will continue to foster interdisciplinary research across diverse academic fields, striving to address global societal challenges and contribute to sustainable development. We are committed to deepening collaboration and co-creation with universities, research institutes, and industries both domestically and internationally, and to providing a world-class environment for research and education. We sincerely ask for your continued support, guidance, and encouragement.

History

1939	ISIR: SANKEN was established in Sakai City with three research departments.
1968	Relocated to Suita City.
1977	Material Analysis Center was established.
1995	Restructured to an Institute composed of six divisions with 24 departments for the purpose of promoting sciences on materials, information and biology.
2002	Nanoscience and Nanotechnology Center was founded. The new center focused its research on nanomaterials and devices, beam science for nanotechnology and industrial nanotechnology. We were selected for the 21st Century COE Program by the MEXT (The Ministry of Education, Culture, Sports, Science and Technology).
2007	Four institutes' alliance (Four institutes' network) was started. ISIR-REIS (Hokkaido Univ.) alliance laboratory was set up.
2008	Division of Special Projects was launched.
2009	Reorganized into three divisions and Nanoscience and Nanotechnology Center. Material Analysis Center was reorganized into Comprehensive Analysis Center. SANKEN Incubation Building was constructed and Company Research Park was started.
2010	The Network Joint Research Center for Materials and Devices and five institutes' alliance (Five institutes' network) were started. SANKEN was the headquarters of this nation-wide five institutes network.
2011	We concluded a research-collaboration agreement with Interuniversitair Micro-Electronica Centrum vzw (imec), one of the world's largest nanotechnology research institute and "imec office" was opened at SANKEN.
2013	The University of Osaka (UOsaka) has been selected as one of the core universities of the MEXT program, COI STREAM, and SANKEN will play a central role of UOsaka.
2016	Dynamic Alliance for Open Innovation Bridging Human, Environment and Materials including SANKEN (UOsaka), RIES (Hokkaido Univ.), IMRAM (Tohoku Univ.), CLS (Science Tokyo) and IMCE (Kyusyu Univ.) was established. SANKEN is the headquarters of this nation-wide five institutes network.
2017	We established "ISIR imec center" (Currently called as "SANKEN imec partnership office") in imec of Belgium to promote the global cooperation network.
2019	Artificial Intelligence Research Center was established.
2021	Official English abbreviation changed from "ISIR" to "SANKEN".
2023	Logo design renewed.
2025	Lunar City Development Research Center was established.

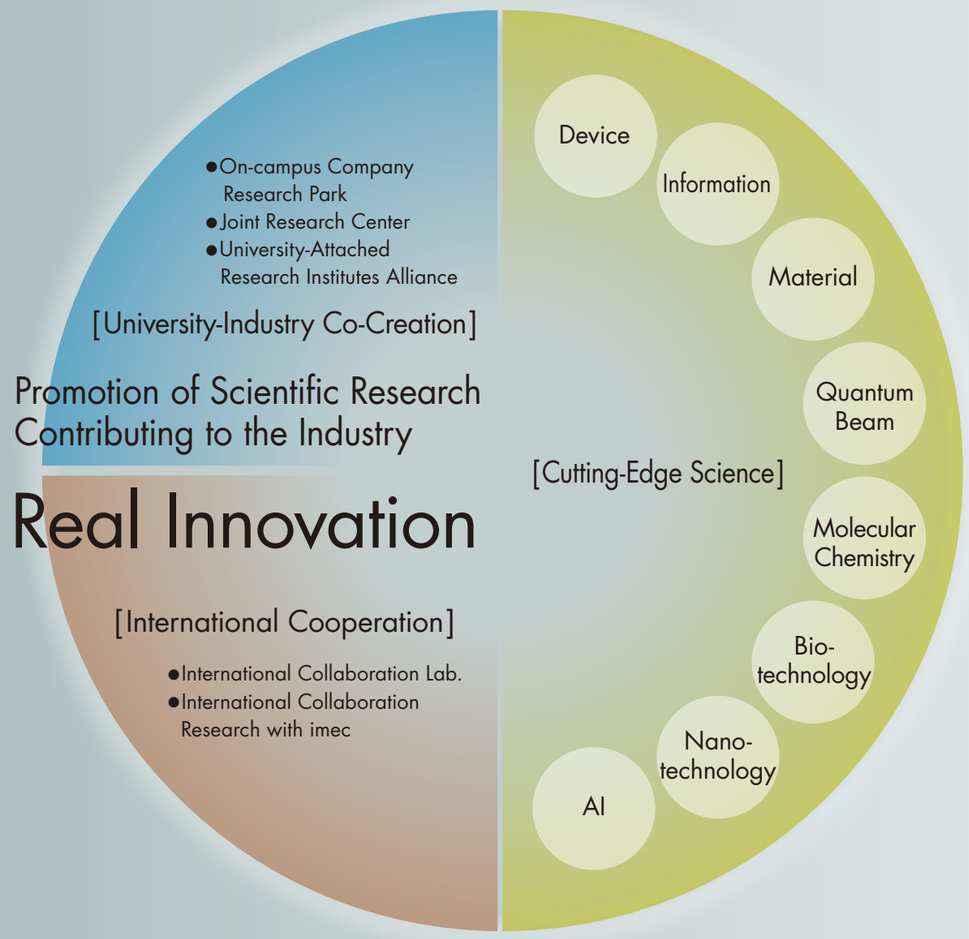
Overview

SANKEN (The Institute of Scientific and Industrial Research) was established in 1939 at Osaka Imperial University, the predecessor of present-day the University of Osaka, in response to the strong desire of the business community in Osaka, Japan, to establish a research institute in Osaka on the fundamentals and applications of natural science necessary for industry.

The purpose of our institute is to “research the basic scientific principles and their applications in specific areas related to natural science that are necessary for industry.”

We have grown into the largest comprehensive research institute of science and engineering at the University of Osaka through numerous reorganizations and expansions of research fields as we strive to become the ideal research institute.

