

# SAMCO NOW

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#### Five Mountain Bonfires Illuminating a Summer Night

Another major summer event in Kyoto, following the Gion Festival, is the Gozan Okuribi (Five Mountains Send-off Fires). Decorating mountainsides with enormous bonfires is a ritual of farewell to our ancestors' spirits when they return to the Pure Land after their homecoming stay during the Bon (Ullambana) period. The photo shows a bonfire in the form of the Kanji character "Big" on Mt. Nyoigatake, that adorns the evening slopes of the eastern mountains. Enjoy this traditional summertime night view in Kyoto.

Photo©A.NAKATA

# Professor Yasuyuki Miyamoto

School of Engineering, Department of Electrical and Electronic Engineering, Institute of Science Tokyo

For this interview, we visited the Ookayama Campus of Institute of Science Tokyo to speak with Professor Yasuyuki Miyamoto about his research on compound semiconductor-based electronic devices.



## Brief History

1988 – 1992	Assistant Professor, Faculty of Engineering, Tokyo Institute of Technology
1992 – 2007	Associate Professor, Faculty of Engineering and Graduate School of Science and Engineering, Tokyo Institute of Technology
2007 – 2013	Associate Professor, Graduate School of Science and Engineering, Tokyo Institute of Technology
2013 – 2016	Professor, Graduate School of Science and Engineering, Tokyo Institute of Technology
2016 – 2024	Professor, School of Engineering, Tokyo Institute of Technology
2024 – Present	Professor, School of Engineering, Institute of Science Tokyo

“**InP HBTs have the potential to become indispensable for the future of high-speed communications.**”

## ► Could you tell us about your current research?

My lab focuses on electronic devices using compound semiconductors, particularly transistors. We work with two main types of materials: indium phosphide (InP)-based and nitride-based semiconductors.

InP-based materials were originally developed for semiconductor lasers used in optical fiber communication. Today, however, they're known for enabling extremely fast electronic devices—especially heterojunction bipolar transistors, or HBTs—which currently offer the fastest performance in the world. Nitride semiconductors, on the other hand, are widely recognized for their use in blue LEDs, but they're also drawing attention as power devices for applications like energy conversion. For example, gallium nitride (GaN) is now common in 65-watt-class AC adapters.

While we previously explored integrating compound semiconductors

into silicon transistor channels, shifts in the technology roadmap led us to focus more directly on compound semiconductor devices themselves. Right now, we're especially interested in pushing the limits of InP- and nitride-based transistor performance.

## ► What led you to this field of research?

In university, I entered the field of electronic and physical engineering. Back in high school, I was into amateur radio and originally wanted to pursue circuits. But I had a friend who was incredibly talented in that area—so talented, in fact, that I thought I might never catch up. That made me reconsider my path.

I realized semiconductors were something you couldn't explore as a hobby—they required the resources of a university or research institution. That's what drew me in. I joined a semiconductor lab and started out studying semiconductor lasers,

learning about crystal growth and wet etching.

When I completed my PhD, I was encouraged to remain in the lab, and at the time, I fully intended to continue my research on semiconductor lasers. However, Professor Yasuharu Suematsu suggested that I shift my focus to electronic devices. Under his guidance, and working alongside Professor Kazuhito Furuya, I began researching electronic devices during my time as an assistant professor.

In some ways, I simply followed the natural course of events—but that path led me into this field, where I've remained ever since. I've been working with indium phosphide (InP) since my fourth year as an undergraduate, which means I've been using this material for over 40 years. Back then, InP was already recognized as an ideal material for semiconductor lasers operating at 1.3  $\mu\text{m}$  and 1.5  $\mu\text{m}$ —wavelengths critical for fiber-optic communications. Even today, InP continues to be the material of choice for optical communication applications.

► **What are your thoughts on the future of this research field?**

Now that I'm 64, I find myself thinking more about the future of the field as a whole rather than just my own work.

There's a growing sense that InP-based devices—especially HBTs—will be essential in the years to come. That's because InP still enables the world's fastest transistors. The performance of high-frequency devices is usually measured by two values: the transition frequency ( $f_T$ ), where current gain becomes one, and the maximum oscillation frequency ( $f_{max}$ ), where power gain becomes one. InP devices currently hold the highest records for both.

The volume of communication data is increasing explosively. Optical fiber networks now require even faster data transmission, and to send more information over a single wavelength, we're pushing signal frequencies beyond 200 Gbaud. Silicon-based transistors can't keep up at these speeds—this is where InP-based devices, especially HBTs, are stepping in.

