

# R&D

## Research & Development

Each company of the "Sumitomo Electric Group" combines its unsurpassed creativity with knowledge and experience to generate ideas that allows the group to contribute to society.

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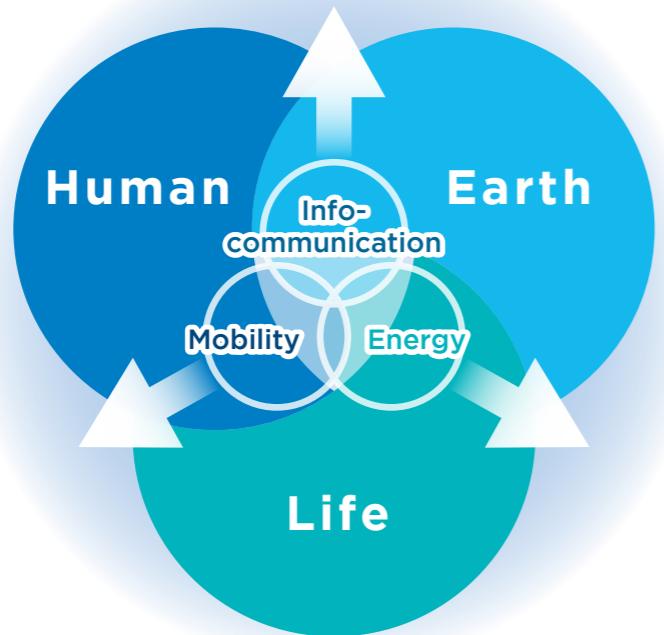
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# R&D Long-Team Vision and Organization

## ► Fundamental Approach

To achieve the Group's management principle of "Pursuing top technologies, evolving technologies that 'connect and support', and generating innovation through the Group's combined strengths", it's important that we (1) further strengthen our technologies in the business domains in which we operate and (2) create new products and services in new business domains.



## ► Strengthen technologies in current business domains

We are increasing innovation in materials and device technologies that support the advancement existing business domains.

- 1) Energy Domain: cable technology that contributes to the strengthening of power grids and energy management technology that is essential for the utilization of renewable energy
- 2) InfoCommunication/Electronics Domains: technologies that achieves high speed and large capacity while realizing small size and low power consumption
- 3) Mobility/High Performance Products Domains: technologies for CASE (Connected Automated Shared Electrified Vehicle).

## ► Create new products and services in new business domains

We are exploring next-generation research and development themes. By backcasting from the social issues of 2030 and beyond, we have defined three technology fields to focus on: "Earth", "People", and "Life". In "Earth" related fields, we will promote technological development related to GX (Green Transformation) for the realization of a sustainable society. In "Human" related fields, we will focus on the technologies necessary for individuals to maximize their abilities. Finally, In "Life" related fields, including in the virtual space, we will focus on technologies that connect person-to-person and person-to-things.

We will extend our strengths fundamental technologies such as materials and devices to support the above three fields.

## ► Three pillars of our strategy

To revitalize and speed up research and development to create diverse technologies, we are strengthening our efforts under three strategic pillars.

### Needs-Driven Driven by the demands of society

Exploring themes derived from backcasting of an ideal society challenges of 2050.

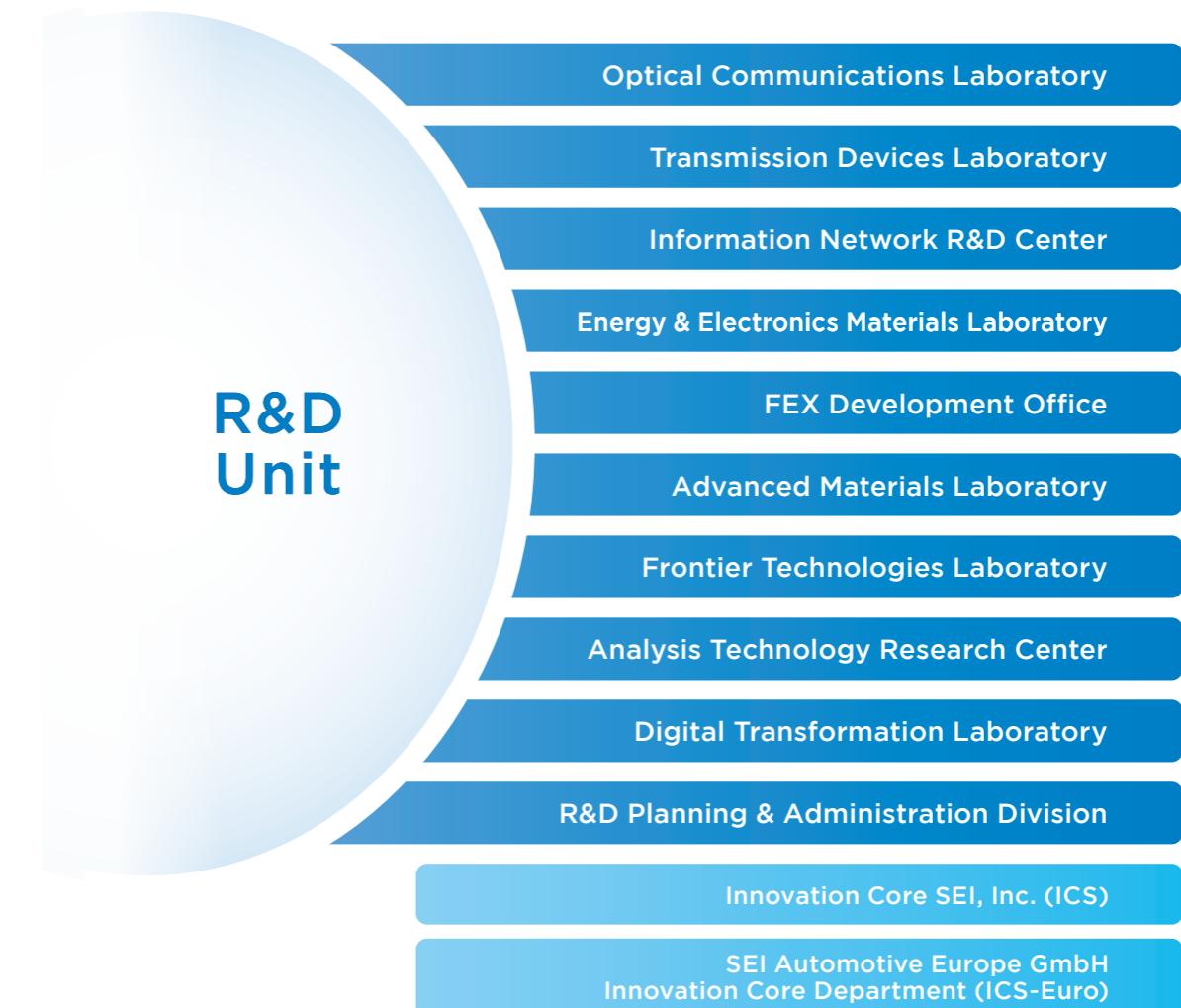
### Speedy Acceleration of the R&D process

Actively introduce materials informatics(MI), process informatics(PI), etc, thereby accelerating the development of materials and processing technologies, on which we pride ourselves, and enhance process efficiency in the from of automation, remote operation, etc.