As the only research institute in Japan that bears the name of “industrial science,” the Institute actively collaborates with industry and trains professionals who contribute to industry, and as a member of the University of Osaka it maintains a close relationship with each graduate school and continues to grow with the aim of contributing to high-level researcher education.



Organization

(As of May 1, 2025)

- Director
  - Faculty meeting
  - Various committees in the Institute
  - Board of Directors
  - Steering committee
  - Administrative Division
    - Administration Dept.
      - Administration, Personnel
    - Research Collaboration Dept.
      - Research Cooperation, Finance, Contract
  - Technical Division
    - Fabrication Group
      - Machining Sect., Device Development Sect.
    - Measurement Group
      - Instrumental Analysis Sect., Information Network System and Public Relations Sect.
  - The SANKEN Strategy Office
  - Public Relations Office
  - Office of Information Network
  - Facilities Management Office
  - Service Facilities
    - Workshop
    - Anechoic Laboratory

- Device
- Information
- Material
- Quantum Beam
- Molecular Chemistry
- Biotechnology
- Nanotechnology

Division1 Information and Quantum Sciences
- Dept. Quantum System Electronics
- Dept. Interface Quantum Science
- Dept. Advanced Electron Devices
- Dept. Intelligent Media
- Dept. Reasoning for Intelligence
- Dept. Knowledge Science
- Dept. Intelligent Interaction

Division2 Advanced Materials and Beam Science
- Dept. Functionalized Natural Materials
- Dept. Transcendent Materials Chemistry
- Dept. Advanced Hard Materials
- Dept. Energy and Environmental Materials
- Dept. Excited Solid-State Dynamics
- Dept. Quantum Beam Physics
- Dept. Beam Materials Science

Division3 Biological and Molecular Sciences
- Dept. Material Excitation Chemistry
- Dept. Synthetic Chemistry for Molecular Systems
- Dept. Regulatory Bioorganic Chemistry
- Dept. Complex Molecular Chemistry
- Dept. Biomolecular Science and Reaction
- Dept. Biomolecular Science and Regulation
- Dept. Biomolecular Science and Engineering

Nanoscience and Nanotechnology Center
- Dept. Functional Nanomaterials and Nanodevices
- Dept. Advanced Nanofabrication
- Dept. Nanocharacterization for Nanostructures and Functions
- Dept. Theoretical Nanotechnology
- Dept. Soft Nanomaterials
- Dept. Bio-Nanotechnology
- Dept. Nanotechnology for Environmental and Energy Applications
- Dept. Nano-Intelligent Systems
- Dept. Nanodevices for Medical Applications
- Dept. Collaborative Nanoscience Research
- Dept. Collaborative Nanodevice Research
- Dept. International Collaborative Research for Basic and Industrial Science
- Dept. Simulation for Nanotechnology
- Dept. Nanoelectronics
- Dept. Nano-Function Characterization
- Dept. Nano-Medicine
- Dept. Nano-Biology
- Dept. Nano Information Technology
- Nanofabrication Shop
- Advanced Research Infrastructure for Materials and Nanotechnology (ARIM)

Artificial Intelligence Research Center
- Div. Core AI Research
  - Dept. Translational Datability
  - Data Analytics Farm
- Div. AI Co-Creation and Integration Research
  - Dept. Biomolecular AI Sensing
  - Dept. Quantum Transformation Functionality
  - Dept. Biomedical Devices and Sensors
  - Dept. Distributed Intelligent Systems
  - Dept. Material-based Biomimetics

Div. Special Projects
- Dept. Data-Driven Synthetic Organic Chemistry for Medicinal and Material Applications
- Dept. Advanced Materials and Implementations
- Dept. Advanced Thin-Film Functional Properties
- Dept. Biomolecular Science and Application
- Dept. Nucleic Acid-Targeted Small Molecule Drug Discovery

Div. Next Industry Generation
- Dept. New Industry Generation Systems
- Dept. Intellectual Property Research

Div. Joint Research/ Research Alliance Laboratories
- Laboratory of Flexible and Power Three Dimensional System Integration
- KOBELCO Future Pioneering Co-Creation Research Center
- Div. Nano-lithography Research

Comprehensive Analysis Center
- Div. Education and Research of Fundamental Analytical Technology
  - Dept. Functional Material Analysis
- Div. Promotion of Interdisciplinary Analytical Research

Research Laboratory for Quantum Beam Science

Lunar City Development Research Center
- Div. Space Life Technology Research and Development
- Div. Space Life Technology Alliance
- Div. Space Life Technology Human Resource Development
- Div. Space Life Technology Collaborative Research

Center for Collaborative Research Education and Training

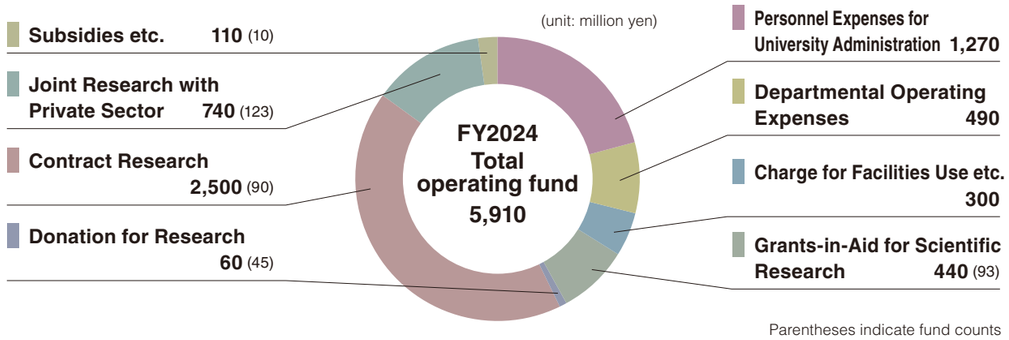
International Collaborative Research Center

