SUMITOMO ELECTRIC
Connect with Innovation

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Innovative Development, Imagination for the Dream, Identity & Diversity

Feature

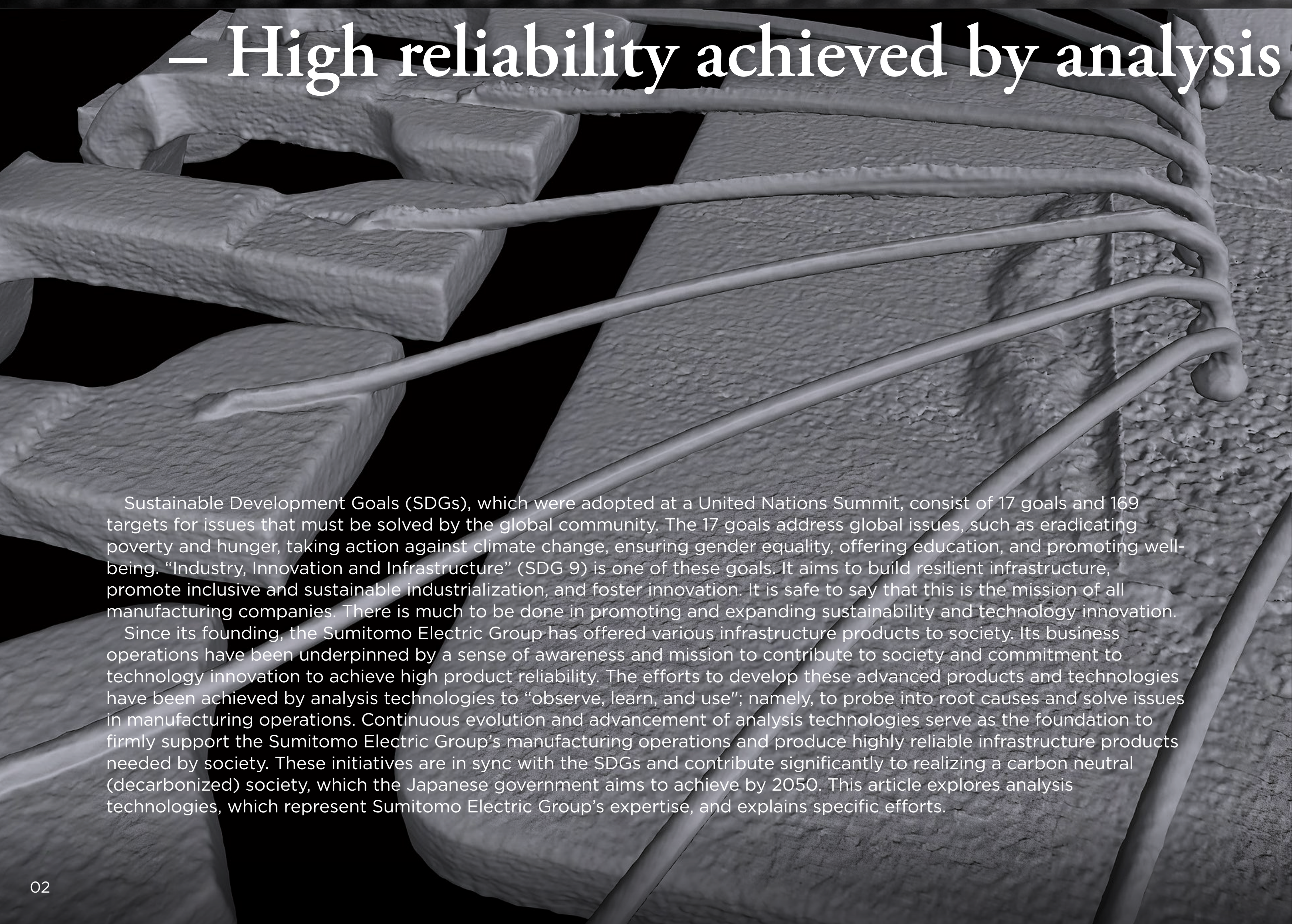
Expertise that underpins the manufacturing operations

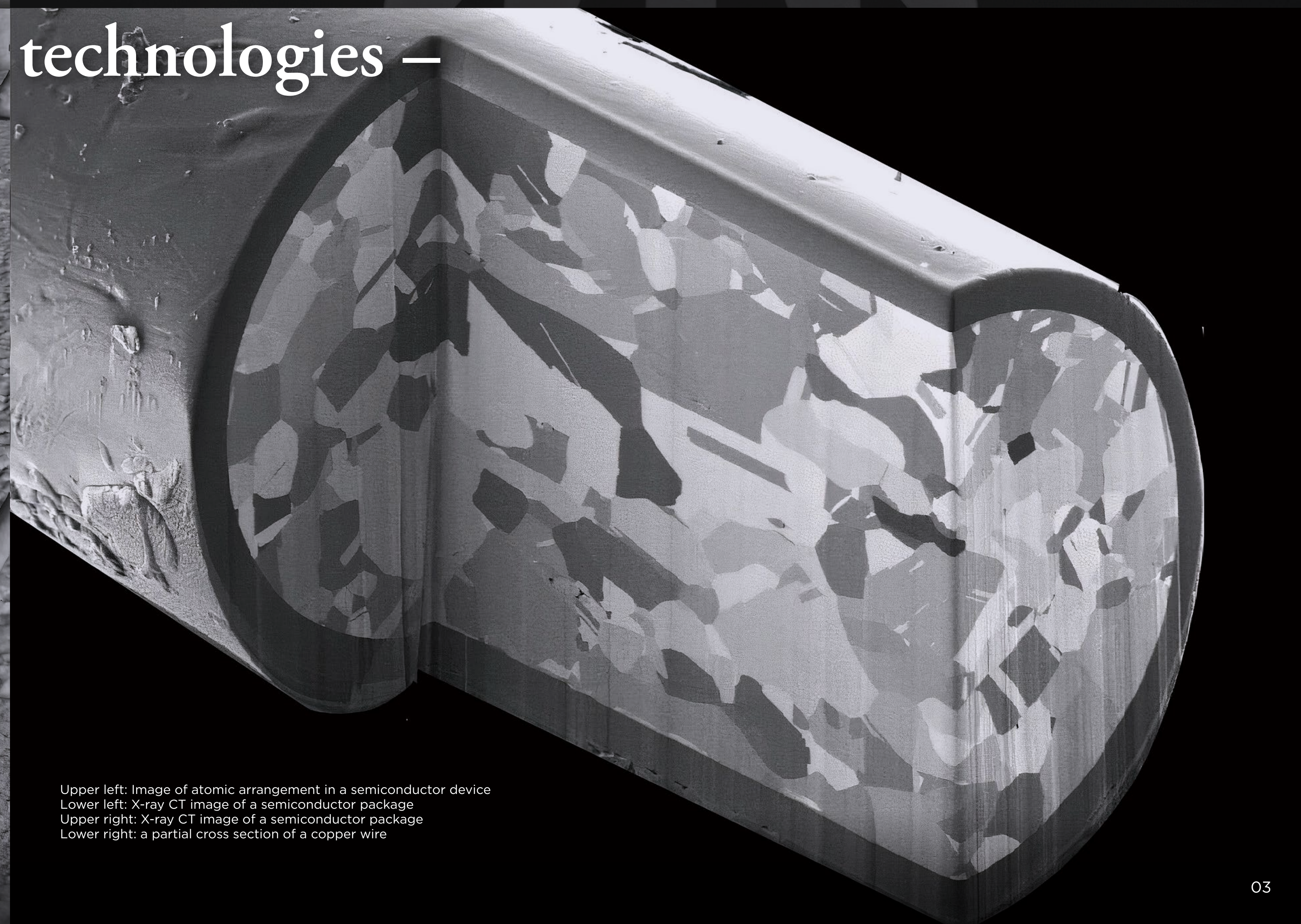
– Analysis technologies to probe into root causes –

SUMITOMO ELECTRIC GROUP

“Observe, Learn, and Use”

– High reliability achieved by analysis technologies –





Sustainable Development Goals (SDGs), which were adopted at a United Nations Summit, consist of 17 goals and 169 targets for issues that must be solved by the global community. The 17 goals address global issues, such as eradicating poverty and hunger, taking action against climate change, ensuring gender equality, offering education, and promoting well-being. “Industry, Innovation and Infrastructure” (SDG 9) is one of these goals. It aims to build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation. It is safe to say that this is the mission of all manufacturing companies. There is much to be done in promoting and expanding sustainability and technology innovation.

Since its founding, the Sumitomo Electric Group has offered various infrastructure products to society. Its business operations have been underpinned by a sense of awareness and mission to contribute to society and commitment to technology innovation to achieve high product reliability. The efforts to develop these advanced products and technologies have been achieved by analysis technologies to “observe, learn, and use”; namely, to probe into root causes and solve issues in manufacturing operations. Continuous evolution and advancement of analysis technologies serve as the foundation to firmly support the Sumitomo Electric Group’s manufacturing operations and produce highly reliable infrastructure products needed by society. These initiatives are in sync with the SDGs and contribute significantly to realizing a carbon neutral (decarbonized) society, which the Japanese government aims to achieve by 2050. This article explores analysis technologies, which represent Sumitomo Electric Group’s expertise, and explains specific efforts.