### International Collaboration with overseas partners

- Global cooperation of SEG to share technology, know-how, ideas, etc
- Alliance with overseas companies, academic institutions, etc

## ► R&D Organization



# Optical Communications Laboratory

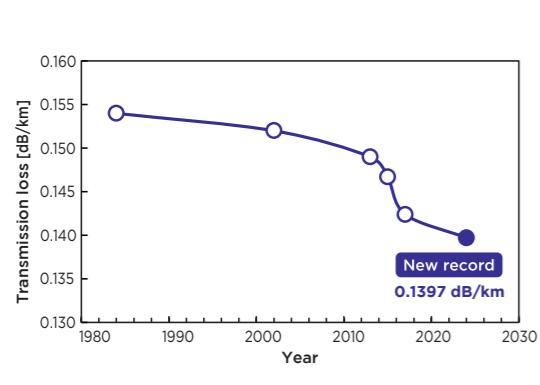
To support the growth of a truly connected society, we continue to innovate in optical fiber technologies that form the backbone of broadband communication networks. We are also extending the reach of optical technologies into emerging areas where they can create new value.

## ► Optical fiber



Z-PLUS Fiber® 150

Since the early 1970s, we have led the development of the Japan-born Vapor-phase Axial Deposition (VAD) method, which allows highly efficient manufacturing of optical fibers. Building on this foundation, we have created numerous innovations, from next-generation optical fibers to a variety of fiber-based technologies.



### Ultra-low loss optical fiber

Using our highly refined pure silica core technology, our ultra-low-loss optical fibers offer industry-leading performance for long-haul, high-capacity optical networks. They have become a preferred choice for submarine cable systems worldwide. In 2024, we set a world record with a transmission loss of **0.1397 dB/km** at 1566 nm, a benchmark that still stands today for solid-core fibers.

### World's First Mass Production of Multi-Core Fiber (Announced in September 2023)

Leveraging our deep experience in low-loss fiber technology and industry-leading advances in Multi-Core Fiber (MCF), we introduced the ultra-low-loss "2C Z-PLUS Fiber® ULL" and achieved the world's first successful mass production of an MCF of this kind.



## ► Next generation optical fibers/Connection technologies

We are driving the development of next-generation multi-core optical fibers (MCF) and their connection technologies, breaking through the limits of traditional single-core fibers and paving the way for future petabit-scale communications.

Fiber type	4-core coupled MCF	4-core uncoupled MCF	8-core uncoupled MCF	19-core uncoupled MCF	19-core coupled MCF
Cross-sectional image					
Cladding diameter [μm]	125	125	125	267	125
Features	Low loss for long distance transmission <sup>1)</sup>	Having optical compatibility with standard fiber <sup>2),3)</sup>	For short distance transmission in the 1.31 μm wavelength region <sup>4)</sup>	6 modes (i.e. 114 spatial channels) for 10 petabit/s transmission <sup>5),6)</sup>	Achieving the world's highest transmission capacity <sup>8)</sup> (announced on March 15, 2023) Ultra high density for long distance transmission with 1.7 petabit/s transmission <sup>7)</sup>

1) <http://www.sei.co.jp/company/press/2016/03/prs023.html>

2) <https://group.ntt.jp/newsrelease/2017/08/08/170808b.html>

3) <http://www.sei.co.jp/company/press/2017/prs083.pdf>

4) <http://www.sei.co.jp/company/press/2015/03/prs022.html>

5) <http://www.kddi-research.jp/newsrelease/2017/092201.html>

6) <http://www.sei.co.jp/company/press/2017/prs097.pdf>

7) <https://sumitomo-electric.com/jp/press/2023/03/prs034>

8) Standard cladding diameter (125μm) optical fiber conditions



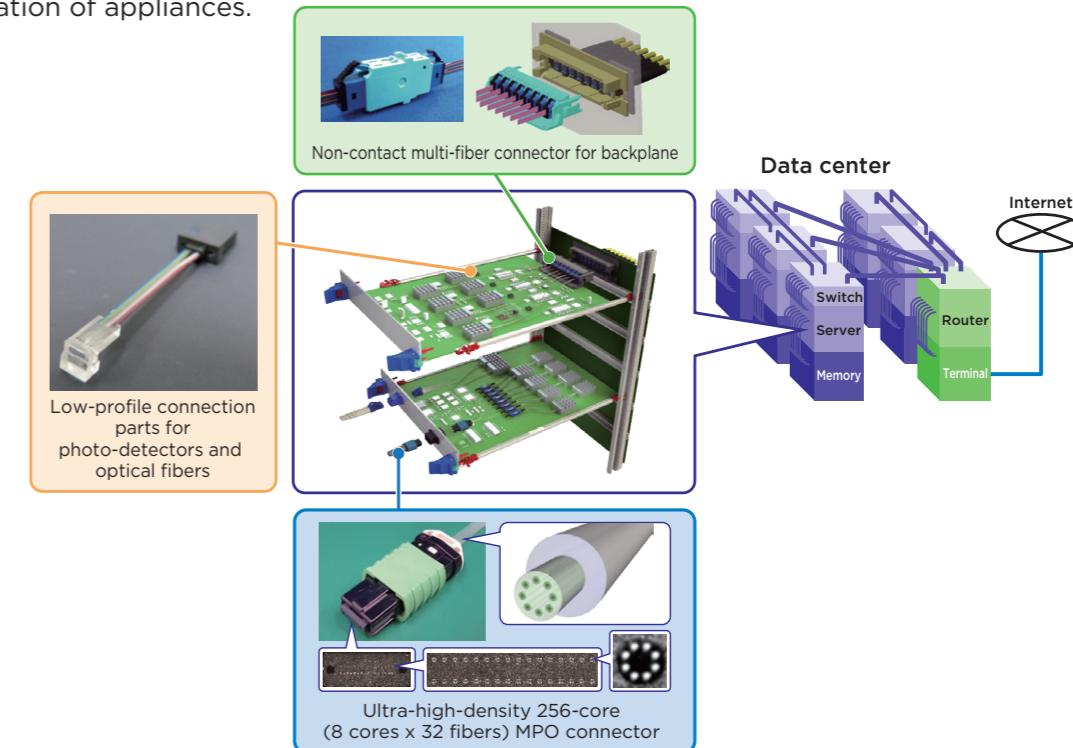
Ferrule with bundle fiber      Ferrule with MCF (Multi Core Fiber)



