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Ultimate in Vacuum

ULVAC

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ULVAC

Cover Photo:
Mt Fuji viewed from Eboshi Rock off the Chigasaki coast
*For details, see Special Features (page 16).
Explanation of cover photo:
In 1968, ULVAC moved from Yokohama City to Chigasaki City, where its headquarters and plant are now located. Chigasaki City has supported ULVAC for over fifty years. To show our appreciation, we put together this Special Feature. The photo shows Mt. Fuji viewed from Eboshi Rock, a famous Chigasaki landmark.

PHOTOGRAPHS
p.4-5 Brooks Automation, Inc.
p.9, 12 PhD JunjiTominaga
p.16-17 Chigasaki City
p.20-21 Toyo Seiki Co., Ltd.

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*Names of companies, organizations, and job titles appearing in all articles are current as of the time they were written.
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Making Bold Inroads into a New Business Area based on Core Technology

—— With an eye toward the continuous stable management in the future, semiconductor-related business is combined with the life science-related business.

● Interviewer
Setsuo Iwashita
President & CEO, ULVAC, Inc.

● Guest
Dr. Stephen S. Schwartz
President & CEO
Brooks Automation, Inc.

Established in 1978, Brooks Automation, Inc., (headquartered in Chelmsford, Massachusetts, USA) has long focused on the robotization of the semiconductor manufacturing process. However, since the semiconductor industry is one of the most volatile industries, the company undertook the challenge of embarking on a new business area based on its core technology in 2010 with the aim of securing continuous stable management for the future. To this end, the company sold underperforming departments, implemented M&A in an aggressive manner using the proceeds from the sale, and successfully shifted its business to life sciences. Dr. Stephen S. Schwartz led this transformation process. He transferred from a leading semiconductor manufacturing company to become president of Brooks Automation, Inc., in 2010. President Setsuo Iwashita of ULVAC Technologies, Inc., invited Dr. Schwartz to the company based on his management philosophy and useful hints for successful M&A.

***All product trademark notices are omitted in this document.**

Clearly define business strategies and aim to achieve stable management for the future

Iwashita: Brooks Automation, Inc., (hereinafter referred to as "Brooks") and ULVAC, Inc. have built and long maintained a close business partnership. Moreover, Dr. Schwartz has provided me consultations not only on business management but also on personal affairs. Taking this opportunity, I would like to extend my sincere appreciation to him. I am excited to hear his views on various issues today. After 2010, Brooks shifted its business strategy and established two core businesses, namely, the semiconductor-related business and the life science-related business. We would like to know your views on how a company should be and how it can grow.

Schwartz: Indeed, we are focused on growth, and it has been an important objective for us during the past 8 years. As a company whose heritage is in serving the global semiconductor equipment market, we had been completely at the mercy of the semiconductor cycles. Of course, that means we benefitted during up-cycles, but we also suffered significantly in down periods which were particularly difficult as it meant significant cuts to cost and reductions of headcount. Against this backdrop, we struggled with the "sustainable" aspect of growth, as it seemed like we were driving a car with one foot on the accelerator, and one foot on the brake.

When we embarked on our transformation, we were intent on a path that would allow us to grow and to diminish our dependence on the cyclical semiconductor business. In fact, we made sustainable growth such a priority, that we sold three of our semiconductor business units that we could not grow, and we used the proceeds from those divestitures to fund other growth initiatives.

Iwashita: Why did you choose life sciences and how did you ensure that employees understood the management policy?

Schwartz: We always work to be accountable to deliver on the commitments that we make to our customers, to the company, and to each other. The one thing that we try to do for employees is to articulate our strategy again and again. We believe that we are positioned and focused on market opportunities which are important to the world – in Life Sciences it is to support the research that will contribute to longer, healthier lives; and in Semiconductor it is to continue to improve the quality of our longer, healthier lives. We believe that these two areas will be worth pursuing for the next decades, and it is easy for our employees to be enthusiastic about our contribution to these important endeavors.

That said, the only thing that we promise employees is that they can expect hard work and change. Under various circumstances, this could be energizing or demoralizing, but we believe that as we have had success, and when employees are able see the fruits of their labor in the benefits to our customers, shareholders, and fellow employees, that we have tipped toward the "energizing" side of the ledger.

We have focused much of the past five years on Leadership Development. When we had only semiconductor products, we spent too much of our management time trying to keep up

with product demand during fast upswings in the market, and containing costs and managing headcount in the downturns. This use of energy was always internal to the company and did not provide much benefit to customers. With our diversification away from 100% front-end semiconductor, we have been determined to make management of cycles a part of our normal course of business, and we have worked to dedicate our management focus around our future, rather than just our daily challenges. Additionally, we have worked to create individual development plans for all of our employees to make sure that we can grow our next generation of leaders, whose job it will be to continue to grow the company in the future.

Flow map-based M&A with a focus on corporate culture and people

Iwashita: I hear that Brooks has actively implemented M&A to acquire new business. In this process, what challenges did you face?

Schwartz: One challenge for us is that we have been quite acquisitive over the past 7 years. When we complete our 2019 Fiscal year at the end of September, more than half of our approximately 3,000 global employees will have been with Brooks for less than two years. When we extend the timeline back to 2014, that fraction grows to more than 70% "new" employees. This is a challenge from the standpoint of culture, behavior, and stability. Our HR team has done a tremendous job getting these new employees and new companies on-boarded and integrated into our company processes and benefits plans. And our management team works extra hard to make sure that we are embedding our company values into all that we say and do so that new employees to Brooks can understand our corporate culture and accepted behaviors.

Also, change is always hard to keep up with, and it seems that we never quite communicate enough to reinforce the reasons for our changes and how the changes fit our general strategy. We can always do better, but we work at this every day.

Iwashita: For M&A, I understand that it is difficult to handle personnel issues and have your corporate culture take root among new employees. When Brooks implements M&A, do you have any criteria according to which you implement them?

Schwartz: We were fortunate to discover a new opportunity where we could use our technology strengths, automation in controlled environments and cryogenics, to solve a global problem. We found that there are more than 2 billion biological samples stored around the world in freezers that have no automation, no precise method for tracking or locating samples, and no guarantee of sample temperature history or quality. The ability to manage and monitor the location, temperature, history, and permission to use a sample is critical to the value of the sample, and the ability of researcher to do high fidelity research. It was an obvious opportunity for us to bring value with our automation and cryogenics expertise to automate the cold storage of biosamples. We set out to learn as much as we could about the problems that resulted from mismanagement of cold samples and we created a Flow Map of what we called the Cold Chain of Condition. We outlined all of the process tools and process steps that we could envision that would bring value to the management of samples. From this Map, we charted a course for both acquisition and internal product development to be able to create an entire cold chain.

