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An Autumnal Panorama of Kyoto Viewed from Senjuji Temple

Here is a temple in the sky that offers a magnificent view of red foliage and a sea of clouds above Kyoto. The temple, called "Mt. Tokonage Senjuji", is surrounded by natural beauty, and you can look out on Kameoka City below. Built by Master Kukai in 807, the temple features a thousand-armed bodhisattva Kannon, believed to be able to heal eye-related problems. Enjoy beautiful natural landscapes in harmony with history, amidst peaceful mountainous serenity.

Professor Akiyoshi Baba

Center for Microelectronic Systems, Kyushu Institute of Technology

For this interview, we visited the Iizuka Campus of Kyushu Institute of Technology (Kyutech) to speak with Professor Akiyoshi Baba about operating and effectively utilizing the Center for Microelectronic Systems, one of Japan's leading open semiconductor infrastructure platforms.

Brief History

2007 – 2019	Associate Professor, Center for Microelectronic Systems, Kyushu Institute of Technology
2019 – 2022	Professor, Organization for Promotion of Research and Open Innovation, Center for Microelectronic Systems, Kyushu Institute of Technology
2022 – Present	Professor, Advanced Research and Social Cooperation Headquarters, Center for Microelectronic Systems, Kyushu Institute of Technology
2024 – Present	Professor, Japan Special Zone for Semiconductor Human Resource Development and Innovation Promotion, Center for Microelectronic Systems, Kyushu Institute of Technology

"This facility must be maintained and kept open to the wider community."

▶ Could you tell us about your current research?

I work on semiconductor microfabrication, particularly the integration technology of CMOS, MEMS, and fusion devices. Most recently, I have been studying semiconductor sensors capable of operating in extreme environments such as the deep sea. At the same time, I have become deeply interested in the operation and effective use of core fabrication facilities, especially shared-use equipment, and I devote much of my time to this area.

From my early career, I worked extensively with microfabrication and analysis tools across many universities and research institutes. A common issue I observed was that once equipment broke down, it was often left unrepaired and essentially abandoned until the next grant could fund a replacement. I wanted to change this. For me, improving how facilities are managed and ensuring their effective use has become almost like a research theme of its own.

Of course, I still pursue research in science and engineering—fabrication of devices and sensors through microfabrication and process integration is one of my core strengths. But device development depends on connecting multiple pieces of equipment into a continuous process. Without well-maintained and interconnected tools, you cannot complete fabrication and evaluation. Unfortunately, many labs still struggle with this. That is why I view research and facility operation as inseparable, and I focus on optimizing both for maximum impact.

▶ How did you come to focus on this theme?

Since graduate school, I have been engaged in microfabrication, and I quickly realized that device fabrication can never be completed with a single piece of equipment. I often had to borrow tools from colleagues' labs, visiting cleanrooms around the country. What struck me was how often I saw the same tool duplicated multiple times in one facility, while the essential idea of connecting tools into a complete process line was missing.

Devices require a continuous sequence of processes. If tools are not linked as a line, projects stall at the stage of elemental technology rather than reaching device completion. I repeatedly encountered this problem.

When I joined Kyutech in 1998, I was surprised to find a fully integrated 4-inch CMOS line already in place. I thought, "This facility must be maintained and kept open to the wider community." That was exactly what had been missing elsewhere. In 2018, when Professor Nakamura became director, the policy of opening the center was clearly emphasized. My own views aligned perfectly with the Center's direction, and since then we have expanded initiatives focusing on openness and optimized operation.

▶ Could you provide an overview of the Center for Microelectronic Systems?

“By experiencing everything from wafer loading to final measurement, participants gain a holistic understanding that goes beyond a fragmented view of single processes.”

The Center houses a fully integrated 4-inch wafer line capable of producing both CMOS and MEMS devices, covering everything from design to final evaluation. We welcome users from both academia and industry, with technical support provided by our staff.

In education, we emphasize reskilling for professionals. Each year we run about 20 hands-on training sessions where participants fabricate and measure CMOS transistors through the entire process flow. By experiencing everything from wafer loading to final measurement, participants gain a holistic understanding that goes beyond a fragmented view of single processes.

Schedules are announced publicly, but we also arrange exclusive sessions upon request from companies. Another distinctive feature is that we do not assign staff to individual tools. Instead, all staff members are trained to handle the full CMOS and MEMS process chain, ensuring seamless training and support without handovers. This system began out of necessity when staff numbers were small, but it has proven highly effective and convenient for users.

▶ What is the current status of the Center’s operation, and what are your future goals?