Network Joint Research Center for Materials and Devices (Support office for the Network Joint Research Center)

Fact Sheet

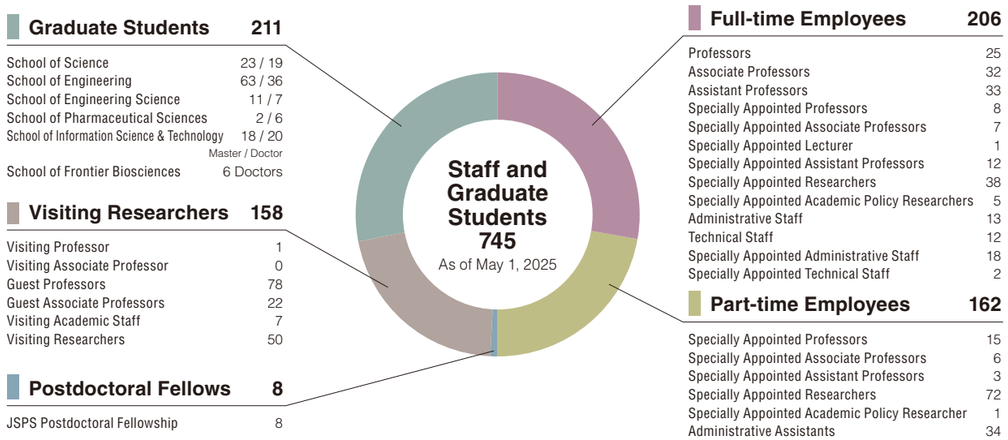
Financial Data (FY2024)

(unit: million yen)

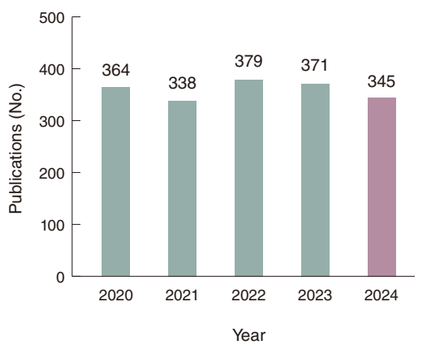


Parentheses indicate fund counts

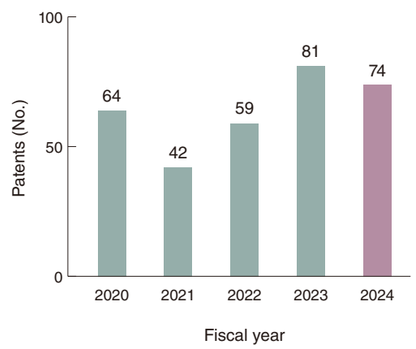
Constituent Member



Publications by Year



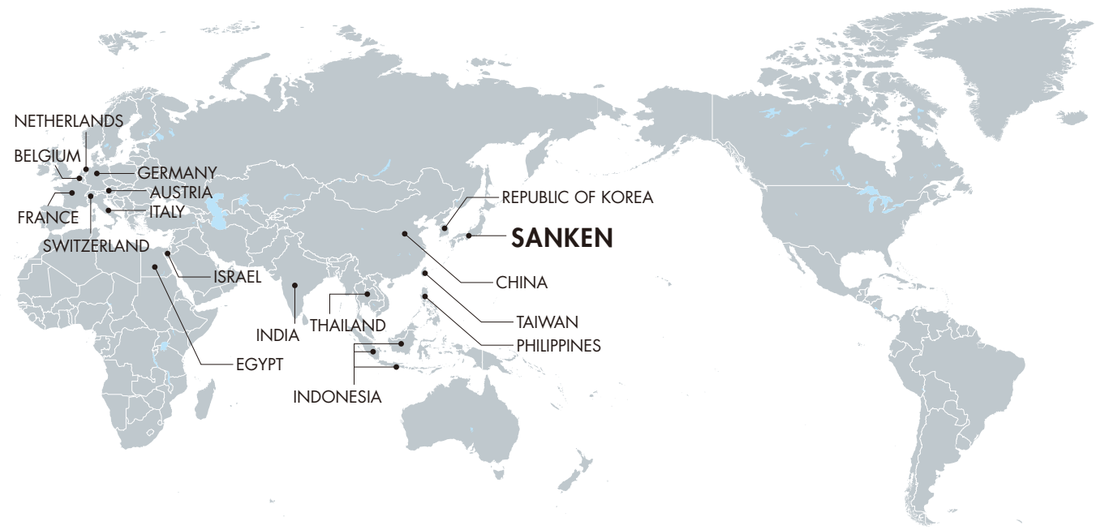
Patents Granted by Fiscal Year



Academic Exchange Agreements of SANKEN with Universities Abroad

GERMANY	Forschungszentrum Julich GmbH RWTH Aachen University University of Augsburg RWTH Aachen University (Institute of Organic Chemistry) Bielefeld University (Faculty of Chemistry) University of Cologne (Faculty of Mathematics and Natural Sciences)
BELGIUM	Interuniversitair Micro-Electronica Centrum vzw (imec)
NETHERLANDS	Eindhoven University of Technology (Department of Mechanical Engineering) Delft University of Technology University of Groningen
SWITZERLAND	University of Geneva (Faculty of Science)
AUSTRIA	University of Vienna
FRANCE	The National Center for Scientific Research University of Bordeaux Ecole polytechnique Université Paris-Saclay
ITALY	The University of Genoa
ISRAEL	The Hebrew University of Jerusalem
EGYPT	Assiut University (Faculty of Science)
REPUBLIC OF KOREA	Chonnam National University Pukyong National University (Basic Science Research Institute) Hanyang University Sun Moon University (Collage of Engineering)
CHINA	Peking University The School of Intelligence Science and Technology (SIST) , Peking University University of Sciece and Technology Beijing (School of Materials Science and Engeneering) Shenzhen University The University of Hong Kong (School of Biological Sciences) Dalian Jiaotong University, Graduate School / School of Mechanical Engineering Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences (SIOM) Chinese Academy of Sciences National Center for Nanoscience and Technology
TAIWAN	National Taiwan University National Yang Ming Chiao Tung University (NYCU) National Cheng Kung University National Tsing Hua University (NTHU)
THAILAND	Thammasat University Chulalongkorn University (Department of Computer Engineering, Faculty of Engineering)
PHILIPPINES	De La Salle University (College of Computer Studies) University of the Philippines
INDIA	Birla Institute of Technology and Science, Pilani
INDONESIA	Brawijaya University

As of May 2025



Company Research Park

We operate a space “Company Research Park.”
This space promotes open innovation by companies in cooperation with our research activities. The users can receive state-of-the-art technical counseling for practical application research and can form and utilize networks as an open innovation base.