These high-speed transistors are crucial for backbone communication networks—linking cities like Tokyo and Osaka, or even crossing continents. As wireless communication systems like 5G and 6G expand, the need for faster wired infrastructure becomes even more pressing. InP HBTs are a strong candidate to fill that role.

There was a time when many Japanese companies were actively researching InP devices, but interest tapered off. Now, only a few organizations in Japan are still working in this field. That said, I believe InP



Anode/cathode switching plasma CVD system 'PD-200STL'.  
ICP etching system 'RIE-10iPH'  
Parallel plate dry etching systems 'RIE-10NR', 'RIE-10NRN'  
Liquid source CVD system 'PD-100ST'.

HBTs have the potential to become indispensable for the future of high-speed communications.

► **You've used several of Samco's systems in your lab. Could you share your experience?**

One of the most memorable systems for me is the RIE-10NR dry etching system. Before that, we had to manually operate each valve one at a time. But with the RIE-10NR, we could process wafers simply by pressing a button on the touchscreen. That shift to recipe-based automation was groundbreaking for us.

The system's reproducibility is excellent, too—we now own three RIE-10NR units and use them regularly. They're reliable and user-friendly.

Another workhorse in our lab is the plasma CVD system compatible with liquid precursors. We use TEOS (tetraethoxysilane) as a silicon dioxide source. Compared to  $\text{SiH}_4$  (silane),

which is flammable and requires strict gas safety training, TEOS is much easier and safer to handle. That's a significant benefit.

Our current CVD system, the PD-200STL, replaced an older PD-240 model. We mainly use it for  $\text{SiO}_2$  deposition. Thanks to the stable operation of these systems, we're able to focus fully on developing new devices. In a university research setting, tools that are both easy to use and capable of consistent performance are incredibly valuable.

I'd also like to touch on equipment sharing in academia. Devices purchased with grants or national project funding are technically project-specific. But it's impractical to buy expensive tools for each individual project. About 20 years ago, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) introduced a system for shared equipment usage, which evolved into today's ARIM (Advanced Research Infrastructure for Materials) program.

This system allows us to share equipment across labs by collecting user fees. That way, we can pool resources for maintenance and

“**In a university research setting, tools that are both easy to use and capable of consistent processing performance are incredibly valuable.**”

supplies, and everyone can access essential tools. Samco systems play a major role in this—especially plasma enhanced CVD and dry etching equipment, which are mainstays in many compound semiconductor research labs.

### ► What do you emphasize in your daily research?

What matters most to me is doing something that excites me. I feel the most joy when I come up with a new idea and it works—whether that's in an experiment, a simulation, or gaining a new insight.

I tell my students that it's hard to generate ideas at the beginning. You need to gain hands-on experience and understand the basics first. In the first six months, it's okay if you don't know what's going on—just follow instructions and observe. As you build experience, you start asking questions, testing ideas, and saying, "What if I try this?"

When something finally works, that's the most rewarding moment. Of course, ideas need to be feasible—you have to understand what's technically possible. But when students bring unique ideas to the table and we try them together, it's exciting. And if it succeeds, it becomes a huge confidence boost for them.

### ► How do you like to spend your free time?

My hobby is water polo. I've been playing since my first year of high school—almost 50 years now. I'm also the faculty advisor for the university swim team.

I try to practice whenever I can. I don't play every weekend, but I swim



Photo: Professor Miyamoto with Samco's ICP Etching System "RIE-400iP"

about twice a week. Just the other day, I swam 1.2 kilometers in the evening.

Water polo is a physically demanding sport. You need stamina to keep up with your opponents, whether you're on offense or defense. Of course, ball handling is important, but in the end, it's all about swimming power. I'll be competing in the World Masters Games in Taiwan next month as part of a 50+ age group team. It's a great way to stay healthy.

### ► Do you have any final thoughts?

I believe the introduction of automated systems like Samco's plasma CVD systems and dry etching tools has fundamentally changed how semiconductor research is conducted in Japanese universities.

Older tools were simpler in design,

and while that made them easy to repair yourself, it also meant taking full responsibility for operation and maintenance. Today's systems are far more sophisticated—you can press a button and the process runs exactly as programmed, with excellent repeatability. That means researchers and students can spend more time on actual research instead of fiddling with the equipment.

For university labs, systems that are appropriately sized and offer reliable, reproducible processing are absolutely essential. I hope Samco will continue to provide easy-to-use, dependable tools that support academic research.

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

**“I hope Samco will continue to provide easy-to-use, dependable tools that support academic research.”**

# Café and Coffee Shop Tours in Kyoto #1

At coffee shops and cafés, we can take refuge and relax in a homelike atmosphere. This series of articles explores places in Kyoto where we can enjoy a nice cup of coffee or tea, local snacks, or light meals. The first spot we recommend is “Shinshindo Kyodai Kitamon-mae,” the oldest café in Kyoto City.