We have established an operating model that does not depend on university funding. Instead, we cover running costs through our own revenue streams. In terms of CMOS facilities and operation, we are among the top in Japan, pioneering the combination of education and equipment use.

By launching design training, opening equipment to external users, and hiring staff with self-generated funds, we have realized true independence and openness. Looking ahead, I hope to see similar facilities established across the country. If such centers existed in multiple regions, users would no longer need to travel long distances, and research and development could proceed more efficiently.

The main challenges are recognition and location. We are situated in Iizuka City, about an hour’s drive from Fukuoka, in a mountainous area. Many visitors say they never expected to find a cleanroom here. Raising awareness to the point where people feel comfortable simply sending us an inquiry is one of our short-term goals. While our role in professional education is fairly well known, our function as an R&D facility is still not sufficiently recognized.

▶ How does your Center differ from other institutions, particularly in handling user information?

We maintain an open-access policy for the facility, while handling all user information with complete confidentiality. Users are not obligated to submit reports, and it is up to them whether to acknowledge the Center in papers or presentations (we sometimes request it, but it is not mandatory). Restrictions on bringing in or removing materials are also relatively flexible.

Another unique feature is our independence from direct university funding, which gives us greater freedom and enables quick decision-making to resolve issues efficiently.

▶ How do you manage the risks associated with equipment downtime in a process line?

Because our facility is run as an integrated line, the stoppage of even a single tool can halt the entire process. This is especially detrimental when there are many external users, as the impact quickly cascades. To minimize downtime, we focus on preventive maintenance and close monitoring of equipment.

We are grateful for the rapid troubleshooting and flexible support from manufacturers, which helps us overcome even long lead times for parts. Ultimately, stable operation is the most critical factor in running a process line.

▶ You’ve been using several Samco systems at your Center. Could you share your experience?

One of our most heavily used tools is Samco’s plasma CVD system, the PD-220NL. We use it for three types of films—amorphous silicon, silicon nitride, and silicon oxide—based on Samco’s standard recipes. Demand for these three film types is so high that reservations are almost always fully booked. To be honest, we could use a second system, but budget and space constraints make that difficult.

Our Bosch-process-compatible deep silicon etcher, the RIE-800iPB, has been running for more than a decade and still maintains highly stable performance with minimal variation, thanks to proper maintenance. In total, we operate five Samco systems, including two ICP etchers and the thick-film CVD tool PD-100ST, all of which continue to run stably over the long term.

▶ What is most important in your day-to-day facility management?

Observation. Whether dealing with people or machines, the first step

From left: First unit of Bosch process-compatible silicon deep etching system “RIE-800iPB”
Chlorine gas-based ICP etching system “RIE-101iPH”
Fluorine gas-based ICP etching system “RIE-101iPH”

Professor Baba with Samco plasma CVD system “PD-220NL”

is careful observation. We look at whether the system is running efficiently and identify what is hindering it. Problems are rarely caused by individuals—they are usually structural. From there, we organize information, form hypotheses, and test them, just as in a scientific experiment.

Currently, the Center has 14 staff members, with about 10 directly involved in prototyping, training, and operations. Managing the balance between training sessions and machine time for users, while keeping the line running smoothly, is our top priority. When issues arise, we act quickly to correct them and continue improving step by step.

▶ What are the specific benefits of your training programs for professionals?

Our through-process training gives participants the unique opportunity to experience the full device fabrication flow themselves. While single-process training is common, few programs allow participants to complete an entire CMOS device on a 4-inch line.

By building a tangible CMOS transistor, participants learn how each step connects, how processes depend on one another, and how line stoppages or cleanroom conditions affect outcomes. These are insights essential for real-world R&D.

▶ How do you like to spend your free time?

I spend my weekends farming, playing tennis, or resting. I grow vegetables in my family’s fields and make the round trip on the expressway each week. Planning around the weather is always a challenge, but I enjoy how it resists human control—just like harvesting itself.

I also try to play tennis once a week, ideally three times, though weekday evenings are often too busy. After exercise, I make sure to rest well. I would love to nap with my cats, but it rarely works out that way.

▶ Any final thoughts?

Our goal is not simply to acquire high-performance equipment, but to use it to accelerate device development that leads to real-world applications. For this, an integrated line and a smooth operational framework are indispensable.

We chose Samco because of the sales team’s quick, precise, and attentive support. Their fast responses to requests for quotes and additional features stood out, and test runs of the equipment before purchase built our confidence. For long-term facility operation, both equipment performance and after-sales support are critical. Since installation, Samco systems have continued to run stably, which we value highly.

We look forward to Samco’s continued development of reliable, easy-to-use systems and long-term support we can depend on.

Thank you for taking the time out of your busy schedule to speak with us.

