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A New Year Snowscape of Toji Temple

One of Kyoto's famous landmarks is the five-storied pagoda of Toji Temple, an ancient Shingon Buddhist training site designated in 1994 as a UNESCO World Heritage Site. The wooden pagoda, measuring 55 meters high and the highest of its kind in Japan, houses 21 Buddha images. Winter landscapes of Toji include a serene, magnificent view with a snow-wrapped pagoda and the hustle and bustle of year-end and new year bazaars held in the temple courtyard.

Samco Foundation's 9th Research Grant Award Ceremony (2025) Commemorative Lecture

"Turning Dreams into Reality: The 'In-Body Hospitals' Created by Nanotechnology — Toward a Society Where Disease Is No Longer a Concern"

At this year's award ceremony, we had the honor of welcoming Professor Kazunori Kataoka to deliver a commemorative lecture. The lecture focused on drug delivery systems (DDS) and their implementation in society. Reflecting on his own research career, Professor Kataoka emphasized the importance of maintaining a long-term perspective to the young researchers receiving grants from the Foundation.

Professor Kazunori Kataoka

Center Director, Innovation Center of NanoMedicine (iCONM), Kawasaki Institute of Industrial Promotion

Professor Emeritus, The University of Tokyo

Brief History

1974 B.S., Department of Synthetic Chemistry, Faculty of Engineering, The University of Tokyo
1979 Ph.D. in Polymer Chemistry, Department of Synthetic Chemistry, Graduate School of Engineering, The University of Tokyo
1979 Research Associate, Institute of Biomedical Engineering, Tokyo Women's Medical University
1988 Associate Professor, Institute of Biomedical Engineering, Tokyo Women's Medical University
1994 Professor, Faculty of Industrial Science and Technology, Tokyo University of Science
1998 Professor, Department of Materials Engineering, Graduate School of Engineering, The University of Tokyo
2004 Professor, Center for Disease Biology and Integrative Medicine, Graduate School of Medicine, The University of Tokyo (Concurrent Appointment)
2015 Center Director, Innovation Center of NanoMedicine (iCONM) /Kawasaki Institute of Industrial Promotion (present)
2016 Professor Emeritus, The University of Tokyo
2016 Vice Chairman, Kawasaki Institute of Industrial Promotion (present)

▶ Introduction

I am deeply honored to have been given the opportunity to speak at the Samco Foundation's Research Grant Award Ceremony. Today, I would like to present a somewhat unconventional topic entitled "Turning Dreams into Reality: The 'In-Body Hospitals' Created by Nanotechnology—Toward a Society Where Disease Is No Longer a Concern."

During my graduate studies, I specialized in polymer chemistry, particularly the synthesis of high-molecular-weight polymers. When I expressed my desire to pursue a doctoral program, I consulted my mentor, Professor Teiji Tsuruta. He encouraged me by saying, "You could continue your current research, but if you are going to pursue something new anyway, why not choose a field related to human health and medicine, which will surely become increasingly important?" That advice led me into the world of biomaterials—namely, drug delivery systems (DDS).

▶ Innovation Center of NanoMedicine (iCONM)

Although I have now retired from the University of Tokyo, I am currently active at the Innovation Center of NanoMedicine (iCONM) of the Kawasaki City Industrial Promotion Foundation.

The Center was established just as I was reaching retirement age, and it celebrates its 10th anniversary this year.

iCONM is located in Kawasaki City, nestled between Tokyo and Yokohama. This area was once dominated by heavy chemical industries, including facilities like the JFE Steel plant. However, with the recognition that the 21st century demands the creation of health and medical industries, both the national government and Kawasaki City initiated a major redevelopment of the area.

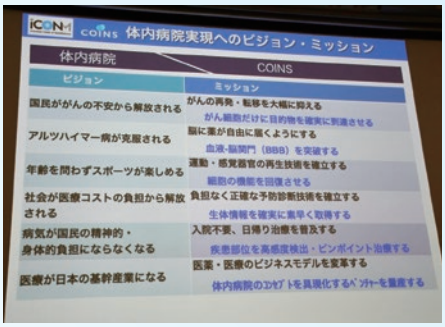
The Center is situated directly across from Haneda Airport, and since the completion of the Tamagawa Sky Bridge two years ago, it can be reached by car in just five minutes from Haneda Airport's Terminal 3. This accessibility has made it easy for international visitors to stop by, transforming iCONM into a globally accessible research hub.