Bundled Fan-In/Out device structure and appearance

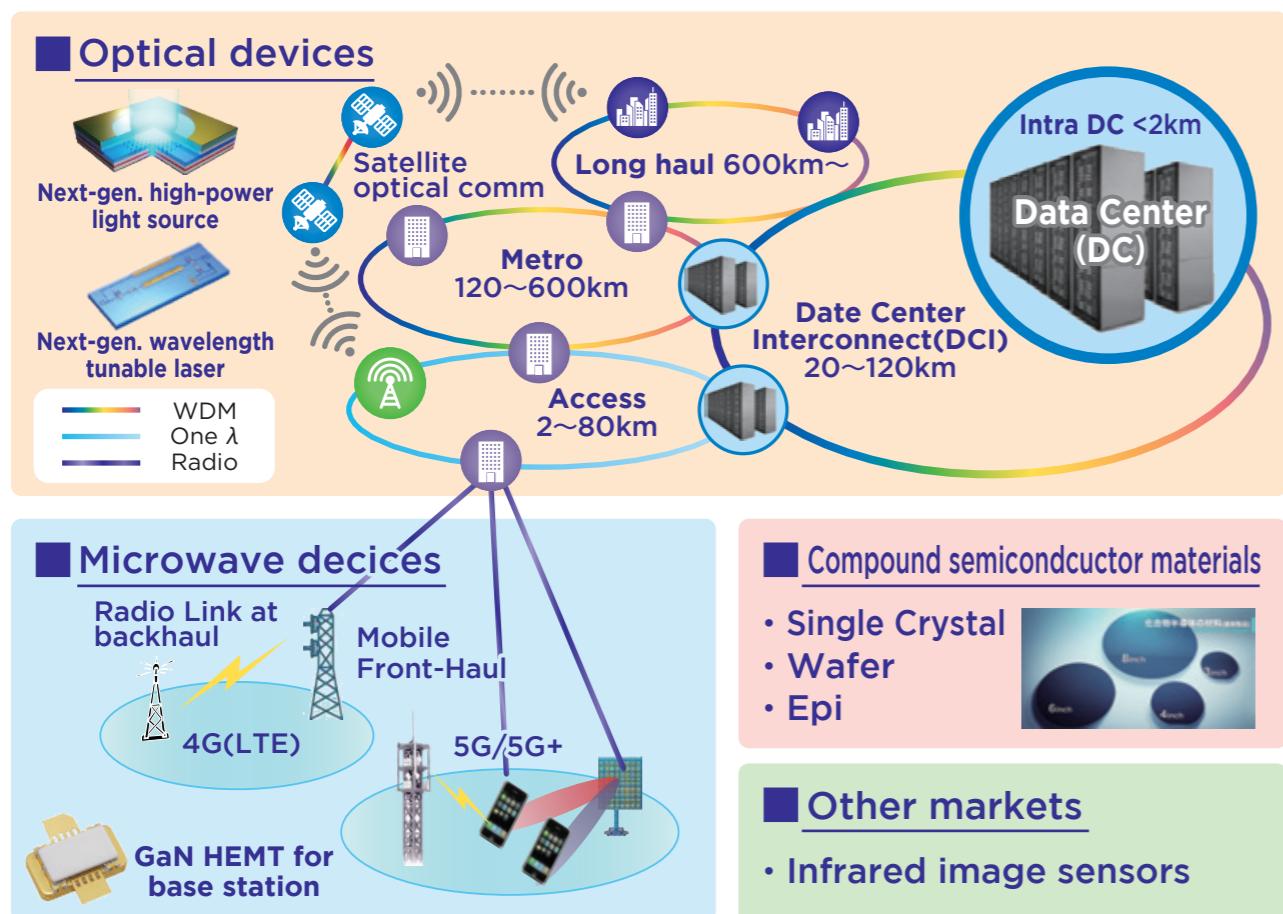
## ► High-capacity interconnection technologies

To support the rapid expansion of data centers, we are innovating high-capacity interconnection solutions that deliver both high speed and energy efficiency through our metal and optical cable technologies. We are also working on cutting-edge high-speed cables that will power the next generation of appliances.



# Transmission Devices Laboratory

Our unique technology encompasses semiconductor crystal growth, epitaxy, processing, high-precision assembly of optical and electronic devices. Using the complete spectrum of technology we possess, we are developing advanced compound semiconductor materials and related products for two major communications markets, that is, optics and wireless. We also aim to enter the non-communications market employing our cultivated elemental technologies.

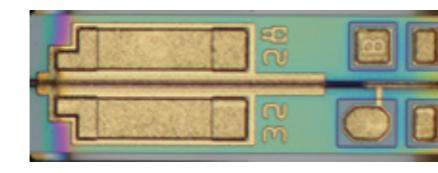
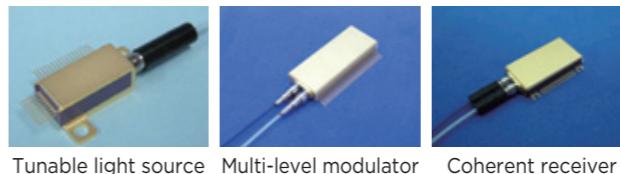


## Compound semiconductors and their applications



We are a pioneer in compound semiconductors, which are applied to various products where silicon cannot be used. We have commercialized a wide array of materials, and are now developing a crystal growth process with higher quality and a larger diameter as well as new materials for cutting-edge electronic devices.

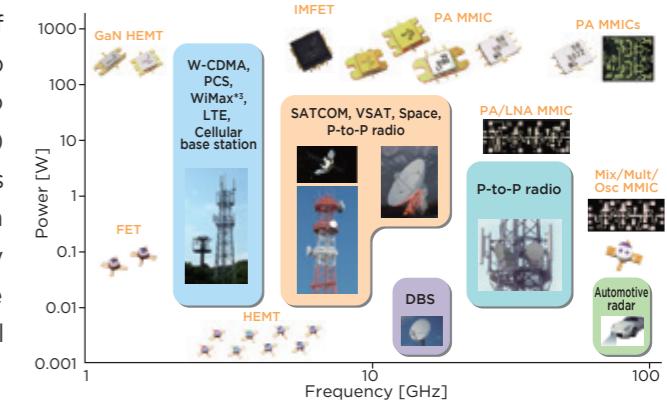
## Optical device



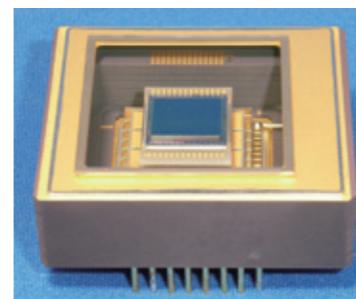
We are developing semiconductor devices for optical-electrical signal conversion in optical communications systems. For long haul, metro networks and data center interconnect (DCI) applications, digital coherent technology is used to realize 10 Tbit/s-class ultra-high capacity transmission. As key components, we are developing high-power tunable narrow-linewidth light sources, multi-level modulators, and coherent receivers employing our compound semiconductor technologies. For access networks and data center applications, we are developing high power and high speed lasers and optical sub-assemblies (OSAs). we are tackling miniaturizing and energy-saving technologies as well as higher transmission speed.

## Wireless device

We developed gallium arsenide (GaAs) HEMTs ahead of our competitors and have supported the expansion of wireless communications. Applying this technology to gallium nitride (GaN), we have greatly contributed to the miniaturization and higher efficiency of 4G(LTE) and 5G base stations. And for next generation wireless networks, we aim to create advanced devices with higher frequency and higher efficiency. In addition, by using high power and high efficiency features, we contribute to realize higher capacity of radio back-haul and satellite communications, and solid state radar.



## Infrared sensing device



Extremely high sensitivity photodetectors and quantum well infrared imaging sensors with new materials are being developed using elemental technologies of photodetectors for optical communications. We are creating new sensing device markets by realizing higher sensitivity, higher operating temperature, and environment-resistant.

## External activity

We are actively involved in fostering new research themes by participating in joint research with many universities and private companies and in national projects, as well as participating in and presenting at many academic conferences in Japan and abroad.

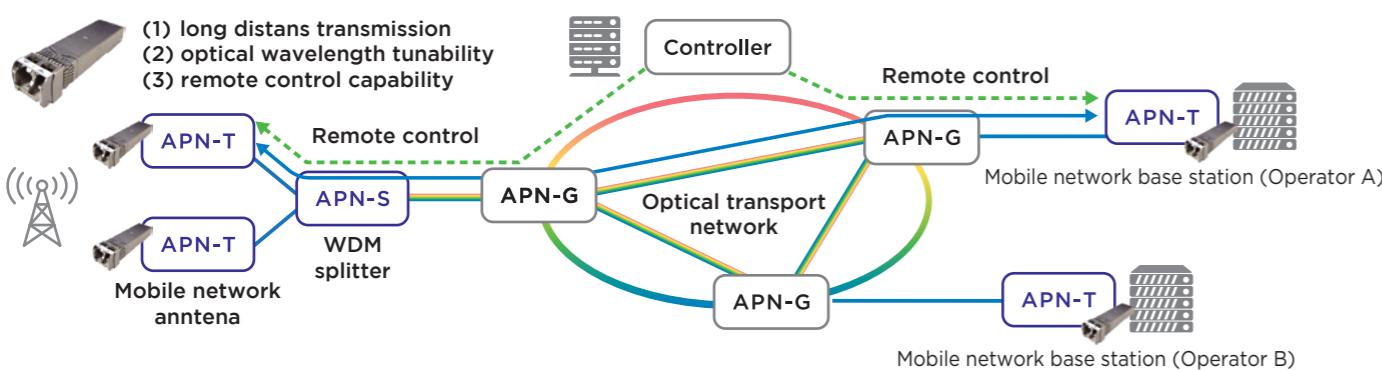
# Information Network R&D Center

We are conducting research and development in optical communication technology for next-generation passive-optical-networks (PON) and all-photonics-networks (APN), which support high-capacity, low-latency, and low-power-consumption network infrastructure, as well as wireless communication technology for 5G/6G and next-generation Wi-Fi. In addition, by utilizing optimization algorithms and AI technology, we are also working on the advancement and management/control of various devices in the fields of networks, mobility, and energy.