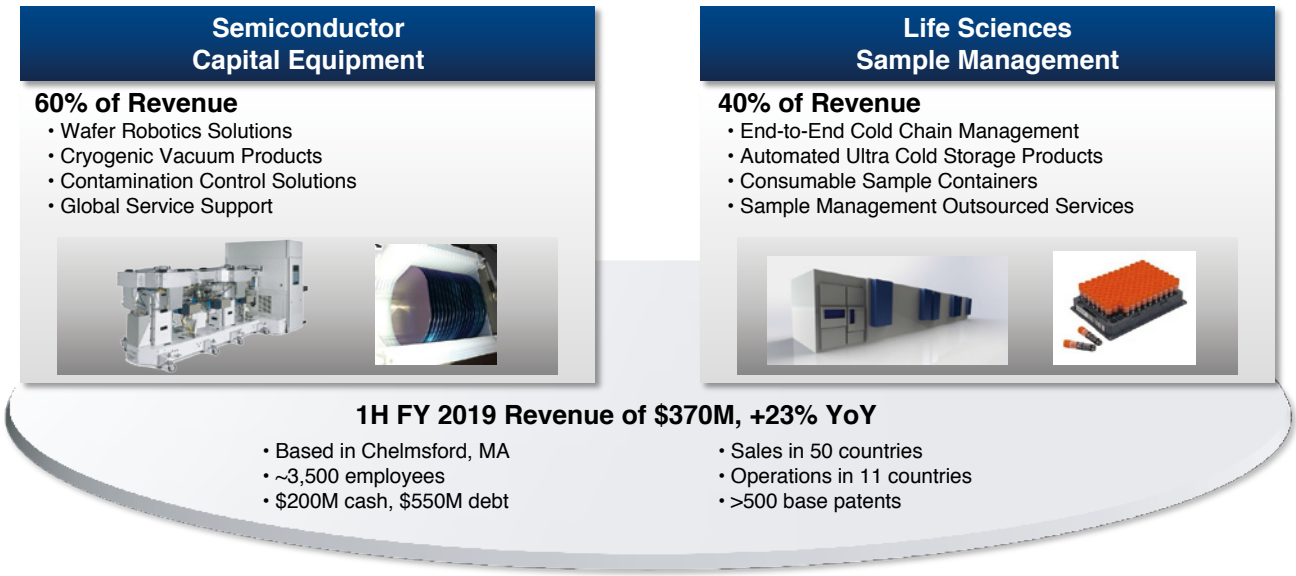
Iwashita: You mean that M&A is implemented based on the flow map of the cold chain. Would you explain the concept of the flow map?

Schwartz: As the saying goes, "no battle plan survives contact with the enemy". In other words, we had a general idea of the types of capabilities to acquire and the names of many target companies, but an acquisition roadmap is rarely as simple as going directly from Point A, to Point B, to Point C. So, we generally adhered to our value map, but sometimes we did acquisitions out of the desired order, or we changed from one target company to another. We adapted many times, but we did not lose sight of our goal to create a high value Cold Chain for biological samples.

Also, our M&A criteria have evolved over the years. In the early days when we were entering the Life Sciences market, we looked to acquire market leading capabilities that satisfied our strategic roadmap. At that time, market leadership was very important. Of course, we had financial criteria to justify those acquisitions but at the start, we were most focused on acquiring a combination of those capabilities which were uniquely strategic in the creation of our Cold Chain Sample Management Solution.

For the past several years we have put more emphasis on specific financial hurdles for our acquisitions, in that we want the returns from the target businesses to be able to exceed our cost of

Fig.1 Brooks Automation at a glance – 1H FY 2019



capital within a reasonable time horizon – typically this is three years for a semiconductor business acquisition, and we allow up to five years for a Life Sciences acquisition.

Of course, any M&A that we do must be with a company that is a good cultural fit with Brooks and a company that we can continue to grow.

Aiming at further development by investing profits in sales in the new third area

Iwashita: Brooks and ULVAC had managed ULVAC Cryogenics Incorporated, which develops and manufactures cryogenic pumps as a joint venture. However, Brooks sold the related department and withdrew from the undertaking. Please tell us about the reasons why you sold it.

Schwartz: I can imagine that this decision might look curious to ULVAC, especially since it is a core business that has high market share and has performed very well. Actually, this was a decision that we made over a period of years. Our original plan was to expand our growth in the cryogenic vacuum space. We performed a strategic market assessment to examine different growth opportunities which were outside of our current semiconductor and related applications. And though we were very positive about the growth opportunities in and around the vacuum technology space, a small company like Brooks could not justify investing simultaneously in three areas – semiconductor automation, life sciences, and vacuum technology, so we decided to focus on automation and life sciences.

We decided that if we were not going to invest in cryogenics, we did not want the business to languish or to suffer share loss from lack of investment, so we decided to run a sale process to see if we could receive a sales price that was fair for the business, from a buyer who would keep the cryopump business unit together. We were fortunate to satisfy both of those criteria and we agreed to the sale to Atlas Copco. We plan to use the proceeds from the sale to continue to invest in both of our remaining businesses.

Our strengths lie in engineering technology and talented people

Iwashita: Brooks established a solid foundation to maintain stable business for the next 10 or 20 years by executing a brave change of direction. Where do you think the advantages of the shift, such as synergy in business, lie?

Schwartz: I would say that the synergy between our Engineering and Science capabilities of Automation and Cryogenics has been of tremendous value to us. At our core, we are an innovative engineering company. Engineering is our heritage and what we have been known for for the last 40 years. We are fortunate to have found an opportunity where automation in ultra-cold environments can benefit the Life Sciences discovery market. When presented with this new challenge, I believe

Profile of Dr. Stephen S. Schwartz
President & CEO
Brooks Automation, Inc.

Birth date: October 24, 1959
<Brief Background>

June 1987: Joined Applied Materials, Inc., Santa Clara, California
- General Manager, High Temperature Films Division

January 1994: Moved to Applied Materials Japan, Chiba Prefecture, to manage the Global HTF Division from Japan for one year.

June 1997: VP and GM of Applied Materials Global Service Business

June 1999: President of Consilium, an Applied Materials Company

January 2001: Asyst Technologies – SVP in Operations

August 2002: Appointed CEO of Asyst Technologies

October 2002: Appointed chairman and CEO of Asyst Technologies

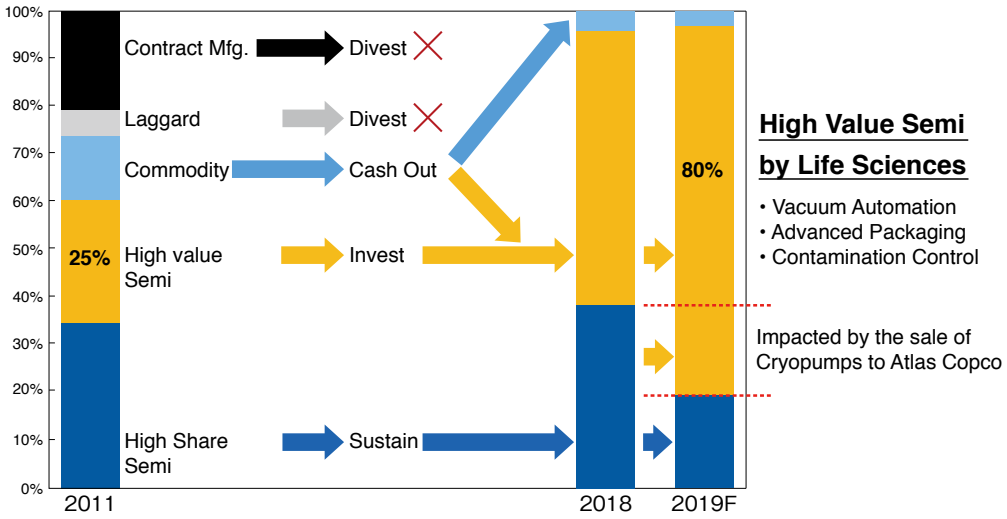
April 2010: Joined Brooks Automation, Inc. as President

October 2010: Appointed president and CEO of Brooks Automation, Inc.