Currently, 14 life-science-related organizations are based at iCONM. A distinctive feature is that it hosts more chemical manufacturers and startups than large pharmaceutical companies. The building itself is designed to promote open innovation, featuring a three-story open atrium at its center that encourages free interaction among researchers from industry and academia.

To efficiently advance the medical application of nanotechnology, the building is vertically integrated: microfabrication on the first floor, polymer synthesis on the second, cell experiments on the third, and animal testing on the fourth. This structure allows research activities to be completed within a single facility.

▶ The "In-Body Hospitals" and Nanomachines

The innovation we aim to achieve is the concept of "in-body hospitals." Just as cameras, audio devices, and mobile phones were once separate but later integrated into the smartphone, we envision consolidating medical devices, pharmaceuticals, and hospital functions into virus-sized smart nanomachines. Through this integration, we hope to transform future healthcare. This vision



Vision & Mission for Realizing the "In-Body Hospitals"

draws inspiration from the film *Fantastic Voyage* (1966), which is familiar to many of my generation. While we cannot shrink humans, we aim to create miniature vehicles capable of entering the body to freely diagnose and treat diseases.

This project was selected for the Center of Innovation (COI) Program funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan, with a target completion year of 2045. This employs a method called backcasting: envisioning a desirable future society first, then working backward to advance research and development. The society we envision is one in which "anyone, anywhere, at any time is liberated from diseases with significant social burden and becomes healthy without even realizing it." The devices that concretely realize these in-body hospitals are nanomachines.

To help visualize their size, consider this analogy: if a human were the size of the Earth, a cell would be comparable to the Tokyo Dome, and a nanomachine would be about the size of a soccer ball. These nanomachines are not mechanical devices with gears, but rather molecular assemblies. When block polymers, composed of water-compatible segments and functional segments, are mixed in water, nanoparticles encapsulating drugs are spontaneously formed through self-assembly. Under an electron microscope, these nanoparticles appear nearly the same size as hepatitis A or influenza viruses.

A critical requirement is ensuring that nanomachines are not recognized as foreign substances in the body. By fully coating the nanoparticles with highly hydrophilic polymers such as polyethylene glycol, they can circulate stably in the bloodstream without clumping. DDS using nanomachines enables drugs to be delivered efficiently to targeted sites. Normally, drugs administered into blood vessels spread throughout the body, causing side effects. Our DDS, however, can deliver drugs only to the intended target site. This concept aligns with what Hippocrates wrote many centuries ago: "A good medicine is one that acts only where it is needed."

▶ Social Implementation of DDS

In DDS, it is essential to prevent drugs from being eliminated by the liver or kidneys as they circulate through the body. One representative nanomachine for DDS we developed—polymer micelles—successfully maintain blood concentrations of anticancer drugs and dramatically increase their delivery to tumors compared with unencapsulated drugs. This is possible because tumor blood vessels are highly permeable, with gaps not found in normal vessels. DDS nanomachines do not leak from healthy vessels but selectively accumulate in tumor tissue. Using high-speed confocal laser microscopy, we directly confirmed this phenomenon in live mice.

Nanomachines can also be equipped with environmental sensing and stimulus-responsive functions. For example, once inside cancer cells, nanomachines detect the acidic environment of endosomes and release their payload, killing the cancer cells. This technology not only enhances therapeutic efficacy but also reduces

side effects. Cisplatin, a common anticancer drug, is known to cause kidney and inner-ear toxicity. However, when delivered via nanomachines, hearing impairment was completely avoided in guinea pig experiments and later confirmed in human clinical trials.

We are also developing light-based therapies. Using nanomachines loaded with photosensitizers, photodynamic therapy (PDT) generates reactive oxygen species upon light irradiation, killing cancer cells. This approach has enabled bladder cancer treatment that reduces tumors without damaging the entire bladder.

More recently, we have been advancing sonodynamic therapy (SDT), which uses focused ultrasound. Nanomachines carrying substances that generate reactive oxygen species upon ultrasound exposure are delivered to tumors, where ultrasound irradiation selectively kills cancer cells. This therapy has shown dramatic improvements in pet dogs with cancer and is currently undergoing clinical studies in human pancreatic cancer patients, where its safety has been confirmed.

We are also actively working on nucleic acid therapeutics. Only about 1.5% of the genome encodes proteins, while the remaining non-coding regions are increasingly recognized as key contributors to disease. Nucleic acid drugs can act on these regions and are attracting significant attention.