Alliances among Research Institutes and Network Joint Research Center

Crossover Alliance to Create the Future with People, Intelligence and Materials (Five-star Alliance)

Five-Star

Five university research institutes across Japan Archipelago (Research Institute of Electronic Science at Hokkaido University; Institute of Multidisciplinary Research for Advanced Materials at Tohoku University; the Laboratory for Chemistry and Life Science, Institute of Integrated Research of Science Tokyo; SANKEN at the University of Osaka; Institute for Materials Chemistry and Engineering at Kyushu University) cooperate with each other to organically cross-over rich research resources including human resources, knowledge, technology, and facilities, and promote research aimed at solving social issues and the development of young researchers.

alliance.tagen.tohoku.ac.jp/english/

Network Joint Research Center for Materials and Devices (NJRC)

NJRC

The Network Joint Research Center for Materials and Devices (NJRC) has been established in FY2011 as a first network of such centers in Japan (a project approved by the Ministry of Education, Culture, Sports, Science and Technology). The five research institutes that make up the center work together to invite researchers from a wide range of research institutions for joint research thorough open recruitment. Taking advantage of the characteristics of the network of centers, we promote joint research with universities, public research institutes, and private companies in Japan and overseas, and strengthen research capabilities and develop human resources in the fields of materials and devices and their related fields.

five-star.sanken.osaka-u.ac.jp/en/

KOBELCO Future Pioneering Co-Creation Research Center

KOBELCO 未来協働研究所
KOBELCO Future Pioneering Co-Creation Research Center

As the labor force continues to shrink due to the declining birthrate and aging population, the manufacturing industry needs to respond to rapid changes in the business environment including decarbonization. In particular, there are urgent needs to evolve the workplace so that workers can demonstrate their ability through operations that generate higher added value.

Therefore, by combining KOBELCO’s diverse and realistic manufacturing experience and technology with the University of Osaka’s AI and other cutting-edge science, the research center will develop solutions that enable workers to grow with digital systems and be more creative.

kobelco-fpc.com/

Education

Members of SANKEN participate in graduate education in cooperation with the Graduate School of Science, Engineering, Engineering Science, Pharmaceutical Sciences, Information Science and Technology and Frontier Biosciences. In addition, we provide the lectures in Interdisciplinary Educational Subjects and contribute partly to the advanced human resource development by participating in R^3 Institute for Newly-Emerging Science Design, the University of Osaka.

International Cooperation

Academic Exchange Agreements of SANKEN with Universities and Research Institutions Abroad

- Inter-University Exchange Agreements: 17
- Faculty-level Exchange Agreements Based on Inter-University Exchange Agreements: 3
- Faculty level Exchange Agreements: 21
- SANKEN Overseas Center: 1

(As of May 1, 2025)

Facilities

Research Laboratory for Quantum Beam Science

This facility has several electron accelerators and intense Co-60 gamma-ray source as joint-use facility and has promoted for developments and applications of ultimate short-pulsed electron beam, free electron laser (FEL) and etc.

Machine List
1. L-band electron linac
2. Co-60 gamma-ray irradiation facility
3. RF-Gun equipped S-band electron linac
4. Time-resolved electron microscope
- THz light source based on FEL of L-band linac

www.sanken.osaka-u.ac.jp/labs/rl/English/

Comprehensive Analysis Center

As a common facility for comprehensively performing composition and structural analysis of various materials, Comprehensive Analysis Center has equipment of composition analysis system, spectroscopic analysis system, electron microscope system, state analysis system.

Machine List
1. Element analyzer
2. Transmission electron microscope
3. Nuclear magnetic resonance
4. X-ray diffractometer
5. Mass spectrometer
- Scanning electron microscope

www.sanken.osaka-u.ac.jp/labs/cac/

Advanced Research Infrastructure for Materials and Nanotechnology (ARIM)

This facility totally contributes to creations of novel nano-materials and nano-devices for companies / universities / institutes researchers in nanotechnology research fields with the latest equipment and technical support.

Machine List
1. 150keV EB Lithography
2. 125keV EB Lithography
3. Helium Ion Microscope
4. Deep Reactive Ion Etching
5. Scanning Electron Microscope
6. Scanning Probe Microscope

nanoplatform.osaka-u.ac.jp

ARIM Japan

Artificial Intelligence Research Center (AIRC)

The Artificial Intelligence Research Center (AIRC) was established for realizing laboratory-led “bottom-up type AI introduction” at SANKEN, which has a wide range of research fields in the under-one-roof.
From 2024, AIRC has been started as an acceleration program of OU master plan realization.
Specifically, the AI center (1) trains young researchers as PI in each research field to be suitable for AI co-created research.
(2) establishes an AI co-creation protocol appropriate for each research field,
(3) establishes “AI co-creation liaison office” for returning the fruits to each department of the University of Osaka, and aiming for implementation in industry and transmission to the world,
(4) conducts researches to lead the solutions obtained by AI to scientific principles without ending them as a black box.