Corporate Profile
Brooks Automation, Inc.

Business: a leading worldwide provider of automation, vacuum, and instrumentation solutions for multiple markets including semiconductor manufacturing, life sciences, and clean energy.
Founded: 1978
Headquarters: Chelmsford, Massachusetts, United States
President and CEO: Dr. Stephen S. Schwartz
Number of employees: 3,500 (2019FY)
Website: www.brooks.com

Fig.2 We went to work…



our team responded extremely well and collaboratively to devise methods to make our automation work at cryogenic temperatures, and to keep samples cold when applying power to move the automation.

Another advantage we have relates to our human resources. We have found that when we are innovative and when we execute at the leading edge of technology, we are able to attract top talented people who are eager to join us to solve some very challenging problems. It is energizing for these employees, and they attract people who are also drawn to these challenges.

I also think that our geographic footprint is an advantage. We operate globally, and we have product development on the East and West Coasts of the U.S., China, U.K., Germany, Korea, and Japan. It allows us to attract very talented people and to give international assignment opportunities to our employees – something very important for our future.

Strengths and weaknesses of Japanese companies in terms of globalization

Iwashita: We envy you. True globalization is a major theme for the future of ULVAC. We would like to know the details of the global business development of Brooks, our predecessor.

Schwartz: We are fortunate that the global markets provide so much opportunity for growth, collaboration, and expansion of our businesses. There is much in the news these days about trade friction and restrictions, but still, for much of the last 50 years this has been a period of the most robust global trade and open markets that we have ever seen. Of course, the ability to compete in different regions requires knowledge of customers, business practices, and regulations, but we have found that the challenges are worth the investment and we are encouraged to continue to build our business in growth regions.

This has always been important, but never more than today, when global mobility is high and trade opportunities are expanding. I personally believe that globalization and the connectivity that exists today has helped all of us to have the opportunity to better understand cultural differences. Younger people especially seem to be more globally fluid than in the past and this trend seems to be increasing.

All of us are the beneficiaries of a more diverse work community.

Iwashita: In that case, I think that Japanese companies are in a difficult position. What do you think are the strengths and weaknesses of Japanese companies in terms of globalization?

Schwartz: Ah, indeed this is a tough question for someone who is not Japanese, but I will give some of my observations/impressions. My comments are also from the perspective of only having worked for US-based companies.

First, in terms of advantages for Japanese companies. I would say that teamwork and alignment of employees around the company objectives seems to be strong. This is a tremendous asset when tackling big challenges.

Second, stability of the workforce is a plus and seems dependable as there is a trust bond that exists and can be built upon.

Third, there seems always to be a culture of quality and adherence to rules and process is commendable and something that permeates market perception about the quality of Japanese products and services.

On the flip side, and this comment is neither an advantage nor a disadvantage, but rather a difference historically between Japanese and American companies. Often, American companies worked to move quickly to develop a product. The process would consist of try, fail, make a change and try again, fail again, etc. Japanese companies tended to take more time to plan, align completely, and then execute to deliver a more finished product. I believe that what is often the case is that somewhere between these two methods there may be an even better way to innovate and deliver high quality products more quickly.

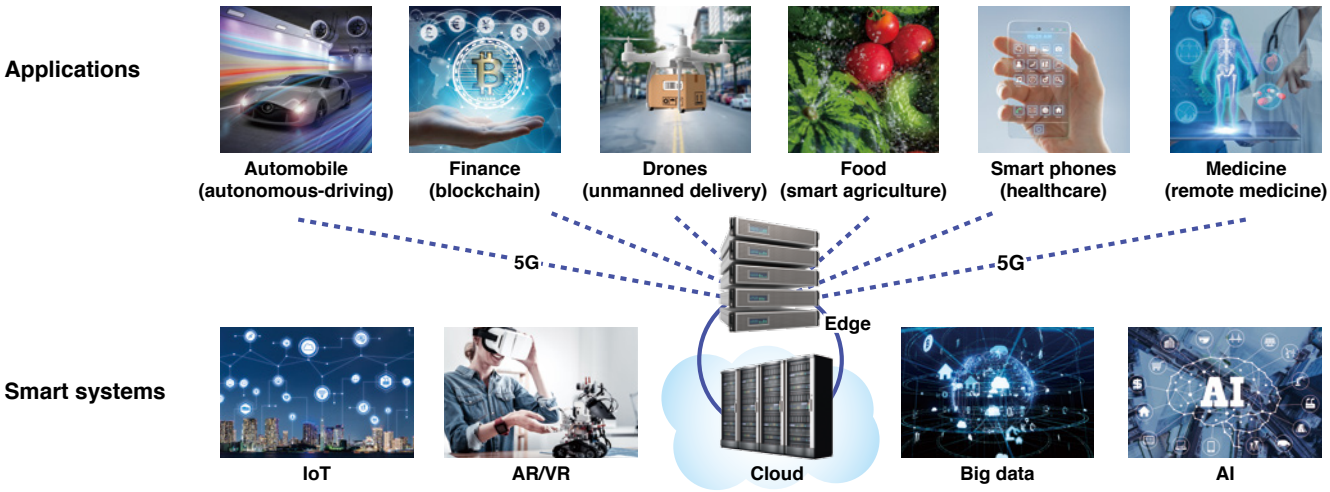
Also, sometimes Japanese companies have been slower or more reluctant to expand outside of Japan.

Vacuum technology will become increasingly more important

Iwashita: Please tell us about the future prospects of Brooks.

Schwartz: We are always looking to the future and we are positive about the prospects that are provided by the markets we serve. In semiconductor, our challenges relate to our ability to stay in front of technology needs of some very big companies

Fig.3 ULVAC's Technology for enabling a smart society = Growth market



Growth markets (key technologies)	Semiconductors (memory & logic), new non-volatile memory, MEMS, Sensors, Communication devices, Power devices, Li-ion batteries (LIB), Advanced packaging, OLED displays, Solar panels

that are getting larger in a rapidly consolidating industry. Size and scale and the ability to develop products quickly will be paramount to success. Our ability to collaborate and to consider alliances with partners will be key.

From a technology standpoint, we see a significant trend in both our Semiconductor and Life Sciences business to lower levels of contamination. For certain, this is accomplished in our semiconductor automation business by the increased number of process steps that are performed under vacuum. Contamination control these days is no longer simply the application of highly purified air, but rather it now includes the vacuum reduction of airborne molecular contamination (AMC). Over the next generations of device technology, we see vacuum technology playing an increasingly valuable role in yield enhancement as well as advanced process technologies. Without question, the vacuum process share of the Wafer Fabrication Equipment Market and the Display Markets is growing faster than the overall market opportunity.

In Life Sciences, the size of the opportunity is clearer than our roadmap. The life sciences market feels much like the semiconductor field was in 1980 – much invention and innovation, very few standards, limited automation, and seemingly unlimited room for experimentation and discovery. We very much want to be a part of this boom and we are looking for ways to continue to grow where we can add value to the research that is changing seemingly on a daily basis. We are still in the earliest innings of this long game.

So, we are positive about the outlook for our markets, and we are somewhat paranoid that we are not the only company who can see these opportunities – that keeps us energized, a bit scared, and definitely working harder to make sure that we can capture these opportunities.