Upper left: Image of atomic arrangement in a semiconductor device
Lower left: X-ray CT image of a semiconductor package
Upper right: X-ray CT image of a semiconductor package
Lower right: a partial cross section of a copper wire

A micro-focus X-ray CT scanner uses X-rays to perform nondestructive three-dimensional observation of the internal structure of a specimen.

– Mission of the Analysis Technology Research Center –

Advanced Analysis Technologies Accelerate Manufacturing

Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS) achieves high-sensitivity surface analysis of elements and structures of chemical species.

Nuclear Magnetic Resonance (NMR) spectroscopy detects the interaction of nuclear spins placed in the strong magnetic field, enabling users to characterize bonding state, mobility, and concentration of molecules contained in liquid and solid specimens.

Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) is used to determine the presence and concentration of trace elements in a solution. There is growing need for ICP-OES as a trace analysis technique for regulated elements to comply with the RoHS and REACH standards.

Integration of material analysis and CAE technologies

In January 2022, the Analysis Technology Research Center (ATRC) of the Sumitomo Electric Group will mark the 20th anniversary of its opening. Its operations date back to the 1960s, when the Test Section was set up in-house, which led to the establishment of the Analytical Characterization Center. Meanwhile, the Computer Department was set up to perform computer-based analysis. The organization was upgraded and expanded, resulting in the establishment of the CAE Research Center. The activities that led to the establishment of the Analytical Characterization Center focused on “analysis” to directly observe and evaluate objects, while the CAE Research Center focused on “analysis” to make predictions based on theoretical calculation.

Computer-aided engineering, or CAE, refers to a system to conduct a preliminary study by computer simulation to determine whether products and materials have problems in terms of performance and quality in the development, design, and manufacturing phases. It enables calculation of physical phenomena, such as the status of force applied, fluid flow, heat transfer, and electromagnetic field. It can also visualize invisible phenomena in and outside objects, such as stress, temperature, and electromagnetic field. Thus, CAE makes it possible to probe into the cause of defects, predict the strength and service life of products, and verify various designs without fabricating prototypes.

Recently, CAE has been used by many manufacturers, and it has emerged as an important tool to ensure product reliability and competitiveness.

Focused Ion Beam Scanning Electron Microscope (FIB-SEM) is the main equipment for cross section preparation and observation.

The Analytical Characterization Center and the CAE Research Center worked on a mission to offer their solutions to the entire company. They were integrated in 2002 to establish the ATRC to probe into the root cause of issues more thoroughly and extensively. According to the prospectus of establishment, the ATRC aims to “change analysis technologies.” More specifically, the ATRC’s mission is to offer solutions for probing into the root cause and solving issues related to products and to develop analysis technologies beyond simply conducting analysis. The mission also includes promotion of information sharing through horizontal deployment of findings derived in this process, thereby strengthening the foundation of the manufacturing operations of the Sumitomo Electric Group.

Technologies to “make the invisible visible”

What are the tasks of analysis? Atsushi Kimura, General Manager of the ATRC, said, “Simply put, they make the invisible visible.”

“At the ATRC, analysis means direct observation of objects, while CAE means a theoretical prediction of invisible or potential phenomena. For example, when the plating thickness of a product varies significantly, the analysis team and the CAE team collaborate to probe into the cause of defects. In analysis, electron microscopy is used to observe the plating’s metallographic structure and growth process, which are invisible to the human eye. Chemical analysis is conducted to verify the composition concentration of the plating solution and ascertain whether plating solution ingredients work as designed. Meanwhile, CAE visualizes the electric field distribution when voltage is applied and the plating solution flow. We probe into the root cause of problems through such collaboration. As you see, both analysis and CAE are tools to make the invisible visible. This enables us to conduct examinations and take approaches from various aspects, spur discussions to solve issues, and come up with solutions,” said Kimura.

The ATRC handles all the products of the Sumitomo Electric Group. It operates in Osaka, Itami, and Yokohama to perform analysis of various products in the fields of automotive components, infocommunications, electronics, environment and energy, and industrial materials. The ATRC also owns a exclusive-use experimental station in a synchrotron radiation facility at the Kyushu Synchrotron Light Research Center, a public research institute in Tosu City, Saga Prefecture. Materials are irradiated with high-intensity X-rays to achieve in-depth analysis. (The details are discussed below.) In 2012, the China Analysis Technology Center was launched in Suzhou City, China, to support the printed circuit board business in particular, mainly in anticipation of the increase in demand to cope with quality issues at production sites in China.

Analysis technologies, which play a key role in ensuring competitiveness

In the manufacturing business, analysis technologies have become increasingly important. It has emerged as a crucial factor in ensuring an advantage in the market.

“Recently, analysis requirements of customers have been more rigorous than before. To maintain our competitiveness, it is essential to ensure advanced analysis capabilities in-house. Some customers require analysis capabilities in their supplier appraisal standards. The assessment results will be notified, and will also be one of the materials for determining orders and market share. In competitive procurement by automakers, suppliers must present the reliability test results of their products. Recently, they are required to present the CAE data as well. That is, suppliers must provide evidence that reliability is ensured. It is therefore extremely important to showcase the analysis capabilities and systems of our group to customers,” said Kimura.

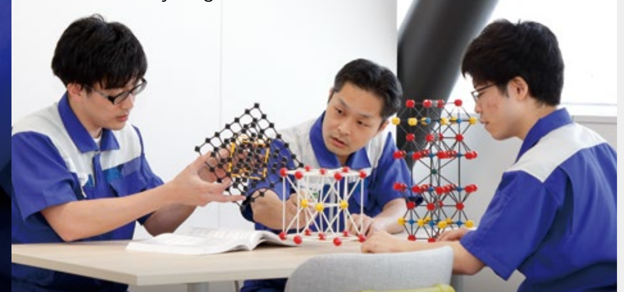
Pretreatment is a task which harnesses the know-how to dissolve samples for chemical analysis.

One of the ATRC’s strengths is that it has the equipment, technologies, and personnel to perform analysis and CAE, which are perfectly suitable for the manufacturing operations by the Sumitomo Electric Group. For example, only three private companies in Japan own the exclusive-use experimental stations in synchrotron radiation facilities, which are mentioned above. The equipment owned by the group is among the most advanced in the industry. Analysis and CAE technologies have been accumulated through many years of operations and have been passed down to date from one generation to the next. What is needed to further advance analysis technologies and improve their capabilities?

“Advancement of the information hub functionality is one of the aspects that we hope to strengthen in the future. We will deploy the findings derived from analysis and create a knowledge database of analysis. We will also enhance guidance and management to maintain the performance of the analysis equipment at production sites and improve the skills of operators. Meanwhile, it is also required to increase the efficiency of the business operations by promoting specialization of the analysis tasks and building a platform. The targets of analysis change rapidly, and analysis technologies continue to evolve. Thus, we actively promote alliances and collaboration with external organizations to harness cutting-edge technologies. We will deepen cooperation, including personnel interaction, with SPring-8, a synchrotron radiation facility of the highest performance in the world, the Japan Proton Accelerator Research Complex (J-PARC), and research institutes and universities. Through these efforts, we aim to take full advantage of cutting-edge analysis technologies to support the manufacturing operations of the Sumitomo Electric Group,” said Kimura.

Atsushi Kimura
General Manager of the Analysis Technology Research Center

Various meetings organized under the initiative of young researchers



Solutions Derived from Analysis Technologies

– Exploring the microscopic world through microstructural analysis and electromagnetic field analysis –

Microscopic characterization required on the atomic level

What analysis technologies does the ATRC have? Microscopic observation is a good example to start with. When a quality issue arises in the product manufacturing process, the ATRC probes into the root cause. Microscopic observation on the atomic (nanometer) level is one of the tasks to "observe the invisible." The crystal structures are observed on the atomic level to characterize the interface (interatomic) bonding. When the cause of the interfacial distortion is identified, the results are shared with the development and manufacturing sites to promote study on optimal interfacial bonding or new materials. Atomic observation and crystal orientation analysis technologies are essential to verify the working principles and to optimize the process in developing and designing materials and devices based on collaboration with computational science. Atomic-level evaluation is an important factor in establishing a difference from competitors.

High-frequency electromagnetic field analysis in the era of 5G communication

Electromagnetic field analysis is another way of observing the invisible. In telecommunications, a major trend now is 5G (fifth generation), which uses high-frequency bands to enable high-speed and large-capacity communication. To visualize the electric field distribution of a device's transmitted signals (high-frequency propagation), CAE analysis is performed on the radiated electromagnetic field, surface current induced by electromagnetic waves, etc. As multiple frequency bands are used in 5G communications, the ATRC has optimized product design for each frequency, and has shed light on issues pertaining to signal loss and noise that result from sending and receiving high-frequency signals.