\* Prices in this article include taxes.



Curry bread set, the signature item of the café (1,000 yen)

The shop is located in an elegantly antique building, as befits the oldest café in Kyoto. Step inside, and you will find the interior decorated with gargoyles, a wooden relief carving, and other expressions of Western culture, quietly claiming their place in that particular setting. The relief features a poem by Wordsworth, a favorite of Hitoshi Tsuzuki, the shop’s founder, who was a Christian and a poet himself. Akira Kawaguchi, his great-grandson and the fourth-generation owner of the café, interprets the poem, stating that the author aims to preserve



Wood relief carving with the poem “The Rainbow” by the English poet William Wordsworth and a plaque saying “Calm Contemplation” by Makoto Nagao, 23rd President of Kyoto University.

the childhood thrill of seeing a rainbow even after growing old.

Hitoshi founded “Shinshindo” bakery in 1913 after learning how to bake bread in Paris. Inspired by cafés in the student district in Paris, he opened a café next to the Kyoto University Faculty of Agriculture in 1930, called “Shinshindo Kyodai Kitamon-mae (literally “in front of Kyoto University’s North Gate”)" (now operated independently). The chic, Westernized design and concept amazed people at the time.

Akira is not only the fourth-generation successor as owner of the shop but also embodies the founder’s spirit. “That’s why I try to maintain the founding context. Extra care is necessary, since the original building materials, such as bricks and mortar, are hard to find,” he says. As the shop’s long-held nickname, “Kyoto University Library No. Two,” suggests, the founder’s spirit of rooting for Japan’s future standard-bearers abides, and breathes throughout the café. “Students don’t change. They study, read books, and so on. It’s only that notebooks and pencils have become computers. That’s all,” he adds.

Long tables (which seat twelve each) and chairs made by Tatsuaki Kuroda, a woodworker, who has been designated as a Living National Treasure of Japan, furnish the café. Two out of eight are offered as a student study zone (1:00 to 6:00 p.m.), while a terrace at the back creates an open atmosphere. There are customers of all stripes, including neighbors and tourists. Those who visit after a long time are happy to see the good,

old café unchanged.

One day, some French tourists visited and were impressed to learn that the shop was a family business. According to them, the number of family-operated shops is decreasing even in France, the country that inspired Hitoshi Tsuzuki to found this café.

As for the menu, students enjoy privileges including a discount service and exclusive items, while the general customer can also enjoy a delightful cup of coffee for 500 yen. The coffee features a unique blend of light and dark roasted beans with a vivid sourness. Customers can order their cups of coffee to be served with creamer added by a barista (instead of themselves), which can prevent their enthusiastic discussions from letting their coffees cool before creamer is added. Iced coffee (600 yen) and soft drinks are also available.

The most highly recommended morning item is a buttered toast and mini salad set (750 yen), while the lunch menu is available until evening. One of the popular items is the curry bread set (1,000 yen), which consists of a hot curry dip and bread (instead of curry-filled bread), accompanied by a mini salad and either coffee or orange juice. For larger-volume eaters, a curry-and-rice version has recently been added (900 yen). The curry roux is made with famous Awaji Island brand onions and Mochi-butu (soft, juicy pork) prepared by Meat Shop Murase, located in Demachi, Kyoto. The rice served for the set is also produced in Japan.

Time seems to pass slowly inside the café, where men and women, young and old, are absorbed in relaxing comfort. Akira says, “The shop should stay unchanged, but the menu has to be updated regularly.” The café’s centennial is just a few years away.



## Shinshindo Kyodai Kitamon-mae

88 Kitashirakawa Oiwakecho, Sakyo-ku, Kyoto City  
TEL: 075-701-4121

- Open from 10 a.m. to 6 p.m. (last order 5:30 p.m.)
- Closed on Tuesdays
- Approx. 5 minutes’ walk from Hyakumanben or Kyodai Nogakubu-mae bus stop, Kyoto City Bus
- Approx. 9 minutes’ walk from Mototanaka Station, Eizan Main Line, Eizan Railway
- Approx. 13 minutes’ walk from Demachiyanaagi Station, Keihan Main Line, Keihan Railway



# Simultaneous Double-sided Wafer Deposition via Plasma Enhanced ALD

## Introduction

Atomic Layer Deposition (ALD) is a technique that enables the formation of thin films at the atomic scale through the alternate supply of two different precursors. ALD is well known for its excellent surface coverage and in-plane thickness uniformity<sup>12</sup>. ALD films have been widely adopted to enhance chemical and moisture resistance, as well as to introduce functional optical properties. In such applications, uniform deposition may be required not only on the front surface of the wafer but also on the back surface and edges.