Looking at future collaboration with ULVAC

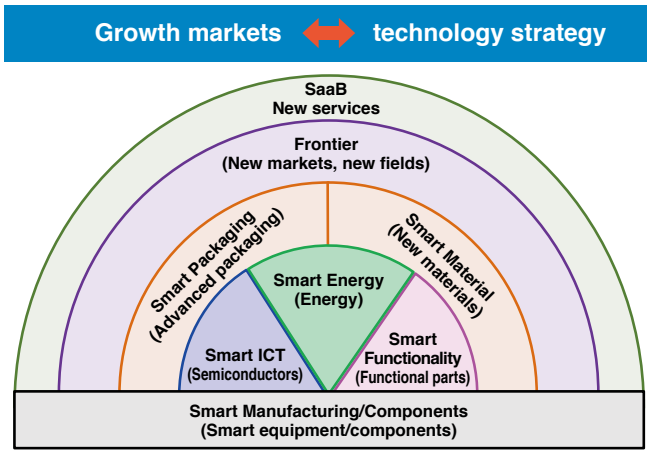
Iwashita: Dr. Schwartz, what type of company do you think ULVAC is? How do you evaluate the company?

Schwartz: ULVAC has many assets, but three immediately come to my mind.

Number 1, ULVAC has a strong and dependable brand and an excellent reputation for superior vacuum technology and dependable products. You are leaders in your markets.

Number 2, Your global capability in terms of breadth and balance is admirable – especially your footprint and presence

Fig.4 Creating growth markets (key technologies): ULVAC's technology strategy



Setsuo Iwashita,
President & CEO,
ULVAC, Inc.

across Asia – particularly your presence in Japan and China, which is formidable.

Number 3, You aggressively invest in R&D and you are applying growth capital to secure your positions.

The combination of these factors and your position in growing markets gives much potential opportunity which other companies cannot easily overcome.

I admit that I am not well-equipped to know disadvantages, but I would suspect that the North American market is one that likely presents an untapped opportunity for ULVAC.

Finally, it is my personal observation, I believe the fact that Iwashita san, as the top leader in the company, is always asking this question - about things that ULVAC can and should do better - is a big advantage for ULVAC as it is this kind of thinking and probing that leads to improvement and new opportunities.

Iwashita: Thank you for your nice comment on ULVAC (laughter).

The ULVAC Group will join forces with one another to contribute to the resolution of global social issues. We think that a smart society can be achieved by electronizing all industries, including medicine, agriculture, information and communications, and energy. To this end, the ULVAC Group is determined to contribute to the world by leveraging its long-accumulated experience and collective strengths in the fields of thin-film technology, device element technology, and material technology as key means. We believe that this is the value of ULVAC. This is only my idea, but I hope that Brooks and ULVAC will further collaborate with each other for the future of both companies.

Schwartz: Through UCI, our Joint Venture company between ULVAC and Brooks, we have a history of cooperation of more than 30 years. I admit that though our relationship has been one of good cooperation, it has not been one of good collaboration. I believe that we missed a real opportunity to take better advantage of our two strong teams to create even more success for our companies. This was a failure of mine to recognize a larger chance through closer collaboration. So, I would welcome a chance to think about more chances to collaborate with ULVAC in the future.

Iwashita: We would be delighted to collaborate with Brooks and ask for your continued support and cooperation. Thank you for sharing your useful and helpful ideas with us today.

A carefree boyhood surrounded by nature's abundance

— What was your boyhood like?

I was born in Ohira Village, Miyagi Prefecture. It is a farming village located on the Sendai Plain, and is the only "village" in Miyagi Prefecture. A Toyota Plant has been built there and the village is now financially better off than the neighboring towns. But it is still a "village."

Ohira Village is unusual in that approximately half of its area is owned by the Ministry of Defense (Japan), and a Self Defense Forces maneuver training field is located near the elementary school. During class, we often heard the sound of cannons and the engines of fighter planes. It might be due to these experiences that I have an affinity for airplanes.

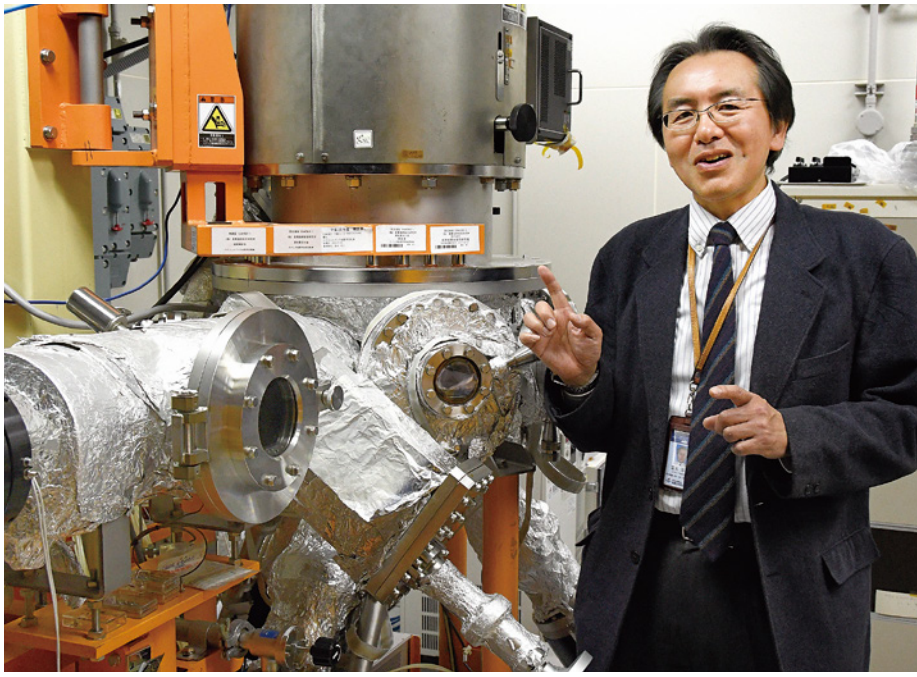
All through elementary school and up to seventh grade, I was so absorbed in the abundance of nature surrounding me that I hardly studied. In summer, we used to dam up a river and use it as a swimming pool. In autumn, you could see a lot of dragonflies flying around. The rice paddies and reservoirs were full of frogs, which we caught and played with. I often dug up potatoes in the fields, too.

When I was in fourth grade, our family moved to a neighboring town (Taiwacho). This was the town where the movie "The Magnificent Nine" (distributed by Shochiku Company Limited), which

Junji Tominaga, Ph.D.

He received his PhD from Cranfield Institute of Technology (now, Cranfield University), UK in 1991. Since 1991 to 1997, he had engaged in the research and development of optical phase-change memory discs (DVD-RAM and DVD-RW) in TDK corporation. In 1997, he left TDK, and moved to National Institute of Advanced Industrial Science (AIST) as a senior staff of the advanced optical memory project using near-field optics. He was the former director of Center for Advanced Near-field Optics Research (CAN-FOR) until 2009. Now he is a prime senior researcher of AIST, and has engaged in nonvolatile electric memory using phase change materials, and topological insulators.

He received The ministry of economy and industry award (1999), Japan IBM award (2000), S.R.Ovshinsky award (2014) and Honda frontier award (2016).