Interview conducted on August 7, 2025

“We chose Samco because of the sales team’s quick, precise, and attentive support. Their fast responses to requests for quotes and additional features stood out, and test runs of the equipment before purchase built our confidence.”

Café and Coffee Shop Tours in Kyoto #2

There is a traditional Japanese coffee shop along the Takase River. Called "Salon de thé François," it was the first coffee shop/café to be listed as a National Tangible Cultural Property (registered in 2003). Its stained-glass windows are positioned to allow sunshine to filter through them, so colored light cascades beautifully onto the white walls inside, as if inviting people in.

*** Prices in this article include tax**

The cake and coffee/tea set is 1,350 yen (pictured: no-bake cheesecake set). A coffee/tea set featuring a special caramel pudding topped with orange confiture (à la carte price: 900 yen) is also available for 1,550 yen.

The Salon de thé François was founded by Shoichi Tateno, an aspiring painter. He opened the café in 1934 as a place where people could freely discuss their thoughts and art. The shop's design and engineering were by Alessandro Bencivenni, an Italian student studying at Kyoto Imperial University (later renamed Kyoto University), and Japanese painters. Shoichi named the shop after Jean-François Millet, his favorite painter.

Once inside, you are immediately led into the north wing of the building, which was renovated in 1941 to evoke the interior of an Italian luxury liner. The design from that era remains largely preserved. A collection of paintings is displayed inside the shop, including a limited reproduction of the "Mona Lisa" and "The Seine Riverside," painted in Paris by the artist Kenzo Itani for the café. Along with a ceramic owl on the wall, they have quietly witnessed the café's history since its founding. Seating capacity totals 80 seats (at tables) across both the original south wing and the north wing.

The Salon de thé François was passed down from the founding couple to their second daughter, Kayoko Imai (President and Representative Director). Now, Hikaru Kondo (Director), Kayoko's eldest daughter, leads the shop's management. "Shoichi was a stylish person. He was short-tempered, but he was always a gentle, loving grandpa to me," she recalls.

A commercial establishment serving as a space where people could enjoy coffee while listening to Western classical music was remarkable in those days, particularly during the mid- and post-war periods, when freedom of speech was restricted. Anti-war activists frequented the shop, and the couple supported their cause. Even today, the shop attracts a diverse group of people, including painters, scholars, and those involved in the film and theater industries. It is not rare to find celebrities among customers.

Some customers, their eyes sparkling, say they have returned after 40 years, and Hikaru relates to their feeling, saying, "I think the unchanged atmosphere makes them emotional." Recently, many tourists have been visiting the shop. As a coffee shop manager, she sticks to the basics. She is never happier than when she sees the aroma of coffee soothe away customers' stress and lift their spirits, allowing them to enjoy the simple pleasure of savoring their coffee.

People's preferences for coffee flavor vary greatly, particularly today, when tastes have become increasingly refined and sophisticated. For this reason, she focuses on the "traditional flavor," while fine-tuning it to meet the best standards of today. The same can apply to baking cakes. The shop's method is straightforward, using carefully selected ingredients to achieve a simple, rustic taste.

The cake set is one of the most popular menu items (1,350 yen), and of these, the no-bake cheesecake made with Danish cream cheese and blueberry sauce is a top choice. Both coffee and tea (à la carte price: 700 yen) pair well with the cakes.

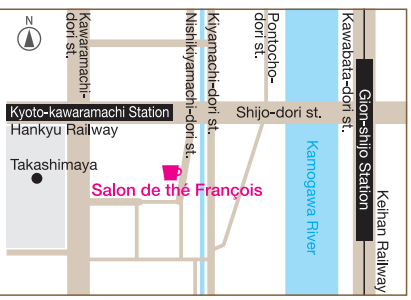
Another charm of the café is how the view changes depending on where you sit. The shop's ambiance also changes according to the time of day. You can enjoy quiet relaxation in the morning and during lunch hours, while in the afternoon teatime, the shop is enveloped in a pleasant hum of conversation.

Of course, the shop's long history has a drawback: when one thing is repaired, another soon needs attention. Hikaru says, however, that she believes this is part of preserving the shop's character. She then adds, "A coffee shop is not simply a place to serve drinks. My motto is always to be prepared to maintain a clean and comfortable space for customers. I'm fortunate because I have foundations laid by my grandparents and mother, as well as the support of customers and staff. I believe the vibrant lives of the people who gather here, our customers and staff, give the shop its energy and allow it to continue."