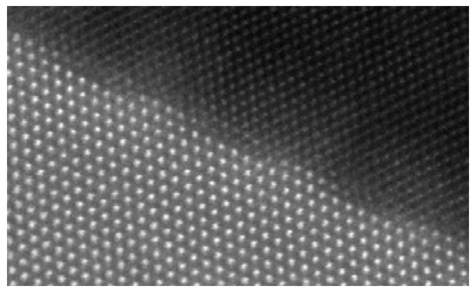
High-frequency transmission, including the 28 GHz band, will evidently require full-scale noise performance evaluation. Accordingly, the large-scale calculation will be inevitably required. The ATRC will introduce equipment with high calculation capabilities and develop large-scale CAE techniques.

Analysis-based exploration: "probing into a mystery" like a good detective

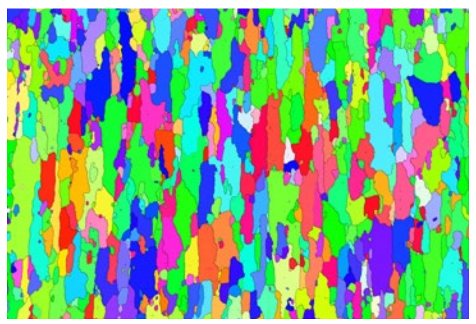
There are various types of analysis technologies, including analysis of the crosslinking degree and additives of insulation coating materials, thermal fluid analysis (e.g., heat radiation design of electronic devices), crystal structure and material analysis (to enhance the functionality of cutting tools), and optical analysis (of optical instruments and parts). Notably, the Sumitomo Electric Group has refined service life prediction technology for electric wires through many years of operations as a manufacturer of electric wires and cables. It has also developed CAE-based technologies to predict the fatigue life of electric wires and cables, which are used for moving parts, including hinges of car doors and mobile phones as well as robot arms, due to bending.

"Masayoshi Matsumoto, Chairman & CEO of Sumitomo Electric, once lived in an area near Baker Street in the U.K., the stage of the detective stories written by Conan Doyle, as an overseas representative. Upon hearing the report about various efforts made by the ATRC, Matsumoto commented, 'Their work is similar to that of Sherlock Holmes.' Our work is to draw inferences based on assumptions and demonstrate them one by one. It is very much similar to that of a good detective, who must cope with difficult cases, conduct thorough investigations, and reveal the facts. This is underpinned by the ATRC members' academic curiosity and pride as scientists to uncover the causes and probe into mysteries. Sumitomo Electric's strength is derived partly from many employees who have such commitment and mindset," said Kimura.

The following pages introduce specific cases of solving issues by using analysis technologies.



This is an atomic resolution image of the crystal interface of a cutting tool material observed by Scanning Transmission Electron Microscope (STEM). Periodic distortion is observed at the interface.



This is a crystal orientation image of an aluminum material by Electron Backscatter Diffraction (EBSD), which is used to visualize the crystal orientation affected by the machining process and thus facilitate the material design.

To Improve the Quality of In-vehicle Products for EVs in China

– Efforts made by the China Analysis Technology Center –

Efforts to carry out kaizen on disconnection of EPB electric wires: Genchi Genbutsu (going and seeing for oneself) and Genjitsu (facts) are the first steps to solve issues.

Ensuring quick analysis of actual products to keep mass production

EPB electric wires processed into harnesses

Establishment of a center to take quick and accurate action at the manufacturing site

In April 2012, the Analysis Technology Dept. of Sumitomo Electric Management (Shanghai) Co., Ltd. (commonly known as the China Analysis Technology Center) was set up at Sumitomo Electric Interconnect Products (Suzhou), Ltd. in Suzhou City, China. Osamu Ohama, who was engaged in launching the center and currently serves as Manager, Yokohama Analysis Dept. of the ATRC, explained the background.

"At that time, we faced an issue about how to ensure the quality of printed circuit boards produced in China. The factory received guidance from the Center Group in Japan, but it was necessary to quickly mass-produce products for mobile phones, whose product cycles were short. Thus, it was decided to adopt a policy and plan to promptly solve quality problems on a local basis. This led to the launch of the China Analysis Technology Center. In the printed circuit board business, where the so-called "out-out" scheme (i.e., manufacture products in China and sell them to customers outside Japan) had been in progress, products were shipped by air to Japan for failure analysis, which required electron microscopy, in some cases. This often resulted in time lags due to the need to transport and analyze samples," said Ohama.

Sumitomo Electric Interconnect Products (Suzhou), Ltd., where the China Analysis Technology Center is located

The China Analysis Technology Center was established to improve the quality and reduce the lead time in production of printed circuit boards. It was based in Suzhou City because an environment was in place to take quick and accurate action against quality problems. Specifically, there were more than 20 affiliated companies in the vicinity, and potential needs were expected in addition to the printed circuit board business. It was also possible to collaborate with universities and private institutions in the vicinity.

Solving issues of EPB electric wires, strategic in-vehicle products for EVs

When the production of printed circuit boards was transferred to Vietnam, the focus of analysis at the China Analysis Technology Center shifted to components for electric vehicles (EVs) whose production was growing in the Chinese market. The specific objective is to contribute to improving the quality in production of battery wires for EVs, windings for motors, and electric wires for the electronic parking brake (EPB) by using analysis technologies. The task is undertaken by Toshiyuki Koizumi of the Analysis Technology Dept., who is the successor to Ohama.

"Analysis of products for EVs started around 2017. There was a turning point in 2019. We strongly promoted activities to improve the quality in collaboration with the ATRC in Japan. Notably, regarding the EPB electric wires, which are strategic products that serve as the source of our competitiveness, the process design was optimized by actual product analysis based on analysis technologies and CAE. This reduced defects, including disconnection in the production process, by 50%. For terminal tab leads for EV batteries, we launched the conductor inspection process with the plant staff. We met customers' rigorous requirements by quickly solving issues on a local basis. We remain committed to probing into the fundamental principles and ensuring the quality in the production process of various products," said Koizumi.

Expansion of sales to local manufacturers and high evaluation from customers

Izumi Oneda of Sumitomo Electric Interconnect Products (Suzhou), Ltd. supervises the operations of production sites in Suzhou. He is responsible for improving and ensuring quality with analysis support from Koizumi and others.

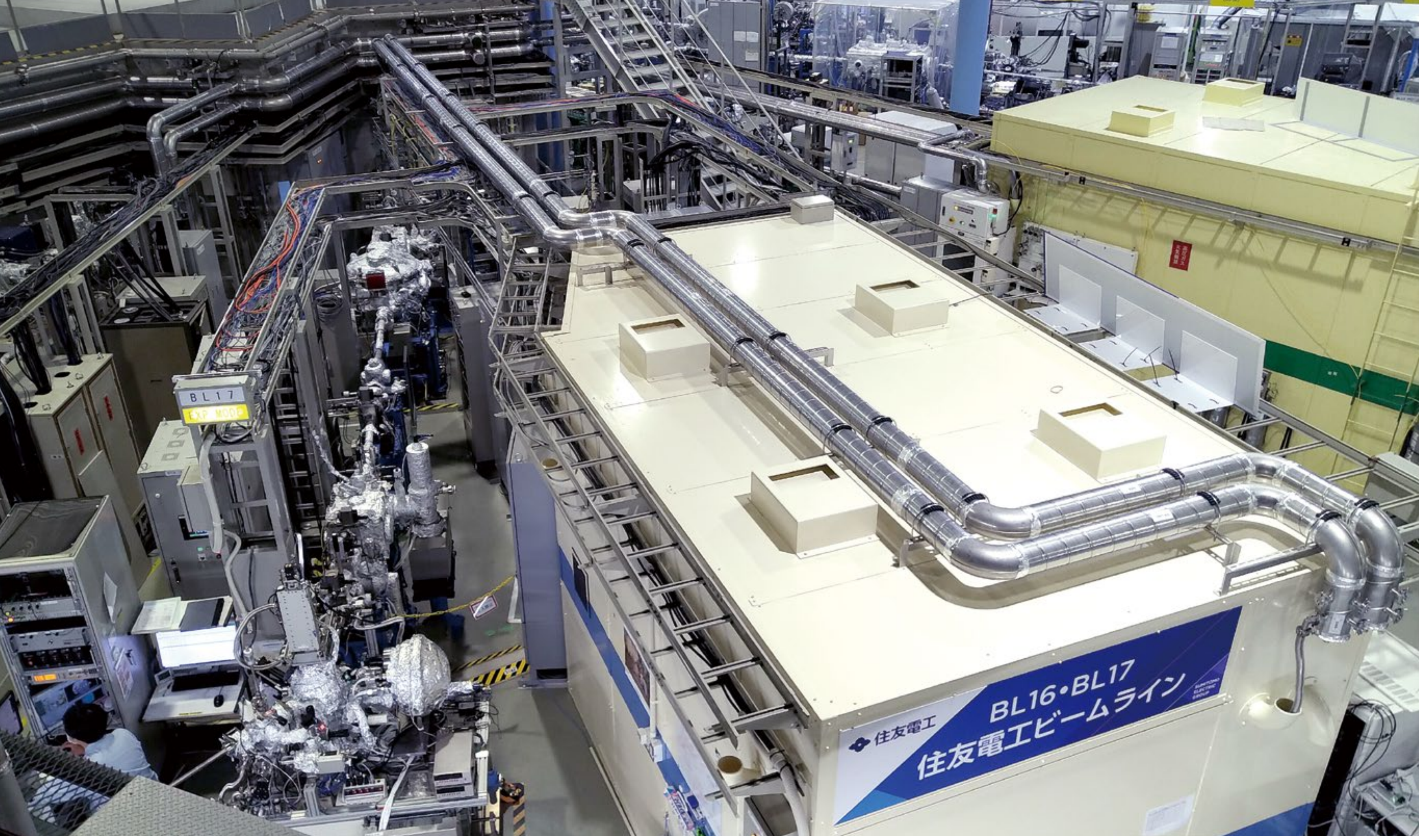
"We operate in China, which is the largest car market in the world. We ensure our competitive advantage through speedy communication between the China Analysis Technology Center and the plant, which is located on the same premises. At present, we mainly supply EV products to Japanese-affiliated automakers, but we have embarked on sales expansion to local manufacturers in China. We have been highly evaluated by local manufacturers thanks to our unique product performance, including flexibility, vibration resistance, and oil resistance, and actual product analysis by the China Analysis Technology Center," said Oneda.