National Institute of Advanced Industrial Science and Technology (Japan)
Nanoelectronics Research Institute Department of Electronics and Manufacruring
Junji Tominaga, PhD, Prime Senior Researcher

Phase-change Memory Research in Which Any Point Reached Marks a New Starting Point

—— Research policy taking a unique point of view with the motto, "We can do it if we try"

The phase-change memory developed in the 1960s is based on a technology that records differences/changes that occur between crystallized and amorphous states of the same material. This technology had been overshadowed by magneto-optical (MO) technology until the 1990s. However, with the commercialization of blue lasers, the requirements for ultra-high density memory increased, which suddenly sparked greater interest in phase-change technology. Dr. Junji Tominaga, a Prime Senior Researcher at the National Institute of Advanced Industrial Science and Technology who is featured in this issue of Vision, has been researching phase-change technology since the 1990s. His research results first led to the development of phase-change CD-RW and Blu-ray compatible ultra-high density DVC-RW disk media, and then to the creation of many wonderful devices, such as the superlattice energy-saving phase-change memory, which he devised essentially on his own. He is currently working on finding practical applications for topological insulators, which hold new possibilities for phase-change memory. We asked Dr. Tominaga about his research on phase-change memory as well as related subjects.

debuted in 2016, was filmed. When I was in elementary school, I enjoyed drawing. My drawings were always selected for prizes in sketching contests and I was awarded supplies such as crayons and paints, so I never had to buy them. The other hobby I had was making model planes.

When I was in ninth grade, instead of studying to prepare for the high school entrance exam, I was secretly focused on studying to obtain an amateur radio operator license, without my parents' knowledge. I did not study my school subjects much, but I was good at math and science. I also liked history.

When I entered high school, I really began to enjoy math and physics. I formed a physics club and was active in it. Since it was not an official club, the school did not give us any money. So I used my own spending money to cover expenses for physics experiments.

One of the devices we made was a sunlight-collecting furnace called a solar furnace. We bought aluminum plates and built something resembling a parabolic antenna after making calculations that would allow us to focus the sunlight on a single point. At a subsequent presentation, we made 1 liter of water boil in 10 minutes.

Following my studies in England, I began research on phase-change technology when magneto-optical technology was the mainstream.

— Is it true that you first joined a private corporation?

After getting my master's degree, I joined TDK's R&D Laboratory in 1985, where I started out working on hard disk research. After about two and a half years (in 1987), TDK's foreign study program sent me to study at Cranfield Institute of Technology in England. During Japan's rainy season, the read-write heads (flying heads) of hard disk systems often broke down due to moisture. TDK decided to send me to England to find out why this was happening.

The Cranfield Institute of Technology that existed when I was studying there cannot be found on maps. That's because an Air Force facility was also present at the Institute. There was a 2,400-meter runway on which even passenger jets could land. I got my PhD at the Institute. I had many wonderful experiences studying in England, and it is not an overstatement to say that my career as a researcher began there. Therefore, I actively encourage the staff at my laboratory to study abroad. Learning about cultures that are different from Japan's and forming new networks can become assets in the future. I send my staff out, telling them just to enjoy life in foreign countries.

Dr. Tominaga (second from right) with his academic advisors at the Cranfield Institute of Technology in England.

When I was finishing my studies in England, the Japanese yen abruptly began to appreciate because of the Plaza Accord, and this caused the hard disk business in Japan to shrink significantly. TDK also withdrew from the hard disk business, except for flying heads, and asked me to work on magneto-optical discs. However, judging that it was too late for that technology, I decided to work on phase-change technology in 1990 and started with research on phase-change CD-RW.

The Magneto-optical (MO) Group had 40 researchers, but my Phase-change Research Group started with just me. The people in the MO Group used to tell me that phase-change technology would never end up producing any products. However, the golden days of MO discs came to an end within a short period. This was mainly because the market around 1994 began to demand a gigabyte class of high-density media in order to handle images.

Just around then, a major debate started over whether to use phase-change or magneto-optical technology for DVD-RAM. A heated controversy was taking place between companies pushing MO and those pushing phase change. It turned out to be a decisive battle. The phase-change camp won in the end.

Changed by a chance meeting with Prof. Tonegawa in an airport

— How did you come to join a specialized research institute?

Prior to commercialization of phase-change discs, I was told by my company to go to the U.S. to present our research results and introduce our new product.

After finishing business in Boston, I was waiting for my flight to New York, my next destination. Prof. Tonegawa happened to be sitting in the seat in front of me in the departure lounge. Since he had just received the Nobel Prize and I was a fan, I decided to ask for his autograph. There was still about an hour before our flight, so I had time to chat with this senior researcher.

Prof. Tonegawa said, "So you've been doing research at a private corporation. It might be time for you to consider going higher."

After returning to Japan, I happened to notice in an academic journal that the National Institute for Advanced Interdisciplinary Research (present-day National Institute of Advanced Industrial Science and Technology (AIST)) was accepting applications for research positions. I sent in my application, thinking that I wanted to pursue phase-change technology all the way. Since the new product that was the result of my research had just been completed, it was a good time for me to take on another challenge. That comment by Prof. Tonegawa in the Boston airport served as the impetus for me to take on new challenges for 22 years after joining AIST in 1997.

Development of ultra-high density optical recording disc using a GST ternary alloy

— We understand that after you joined the Institute, you produced one new result after another.

I was one of two researchers hired through the application process. There was a third researcher who had come from the former Electrotechnical Laboratory. So with a secretary, there

■ **Explanation of a Stirling engine model**

The lower part, which is equivalent to an electrode, is a cup into which hot water is to be poured. Pouring hot water into the cup is the same as applying an electrical current. This switches the phase-change film. Think of the piston as a Ge atom. It is going up and down now, isn't it? This movement of the atom is applying work to the outside. In other words, entropy is being discarded. This is the same principle as that used for switching in phase-change memory. The author of the technical paper had thought about merely adding heat. He missed the point. The upper area is at room temperature and the heat difference from the bottom vessel causes the movement. The upper area can be used for dissipating heat.

were four of us. We were given a newly-built research wing. Over the next 6 to 7 years, we filled the wing with equipment and people.

Research back then was focused on ultra-high density optical recording using phase change. Since light is also a wave in terms of characteristics, it is not possible to focus all of it onto a single point. Also, since waves are subject to a principle called diffraction limit, only 1/4 to 1/3 of the wavelength can be focused. So we began researching a super-resolution technology that would use a solid film and open a light window in response to heat instead of light.

We used a ternary alloy consisting of antimony (Sb), germanium (Ge), and tellurium (Te). This was in 1999. For this research, we received the Minister Award from the Ministry of International Trade and Industry (present-day Ministry of Economy, Trade and Industry), and we also received an award from IBM in 2000.

Next, in 2009, we developed a Blu-ray DVD disc with 4X density using optical super-resolution technology. We gave a demonstration of this disc at the Kyoto Office of Mitsubishi Electric Corporation. We set up four high-definition TVs and the ultra-resolution DVD disc we had developed, along with a single Blu-ray light source, and we succeeded in projecting four images simultaneously on the four TVs.

The wavelength was 400 nanometers and the resolution was 60 to 80 nanometers. Since the current Blu-ray resolution is 140 nanometers, we were successful in projecting images with four times the current density simultaneously on four channels. The images we used included scenes of famous places in Kyoto and flowers. I think this 60-nanometer resolution might still be the world's highest among super-resolution technologies.