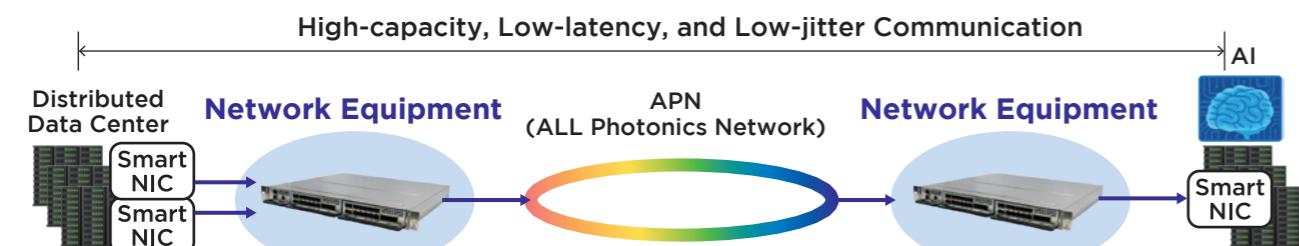
## Optical network systems

As optical network communications advance in terms of speed and capacity, there is a growing need for improved energy efficiency and lower network latency. An all-photonics network is technology that transforms conventional network devices and equipment, which required conversion between optical and electrical signals, into photonics-based (optical) technology, enabling high-capacity, low-power and low-latency communication. At our center, we are advancing research and development of optical transceivers and network equipment, which form the foundation of an all-photonics network.

We are working on research and development of optical transceivers (APN-T) and wavelength division multiplexing splitters (APN-S) with the goals of achieving an all-optical network between mobile network base stations and antennas with a specific focus on: (1) long distance transmission, (2) optical wavelength tunability, and (3) remote control capabilities.



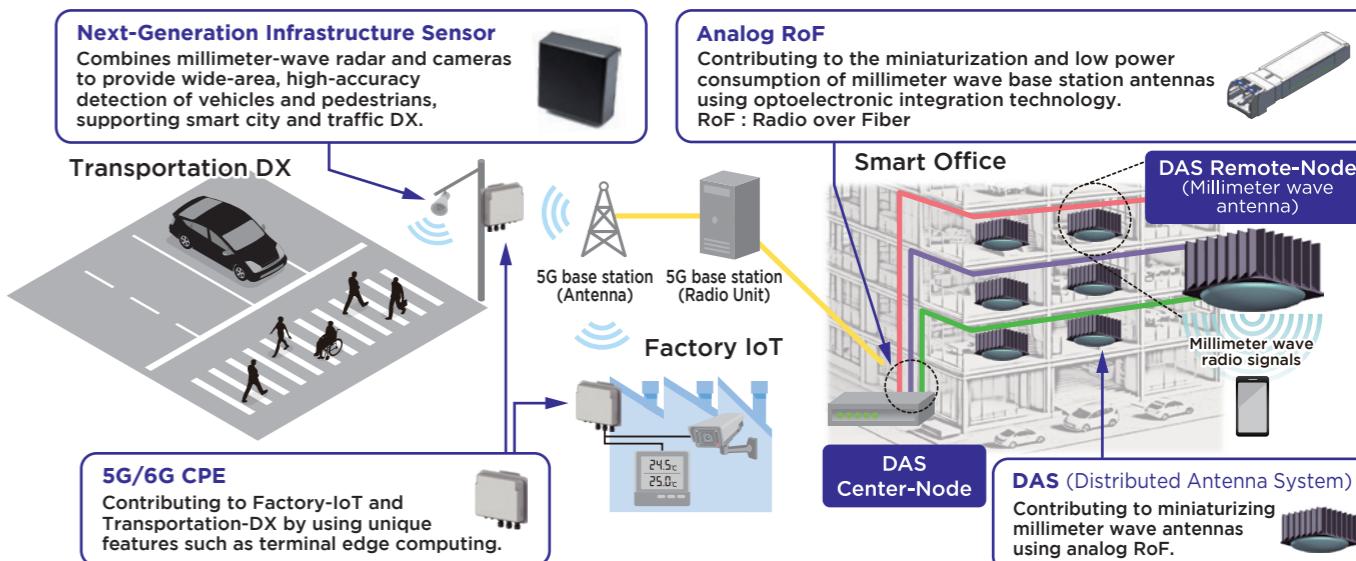
We are engaged in R&D of networking equipment capable of connecting network facilities with low latency and low jitter, and enabling all-optical networking for higher-capacity networks (400 Gbps class) such as metro/data center connections.



As next-generation FTTH technology, we are pursuing research and development on 25GS-PON and 50G-PON to achieve even higher speeds beyond 10G-EPON.

## Wireless systems

The IoT and Digital Transformation (DX) markets are rapidly expanding, driven by 5G technology featuring Enhanced Mobile Broadband (eMBB), Ultra-Reliable Low Latency Communications (URLLC), and Massive Machine Type Communications (mMTC), as well as sensor technology capable of high accuracy detection of vehicles, and pedestrians and other objects. To address the needs of these markets, our R&D center is utilizing its core technology – including wireless and antenna technology, optoelectronic integration technology, and signal and data processing technology – to develop equipment for 5G/6G and next-generation Wi-Fi, as well as sensor devices for transportation infrastructure applications.



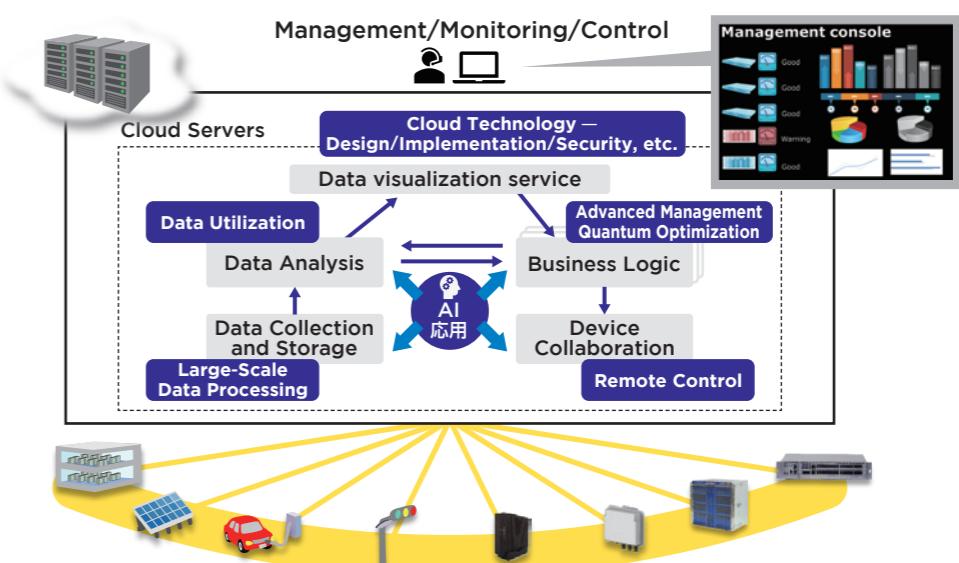
## Information processing system

We apply advanced information-processing techniques to analyze and capitalize on data collected from network equipment, vehicles, and a wide range of other devices. Building on this foundation, we are engaged in R&D in two principal areas:

- Technology that transforms conventional equipment into smart, connected assets (Smart Device Manager)
- Data-utilization systems driven by cutting-edge algorithms

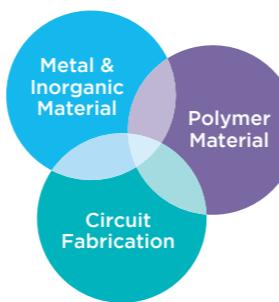
Our core competencies span:

- Cloud engineering—architecture design, implementation, security, data management, and cost optimization
- Data analytics—machine learning and generative AI
- Mathematical optimization and quantum computing



# Energy & Electronics Materials Laboratory

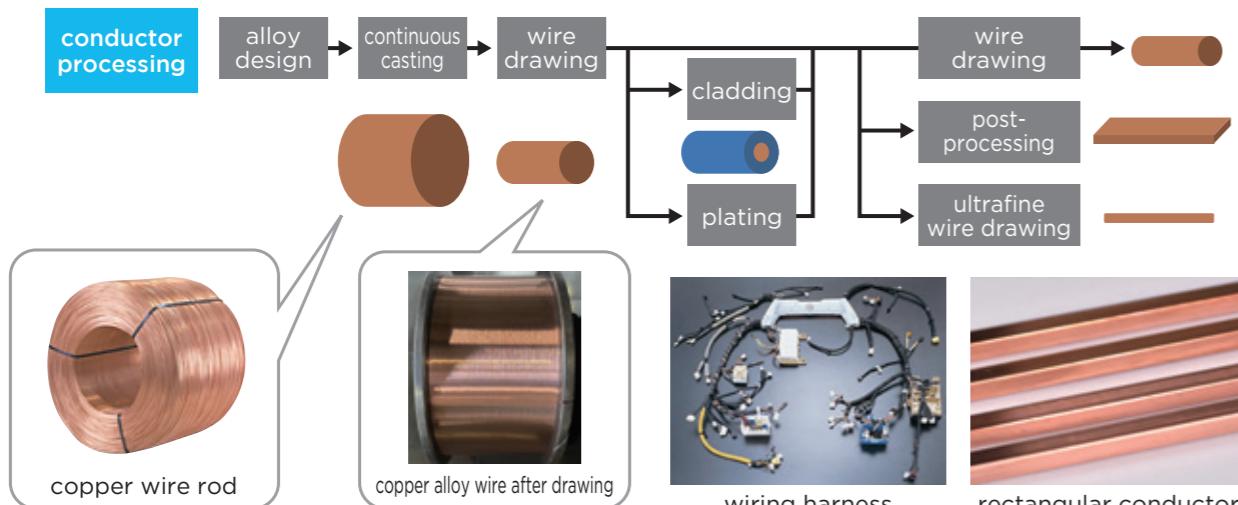
We contribute to the development of products and technologies in the Group's extensive business fields by leveraging our core technologies for metal, inorganic, and polymer materials as well as circuit fabrication. Moreover, to contribute to innovative businesses in new fields, we strive to refine and expand our core technologies.



## ► Metals and inorganic materials technology

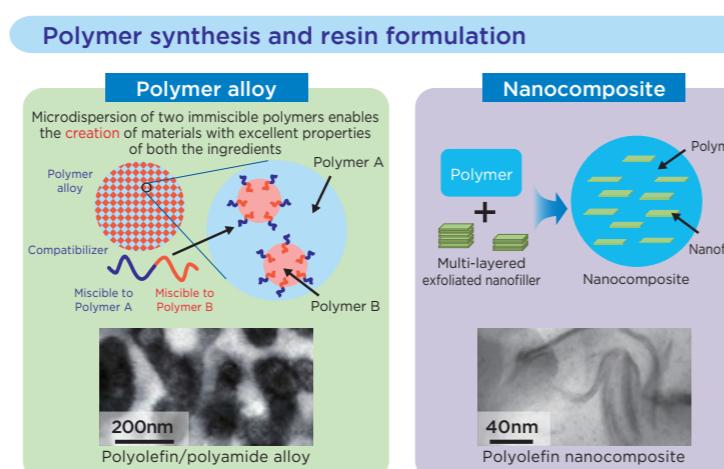
Having developed distinctive conductors using techniques such as continuous casting and plastic processing as well as designing of new alloys and composite material technology dealing with plating and cladding, the laboratory drives Sumitomo Electric's business relating to various types of wiring including wiring harnesses.

In addition, the laboratory has undertaken development of materials and processes helpful towards resources recycling and carbon neutrality.



## ► Polymer material technology

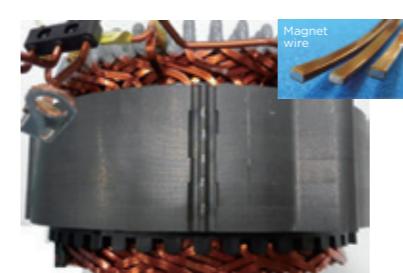
Employing polymer synthesis and resin formulation technologies, we have been developing a wide array of products such as electric wires and cables in the fields of environment & energy, electronics, and automotive, as well as magnet wires for environment-friendly vehicles. We are also working on the development of newly functional and high performance polymer materials through nano-sized material structure control (polymer alloy and nano-composite).



Heat-shrinkable tubing



Multi-core composite cable for electric parking brake



Magnet wires for environment-friendly vehicles



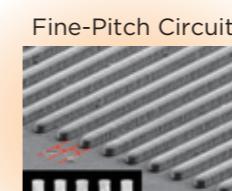
HVDC power cable for interconnector



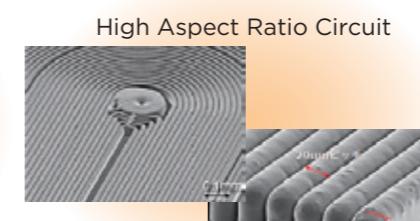
AC power cable for offshore wind power generation

## ► Circuit fabrication technology

As technologies for higher density, finer circuits and high-speed transmission, we are advancing the development of fine circuit formation technologies using plating, and circuit formation technologies with excellent high-frequency transmission characteristics, along with their application to products.



Fine-Pitch Circuit



High Aspect Ratio Circuit



Flexible Printed Circuit



Multilayer Circuit



Millimeter-Wave Antenna Circuit



Smartphone



Wearable terminal



Medical devices



Millimeter-Wave antenna



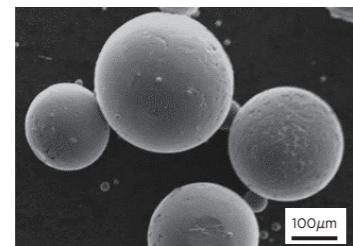
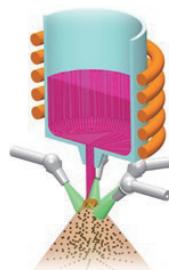
Car

# Advanced Materials Laboratory

We create unique metallic and inorganic materials through process innovation using our original ultra-high pressure and powder metallurgy technologies, and computational science. We contribute to the expansion of our business in industrial materials and other business fields through the development of highly functional materials and parts including cemented carbide cutting tools, diamonds, ceramics, sintered ferrous alloy parts, and special steel wires.