The China Analysis Technology Center has been stepping up its efforts, including equipment investment and collaboration with local universities. It will further accelerate efforts to solve issues at production sites by offering guidance and training to the national staff members who are engaged in analysis.

Osamu Ohama
Manager, Yokohama Research Dept., Analysis Technology Research Center

Toshiyuki Koizumi
Manager, (Suzhou) Analysis Technology Dept., Sumitomo Electric Management (Shanghai) Co., Ltd.

Izumi Oneda
Manager, Electric Wire Div., Sumitomo Electric Interconnect Products (Suzhou), Ltd.



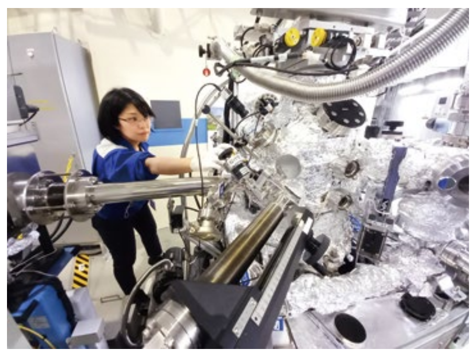
Sumitomo Electric's Beamline (equipment using synchrotron radiation from the accelerator for analysis) at the Kyushu Synchrotron Light Research Center

Analytics of Electronic Devices to Realize High-speed and Large-capacity Communication

– Advanced techniques for improving quality –

GaN HEMTs, electronic devices indispensable in the era of 5G

In Japan, the commercial service of 5G mobile communication, which is mainly used for mobile phones, started in some areas in the spring of 2020. Characterized by high speed, large capacity, low latency, and simultaneous connectivity, 5G mobile communication is expected to significantly change our daily lives and society. 5G communication requires transistors (i.e., electronic devices) that enable processing of electric signals at high speed with high output and low power consumption. The Sumitomo Electric Group was quick to start a study on new electronic devices with the future of telecommunications in mind. It focused on a material called gallium nitride (GaN), whose material properties are superior to those of conventional silicon, and developed GaN HEMTs characterized by both high speed and high output by combining GaN with High Electron Mobility Transistors (HEMTs). In 2007, the Sumitomo Electric Group marketed GaN HEMTs, which were used for 3G base stations. The GaN HEMTs were highly evaluated in the market and have evolved into products for 4G and 5G. The ATRC has contributed significantly to this evolution.



In XPS (X-ray Photoelectron Spectroscopy), substances are irradiated with synchrotron radiation to investigate the state of electrons on the surface and the state of chemical bonding.

The Kyushu Synchrotron Light Research Center

Process damage that occurs in the manufacturing operations

Yoshihiro Saito, a senior assistant manager of the Yokohama Analysis Dept. of the ATRC, has been engaged in the development of devices for 16 years since joining the company. He has been working on various analysis activities by taking full advantage of his experience. Uneven quality is one of the issues in manufacturing devices. As devices go through many steps, their characteristics change slightly. The manufacturing process of GaN HEMTs can be simply explained as follows: Epitaxy (a phenomenon in which single crystals grow in the same crystal orientation) technique is used to grow single crystals of GaN and aluminum gallium arsenide nitride (AlGaN) on substrates, and electrodes are attached in the final step.

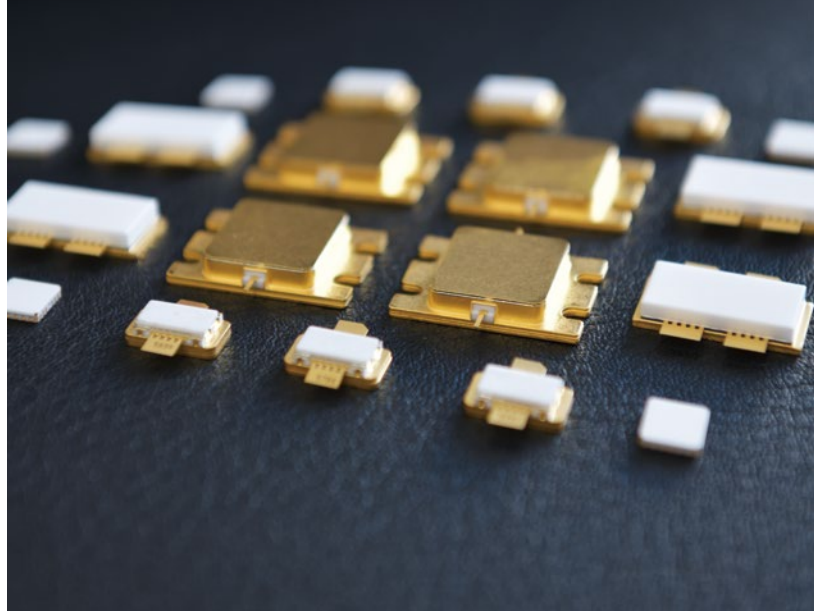
"One of our tasks is to probe into the cause of uneven quality. In the manufacturing process, some steps cause damage to gallium nitride, which is used as a material. Our mission is to explore the damage. For example, we evaluate and identify various types of damage to GaN, which is a compound of nitrogen (N) and gallium (Ga), such as differences in the composition, oxidization of the GaN surface, contamination with impurities, and defects of the crystal structure. Such damage results in deterioration of characteristics that GaN HEMTs are expected to offer. Thus, it is essential to probe into the cause. Based on the analysis results, the manufacturing sites optimize the process conditions to carry out kaizen and improve the quality. Analysis technologies also contribute to development activities to enhance the product performances. The Sumitomo Electric Beamline, which has been installed at the Kyushu Synchrotron Light Research Center in Tosu City, Saga Prefecture, is very useful in analyzing materials on an atomic level and help differentiate ourselves from competitors," said Saito.

Yoshihiro Saito
Senior Assistant Manager, Yokohama Analysis Dept., Analysis Technology Research Center

Synchrotron radiation and luminescence — Establishing various analysis techniques

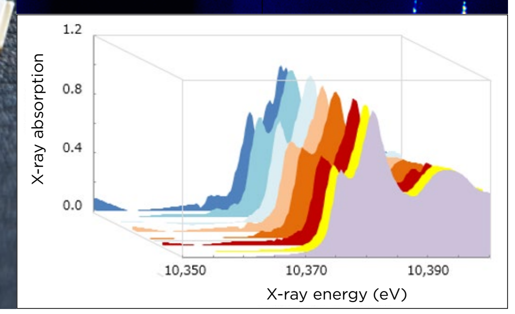
Synchrotron radiation, which was mentioned by Saito, is an extremely intense artificial beam that is generated by a large-scale accelerator. The beam consists of powerful, short-wavelength electromagnetic waves (X-rays) that get emitted when the path of high-speed electrons is bent by a magnet. Irradiating a material with these X-rays causes the release of various signals from the material. By studying these signals, the structure and characteristics of the material can be analyzed on an atomic level. In the synchrotron radiation experiment facilities, we can perform in-depth analytics by using high-strength X-rays 10,000 times to 100 million times more intense than those of small equipment. The Sumitomo Electric Group started its synchrotron analysis activities at public beamlines at SPring-8 in Hyogo Prefecture, which is one of the largest synchrotron radiation facilities in the world. Then, it installed its own beamlines at the Kyushu Synchrotron Light Research Center in Tosu City. These beamlines have been operated since November 2016 to meet various analysis needs, including devices. Takumi Yonemura of the Yokohama Analysis Dept. was engaged in synchrotron radiation analysis for some time after he joined the company. At present, Yonemura works on an analysis technique called photoluminescence to use synchrotron radiation more effectively.