Our research focuses on nucleic acid therapeutics for glioblastoma, a malignant brain tumor. The brain is protected by the blood–brain barrier, which limits drug delivery. However, by downsizing nanomachines, we have developed a unit capsule-type nanomachine capable of passing through this barrier. This nanomachine, approximately 17 nm in size—comparable to an antibody—can be fabricated using a simple process. It accumulates efficiently in the brain, suppresses tumor cell proliferation by over 90%, and significantly improves survival rates. Clinical trials for this technology began in 2024.

In addition, we are pursuing regenerative medicine using messenger RNA (mRNA). Unlike DNA, mRNA does not damage genes and is therefore safer. We have developed nanomachines carrying mRNA that promotes cartilage regeneration and confirmed smooth regeneration in animal studies. Clinical trials for osteoarthritis treatment were submitted for approval in Australia this July, and the world's first mRNA-based regenerative therapy is expected to begin soon.

Our ultimate dream is brain regeneration, in which nanomachines deliver mRNA to the brain to rejuvenate neurons. While this hasn't been achieved yet, I sincerely hope the younger generation will make it a reality.

▶ Q&A Session

Q: How did the concept of the "In-Body Hospitals" originate?
A: It's a rather unconventional title, but it emerged during discussions with team members while we were formulating the MEXT COI Program proposal. As we explained internal biological phenomena and stimulus-responsive nanomachines, someone remarked, "That's like having a hospital inside the body." That is how the term "in-body hospitals" was born. Since this project cannot be completed in three or five years, we set a long-term goal of 2045 and created a roadmap by working backward from that future vision.

Q: Do nanomachines stop functioning after one use? Wouldn't large quantities be required?
A: That is a very perceptive question. Current nanomachines are designed to break down after a single use. However, it is not necessary to deliver drugs to every cancer cell. When cancer cells die, they release specific proteins that activate immune cells, which in turn recruit cancer-fighting T cells. In other words, cancer can be treated by leveraging the immune system, without targeting every single cell.

Q: Is eternal youth or immortality the ultimate dream, and is it possible?
A: Unfortunately, that is absolutely impossible. However, extending healthy life expectancy is achievable. Our successor project targets senescent cells, which cause aging. By eliminating these senescent cells, we may be able to slow aging and reduce cancer susceptibility. Science and technology expand our options by making the impossible possible. How society utilizes these advancements is a question we should all consider.

Q: Do you have a message for young researchers?
A: That is perhaps the most difficult question. My fundamental mindset is curiosity that crosses boundaries. Encouraged by my supervisor, I entered a completely unfamiliar field, which allowed me to view my own research objectively. Staying within a comfortable research area is fine, but stepping beyond it into seemingly unrelated fields can lead to unexpected discoveries. Japanese science and technology are world-class, and I hope young researchers will boldly take on such challenges.

Lecture: September 25, 2025
@ Kyoto Research Park

Café and Coffee Shop Tours in Kyoto #3

"Soirée", founded in 1948, is a coffee shop known for its chic ambiance, softly illuminated by tasteful blue lighting. At the entrance, a sign beside the door bears a poem about the aroma of coffee, handwritten by the poet Count Isamu Yoshii, a close friend and frequent patron of the founder, seems to gently invite visitors inside. Many find themselves instinctively opening the door.

Jelly punch with five-colored jellies and made-in-Kobe soda; extra-thick butter toast with cinnamon sugar (two other variations available), shareable by two; and house-blend coffee.

Junko Shimoyama, the granddaughter of the founder, Kazuo Motoki, has been the shop's third-generation owner for the past 10 years. She reminisces about him and says, "He used to give me stylish and rare toys made in France or other Western countries. He was such an awesome grandpa for a five-year-old." However, he suddenly passed away, and her father, who was then a company employee, decided to take over the café, following the advice of those around him, who said it was a waste to close such a valuable shop.

Before opening Soirée, Kazuo ran an art gallery. Artists he befriended through work helped him with the café's design and decorations. He deliberately chose not to play background music, as he felt that the conversations of customers were music enough.

The woodcarvings on the shop's exterior and interior, as well as the furnishings, were created by Sadaharu Ikeno, Kazuo's friend and a Nitten[1] sculptor. Ikeno drew inspiration from a rural church in France, where he had studied art.