産業科学AIセンター

www.sanken.osaka-u.ac.jp/labs/aic/

Clues to change the future found in data: Causal inference to interpret society

In these modern times, actions such as shopping using a smartphone and boarding using an IC card are accumulated as data. Professor Shohei Shimizu, who began to work at the Department of Reasoning for Intelligence, SANKEN in February 2025, seeks clues to improve the future by determining "cause and effect" in data using the method of "causal inference."

Professor **Shohei SHIMIZU**
Department of Reasoning for Intelligence

"Ability of dialogue" is important for data scientists

Prof. Shimizu decided that he wanted to be a researcher in the fifth grade of elementary school. He was wondering about his future job when observing his father, who worked as an engineer, and his friend, who was good at playing baseball.

"I thought that I could live without problems if my original ideas are useful."

Prof. Shimizu engages in research into "causal inference." This is a statistical method to select more effective measures by identifying influential factors in data and the power of influence.

"I was introduced to causal inference when I joined the School of Human Sciences at the University of Osaka to learn about awareness and the human brain. The analysis required observation of all influential factors (variables), but this was unrealistic. Since I was good at math, I selected causal inference as a research theme because I thought that many people would be helped when a causal relationship could be found in data. I had ideas similar to those when I was an elementary school student."

For example, variables in sales of shampoo include fragrance, bottle design, and commercial messages. However, it is extremely difficult to identify all variables. The effects of influencers may now also be a variable, although such effects did not exist previously. Therefore, Prof. Shimizu emphasizes that it is important to listen to local input.

"For data scientists, it is not enough just to have knowledge about statistics and AI. They need to understand interests and situations in fields such as marketing, medical science, and psychology, and carefully study the hypothesis used for the research, so that the data can be useful."

Training of personnel who can collect and analyze useful data

Personnel who can correctly interpret a causal relationship have become increasingly important. What is a "correct causal relationship"? Correlation means a relationship, in which "two things may occur concurrently." A causal relationship means "cause and effect."

There is a joke report about a strong correlation between the amount of consumption of chocolate in a country and the number of Nobel prize winners. The data used in the report are true, but the result does not confirm that the number of Nobel prize winners will increase when chocolate consumption increases. A third variable, such as economic wealth, may affect these two factors. This is referred to as a confounder factor.

Complex data are liable to miss confounder factors. While big data can be collected increasingly more easily, there is a critical shortage of personnel who can use these data correctly. Shiga University had a sense of crisis about this situation, and thus established the Faculty of Data Science in 2017, as the first such school in Japan. Prof. Shimizu contributed to the establishment of the School as a founding member.

"Although statistics has been included in economics and psychology, it became possible to learn statistics systematically in the independent department. Graduates from the school are working in various fields, including manufacturing and consultation businesses. More companies have formed a department of data analysis to avoid leak of confidential data. The field of data science is characterized by many students who learn in the doctoral program while working for a company."

Data science used to find a clue to change the future

Now that statistical tools and artificial intelligence (AI) can be used easily, there is a risk that "apparently true but incorrect results" may be produced. In addition, statistics is likely to be thought of as data that can be used to certify scientific correctness. Prof. Shimizu sounds a warning for this situation.

"Statistics is just a tool to show results obtained based on an assumed condition. The results cannot be used if the assumption is wrong. Statistics is not a magic bullet to produce perfectly reliable information. Our role is to think about how we perform an analysis based on a reasonable assumption."

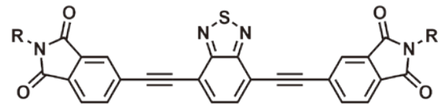
Prof. Shimizu is still trying to use statistics to find clues for a better future.

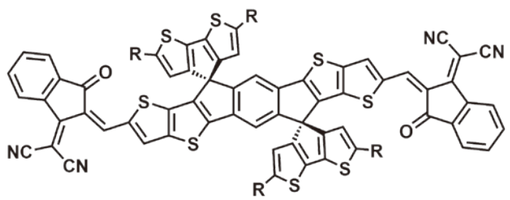
"AI has the ability to predict the future, but it is necessary to understand the causal relationship for change. Even if the incidence of a disease can be estimated to be higher over several years based on health-checkup data, a causal relationship is needed to prevent development of the disease."

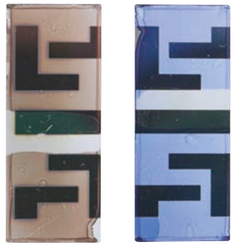
Prof. Shimizu promotes development of software to visualize causal relationships for implementation in society. He also pursues open science by disclosing his cause-and-effect searching program. "Data scientists are challenged to solve problems using causal inference, which is used to find clues in data to change the future, as a bridge between data and society."

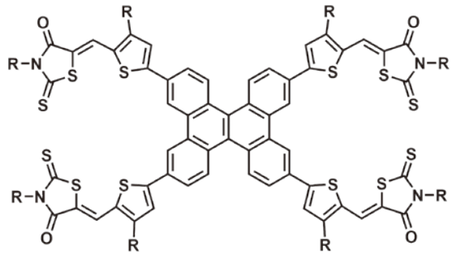
by Mari Ando (Japanese text)

Department of Soft Nanomaterials
NEWS RELEASE 10-SEP-2024









Molecular level changes translate to big efficiency gains for organic solar cells

A team of researchers led by SANKEN has synthesized a new molecule that gives organic solar cells excellent power conversion efficiency

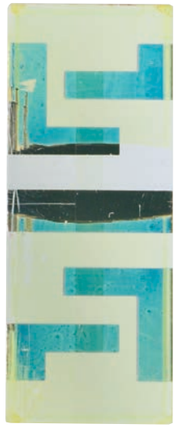
Assistant Professor **Seihou JINNAI**

陣内 青萌

Organic solar cells (OSCs)—promising alternatives to traditional inorganic solar cells—have many features that make them key players in a greener future. One of these features is tunable chemistry, which allows scientists to precisely adjust or modify the properties of chemical systems to achieve desired outcomes. Now, researchers from Japan have tuned them to increase power conversion efficiency.