"In photoluminescence, a substance or material is irradiated with a laser beam to observe the photons, which are generated when the excited electrons return to their ground state. The generated photons are easily affected by defects and impurities in a substance. Thus, in-depth analysis of the obtained emission spectrum makes it possible to acquire information about defects and impurities in the substance. This is one of the techniques to evaluate the process damage for GaN HEMTs. Based on the information about defects derived from photoluminescence, we determine the defect and find out how it affects the product characteristics by using synchrotron radiation and scanning transmission electron microscopy. In developing analytics and analysis techniques, it is important to collaborate closely with the manufacturing team to identify product issues a few years ahead, introduce new analysis techniques that are required to solve issues, and develop analysis technologies in advance. I believe that such efforts help ensure good quality in the manufacturing operations," said Yonemura.



GaN HEMT

X-ray diffraction data using synchrotron radiation to identify the material structure.



In-situ X-ray absorption spectroscopy measurements using synchrotron radiation for the interface state between an insulation film and semiconductor when the GaN-HEMT is in operation

Takumi Yonemura
Assistant Manager, Photonics Analysis Group, Yokohama Analysis Dept., Analysis Technology Research Center

Shinya Nishiyama
Manager, Electron Devices Quality Assurance Group, Quality Assurance Dept., Sumitomo Electric Device Innovations, Inc.

Strong collaboration between development and manufacturing members and the ATRC

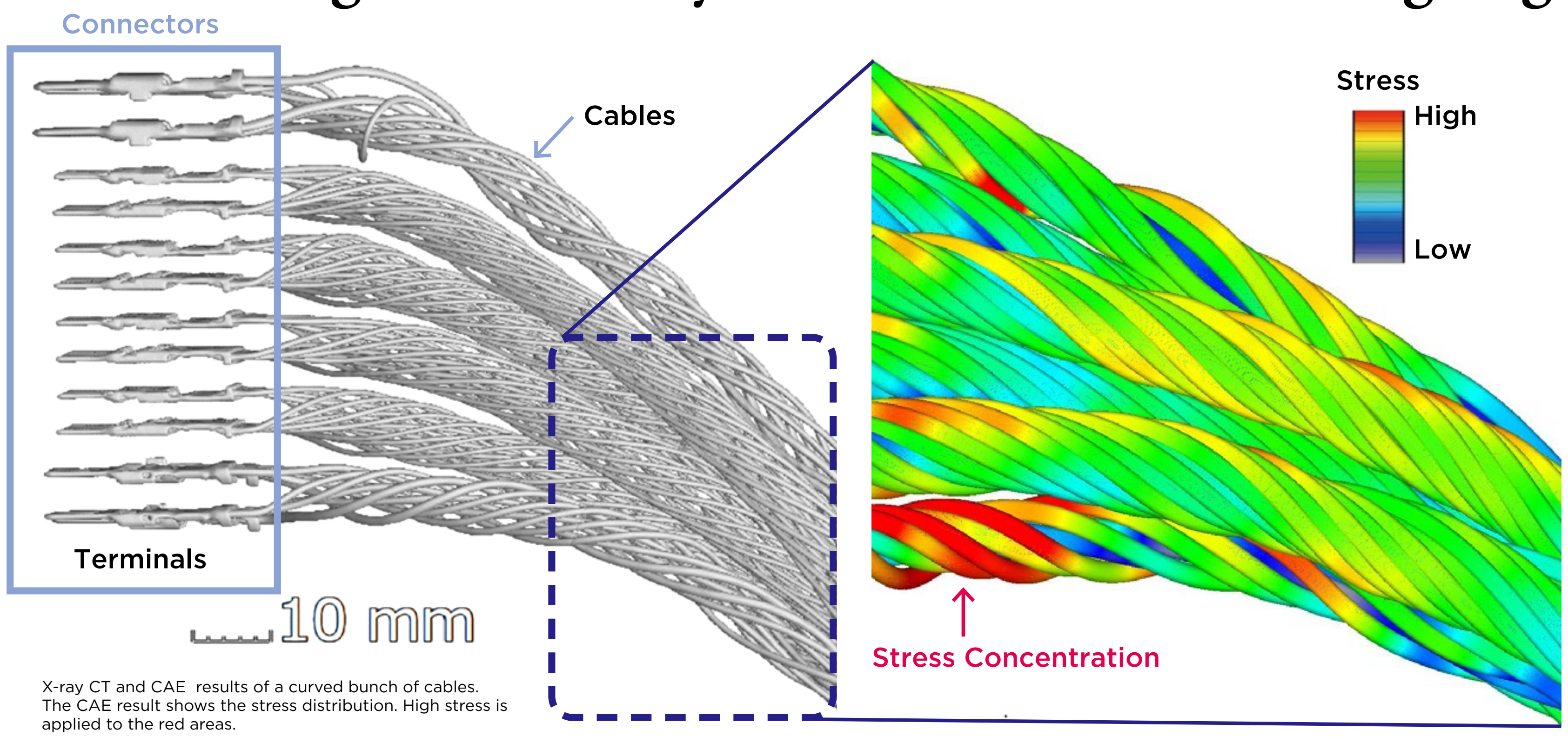
GaN HEMTs are developed and manufactured by Sumitomo Electric Device Innovations, Inc. Saito and Yonemura work in strong collaboration with the engineering staff of Sumitomo Electric Device Innovations. Shinya Nishiyama of the Quality Assurance Dept. is one of the engineering staff members. Nishiyama is responsible for verifying, evaluating, and assuring the quality of products to be shipped, in addition to those to be commercialized in the future.

"We have acquired a lot of findings about GaN HEMTs over many years of operations, so we regard them as mature products. However, some defects arise and cause problems in the process, which consists of many steps. The ATRC gives us reassurance when we need to cope with problems. We have maintained strong trusting relationships with customers thanks largely to the ATRC. We have been rapidly increasing production in response to the support in the market. We aim to enhance collaboration with the ATRC to market high-performance and high-quality GaN HEMTs," said Nishiyama.

At present, further die shrink is required for GaN HEMTs to cope with the 5G high-frequency bands. It is also required to achieve higher output than before. To maintain market competitiveness, it is necessary to ensure high mass productivity and cost advantage. The ATRC has a key role to play toward further evolution of GaN HEMTs.

Challenges Toward "CASE" Innovation in the Auto Industry

– Evaluating the reliability of wire harnesses and designing high-speed communication parts –



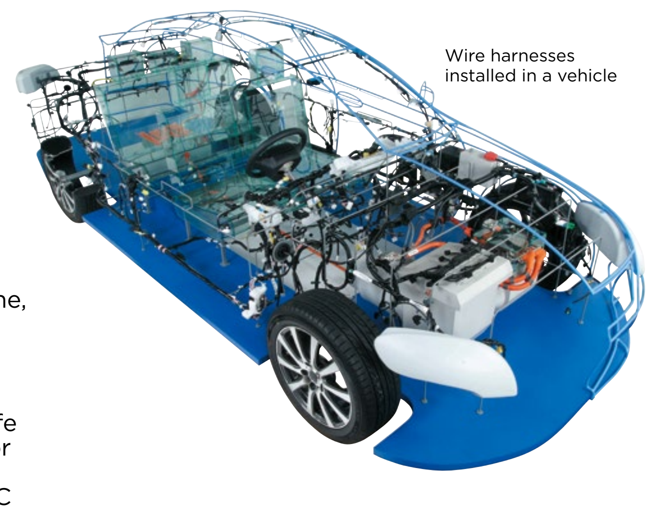
X-ray CT and CAE results of a curved bunch of cables. The CAE result shows the stress distribution. High stress is applied to the red areas.

Estimation of the fatigue life by CAE technology

The auto industry has been undergoing a once-in-a-century paradigm shift. CASE (Connected, Autonomous, Shared & Services, Electric) is the keyword of the trend. The Sumitomo Electric Group has been implementing various measures for CASE as a general automotive components supplier. This section focuses on CAE of wire harnesses, which are the main products, and connectors, which are used to connect wire harnesses.

Many wire harnesses are used for in-vehicle wiring of automotive components. They form a system to transmit energy and information. Their functionality is equivalent to that of the nervous system and blood vessels in the human body. The reliability evaluation was one of the major issues. The service life until fatigue disconnection occurs is one of the reliability factors. Notably, reliability evaluation of door wire harnesses, which are frequently moved by open-close motions, was a major issue. The Sumitomo Electric Group started simulation to estimate the fatigue life of cables by bending motions in the 1990s. Shigeki Shimada, Manager of the Osaka Analysis Dept., has been engaged in development of CAE techniques since the 1990s.