Incidentally, the Nobel Prize in Chemistry 2014 was awarded for an application of super-resolution technology. It was achieved by research groups in Germany and the U.S., but their resolution was only 90 to 100 nanometers. Our resolution was superior, but they applied the technology to the medical field. When we heard the news of the Nobel Prize award, I commented to our research staff, "We just missed it! Maybe we should have targeted a living organism." If we had worked with a living organism, we might have won the Nobel Prize .... (Laughter)

From a high-resolution phase-change disc to superlattice energy-saving phase-change solid-state memory

— New research themes seem to be showing up one after another in phase-change memory research.

The next thing we worked on was energy-saving phase-change memory utilizing the uniquely conceived superlattice, which used chalcogenide instead of a GST ternary alloy. Until then, I had been working on optical phase-change discs. However, in 2006, someone involved in semiconductor devices came to us and asked us to focus as well on phase-change memory using electricity. That was a catalyst for me. It was very good timing. That was when all companies were beginning to withdraw from optical discs and, following the economic downturn precipitated by the bankruptcy of Lehman Brothers in the fall of 2008, companies began moving their production from Japan to overseas.

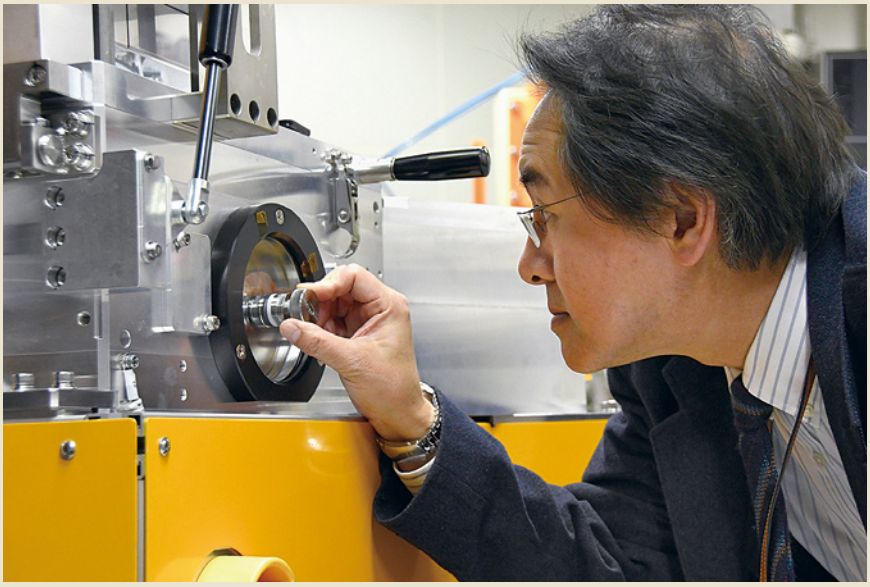
The first step I took was to read technical papers related to electrically switched phase-change memory. One paper included an extremely beautiful device temperature distribution diagram that was color-coded into 1.4 million colors using thermal analysis software based on computer simulation. Although the paper described the results when the maximum temperature was 650°C (molten state) and 200°C (crystallized state), it did not say anything about the instant of phase transition.

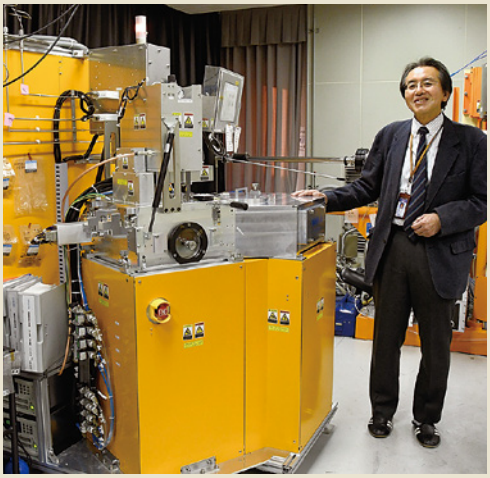
I kept wondering, "Why this omission?" I thought something was wrong.

Phase change means the material goes back and forth between crystallized and amorphous states, repeatedly melting and cooling. It is a heat cycle in which the state is fixed by raising and lowering the temperature. This is a thermodynamics issue. Thermodynamics is governed by basic laws*, known as the first, second, and third laws.

In other words, then, the paper used only the first law for its argument. A thermodynamic cycle would not work with just that. The paper did not consider how much entropy was being lost within the cycle. That is, it ignored the second law of thermodynamics. Since I specialized in physical chemistry, I was convinced that solving this issue would produce improved results. I thought, I would do it if nobody else was going to do it.

I had also been aware of this entropy issue during the time I had previously worked on optical discs. When I made the actual calculations, I found that 95% of the energy disappeared as entropy, and I knew I had to prevent it from disappearing. Although I could not completely eliminate entropy, my efforts to eliminate this 95% energy loss brought me to superlattice phase-change memory.





Dr. Tominaga with the QAM, a compact sputtering system for thin-film deposition R&D. We use this system for evaluating the majority of our current experiments.

A topological insulator is what I'm working on now.

— So that was not the end of your phase-change research.

Actually, a superlattice in which GeTe and Sb_2Te_3 in crystallized states were stacked reduced the energy requirement of phase-change memory, and I thought that would be the end of it. Because of the Great East Japan Earthquake that occurred on March 11, 2011, I was unable to conduct any experiments for a while, so I decided to read a variety of technical papers. I ran into the strange term "topological insulator." Then I found out that Sb_2Te_3 is a topological insulator. I became really interested, since the superlattice memory I had been working on used the same material, but at first I could not understand anything from reading. Nevertheless, I felt that there was huge potential there. As the Japanese proverb says, repeated reading made the meaning clear.

Since there was a professor who was researching this subject at the Tokyo Institute of Technology, I decided to visit him to ask for more details. During the visit, he gave me some homework, and when I got home I carried out a simulation. I was able to definitely confirm the phenomenon the professor had described.

The process involved using a magnet to destroy the time-reversal symmetry of electron spin. The device repeated the "set" state, indicating low resistance, and the "reset" state, indicating high resistance. When I brought a magnet close to the device during this cycle, the resistance value surged and got stuck in the high-resistance state, and would not return to the low-resistance state. Thinking that it might have broken, I removed the magnet, and then the device returned to the low-resistance state. I realized that this phenomenon had something to do with electron spin.

So I have started a spin control project and am currently researching topological insulators.

I'm convinced that if we can develop practical applications for topological insulators, they will be welcomed as an important technology in support of the AI and IoT society of the future. (For details, see page 13.)

Agreeing with Yozan Uesugi's famous saying, "Where there is a will, there is a way"

— What is your policy on research activities?

I have just one policy. I am particularly interested in things that others have deemed impossible. I fully agree with the famous maxim by Yozan Uesugi, the feudal lord of the Yonezawa Domain in Yamagata: "If you try, you can achieve it; if you don't, it will never be achieved. It was not achieved because you didn't try." I interpret this maxim to mean that you cannot achieve something if you have already decided you won't be able to, and you can achieve it if you try. My research activities are guided by a philosophy like this.

When you read technical papers in some research field, you often notice issues that nobody has addressed or that have been overlooked. I approach this with the attitude of, "I must solve these issues."