## Powder metallurgy

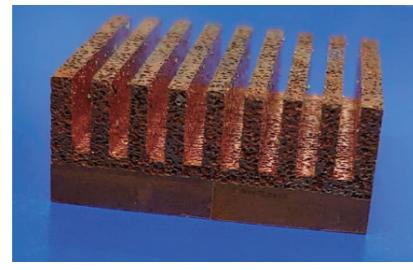
We have developed cemented carbide and cermet for cutting tools and sintered ferrous alloy and aluminum alloy parts for automobiles. We are now developing original metal powder as P/M raw material using atomizer, and porous metal which contribute to heat management technologies.



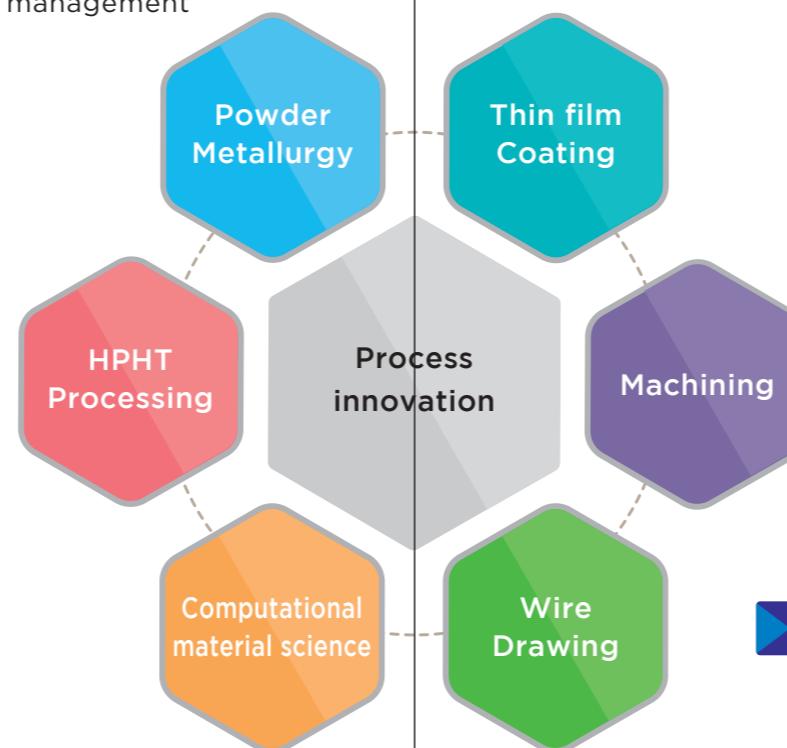
Metal Powder for P/M



Cemented carbide materials



Porous metal heat exchanger

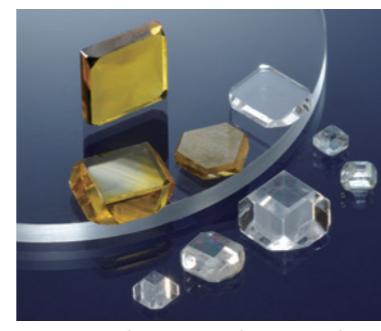


## Ultra-high pressure technologies

We have developed materials such as sintered diamond, nanopolycrystalline diamond and highpressure synthetic diamond, and processes using our ultra-high pressure technology. Recently, we have begun development of new diamond materials with improved mechanical strength and electrical properties.



Nano-polycrystalline diamonds



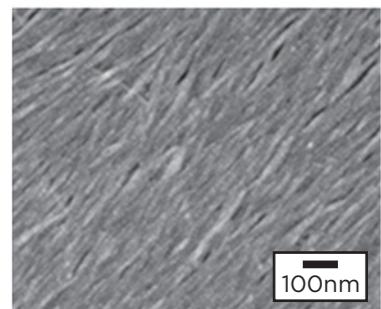
Synthetic single crystal diamonds

## Thin film coating technology

We are developing a coating technology to apply a ceramic film with high hardness and good adhesion on cutting tools. We are also developing nano filtration membrane for use in the environmental field.



PVD coated inserts



Nano filtration membrane

## Machining technology

We are developing high value cutting tools by using machining monitoring techniques and advanced tool fabrication processes including 3D printing.



Sensing tools

## Wire drawing technology

We are developing high performance and strength steel wire such as spring wire, steel tire cords and prestressing steel strand, and high strength electric wire with our drawing, heat treatment and electroplating technology.



High-strength conductive wire



Steel tire cord

# Frontier Technologies Laboratory

Predicting future social needs through the study of world trends including SDGs, DX and GX, we are developing revolutionary technologies that will be required for our business in the future.

## Hydrogen Society & Hydrogen production

### MCH Electrolytic Synthesis System

We are collaborating with ENEOS Corporation in a megawatt-scale large plant demonstration test by providing electrochemical cells utilizing cell stack technology from redox flow batteries for their "Direct MCH® synthesis technology," which they are actively developing.

By developing technology to mass-produce MCH, a hydrogen carrier, we aim to contribute to the realization of a future hydrogen society.



### AEM-type Water Electrolysis System

Our company is advancing the development of an AEM (Anion Exchange Membrane) type water electrolysis system, which has the potential to produce hydrogen at a low cost without using rare precious metals.

The AEM type water electrolysis system has a high technical affinity with redox flow batteries, and by applying the cell stack technology developed for redox flow batteries, we aim to develop a high-performance and highly reliable water electrolysis system, contributing to the realization of a green society.



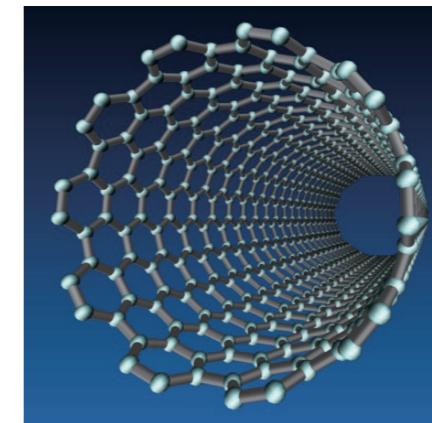
## High-Temperature Superconducting Wire

Development of a low-cost, rare-earth-based, high-temperature superconductor is under way using Sumitomo Electric's proprietary chemical solution deposition method. This superconductor is 200 times superior to copper wires in current carrying capacity at -196°C using liquid nitrogen. Moreover, Sumitomo Electric has developed the world's first stable superconducting joining technology and created a coil that can produce a magnetic field with permanent currents. These technologies are expected to enable high-temperature superconductors to be deployed in nuclear magnetic resonance (NMR) devices and magnetic resonance imaging (MRI) devices. In addition, use of the high-temperature superconductor is anticipated in magnets for small fusion reactors and superconductor motors.



## Carbon Nanotubes for Next generation wire

Carbon nanotubes (CNTs) are innovative materials that combine lightweight properties with excellent conductivity and strength. To unlock their potential as next-generation wire materials, we are developing a comprehensive process from CNT synthesis to high-orientation wire manufacturing. By actively utilizing carbon, we aim to contribute to the realization of a green and sustainable society.