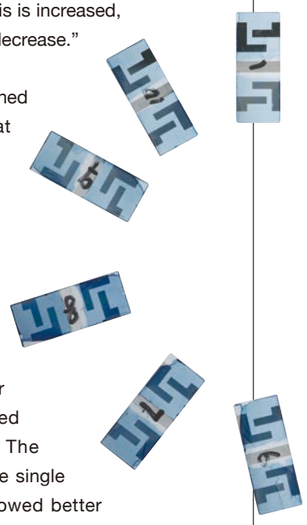
In a study published recently in *Angewandte Chemie International Edition*, researchers from the University of Osaka have reported a new organic semiconductor that gives better power conversion efficiency than the accepted standard.

OSCs are light and flexible and can be produced on a large scale for relatively low cost. They are therefore highly promising for applications such as agrivoltaics where large areas of land are used to simultaneously grow crops and turn the sun's energy into electricity.



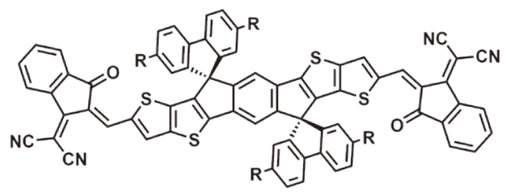
Generally, OSCs contain two organic semiconductors, one to transport charge carriers known as electrons (the acceptor) and one to transport the other carriers known as holes (the donor). A current flows in a semiconductor when excitons—combination of an electron and a positive hole—are split into these carriers giving electron-hole pairs. Excitons are bound tightly together, but sunlight with enough energy can cause them to dissociate and generate a current.

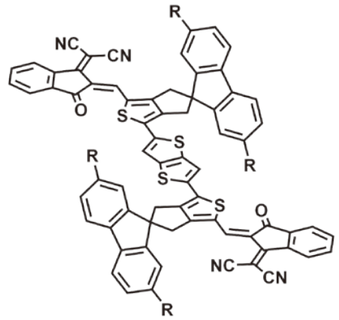
"Reducing the amount of energy needed to break up an exciton—the exciton binding energy—makes it easier to convert the light into the desired current," explains lead author of the study Seihou Jinnai. "We therefore focused on the factors that contribute to the binding energy, one of which is the distance between the electron and the hole. If this is increased, then the binding energy should decrease."



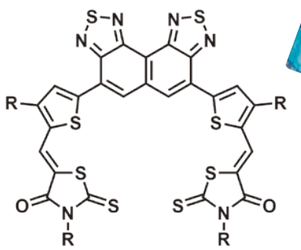
The researchers therefore designed a molecule with side units that had the effect of separating the parts of the molecule that accommodate the electron and the hole. The synthesized molecule was used as an acceptor in a bulk heterojunction OSC along with a donor material, and the system showed increased power conversion efficiency compared with the accepted standard. The molecule was also tested as the single component of an OSC and showed better conversion of light to current.

"The molecule we designed shows that the nature of side units in acceptor molecules is key to the exciton behavior and its efficiency as a result," says senior author Yutaka Ie. "This result provides an important demonstration of what can be achieved by tuning chemistry for OSCs applications."



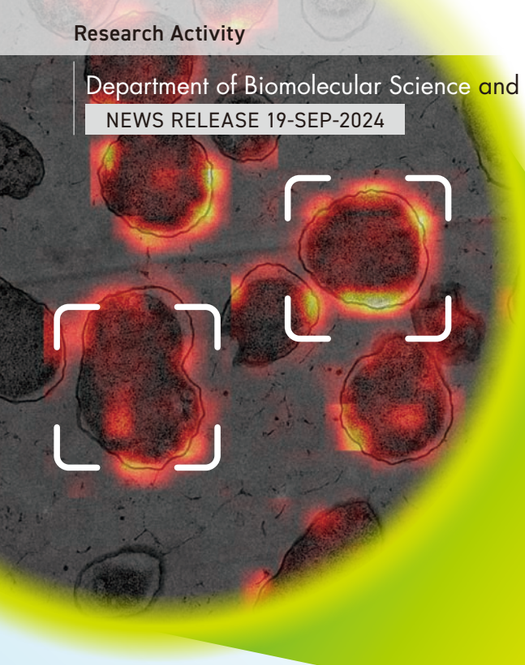


The findings indicate the potential of rational design of organic semiconductors and are expected to lead to new devices including high-performance OSCs and wavelength-selective transparent OSCs. General improvements in performance are also expected to enhance the potential of OSCs in large-scale photovoltaic applications, naturally leading to green energy alternatives.



The article, "Nonfullerene Acceptors Bearing Spiro-Substituted Bithiophene Units in Organic Solar Cells: Tuning the Frontier Molecular Orbital Distribution to Reduce Exciton Binding Energy," was published in *Angewandte Chemie International Edition* at DOI: https://doi.org/10.1002/anie.202412691

Department of Biomolecular Science and Regulation
NEWS RELEASE 19-SEP-2024



The article, “Bioinformatic analysis reveals the association between bacterial morphology and antibiotic resistance using light microscopy with deep learning,” was published in *Frontiers in Microbiology* at DOI: https://doi.org/10.3389/fmicb.2024.1450804

Prof. Nishino’s group from SANKEN find that antibiotic-resistant bacteria exhibit characteristic morphological changes that can be detected microscopically in the absence of antibiotics using a bioinformatics approach

Size matters:
bioinformatics accurately detects short, fat antibiotic-resistant bacteria

Penicillin was hailed as “the silver bullet” when it was discovered, as it had the unprecedented quality of being able to kill disease-causing bacteria without harming the human body. Since then, a multitude of other antibiotics have been developed that specifically target a wide range of bacteria; but the more often they are used, the greater the risk that antibiotic-resistant strains will arise.

In a study recently published in *Frontiers in Microbiology*, researchers have revealed that bacteria exhibit characteristic shape differences when they are resistant to drug treatment.