Traditional film deposition techniques such as Plasma Enhanced Chemical Vapor Deposition (PECVD) and sputtering generally require separate process cycles to coat both surfaces of a wafer. This repetition can negatively affect process efficiency and reproducibility. In contrast, the superior conformality of ALD allows for dual-surface film formation in a single cycle. Although previous studies have demonstrated simultaneous deposition using thermal ALD, reports involving Plasma Enhanced ALD (PEALD) remain limited.

This report describes the successful simultaneous dual-surface deposition of AlO<sub>x</sub> thin films on silicon wafers using a direct plasma-based PEALD process.

## Experimental Conditions

This study examined the feasibility of simultaneous dual-surface film deposition on silicon wafers using the Plasma Enhanced Atomic Layer Deposition (PEALD) technique. 6-inch Si wafers polished on both sides were suspended within the reaction chamber using spacers, as illustrated in Figure 1. Trimethylaluminum (TMA) was employed as the aluminum precursor, and oxygen was introduced in plasma-enhanced mode as the oxidant. The substrate temperature was maintained at 300°C, and the gas flow was oriented horizontally.

To evaluate deposition characteristics, film

thickness distributions on both the front surface and back surface of the wafer were measured. Spacer heights of 7 mm, 11 mm, and 14 mm were tested to determine their influence on thickness uniformity.

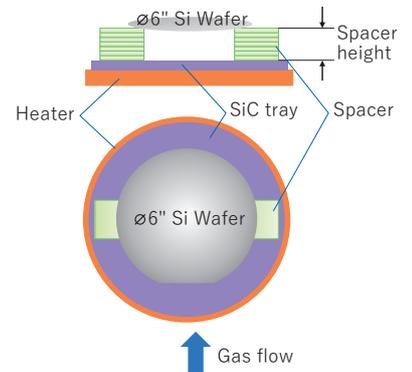


Figure 1. Sample Placement Diagram

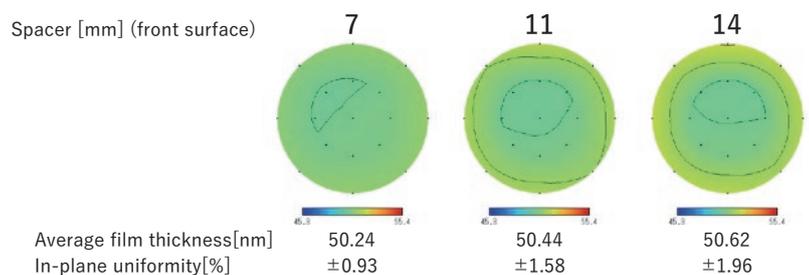


Figure 2. Film thickness distribution on the front surface

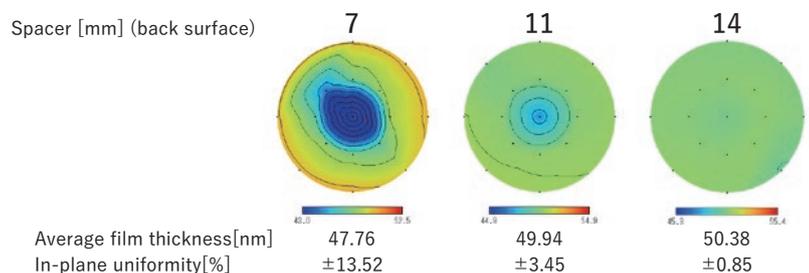


Figure 3. Film thickness distribution on the back surface

## Results and Discussion

As shown in Figure 2, ellipsometry measurements of the front surface revealed no significant variation in average film thickness across the three spacer heights.

When the spacer height was varied between 7 mm, 11 mm, and 14 mm, no significant fluctuation was observed in the average film thickness. A slight increase in thickness near the wafer edge was noted; however, in-plane uniformity remained within  $\pm 2\%$ , indicating excellent reproducibility.

In contrast, the back surface results shown in Figure 3 exhibited clear improvements in both average thickness and in-plane uniformity with increasing spacer height.

A consistent pattern of central thinning and edge thickening was observed, suggesting limited plasma radical transport to the center of the wafer.

Figure 4 presents the ratio of back surface-to-front surface film thickness. As spacer height increased, the ratio approached unity, reaching 0.99 at 14 mm. This indicates nearly equivalent deposition on both surfaces.