Junko guided us through the café's many elaborate woodcarvings, including motifs such as "Grapes," a symbol of abundance in Europe; "Bacchus," the god of wine; and "Pan," the god of pastures. One particularly striking piece depicts sunflowers, carved so intricately that even the backs of the flowers are carefully detailed, demonstrating remarkable craftsmanship.

Seiji Togo, a prominent painter in the 1900s and a member of the Nika Association[2], also contributed to Soirée's décor. Introduced to the café by his friend Ryozo Sasaki, a painter of the same association, Togo later became a regular customer. His original illustrations appear on the shop's coasters, tumblers, goblets, and coffee cups. If you order coffee on the first floor, it's served in those specially designed original cups, which are also available on the Soirée online store.

The coffee at Soirée has a rich, full-bodied flavor, and it is also used to make the café's jellies, one of its signature offerings. What began as simple jelly cubes served in milk or wine was later developed into the now-iconic "Jelly Punch" by the wife of the second owner—Junko's mother. Initially, the shop's jelly desserts only used red jelly. Her mother added four new colors to make a five-colored jelly-and-milk treat to encourage Junko to drink milk, which she disliked. Then she substituted soda for milk, because its transparency enhanced the vibrant colors of the jelly. Last year marked the semicentennial anniversary of Jelly Punch.

Other jelly-based menu items include "Jelly Punch Float" and "Jelly Coffee Float," both topped with ice cream, which creates a perfect harmony with jelly. Alcoholic beverages such as the highball are still a popular item, reflecting the nostalgic idea of a café as a place for adults to relax and unwind.

Among the shop's 52 seats, the east-side seats on the second floor are particularly popular during cherry blossom season, as they offer a magnificent view of the blooming trees along the Takase River.

Soirée's charm can also be enjoyed beyond the café itself through special events. Junko is planning to host one at Mitsukoshi Department Store in Nihonbashi, Tokyo, next March.

"This distinctive atmosphere of the shop is something I want to invite customers to enjoy. That is something I cherish as time goes by," Junko says.

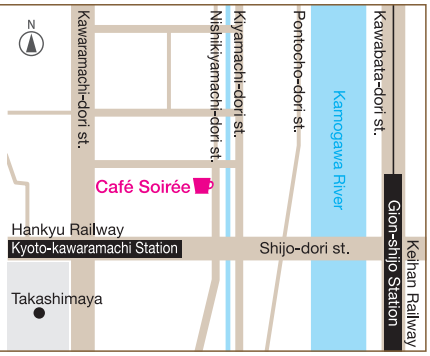
Jelly Punch bag charm commemorating the item's 50th anniversary

1. The Japan Fine Arts Exhibition, established in 1907.
2. One of Japan's prestigious art associations.

Café Soirée

95 Shinmachi, Nishikiyamachi Street Shijo Agaru, Shimogyo-ku, Kyoto City
TEL: 075-221-0351
Website: https://www.soiree-kyoto.com/

- Tue-Fri: Open from 1:00p.m. to 7:00p.m. (last order: 6:00p.m.)
- Weekends/Holidays: Open from 1:00p.m. to 7:30p.m. (last order: 6:30p.m.)
- Closed Mondays & Year-end holidays (December 29 to January 3)
- Located 30 m from Exit 1-A at Kyoto Kawaramachi Station, Hankyu Railway / 200 m from Exits No. 4 & 5 at Gion Shijo Station, Keihan Railway



Stable Device Isolation Processing for 6-Inch GaN-Based Power Devices

Introduction

Gallium nitride (GaN)–based semiconductors are anticipated to serve as next-generation power device materials to replace silicon (Si). Owing to their superior physical properties, such as a wide bandgap and high electron mobility, GaN-based semiconductors have been extensively researched and developed, along with silicon carbide (SiC)[1]. These materials have already been commercialized in high-frequency devices for signal amplification, as well as in power devices for power control and conversion, and their market continues to expand[2].

In particular, GaN high-electron-mobility transistors (GaN-HEMTs), which require low ON-resistance and high channel mobility, have been successfully fabricated on Si substrates[3]. As a result, production using 6-inch and 8-inch wafers is now underway. Samco Inc. supplies ICP-RIE and CVD systems for fabricating GaN-based light-emitting devices, which are widely used from research and development through mass-production processes. The etching rate, in-plane uniformity, and stability during continuous processing of Samco's ICP-RIE systems have been highly evaluated by many users.