For example, when I moved from TDK to AIST, I began research using light. Rather than just watching a scanning tunneling microscope (probing microscope), which uses proximity field light, I wondered if I could apply this to some mechanism for making things.

Since a probing microscope uses light to view atoms, it has atomic-level resolution. This idea became the starting point for my development of optical super-resolution thin film technology in 2009. Superlattice phase-change memory also uses the same technology.

In phase-change memory, material goes back and forth between crystallized and amorphous (set and reset) states. As I mentioned earlier, there is always some energy loss. I had thought it would be

* **The first law:** The increase in energy inside a system is equal to the sum of the work and heat added from outside. This is the law of conservation of energy, including heat.

The second law: Increasing the thermal energy of a system (moving a system from a lower temperature to a higher temperature) is not possible in an otherwise unchanging system. This is the principle that entropy in an isolated system can never decrease over time.

The third law: The entropy of any given substance is zero at absolute zero (0K). Absolute zero cannot be reached through a finite number of processes. This is also referred to as Nernst's heat theorem.

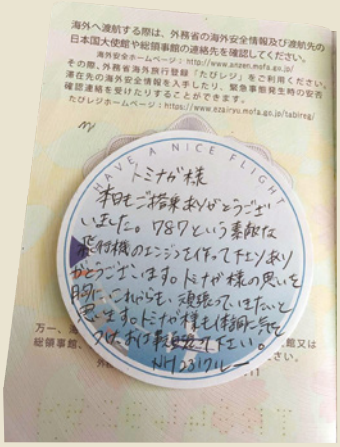
Column (Comment by Dr. Tominaga)

In this colorful age, equipment should also come in bright, fun colors.

QAM, a compact sputtering system for thin-film deposition R&D

For information about the system, visit ULVAC KYUSHU CORPORATION website: https://www.ulvac-kyushu.com/summary/qam/

I really appreciate the fact that ULVAC has been creating excellent systems. However, ULVAC systems are made to look like experiment systems. I asked ULVAC to paint the system to be delivered to us in a special color. Nowadays, even judo uniforms have gone from white to colorful and many other things have become more colorful than they used to be. So I think it's OK to supply colorful systems in fun colors instead of being restricted to the typical factory look. I think women will find these colors more inviting, too. When I went to England, the systems were painted orange. I really liked it. When we specified orange as the color of the first system to be installed here, the person in charge kept asking if that was really OK.



Message from the aircraft captain

interesting to fundamentally overturn this situation, and I developed superlattice phase-change memory with crystal-to-crystal phase transition.

At that time, many people said it could never be done. I thought, who decided that it can never be done? It seemed to me that it had simply never been tried. I think focusing on areas being overlooked by everyone and creating something useful is the mission of researchers.

Never go against nature, just try to fool it.

— Where do you find inspiration?

I get ideas when I'm brushing my teeth in the bathroom every morning. The super-resolution technology I mentioned earlier came to me when I was in the bath. The initial inspiration came when I was bathing my daughter. Since I keep thinking about the issue until inspiration comes, it is more like a direction that emerges while I'm thinking rather than a flash of inspiration. I check the inspiration against various types of literature and theories, but in most cases it requires tricking nature. I learned this approach of "fooling nature" while I was studying in England.

The professor I was studying with specialized in metallurgical engineering and was researching metal fatigue in jet engines and airplane bodies. He used to say, "What technology needs to do is fool nature. If you make something that tries to conquer nature, nature will get even with you. Therefore, do not try to surpass or conquer nature. But if you can fool it, nature will be accepting."

This concept also applies to the entropy issue in my superlattice memory. Maxwell's demon lives there, and you must pay a heat energy tax to the demon whenever you use heat energy. That is nature's law. In other words, you cannot create a heat engine that has zero entropy (the law will not permit a perpetual motion machine). Therefore, we just have to cleverly fool Maxwell's demon.

Enchanted by the sound of jet engines

— What are your hobbies?

My hobby is flying radio-controlled airplanes. On weekends, I'm out doing that. I like airplanes' aerodynamic shapes, which conform to fluid dynamic principles.

At the university in England, I belonged to a group that was developing and researching turbine blades for Rolls-Royce jet engines. The ANA 787 uses a Rolls-Royce jet engine. When I travel on business, I try to fly ANA. The seats are equipped with noise-canceling earphones, but I never use them because I'm interested in jet engine sounds.

One time, a flight attendant came to my seat and said, "If you wear these, they will eliminate the noise and you'll be more comfortable." I said, "I was once involved in researching turbine blades. So I'm very interested in engine sounds, and I'm enjoying them because I can tell the engine is running normally." The attendant must have relayed this to the cockpit. When I was getting off the plane, I was handed an appreciative message from the captain. It said, "With a customer like you riding our plane, we can operate it with peace of mind."

The best time to enjoy airplane engine sounds from Narita Airport is when a south wind is blowing, and the best spot is Sakuranoyama Park in Narita. Since many flights come in between 2:30 and 3:00 PM, that time slot is really good. My favorite spot is the embankment located near Osaka International (Itami) Airport. Planes fly a mere 50 meters above your head. But riding in an airplane is the best. Rather than hearing it as noise, try to listen to it as art. (Laughter)

Japanese companies should forge ahead by merging phase-change and magnetic technologies

— Can phase-change memory and other types of memory coexist?

What we need to do from now on is combine phase-change memory with MRAM. Using a topological insulator, we can operate memory without using an ordinary magnetic material. We will also be able to freely control spin without using a magnetic material. What we need to do in phase change is separate the part of phase-change memory in which a topological insulator is used to control spin from the part of the memory that uses spin, and embed both of them inside a single device. That is the future I'm thinking about. There is no need to eliminate either of these technologies. We just need to proceed on the same path together. I think that will help Japanese companies grow. We need to avoid battles like the one that occurred in the past over optical discs!

Text of a lecture by Dr. Junji Tominaga (excerpted version) given on November 21, 2018
Special lecture "Next-generation Phase-change Memory" (hosted by ULVAC EQUIPMENT SALES, Inc.)

About topological insulators, which are considered very promising in view of an IoT and AI society based on big data

In phase-change memory, which is Dr. Tominaga's research area, it is safe to say that any point reached marks a new starting point. He is currently working on topological insulators for use in next-generation phase-change memory. What does this strange word "topology" mean? We will introduce the possibilities and application fields of topological insulators, to which the topology theory is applied.

The Nobel Prize in Physics 2016 was awarded to the following three people: Thouless, Haldane, and Kosterlitz. These three introduced the concept of topology, which is one of the geometric theories in mathematics, and discovered topological phase transitions in the basic characteristics of matter. While developing materials at the cutting edge of modern science in the 21st century, scientists all over the world are waging research battles in pursuit of great possibilities.

As part of this, research is underway on topological insulator materials, in which electricity flows on the surface despite the fact that no electricity flows inside.

Tominaga: In the fall of 2010, I had submitted a paper on superlattice energy-saving phase-change memory to a professional journal, and I was relieved that the paper had just been accepted. Because of the Great East Japan Earthquake of March 11, 2011, I could not conduct any experiments for three or four months, so I spent most of my time reading technical papers. One paper said that Sb_2Te_3, which I was working with, is a topological insulator. While I was reading technical papers, the expression "time-reversal symmetry" caught my attention.