## Redox flow battery

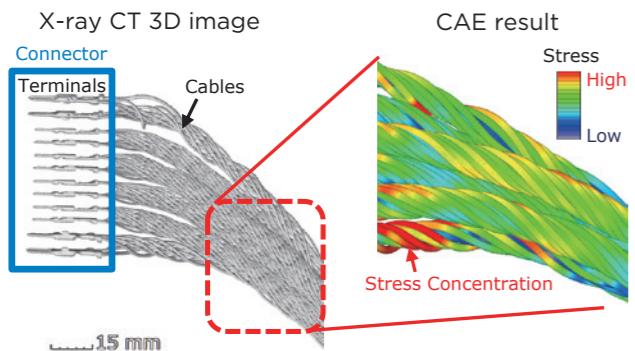
For power grids that use renewable energy-based power generation, the role of storage batteries is vitally important, charging and discharging power in response to fluctuations in the amount of generated power. The redox flow battery is suitable for irregular, highly fluctuating charge-discharge operation. Moreover, the amount of power stored in it can be accurately monitored and controlled. Therefore, it is an ideal storage battery for smart grids designed for efficient use of renewable energy sources such as solar and wind. The redox flow battery is considered a key device toward achieving carbon neutrality. While we have placed redox flow batteries on the market, we are working on further product development with the aim of putting them into full practical use.



# Analysis Technology Research Center

We support the manufacturing and development of our group's products through advanced analysis and CAE (Computer Aided Engineering) technologies. Our main bases are in our Osaka, Itami and Yokohama works. We have bases in external facilities such as the Kyushu Synchrotron Light Research Center.

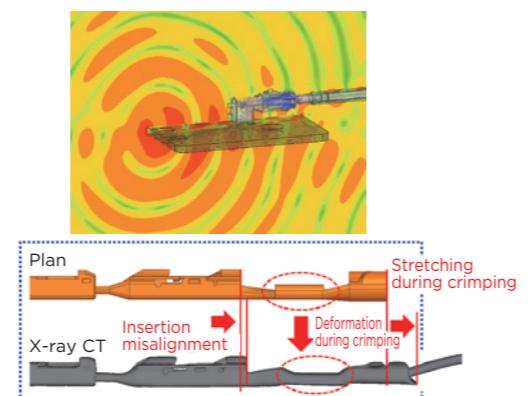
## Electric wire service life prediction



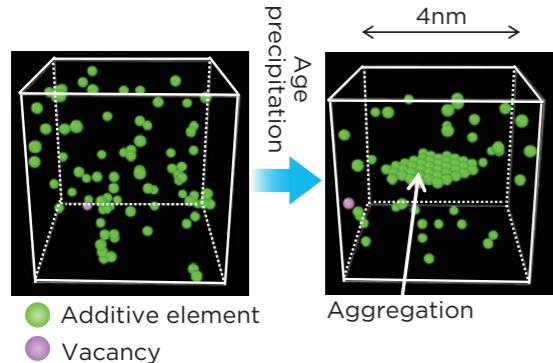
Automotive doors and robot arms incorporate electric wires and cables in moving parts. We are developing CAE technology for predicting the service life of these cable and wires by utilizing X-ray CT and AI techniques that can obtain their twisting and bending trajectories automatically.

## High frequency electromagnetic analysis for high-speed communication

We use high-frequency electromagnetic analysis to develop products that support high-speed communication technologies such as CASE and 5G. In order to capture electromagnetic waves with shorter wavelengths due to higher speeds, we make the most of large-scale computing servers, and we are also promoting collaboration with actual observation technology to take into account minute changes in shape during product processing.

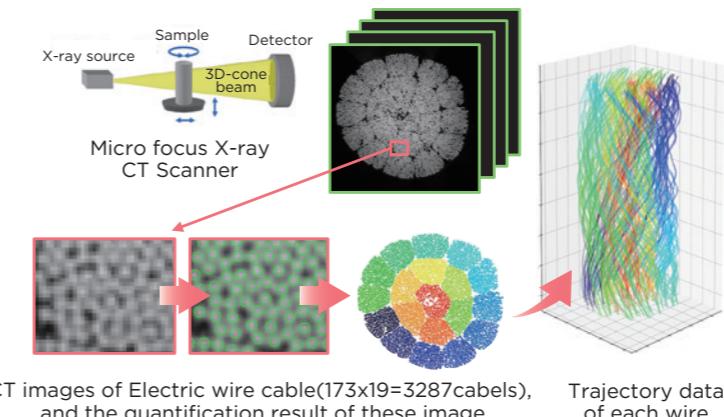


## Computational materials design for aluminum harnesses



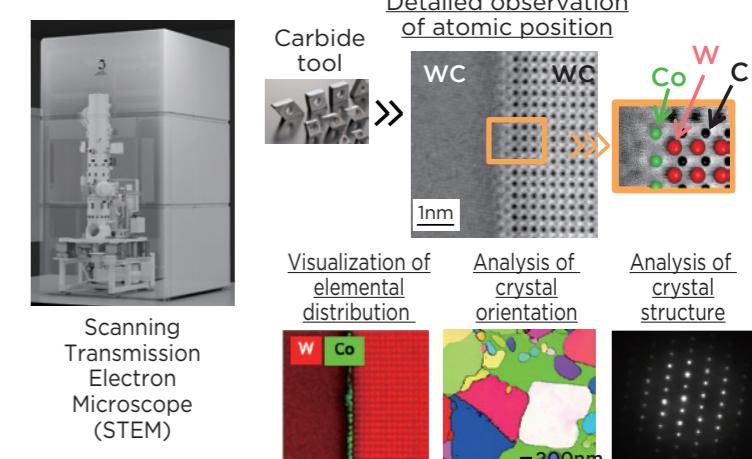
When certain elements are added to aluminum wire, their atoms aggregate over time to increase the strength of the wire. We are developing a simulation technology that can visualize this aggregation behavior in order to select the additive elements and to determine the aggregation conditions.

## Quantification of three-dimensional structures with data analysis technology

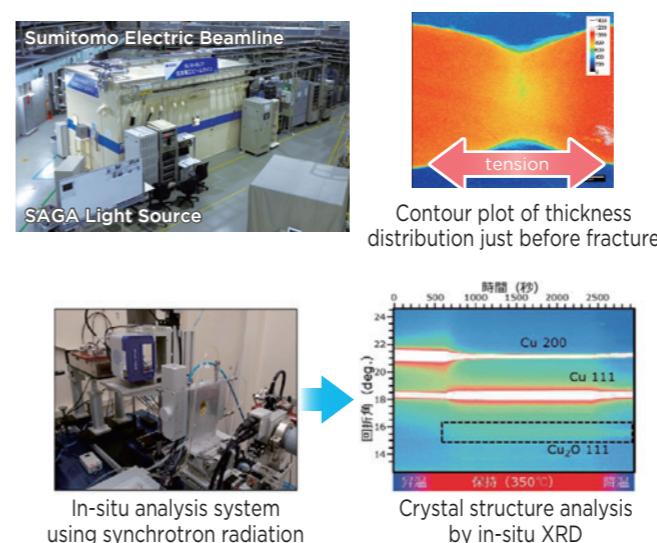


We visualize the three-dimensional structure of the product. We quantify the structure with the latest data analysis technology. And, We visualize the three-dimensional structure of products and quantify it with the latest data analysis technology and use this to solve or improve upon product quality problems using DX technology.