Figure 1. ICP-RIE system RIE-800iPC

In this report, continuous device isolation processing of GaN-based power devices formed on 6-inch Si substrates was investigated using the mass-production-ready ICP-RIE system RIE-800iPC. The stability of continuous processing for 25 wafers is reported.

Experimental Procedure

Device isolation etching was performed on a cassette of 25 6-inch Si wafers with a GaN layer using the ICP-RIE system RIE-800iPC to evaluate the stability of a mass-production process. Figure 1 shows the external appearance of the RIE-800iPC. The etched sample structure is shown in Figure 2. A GaN layer with a thickness of approximately 7 µm was formed on a Si substrate, and a photoresist (PR) mask was patterned through exposure and development. The patterned PR mask covered approximately 90% of the wafer, leaving an opening area of about 10%.

Device isolation processing requires etching the GaN layer down to the Si substrate, and this condition must be achieved uniformly across the entire 6-inch wafer. Consequently, some over-etching into the Si substrate is inevitable. Excessive over-etching, however, may cause device damage and height non-uniformity, leading to reduced accuracy in subsequent processes. In addition, variations in GaN layer thickness exist between wafers.

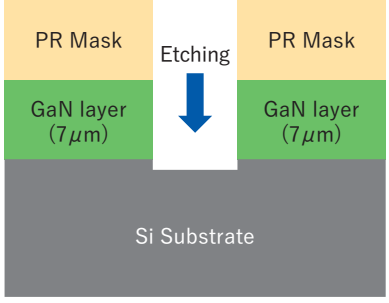


Figure 2. Sample structure and GaN layer etching using a PR mask

To stabilize the over-etching amount, an optical emission spectroscopy-based endpoint monitor (HORIBA EV-140C) was employed.

Experimental Results

Continuous processing of 25 wafers loaded into a single cassette was performed using endpoint detection. The GaN layer thickness of the wafers used in this experiment was approximately 7 µm, with thickness variations of several percent among the wafers. Since etching was performed until the Si substrate was reached based on the endpoint detection recipe, stable etching rates yield etching times that correspond to the GaN film thickness of each wafer.

Figure 3 presents the endpoint detection result and cross-sectional scanning electron microscope (SEM) images at the wafer center for the first wafer in the 25-wafer continuous process, in which over-etching was controlled by automatic etch stop based on endpoint detection. In the endpoint detection graph, the green line represents the emission intensity of nitrogen (N), and the red line represents that of silicon (Si). After completion of GaN etching, the Si emission intensity increased, and the etching was stopped at 648 s when the signal stabilized. Cross-sectional

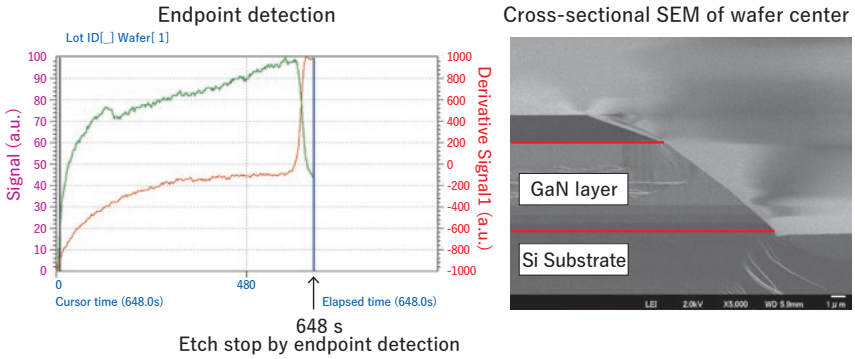


Figure 3. Etch stop based on endpoint detection and cross-sectional SEM results for the first wafer in 25-wafer continuous processing

SEM observation confirmed that the GaN layer had been completely etched and that the Si substrate had been reached.

To evaluate within wafer etch uniformity and etching rate stability, the 1st, 13th, and 25th wafers were selected from the lot. Etch depth measurements were conducted using a stylus profilometer, and etching rates were calculated from the etching time. The results are shown in Figure 4.

For the three wafers (1st, 13th, and 25th), step height measurements were performed at nine points excluding the outer 5 mm edge region. The average etching rate was 675 nm/min, within wafer uniformity was <±3%, and the etching rate uniformity within the lot was ±0.35%. These results confirm the stability of the process during continuous processing of 25 wafers.