"The reliability requirements of automakers became more stringent than before around 2000. At that time, the competition among wire harness manufacturers to develop CAE technologies intensified. We were outstripped by competitors in the technology to estimate the fatigue life of a cable. Customers criticized us for being 10 years behind competitors. Under these circumstances, the ATRC was launched by integrating the analysis team with the CAE team and embarked on the development of more accurate CAE in collaboration with Sumitomo Wiring System, Ltd., which was in charge of experiment and verification. A turning point came when new CAE techniques were established by using X-ray CT to visualize the wire shape in cables and identify the locations that were likely to be damaged in cables and the factors that dominated the fatigue life," said Shimada.



Wire harnesses installed in a vehicle

At present, the ATRC is highly evaluated by automakers, which are our customers, for its CAE technologies that are among the highest in the industry.

Wire harnesses changing due to the big trend in EVs

Reliability evaluation of wire harnesses is important because it is directly linked to the safety and security of vehicles. Namely, wire harnesses are expected to ensure reliability without causing disconnection until the end of the service life of vehicles. Yuki Tanaka, Manager of Wiring Harness Reliability Section, Experiment & Evaluation Dept., Sumitomo Wiring System, Ltd., commented as follows:

"Recently, new model cars have been developed in shorter periods than before. Meanwhile, the flex durability requirements of wire harnesses have become more rigorous. It is difficult for wire harness manufacturers, including Sumitomo Electric, to secure time for design rework. This necessitates the use of CAE in the design phase. CAE plays a key role in solving problems in advance based on simulation. In competitive bids to receive orders, suppliers are required to verify reliability by using simulation technologies. We will further advance simulation technologies and train personnel who can use such technologies to organize a strong CAE team," said Tanaka.

Soichiro Okumura, who is in charge of development of CAE techniques in the Osaka Analysis Dept., worked with Shimada on CAE-based technologies to estimate the fatigue life of wire harnesses. He said that the developments in CASE have brought about a new phase in CAE for wire harnesses.

"EVs, which represent 'Electric' in CASE, require large currents. Inevitably, they require thick cables. While conventional in-vehicle cables for energy transmission consisted of dozens of wires, cables for EVs consist of up to thousands of wires and have complicated structures. We estimate the locations that are likely to be damaged and disconnected. These efforts also aim to establish know-how for extending the service life of cables. The wires are stranded and bent in various ways, and this affects the performance and efficiency of the manufacturing process. We hope to achieve highly reliable cables required for EVs by taking full advantage of CAE," said Okumura.

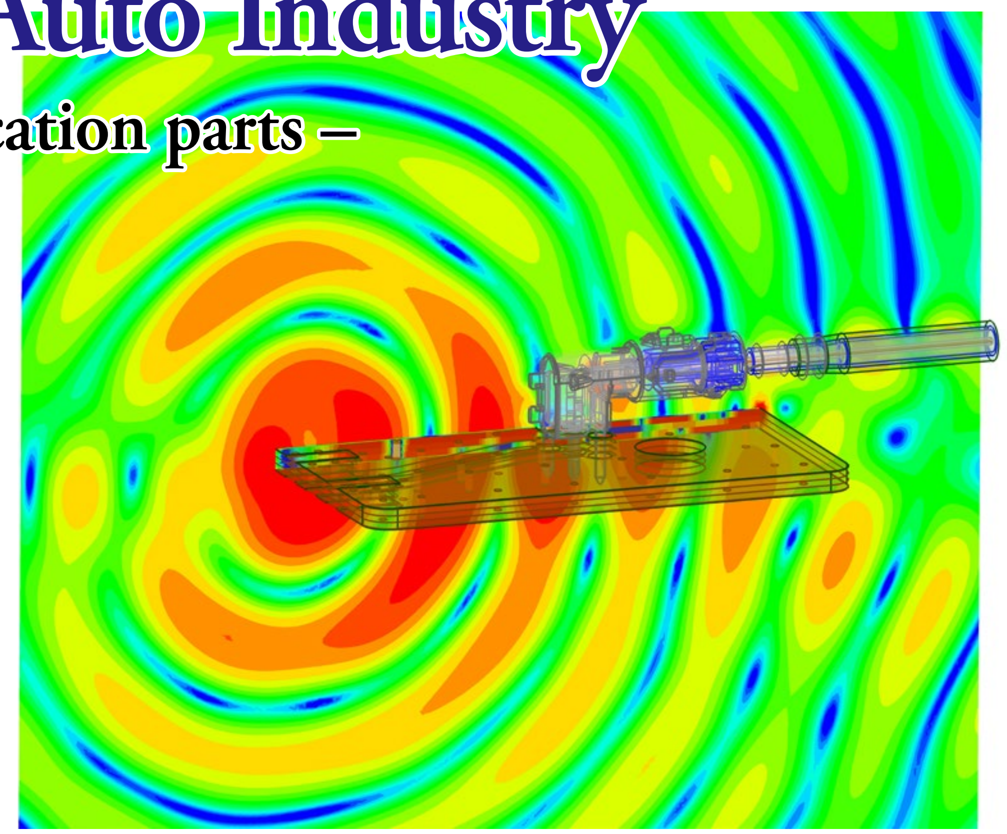
Development of high-speed communication connectors by using CAE

"Connected" in CASE refers to "connected cars." Various kinds of data, including the vehicle condition and road condition around the vehicle, are obtained from sensors to create value in various ways. In-vehicle wire harnesses transmit information to achieve connectivity. The key point here is that the frequency of transmitted signals has been increasing in line with the increase in communication speed and capacity. Smooth transmission of signals is indispensable to achieve connectivity. Masanao Yamashita, who is affiliated with the Connected Technology Development Promotion Dept. of the CAS-EV Development Promotion Divison, has been working to meet this challenge.

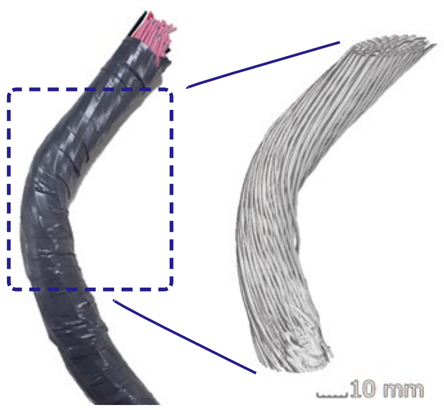
"Connectors take on a role for connecting wire harnesses that are routed throughout a vehicle. In high-frequency communication, electric signals which have extremely short wavelengths are transmitted in very short time. Signals are significantly affected by electrical disturbances of the signal path mainly caused by connectors. They may be attenuated by reflection, resulting in communication mismatches. Thus, the connector shape must be designed to ensure smooth signal throughput. CAE is used in this process. We use CAD to design the shape, which is loaded into the analysis software in the computer. We then configure the communication conditions and perform finite element analysis (FEA) by fragmenting the analysis target into many small elements called "mesh," which is one of the CAE techniques, to derive the optimal shape of a connector. This is one of the means to achieve connected cars," said Yamashita.

Calculation, on which Yamashita works, is one of the challenges. In CAE, the mesh size must be finer to represent the higher frequency, whose wavelength is shorter. The calculation required in analysis and the amount of data handled have been increasing continuously. Efforts have been made to develop CAE technologies and build a system in anticipation of next-generation CAE, including the upgrade of the equipment.

The Sumitomo Electric Group's efforts related to analysis technologies, which have been discussed above, are just examples. The ATRC handles all products in all the business fields. Superb analysis technologies help ensure a competitive advantage. Evolution of analysis technologies is driven by a sense of mission of each researcher to guarantee high product reliability and contribute to better manufacturing operations. Sumitomo Electric will continue to take on challenges to fulfill the mission.



This electromagnetic noise radiation chart based on high-frequency CAE shows the strength of waves during electromagnetic radiation at the connector (red: strong). The waves propagate in varying intensity.

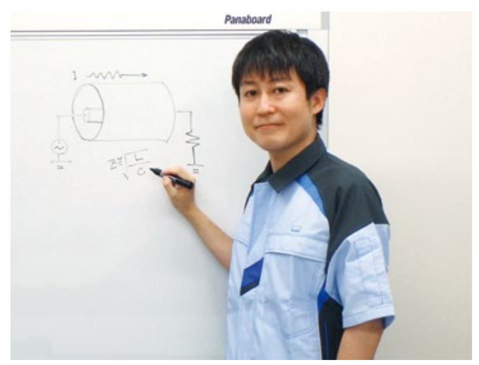


The appearance of the cable and X-ray CT 3D image, which offers findings required for CAE

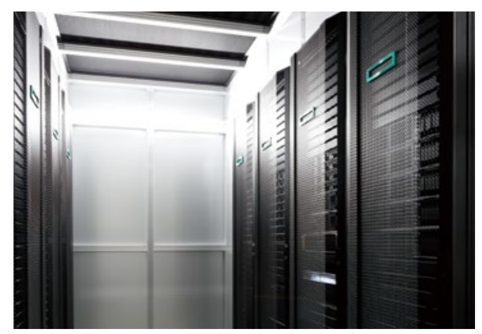
Shigeki Shimada
Manager, Osaka Analysis Dept., Analysis Technology Research Center

Soichiro Okumura
Assistant Manager, CAE2 Group, Osaka Analysis Dept., Analysis Technology Research Center

Yuki Tanaka
Manager of Wiring Harness Reliability Section, Experiment & Evaluation Dept., Sumitomo Wiring System, Ltd.