## Fine structure analysis with atomic-level resolution



## Atomic-level analysis and in-situ analysis using synchrotron radiation

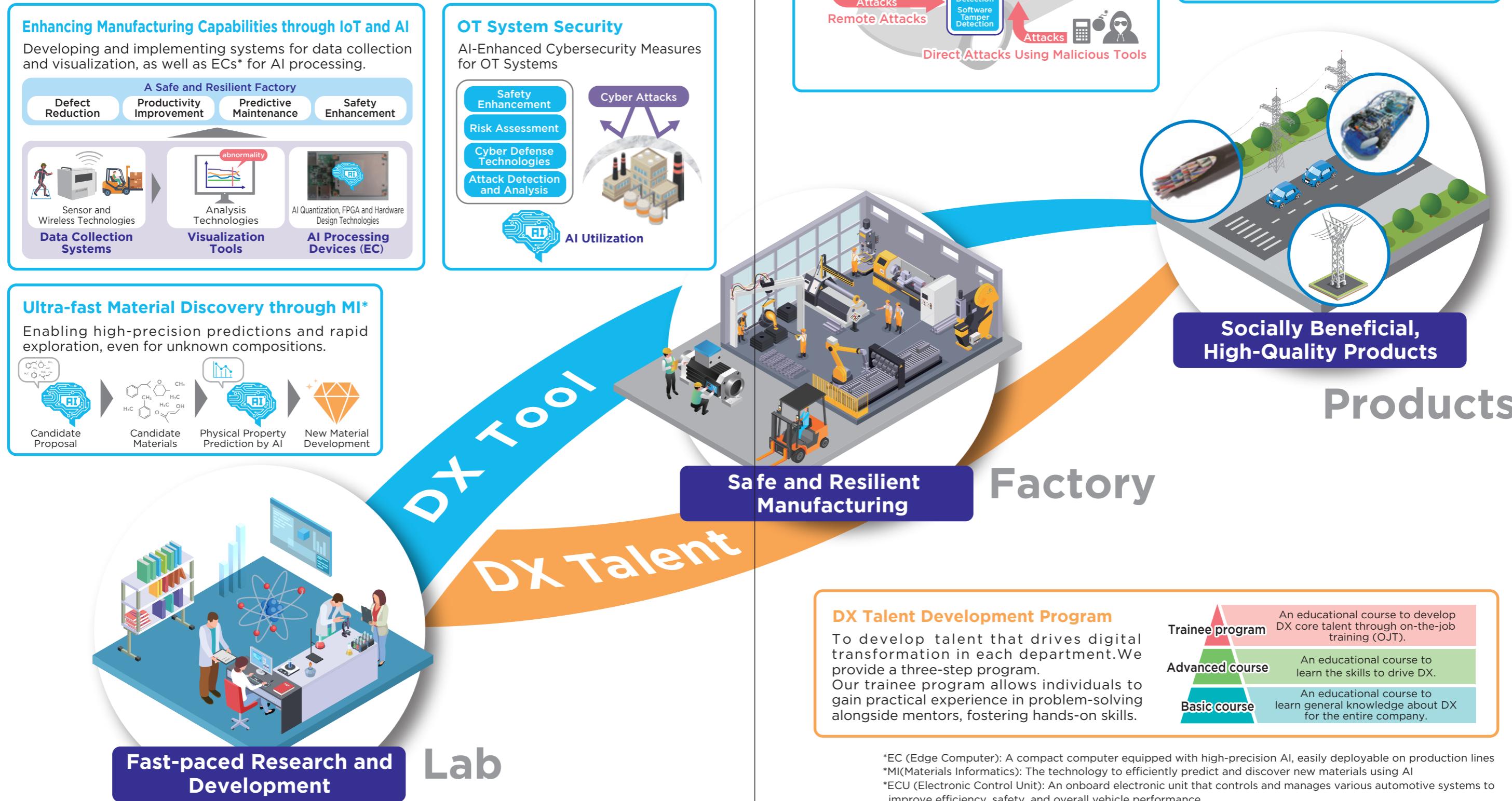


We develop analysis technologies using synchrotron radiation, neutrons and other leading analysis technology in order to investigate material structures at the atomic level.

We operate the Sumitomo Electric beamlines at the SAGA Light Source and use daily analyses to advance our research and product development.

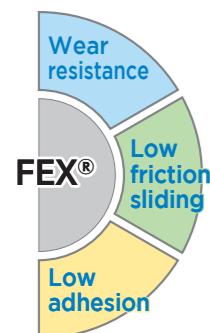
# Digital Transformation Laboratory

At the DX Technology R&D Center, we focus on developing core technologies for IoT, AI, and security, as well as nurturing talent. By doing so, we drive digital transformation (DX) to strengthen the Sumitomo Electric Group's manufacturing capabilities and accelerate research and development.



# FEX Development Office

We are dedicated to the development of cross-linked fluoropolymer materials, precision coatings, and productivity improvement, aiming to expand the applications of our crosslinked fluoropolymer technology named FEX®. While focusing on collaboration with existing businesses, we are advancing the development of new products for consumer, automotive, and die and mold applications that leverage the characteristics of cross-linked fluoropolymers.



## Wear resistance

Improve wear resistance of fluoropolymer materials

## Low friction sliding

Improve the performance of friction components under dry and liquid lubrication

## Low adhesion

Improve the release of molds for rubber and resin; enhance product conveyance

## Cross-linked fluoropolymer coating, tapes, and sheets

Carbon neutrality, based on life cycle assessment (LCA), is becoming increasingly important in the automotive and consumer industries, alongside traditional environmental protection measures. As a result, there is a rising demand for reducing sliding loss. The advantages of cross-linked fluoropolymers, including low friction, wear resistance, and anti-seizing properties, are attracting attention for products designed to mitigate sliding loss. Additionally, cross-linked fluoropolymers are known for its water and oil repellency, non-adhesiveness, low friction, and wear resistance. These properties improve mold release for rubber and resin and enhance product conveyance by reducing dust emission and contamination. In addition to coatings, we are developing tapes and sheets in our cross-linked fluoropolymer line.



FEX® Tape

## Cross-linked fluoropolymer products for semiconductor manufacturing equipment

Fluoropolymers are widely used in semiconductor manufacturing equipment due to their chemical resistance, heat resistance, and purity. To improve processing speed and reduce power consumption of the semiconductor products, manufacturers are increasingly competing to achieve narrower wiring widths. In this competition, addressing unwanted particles that cause particle contamination has become more important than ever. Cross-linked fluoropolymers maintain the excellent properties inherent to fluoropolymers, such as chemical resistance, while overcoming the disadvantage of being prone to wear. We anticipate that our cross-linked fluoropolymer technology will contribute to particle reduction, and we are developing its application in semiconductor manufacturing equipment.

# R&D Planning & Administration Division

Aiming to carry out our long-term management plan (2030 VISION) that sets forth the managerial direction of our group company, we administer projects based on the achievements of our R&D unit. For the development and growth of our technologies and business areas, we support the launch of new research initiatives and commercialization of the results of our developments. We also promote collaboration within our group, joint research with universities and research institutions, participation in national projects, and cooperation with other companies. Regarding the US and Europe, we have set up local bases, where we gather the latest information, and encourage entry to development projects. Furthermore, we hold training workshops to nurture future leaders and networking between them.

## Overseas Operations

### Innovation Core SEI, Inc. (ICS)

### SEI Automotive Europe GmbH Innovation Core Department (ICS-Euro)



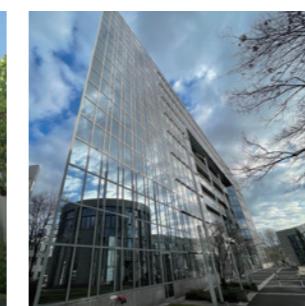
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San Jose Office



Wiesbaden Office

ICS, which serves as the overseas R&D base of the Sumitomo Electric Group, has offices in the United States and Europe. ICS aims to be a source for Sumitomo Electric's innovation. By leveraging the advantages of these locations, ICS can quickly perceive dynamic changes in technology and market trends. By engaging in open collaboration with local partners while working closely with the laboratories in the Japan headquarters, ICS supports the development and commercialization of "energy", "mobility", "new materials" and "next-generation optical communication" technologies.

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The China Analysis Technology Center is located in Suzhou, east China, and provides analytical support for the production and development of our group in China.

# R&D Network