Salon de thé François

Shijo-sagaru, Nishi-Kiyacho-Dori,
Shimogyo-ku, Kyoto City
TEL: 075-351-4042
Website: https://francois1934.com/

- Open from 11 a.m. to 10 p.m. (last order: 8:00 p.m. for meals/9:30 p.m. for drinks and desserts)
- Open year-round except for the following days: December 31, January 1-2
- Located right by Exit 1-B at Kyoto-kawaramachi Station, Hankyu Railway



Atomic-Level Etch Control: Introduction to Atomic Layer Etching (ALE) Systems

Introduction

As semiconductor devices continue to become more miniaturized and highly integrated, control of the etching process at the atomic level has become essential. Among various technologies, Atomic Layer Etching (ALE) is receiving significant attention.

ALE is a cyclic process composed of alternating modification and removal steps, each of which involves a self-limiting reaction.[1, 2] During the modification step, the etchant adsorbs to the surface of the substrate, reacts with a single atomic layer, and forms a modified layer. This reaction proceeds in a self-limiting manner and does not proceed further once the layer is fully modified.

In the removal step, only the modified layer is etched, while the substrate and unreacted atoms are not affected. Due to these two self-limiting reactions, the thickness of the atomic layer removed per cycle remains constant, yielding the following process advantages:

1. **High-Precision Depth Control**
   The etch amount per cycle is stable in the range of several angstroms, enabling highly precise control of etching depth.
2. **Low Damage**
   The use of low-energy ions minimizes damage to the substrate and reduces defect formation.
3. **High Uniformity**
   Uniform etch depth across the wafer is achieved, providing excellent process reproducibility.

Based on these features, ALE has been applied to the fabrication of advanced devices such as FinFETs, 3D NAND, power devices, and compound semiconductors.

ALE can be implemented using several modes, including Plasma ALE, Thermal ALE, and Plasma-Thermal ALE.[3, 4] Samco is engaged in extensive research and development related to each of these methods. This article introduces the features of Samco's ALE systems, as well as related process data.

ALE Systems

Samco has developed ALE capabilities by incorporating ALE functions into conventional Inductively Coupled Plasma (ICP) etching systems. As a result, a single system can be used for both ICP etching and ALE. Samco's ALE systems incorporate the following two technical capabilities:

1. **Precise Control in the Low Bias-Power Range**
   Samco systems include an attenuator and switching unit in the high-frequency transmission line of the bias power supply. In order to ensure that only the modified layer is etched during ALE, precise control in the extremely low output range is required, and the optimal control range varies depending on the material. The attenuator adjusts the ion energy reaching the substrate from the plasma, enabling precise control in the low bias-power range. In addition to the attenuator, Samco also enhances control performance through bias power monitoring using a power meter, ensuring stable and repeatable operation.
2. **Improvement of Gas Switching Speed**
   To improve gas switching speed in the reaction chamber, an ALE-specific gas box is positioned in close proximity to the chamber. Since ALE requires switching between gases for the modification and removal steps, minimizing the switching time is crucial for throughput improvement. Gas switching time depends strongly on both the length of the gas lines and the valve response time. Therefore, by shortening the piping configuration, switching speed is increased, modification reproducibility is maintained, and cycle time is reduced.

In addition, in Quasi-ALE—a process similar to ALE that does not involve self-limiting reactions—the etch depth per cycle is determined by the thickness of the deposited etchant during the modification (deposition) step. Compared with ALE, higher gas switching precision is required to ensure reproducibility.[5]

Process Data

A GaN/AlGaN chip sample was mounted with oil onto a 6-inch silicon wafer coated with Thermal SiO_2 and polyimide tape, followed by ALE. Chlorine (Cl_2) gas was used for the

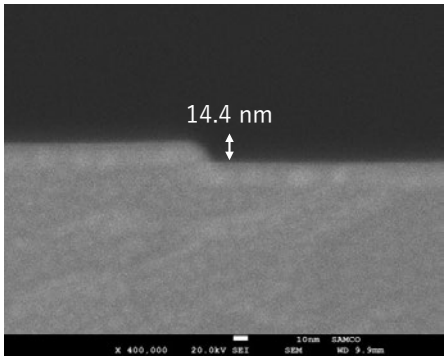


Figure 1. SEM image of GaN/AlGaN etched by ALE (500 nm trench width).