Antibiotic resistance is a major public health problem worldwide, as it means that we have fewer and fewer options for treating bacterial infections. Identifying antibiotic-resistant bacteria quickly is important for ensuring that patients receive effective treatment; but the most readily available method for doing this involves several days of growing the bacteria in a lab and treating them with drugs to see how they respond.

“There is some evidence that antibiotic resistance reveals itself in other ways; for example, the morphology of Gram-negative rod-shaped bacteria changes when they are exposed to antibiotics,” says lead author of the study Miki Ikebe. “We were interested in determining whether this feature could be used to detect antibiotic resistance without actually treating the bacteria with antibiotics.”

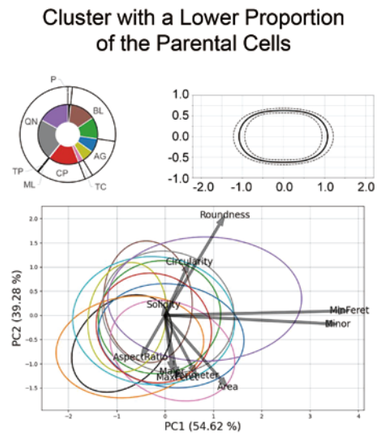
To do this, the researchers exposed *Escherichia coli* to fixed concentrations of different antibiotics, prompting them to develop antibiotic resistance. They then removed the antibiotic treatment and used machine learning to assess the shapes, sizes, and other physical features of the bacteria based on microscope images.

“The results were very clear,” explains Kunihiko Nishino, senior author. “The antibiotic-resistant strains were fatter or shorter than their parental strains, especially those that were resistant to quinolone and β-lactams.”

Next, the researchers explored the genetic makeup of the antibiotic-resistant bacteria to see whether there was any connection between bacterial shape and antibiotic resistance. The results showed that genes related to energy metabolism and antibiotic resistance were indeed associated with the shape changes that were observed in the antibiotic-resistant bacteria.

“Our findings show that drug-resistant bacteria can be identified from microscope images, in the absence of antibiotics, using machine learning,” says Mitsuko Hayashi-Nishino, supervisor of the research.

Given that the bacteria that were resistant to quinolone, β-lactams, and chloramphenicol all exhibited similar shapes and sizes, it seems likely that the same genetic mechanism is responsible for antibiotic resistance in all of these strains. In the future, a machine learning tool could be used to rapidly assess samples taken from patients to help prescribe the right drug to treat their infection.



K. Nishino
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M. Ikebe
Miki IKEBE

Department of Bio-Nanotechnology
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NEWS RELEASE 25-SEP-2024

大城敬人
Associate Professor Takahito OHSHIRO

谷口正輝
Professor Masateru TANIGUCHI

First made-in-Japan biomolecular sequence provides boost to medical care and innovation in biomolecular R& D

A research team from SANKEN, led by Professor Taniguchi and Associate Professor Ohshiro, has developed Japan's first biomolecular sequencer prototype, crucial for gene-based cancer diagnosis and treatment.

Biomolecular sequencers are devices for deciphering genetic information and are essential advanced equipment for gene-based cancer diagnosis and treatment. Previously, a research team at the University of Osaka demonstrated that biomolecular sequencers can be used to determine the base sequences of DNA and RNA and the amino acid sequences of peptides. This time, the team collaborated with the industry to successfully developed a prototype device of the first made-in-Japan biomolecular sequence.

The verification of the principle of the biomolecule sequencer had been carried out by this research team over a period of more than 16 years; however, the development of a measurement chip and measurement device has proven to be a significant hurdle to its practical application.

The research team headed by Professor Masateru Taniguchi and Associate Professor Takahito Ohshiro worked jointly with H.U. Group Research Institute G.K., a wholly-owned subsidiary of H.U. Group Holdings, Inc., which includes Japan's largest provider of clinical laboratory testing services (SRL Inc.) and in vitro diagnostics (Fujirebio Inc.), to review and evaluate the materials, fabrication processes, and functions of the measurement chip and measurement device from a practical application perspective. Based on the results obtained in this study, a new design was developed and with the strong support of Sony Global Manufacturing & Operations Corporation, a prototype biomolecule sequencer was successfully developed.

The team will continue to develop AI optimized for biomolecular sequencers for fast and accurate gene-based diagnostics while working to create a ‘peptide sequencer,’ a globally contested area of research, to realize a powerful tool in peptide drug discovery.

Research Reports

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Dept. of Advanced Hard Materials

2024.9.19 **Size matters: bioinformatics accurately detects short, fat antibiotic-resistant bacteria**
Dept. of Biomolecular Science and Regulation

2024.9.25 **First made-in-Japan biomolecular sequence provides boost to medical care and innovation in biomolecular R&D**
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Dept. of Biomolecular AI Sensing

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Dept. of Energy and Environmental Materials

2025.3.26 **Making the physics of glass more transparent**
Dept. of Theoretical Nanotechnology

Awards

the 2024 "Sir Martin Wood Prize"

Department of Theoretical Nanotechnology
Professor **Emi MINAMITANI**

The Sir Martin Wood Prize was established with an endowment from Oxford Instruments, a British scientific instrumentation company, to provide additional incentives for young researchers in Japan who are conducting outstanding research. The prize is awarded to young researchers who have made outstanding achievements in condensed matter science at research institutions in Japan. Professor Minamitani was selected for this award for her research on "Correlation between Nanostructures and Transport Properties in Inhomogeneous Condensed Systems."

I would like to express my sincere gratitude to my collaborators and all those who have supported my research activities upon receiving this award. It is a great honor to be recognized with such a prestigious award. I am determined to continue dedicating myself to my research with even greater effort.