Masanao Yamashita
Connected Technology Development Promotion Dept., CAS-EV Development Promotion Div., Automotive Business Unit



Large-scale calculation servers that underpin high-frequency CAE (Itami Works)

"When building an organization, psychological safety must be ensured.

To this end, it is necessary to promote communication steadily.

This helps members unleash their potential and make the plant strong."

id
Featured person

Keiko Iwai

Plant Manager, Yokohama Lightwave Plant,
Lightwave Production Dept,
Lightwave Device Div,
Sumitomo Electric Device Innovations, Inc.

1993: Joined Sumitomo Electric Industries, Ltd.
Optical Functional Parts Div., Optoelectronics Labs. (currently Transmission Devices Labs.)
1995: Semiconductor Optical Device Div., Optoelectronics Labs.
2003: Laser Mass Production Technology Project, Quantum Device Div., Transmission Devices Labs.
2007: Device Analytics and Reliability Group, Optical Communication Device Div., Transmission Devices Labs.
And Optical Process Production Engineering Group, Optical Device Manufacturing Dept., Optical Transmission Device Business Div.
2010: Temporarily transferred to Sumitomo Electric Device Innovations, Inc.
Device Process Engineering Section, Device Production Dept, #1, Lightwave Device Div.
2013: Manager, Lightwave Quality Control Group 1, Yokohama Lightwave Production Dept., Optical Components Business Div., Sumitomo Electric Device Innovations, Inc.
2020: Plant Manager, Yokohama Lightwave Plant, Lightwave Production Dept, Optical Components Business Div., Sumitomo Electric Device Innovations, Inc.
2021: Plant Manager, Yokohama Lightwave Plant, Lightwave Production Dept, Lightwave Device Div, Sumitomo Electric Device Innovations, Inc., and was appointed to current position

Maintaining a forward-looking and positive attitude

To maintain a work-family balance and live true to myself

Acquiring a habit of thinking deeply in R&D activities

I majored in physics at university. In the master's course, I was engaged in basic research on the behavior of magnetic mixed crystals. I was inspired by the laboratory professor's attitude toward science. It was commitment to thinking deeply. I was able to maintain this attitude in optical communication research, in which I was engaged after joining Sumitomo Electric. In job hunting, I hoped to join a company where no one from the same department worked before.
I wanted to find a workplace where my personal capabilities were evaluated impartially, instead of a workplace where I was compared to someone else.
In a job seminar, I found Sumitomo Electric attractive because it respected people and provided employees with many opportunities to take on challenges. More importantly, I was attracted by the personality of employees whom I met through job hunting, and this was the main reason that I decided to join Sumitomo Electric.

After joining the company, I was assigned to the Optoelectronics Laboratory to undertake R&D operations on optical communication. This was completely different from my major at university, so I studied optics from scratch to conduct research. I was much impressed by the evaluation of the transmission characteristics of optical devices. We used a mechanism to predict the results based on preliminary data. Quantified parameters were introduced to identify transmission defects at an early stage. I had a sense of accomplishment in contributing to the improvement of product quality.
I was also engaged in commercialization of transmission modules for optical communication, which had just begun at that time.
I had a very fulfilling life as a researcher.

Balancing parenting and work

When I joined the company, the number of female engineering staff members was small compared to today. The career paths of female employees were not discussed as often as today. I was not the type of person who envisioned the future of her career. I attached importance to taking care of impending issues and taking action properly with fun. I did not have a future vision of my work and life when making choices. For example, I did not necessarily have a strong wish to pursue my career over the long term despite life events specific to women or to produce substantial results in my research career. My code of conduct was to do what I was supposed to do positively and pleasantly. I got married in the third year after joining the company.
I gave birth to my first child two years later. I then gave birth to my second child two years later. I delivered my third child three years later. I became a parent of three children in five years.
I entered a new phase, balancing work with parenting. I had job satisfaction, so I did not think of retiring at all.

The short working hours program, which was not in place when I gave birth to my first child, had been established by the time I gave birth to my second child. However, it was not easy to balance work with family even after this program became available.
I tried to increase the efficiency of my work on a daily basis so that I could respond to calls from the nursery school any time in the event of changes in the physical condition of my children. I also shared information with members to avoid inconveniencing others. During parenting, the time and physical constraints were frustrating, but my personal growth with children benefits me in my current work. Children should grow in society and build relationships with their community and neighbors while their mothers support them with no strings attached. The same applies to relationships with plant members. A supervisor oversees the operations and listens to what they have to say. This allows the members to work independently.

With the plant members

How to motivate members to raise their hands and express their opinions

There was a major turning point in 2010, 18 years after joining the company. I was temporarily transferred to Sumitomo Electric Device Innovations, Inc. I was in charge of the quality control operations. It is worthy of note that I was appointed leader of the working group to reduce quality abnormalities, which aimed to improve quality, as part of the activities to strengthen the operations. This turning point led to my subsequent mission in a management position and my current mission as plant manager. The quality kaizen activities aimed to improve the quality of products produced at the plant. Unlike my research career, I had to directly cope with the production site at the plant. The important first step for quality improvement was to quickly disseminate and share information about the situation when an abnormality or defect occurred. Bottlenecks are inevitable somewhere in the communication process, so it is necessary to create an environment and culture where plant members can communicate by raising their hands and expressing opinions. I started with conversation. There was some backlash, and I had psychological barriers to overcome. I hesitated to take a step forward, wondering: "How will my opinion be accepted? Is it okay to make proposals?" My mission was to clear these hurdles. This remained one of the issues to be tackled after taking the position as section manager and later as plant manager. Thus, I have placed top priority on "talking, listening, and conveying messages" by maintaining communication with the plant members. This produces a sense of security (psychological safety), and I believe that this is one of the important factors to get things going.

As plant manager, I aim to create a strong plant where productivity and quality are maintained at high levels. Whether this can be achieved or not depends on the mindset of each member. If psychological safety where "they can talk about anything and their opinions are not denied" is ensured, all members will be motivated to express their opinions and ideas voluntarily and take action to improve their workplace. As plant manager, I promote daily communication to understand and support them. I still go through trial and error, but I want to encourage young people, both women and men, to clarify their vision. As long as you are positive, you will be able to find answers and overcome hurdles under any circumstances. I am confident that this makes your work and life more creative and enjoyable.

The Launch of Three Newly Developed Cutting Tools to Achieve High Efficiency Machining

To reduce lead times and the cost of producing machine parts, there is a growing need to increase the manufacturing efficiency and extend the tool life of cutting tools. This section introduces three new cutting tool products that meet these needs and achieve high efficiency manufacturing.

1 AC8020P
New coated grade for steel turning

This insert grade is ideal for high-efficiency steel turning in the production of parts used in the automotive, heavy electric equipment, steel, and construction industries.

Chipping resistance has been improved by more than 2.5 times that of conventional products, so as to achieve excellent stability and longer tool life in the high-efficiency machining of medium to high carbon steel.

2 AC5005S
New coated grade for turning of difficult-to-cut materials

This insert grade is ideal for machining difficult-to-cut materials, such as Ni (nickel) base alloys, Co (cobalt) base alloys, and Ti (titanium) alloys, which are often used in the aircraft and medical industries due to its superb heat resistance and corrosion resistance. With 1.5 times higher efficiency in machining difficult-to-cut materials than conventional grades, tool change frequency and tool consumption are reduced, resulting in lower tool costs.

QUARTERLY id

3 SEC-Sumi Dual Mill™ DMSW Type high-feed roughing cutters

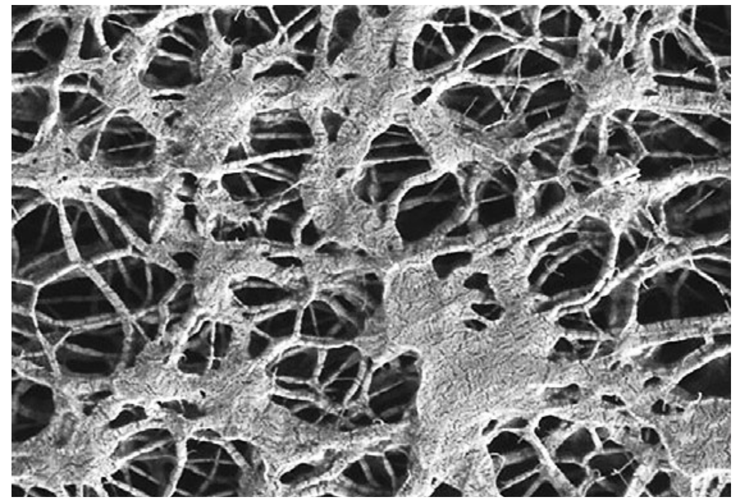
High-feed milling cutters for high-efficiency roughing that meets the various machining needs of the automotive, aerospace, ship building, industrial machinery and die-mold sectors.