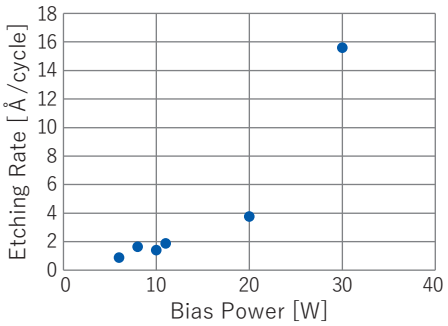
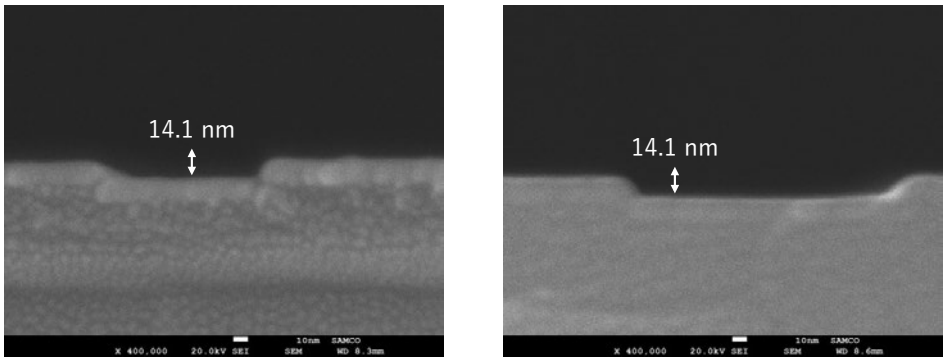


Figure 2. Relationship between bias power and etch rate in ALE processing of GaN/AlGaN.



(a) 100 nm Trench Width (b) 200 nm Trench Width

Figure 3. SEM images of GaN/AlGaN ALE-etched trenches with (a) 100 nm width and (b) 200 nm width.

modification step, and argon (Ar) gas was used for the removal step.

Figure 1 shows a scanning electron microscope (SEM) image of a trench structure with a width of 500 nm, processed by ALE and with the SiN mask removed. After 88 ALE cycles, the etch depth reached 14.4 nm. The etch rate was 1.63 Å/cycle, demonstrating true atomic-scale etching control.

Figure 2 shows the results of an etch rate measurement per cycle under varying bias power conditions. A stable etch rate was observed in the 6–11 W range, indicating that the self-limiting nature of ALE was successfully maintained.

Figure 3 shows SEM images of trenches with widths of 100 nm and 200 nm, processed under the same conditions as the 500 nm trench. In both cases, the etch depth was 14.1 nm, confirming suppression of the microloading effect and achievement of excellent depth uniformity, regardless of the pattern width.

Conclusion

This technical report has introduced the features of Samco's ALE systems, which enable atomic-level etching control, and has presented representative process data. ALE demonstrates advantages in etch depth precision and damage suppression, areas where conventional ICP etching faces challenges.

Future reports will introduce further evaluations related to substrate damage and device performance characteristics.

Acknowledgements

We would like to express our sincere gratitude to Nagoya University for providing the samples used to obtain the SEM images featured in this technical report.

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New Advanced Technology Development Center Officially Open

On September 1, 2025—Samco Inc.'s 46th anniversary—the new Advanced Technology Development Center at our Kyoto headquarters was successfully completed.

The new facility features a Class 1,000 cleanroom (U.S. Federal Standard), providing a controlled environment comparable to production sites. The expanded space will house state-of-the-art experimental and evaluation equipment to accelerate the development of next-generation processes, including production tools and advanced technologies such as Atomic Layer Etching (ALE). By strengthening our research and development framework, the new center will play a vital role in driving Samco's future growth and innovation.

Location: 93 Tanakamiya-cho, Takeda, Fushimi-ku, Kyoto, Japan (adjacent to the existing R&D Center)

Structure & Floor Area: Two-story steel frame, approximately 860 square meters

Samco to Supply Australia's First ALE System

RIE-400iP-ALE to be Australia's first ALE System to be installed in University of Adelaide's new Quantum Materials and Device Fabrication Lab

Samco Inc. will deliver its advanced RIE-400iP-ALE system to the University of Adelaide, introducing Atomic Layer Etching (ALE) technology to Australia for the first time. The system, supplied in partnership with Samco's Australian distributor Ezzi Vision, is scheduled to ship from our Kyoto factory in December 2025.

Supported by the Australian Research Council's Linkage Infrastructure, Equipment and Facilities (LIEF) scheme, this initiative will establish the National Atomic Layer Etching Facility within the University's new Quantum Materials and Device Fabrication Lab. The RIE-400iP-ALE will enable precise layer-by-layer etching of III-V semiconductor materials such as GaN, GaAs, and InP—supporting the development of next-generation nanoscale and photonic devices.

Dr. Andy Boes of the University of Adelaide commented, "Samco's ALE system will allow us to process III-V materials at the atomic scale, advancing research in quantum technologies and photonics."

Samco is honored to support this milestone project and look forward to contributing to Australia's growing semiconductor research community.

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