Finally, the etch stop times for all 25 wafers are shown in Figure 5. The etch stop times ranged from 641 to 670 s, corresponding to a variation of ±2.2%. Given that the etching rate variation was only ±0.35%, this indicates that the variation in etch stop time is primarily due to differences in GaN film thickness between wafers. These results demonstrate the effectiveness of endpoint monitoring in controlling the over-etching amount, even for wafers with several-percent differences in GaN film thickness.

Conclusion

This report has presented a device isolation processing technique for GaN-based power devices using the mass-production-ready ICP-RIE system RIE-800iPC, along with its excellent process stability. Featuring high process reproducibility and superior in-plane etch uniformity, the RIE-800iPC is suitable not only for GaN semiconductor etching but also for a wide range of materials, including compound semiconductors such as GaAs and InP, and Si-based materials such as SiO_2 and SiN. It also supports ferroelectric and metallic materials such as PZT and Pt, as well as polymer materials such as polyimide.

Samco will continue to actively promote the development of process technologies for next-generation devices, contributing to resolving stability issues and improving quality in customers' mass-production processes.

■ References

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2. Yusuke Kumazaki et al., "Over 80% Power-Added-Efficiency GaN High-Electron-Mobility Transistors on Free-Standing GaN Substrates," Applied Physics Express, 14, 016502 (2021).
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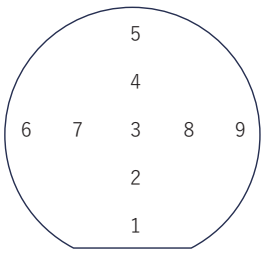

Nine-point measurement on a 6-inch wafer (outer 5 mm excluded)

	1st Wafer	13th Wafer	25th Wafer
Time [s]	648.0	652.5	644.4
Average etch depth (9 points)[μm]	7.29	7.31	7.27
Etching rate [nm/min]	675.0	672.2	676.9
Within wafer uniformity	±2.32%	±1.99%	±1.90%
Etch rate uniformity (within lot)		±0.35%	

Figure 4. Within wafer uniformity and etching rate results for the 1st, 13th, and 25th wafers

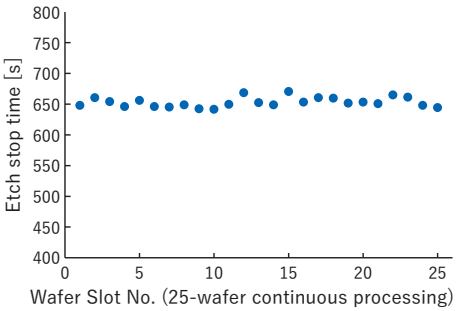

Figure 5. Etch stop times during 25-wafer continuous processing

Chairman Osamu Tsuji Awarded Honorary Doctorate by Kyoto Institute of Technology

On December 12, 2025, Osamu Tsuji, Founder and Chairman of Samco Inc., was awarded an honorary doctorate by Kyoto Institute of Technology (KIT). This distinction recognizes Dr. Tsuji's longstanding contributions to education and research at KIT. Through his leadership at Samco, he has supported the advancement of thin-film processing technologies. In parallel, he has delivered lectures on materials science at KIT for many years, sharing practical insights from industry with students.

The conferment ceremony was held on the KIT campus and attended by President Yoshimoto and other university officials. The program included the presentation of the honorary doctorate certificate, a congratulatory address by the president, and remarks of appreciation by Dr. Tsuji.

Samco believes that close collaboration between industry and academia is essential for technological innovation and the development of future talent. The company will continue to contribute to education and research through cooperation with universities and research institutions.

Chairman Osamu Tsuji receives an honorary doctorate from Kyoto Institute of Technology on December 12, 2025.

Upcoming Events

SEMICON China 2026

Date: March 25-27, 2026

Location: Shanghai New International Expo Centre

Booth: 2263 (Hall N2)

SEMICON SouthEast Asia (SEA) 2026

Date: May 5-7, 2026

Location: MITEC, Kuala Lumpur, Malaysia

Booth: 2618 (Hall 5-8, Level 2)

CS Mantech 2026

Date: May 18-21, 2026

Location: Portland Marriott Downtown Waterfront, Oregon, USA

CSW 2026 (Compound Semiconductor Week)

Date: May 24-28, 2026

Location: Kumamoto-Jo Hall, Kumamoto, Japan

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