29th Ando Momofuku Award

Department of Advanced Electron Devices
Professor **Tsuyoshi SEKITANI**

Ando Momofuku Award is sponsored and presented by the Ando Foundation, is given to researchers, developers, and venture entrepreneurs who have contributed to the promotion of food science and the creation and development of new foods through their original research. The award was established by Ando Momofuku, founder of NISSIN FOOD PRODUCTS, inventor of instant noodles, and the creator of the brand Cup Noodles.

Professor Sekitani developed a sheet-type wireless electroencephalogram (EEG) sensor system using flexible and stretchable electronics. This innovative technology enables the creation of compact, low-cost measuring devices that can accurately measure biological information. Applying this technology to food science will provide new potential to research on a sense of taste and tasty flavor as well as and foods that support mental and physical health.

At the award ceremony, Professor Sekitani said, "Early detection and treatment are important for health management. By noticing abnormalities early, we can aim for a future where we can maintain our health through diet, and we will continue to devote ourselves to research and development and social implementation."

21st (AY2024) Japan Academy Medal

Department of Functionalized Natural Materials
Associate Professor **Hirotaka KOGA**

The Japan Academy Medal recognizes the outstanding achievements of promising young researchers and encourages their continued contributions to science. Recipients are selected from the awardees of the JSPS Prize, granted by the Japan Society for the Promotion of Science. In 2024, Associate Professor Koga received the JSPS Prize for his research on "Interdisciplinary Functional Development of Biomass Materials for Green Material Innovation," and was subsequently chosen as one of six recipients of the Japan Academy Medal from among the 25 JSPS awardees.

I am deeply honored to receive this generous award, and I feel a sense of responsibility. This is not due to my own efforts, but rather to the guidance and support of my mentors, collaborators, colleagues, students, and family. I would also like to express my deepest gratitude to SANKEN and the University of Osaka for providing me with such a favorable research environment. I will continue to work hard in my research so as not to be ashamed of this award.

imec

The 13th imec Handai International Symposium

On December 9, 2024, the 13th imec Handai International Symposium was held at the imec headquarters in Leuven, Belgium. Since we entered into the Collaborative Framework Agreement in November 2011, we alternately hold annual symposiums between Japan and Belgium / the Netherlands.

In 2023, the SANKEN–imec partnership entered the second phase to expand our collaboration from the departmental to the institutional level. This year, we actualized our holistic collaboration by holding the Symposium which attracted representatives from the Graduate School of Medicine, the Graduate School of Engineering Science, and the Joining and Welding Research Institute as well as from SANKEN and the Graduate School of Information Science and Technology which joined in the Agreement in May 2018. More than 60 attendees, including imec members, shared and discussed expertise in innovative research and practical advancements in research fields ranging from semiconductors, quantum, nanotechnology, life sciences, medicine, biotechnology, AI, information processing, human sciences, and sensor technology to wearable devices.

After the Symposium, participants joined a lab tour to experience imec's advanced technologies firsthand. At imec's 300 mm super cleanroom in Leuven, they observed the forefront 300 mm wafer process / EUV and analyses equipments which feature advanced scaling CMOS and microfabrication technologies. Later, they visited the imec-NL / Holst Centre in Eindhoven, the Netherlands, to explore outstanding research in flexible electronics and wearable devices, as well as future-oriented research initiatives in health and nutrition at the OnePlanet Research Center in Wageningen, the Netherlands. This included demonstrations of health monitoring technologies which leverage sensing and AI.

During these days, the attendees had a lively exchange of expertise and scientific views on continuing and potential cooperative research, strengthening researchers' networking.

Integrating the expertise and technological capabilities of both parties, we aim to drive groundbreaking innovation, yield significant impacts on both industrial and academic sectors, and address societal challenges for our future well-being.

(The SANKEN Strategy Office)

International Conference Q-BASIS 2024

Owing to the generous contributions of all those involved, the international conference "Q-BASIS 2024" was successfully held at SANKEN, from November 11 to 14, 2024, co-organized by SANKEN and the JST-Mirai LPA (Laser Plasma Acceleration) project.

Over the course of the conference, more than 100 participants from six countries took part. Focusing on "Quantum Beam Application for Science and Industries," the program featured three keynote lectures, 34 invited talks, and 30 poster presentations. In addition, 12 companies cooperated with the conference by exhibiting their highly sophisticated instruments as well as introducing their state-of-art technologies.

As in the previous time, the conference provided a productive forum for exchanging cutting-edge research and ideas from around the world. Topics ranged across quantum beam science, plasma physics, laser science, materials science, chemistry, biology, and medical and pharmaceutical sciences.

On the last day, participants visited the Research Center for Nuclear Physics (RCNP) at the University of Osaka, where they toured the ring cyclotron accelerator and other advanced research facilities.

We sincerely look forward to meeting you again at the next Q-BASIS conference in 2026.

Q-BASIS

The 28th SANKEN International Symposium

The 28th SANKEN International Symposium was held at Awaji Yumebutai in Hyogo Prefecture from January 8 to 10, 2025. The symposium, featuring "Trans-Scale Science and Technology for Future Society," brought together distinguished researchers, promising young scientists and graduate students from Japan and abroad to discuss cutting-edge scientific achievements and their applications across diverse fields such as quantum science, information technology, materials science, beam science, life science, chemistry, and nanotechnology.

The symposium highlighted "maximizing the potential of science and technology to contribute to the realization of a sustainable, safe, and secure future society." The discussions focused on research excellence across different scales of time and space in a multitude of research fields. Participants shared novel perspectives and insights, which marked a major step toward sustainable development and innovative technologies for future society. It was a great honor to welcome 17 distinguished researchers from overseas.

More than 40 researchers participated in the poster session and vibrantly exchanged latest ideas and proposals, which demonstrated the energy and enthusiasm of promising young scientists to pioneer innovative excellent research.

The Symposium built valuable momentum to influence future research and industrial applications, and to foster international collaboration in the next-generation science and technology.

Tohru SEKINO (Organizer, Professor of SANKEN)

THE UNIVERSITY OF OSAKA

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July 2025