A composite arc-shaped cutting edge design with multiple connecting arcs, made possible by advanced insert molding technology, enables high-efficiency machining at ultra-high feed rates and large cutting depths, and achieving excellent surface roughness. Even when machining with long tool overhang, stable machining is possible without chattering.

Accelerating Membrane Distillation Technology Development to Expand Sumitomo Electric's Water Treatment Business

– Tapping New Markets in a New Field –

Sumitomo Electric was the world's first manufacturer to develop the technology used to make fluoropolymer polytetrafluoroethylene (PTFE) porous through drawing and has supplied the porous material under the name POREFLON™. In the early 2000s, the Company developed a water treatment membrane module incorporating hollow fibrous POREFLON™ and has shipped the module to various markets in Asia and North America, as well as in Japan, for water and sewage treatment and various industrial wastewater treatment applications. With the aim of further expanding its business, Sumitomo Electric has recently signed a memorandum of understanding concerning membrane distillation development with KMX Technologies LLC in the United States. The two companies will promote a joint technology development project to cultivate new markets in new fields.



Microstructure of POREFLON™

■ What is POREFLON™?

POREFLON™ is Sumitomo Electric's original porous material made of PTFE, which is superbly chemical resistant, heat resistant, and durable.

PTFE is a material that inherently has low affinity for water, or is greatly hydrophobic. Sumitomo Electric has made it possible to use it for membrane-filtration water treatment applications by improving its affinity for water through the Company's proprietary process, making POREFLON™ highly hydrophilic.

In the photo shown at the upper right, the areas pictured in black (pores) allow water to pass through. The mesh-like white PTFE fibers precisely separate solid content. Thus, the product is utilized as a water-treatment filter membrane with high water transmissibility and clarification.

■ What is membrane distillation?

Membrane distillation is a water treatment process, or a technology that allows steam to permeate a membrane, utilizing the difference in boiling point between water and substances to be separated from the raw water. Unlike membrane filtration applications, membrane distillation requires a membrane to have hydrophobicity and heat resistance, which are inherent properties of PTFE materials. The hollow POREFLON™ fiber membrane developed by Sumitomo Electric is highly hydrophobic, heat resistant, and water resistant. These characteristics are very useful in membrane distillation systems.

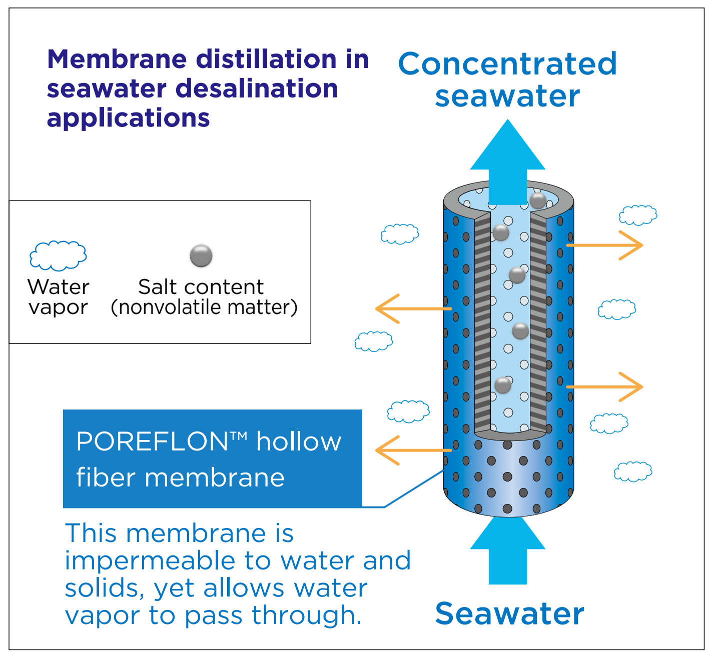
■ How can the membrane distillation technology be used for future approaches?

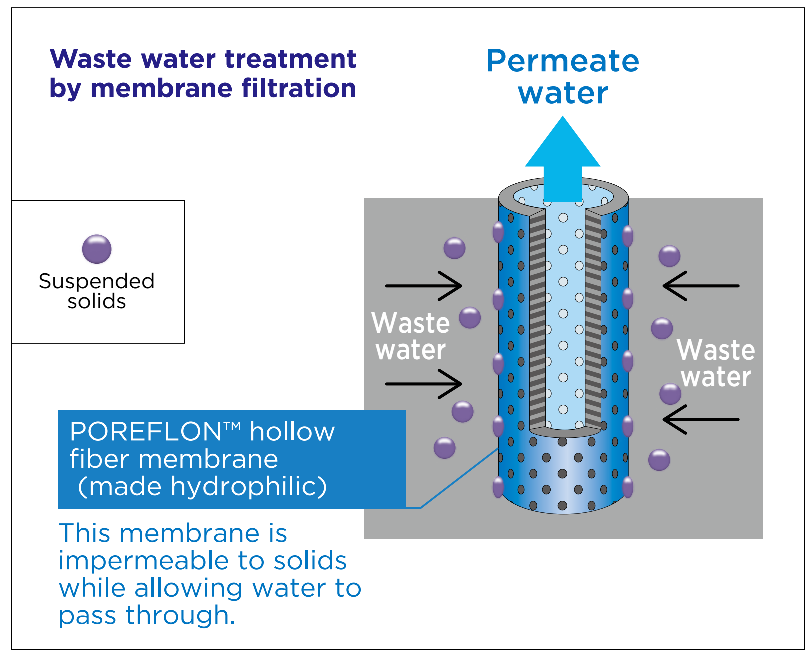
The membrane distillation technology incorporating POREFLON™ enables high-efficiency recovery of water and valuables from wastewater and waste volume reduction. The technology can be used in a wide range of applications, including the recovery of rare-earth metals from coal mine drainage, seawater desalination, and volume reduction of the desalination byproduct, that is, concentrated seawater (high-concentration salt water). This way the membrane distillation technology helps provide water resources and reduce environmental burden.

In addition, with the aim of building a sustainable society, Sumitomo Electric actively uses waste heat produced by power plants and solar energy and other renewable energy sources to supply power to membrane distillation systems.

Sumitomo Electric is committed to solving water treatment challenges around the world and to conserving the global environment by drawing on its years of experience in water treatment technology, promoting technology development and supplying its quality products.

Differences in water treatment between membrane distillation (left) and membrane filtration (right)





A Picture of Sumitomo Electric in Those Days

1975

Large-scale Construction Project Outside Japan

Construction of a transmission line completed under severe conditions in Iran

Transmission Line Project in Iran

After the first oil crisis, many countries, including Japan, faced an economic downturn. Meanwhile, many large projects were undertaken in the Middle East. Sumitomo Electric made efforts to enter the Middle East market. In 1975, it received an order for a TS-19 project (construction of a large transmission line) for the first time from Iran Power Generation and Transmission Company. In 1977, it also received an order for a TS-28 project. During the same period, Sumitomo Electric received orders for large construction projects in other countries. The transmission line construction group was integrated with the underground line construction group to launch the Power Cable Construction Div. and strengthen the business organization.

The TS-19 project, for which Sumitomo Electric received an order for the first time in Iran, aimed to supply electricity from the Persian Gulf in the south to the Sarcheshmeh Copper Complex in the central part of the country. While most of the southern part is desert, the central part is highland of over 3,000 m above sea level. Such extreme conditions made this project difficult. Meanwhile, the TS-28 project aimed to connect the Neka Power Plant on the coast of the Caspian Sea in the north with Tehran, the capital of Iran, which suffered from an electricity shortage, by a transmission line of about 300 km to supply electricity. Construction in the low and soft ground area on the coast of the Caspian Sea (spanning about 40 km) and the steep area from less than 100 m above sea level to 2,600 m above sea level (spanning about 30 km) was extremely tough because these areas were constantly moist.

These projects required construction work under severe conditions. In the desert area in the southern part of the country, the temperature exceeded 122°F (50°C) under the blazing sun in midsummer. In the central part, the temperature dropped to nearly −22°F (−30°C) in winter. There were various unexpected situations, but the know-how derived from the experience was highly useful in subsequent construction projects undertaken by Sumitomo Electric. The TS-19 project was completed in March 1978. The TS-28 project was delayed due partly to the Iranian Revolution and the Iran-Iraq War and was completed in February 1982.

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Information and videos not posted in this magazine are found on the "id" special site

https://global-sei.com/id/

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