Further analysis of the  $\text{AlO}_x$  films deposited under the 14 mm condition showed refractive index values ranging from  $n = 1.705$  to  $1.712$  on both surfaces. Wet etch rate (W.E.R.) testing with respect to buffered hydrofluoric acid (BHF) yielded rates of 87.6 nm/min on the front surface and 85.7 nm/min on the back surface, confirming the uniformity of film composition and structure.

These results collectively demonstrate that a spacer height of 14 mm enables highly uniform dual-surface deposition in both film thickness and material quality.

## Conclusion

This study investigated a method for simultaneous dual-side deposition of  $\text{AlO}_x$  films on silicon wafers using the Plasma Enhanced Atomic Layer Deposition (PEALD) technique, in which wafers were suspended within the

chamber using spacers. Spacer heights were varied between 7 mm and 14 mm. The results indicated that increasing the spacer height led to a reduction in thickness differences between the front and back surfaces. At a height of 14 mm, the film thickness ratio reached 0.99, demonstrating nearly equivalent deposition on both surfaces.

Furthermore, under the 14 mm condition, the refractive index and wet etch rate measurements revealed negligible differences between the front and back surfaces. These findings confirm that uniformity was achieved not only in film thickness but also in film quality.

Future work will focus on extending this approach to other film materials and deposition conditions, with the aim of further optimizing the process and broadening its applicability.

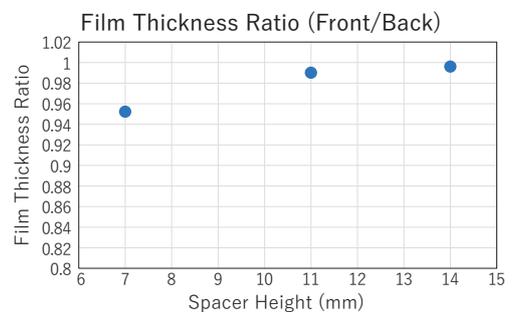


Figure 4. Back-to-front film thickness ratio by spacer height

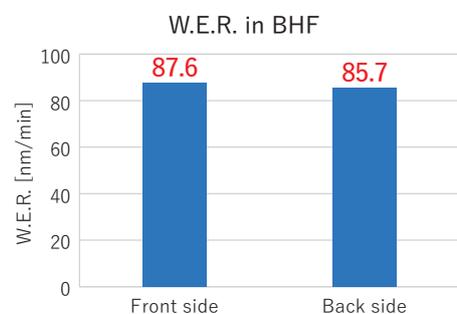


Figure 5. W.E.R. of  $\text{AlO}_x$  in BHF at spacer height of 14 mm

## References

- Samco Now Technical Report, Vol. 93, April 2016
- Samco Now Technical Report, Vol. 118, July 2022

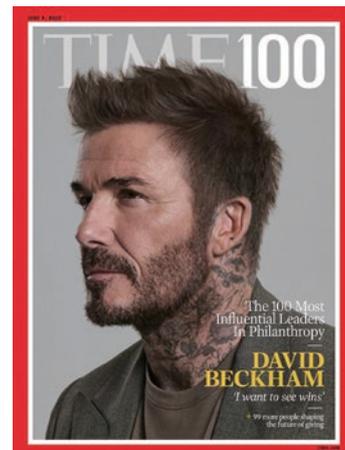
## Samco Inc. featured in TIME Magazine

We are pleased to share that Samco Inc. has been featured as partner content in the globally renowned TIME magazine. Titled “Taking a Quantum Leap,” the article briefly traces our journey from a Kyoto garage in the 1970s—where we developed our first PECVD system—to our current role as a global supplier of semiconductor processing equipment. It also touches on CEO Osamu Tsuji’s reflections on our commitment to innovation, collaboration, and the growing importance of compound semiconductors and quantum technologies. The full article can be viewed at the link below:

Taking a Quantum Leap →



We remain committed to further enhancing our corporate value and sincerely appreciate your continued support and encouragement.



## Indian Students from Kyoto University’s KU-STAR Program Visit Samco

On June 2, Samco Inc. welcomed seven students from Kyoto University’s KU-STAR Program for India 2025 to its Kyoto headquarters. The group, composed of students from top institutions including IIT Delhi and IISc Bangalore, toured Samco’s production building, visited the company museum, and attended a presentation by engineer Dr. Hemanth. They also had the opportunity to meet CEO and Founder Osamu Tsuji, who shared words of encouragement. Samco is proud to support the KU-STAR Program and its partnership with Kyoto University.



Kyoto University’s KU-STAR Program Students with Samco’s CEO Osamu Tsuji and Dr. Hemanth during their visit to Samco HQ in Kyoto