So I decided to apply a magnetic field. When I brought a magnet close to an ordinary ternary alloy, nothing happened. But when I brought a magnet close to the superlattice stacked film I had developed, its threshold voltage jumped from 0.8 to 2 V. When I removed the magnet, the threshold voltage returned to its original value. It was a weak magnet of around 0.1 Tesla, but I found that bringing this magnet close to the film changed its resistance value by two orders of magnitude. The change that occurs in MRAM is much smaller. Based on past experience, I had thought that phase change did not exhibit any magnetism. This experiment showed that destroying the time-reversal symmetry would cause some change.

In a topological insulator, the state of its electrons (wave function) is said to be "twisted," unlike in ordinary insulators. An unimaginable phenomenon was confirmed in which this twist prevented electricity from flowing inside the material while allowing it to flow only on its surface.

Tominaga: The $Ge_2Sb_2Te_5$ ternary alloy is an ordinary insulator since it does not have any twist. In other words, there are two faces inside the alloy. Part of it is an ordinary insulator while another part is different.

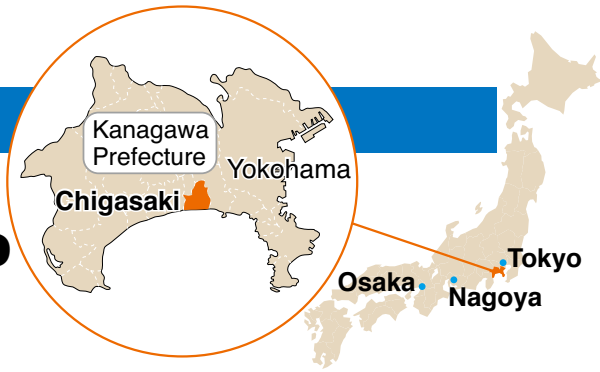
What about a superlattice? An ordinary topological insulator only has planar electrical conductivity. $(GeTe)_2$ is an ordinary insulator while Sb_2Te_3 is a topological insulator. When these two materials are repeatedly stacked, electricity will flow not only on the surfaces, but also on their interfaces. Since increasing the number of layers will proportionately increase the number of interfaces, we can extract more two-dimensional current and spin current. Furthermore, this can be accomplished at temperatures that are practical for manufacturing instead of at super-low temperatures. It works fine at 470K. I cannot go into detail due to lack of space, but the technical paper in which I published my research results was cited in other papers around 300 times in 2017. There is now global competition to create materials like this.

There are many kinds of memory, and the fastest types are CPU, SRAM, DRAM, etc. Below these, there are storage memory devices, such as optical discs and hard disks (HDs). In terms of processing speed, DRAM is faster than HD by three orders of magnitude. When handling big data, this difference will become a major problem. To solve this problem, storage class memory has emerged. It is phase-change memory.

The great potential of phase-change memory, to which topological insulator superlattices will be applied

- The next-generation phase-change memory will be a superlattice type and will be able to achieve significant energy savings.
- Phase-change memory is ideal for AI chips.
- It will become possible to carry out machine learning using big data and without using DRAM.
- Superlattice films using van der Waals bonding can also be made using sputtering.
- GeTe/SbTe superlattice film is a topological insulator.
- If topological characteristics can be manifested successfully, they can be applied to spin memory in the future.
- Advances in phase-change memory can be expected to be applied to fields beyond memory.

From Chigasaki to the World
Origin of **Technology Strategies** and **R&D**
—A corporation rooted in the local community



Head Office / Plant

◆ Our Head Office and Plant have grown together with the local community

ULVAC, Inc.'s Head Office and Plant are located in the middle of a residential area in Chigasaki City, Kanagawa Prefecture. The site area is approximately 48,000 square meters, and about 1,600 people work here, including ULVAC employees and employees of partnering companies. On clear days, it is easy to see Mt Fuji from the 6-story company building where we greet our customers.

At the Head Office/Plant, we primarily manufacture and conduct R&D on vacuum equipment and components for displays and semiconductors, as well as for medical/pharmaceutical applications and general industries. Because we deal with extremely large equipment, each work site is two stories high, and some work sites are clean rooms.

The "History River" corner, located on the 5th floor of the Head Office/Plant building, shows ULVAC's history.

The Head Office/Plant relocated to Chigasaki City in 1968. Back then, the area was mostly rural, except for a few small factories, and regular bus service was not available.

Mt Fuji and ULVAC TECHNO, Ltd. buildings are visible from the ULVAC Head Office.

Space Town Chigasaki

Chigasaki City has many associations with space. The astronaut Soichi Noguchi is from Chigasaki City. ULVAC's third president, Chikara Hayashi, served as the first leader of the Chigasaki Chapter of the Young Astronauts Club of Japan.

In addition, the Chigasaki Space Forum, a citizens' organization that is the successor to the Young Astronauts Club of Japan, receives funding and other support from Chigasaki City. Recently, ULVAC has been collaborating with the Forum by hosting vacuum experiments and factory tours for children as part of the regularly scheduled Chigasaki Space Classroom. We conduct experiments that are fun for both children and adults, such as inflating marshmallows, boiling water, demonstrating vacuum deposition, shooting a vacuum cannon, and making aerated chocolate.

▲ A vacuum cannon experiment in which a ping-pong ball, shot out at approximately 1,000 km/hr, pierced an aluminum can

◄ An experiment in which melted chocolate was fed into vacuum equipment to make aerated chocolate

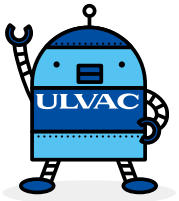
Rice Paddy Project utilizing fallow fields

In the Rice Paddy Project, which marked its tenth year in 2019, we borrow fallow fields within the city to grow rice, in order to provide environmental education to children and recreational activities for our employees. Our employees and their family members, along with members of local nonprofits and university students, try to do as much of the work manually as possible, from paddy plowing and rice transplanting to harvesting. We also hold a harvest festival in which all participants enjoy the harvested rice together.

▲► Rice transplanting and harvesting

ULVAC Global Festival (ULFes)

Every year, we hold the ULVAC Global Festival, an event to show our gratitude to all our stakeholders for their unwavering support. A variety of activities are offered, including the Gourmet Grand Prix and produce exhibit hosted by our group companies in Japan and overseas, stalls and exhibits, factory tours, vacuum experiments, and performances by brass bands and cheerleaders from local junior and senior high schools. We also invite children from nearby children's care facilities. The festival in FY2018 was a great success, with approximately 5,000 visitors attending.



▲ULVAC's mascot character Mr. ULVAC

▲ Big prize drawing

◄ Children loved the mascot characters!

Tsurumine Higashi District

On-site vacuum experiments at the Community Center

When the Community Center in the Tsurumine Higashi District of Chigasaki held a special commemorative event in honor of its fifteenth anniversary, we conducted on-site vacuum experiments. At the event venue, the multiple experiments we had prepared to demonstrate the vacuum principle brought forth exclamations of surprise from participants. We plan to continue holding events that will encourage children to develop an interest in science and vacuum technologies.

▲Magdeburg hemispheres demonstration

Chigasaki City beach clean-up activities

Twice a year, ULVAC, together with other local companies and community organizations, participates in clean-up activities at Chigasaki's Southern Beach. The activities help ensure that people using the beach will have a pleasant experience.

▲Beach cleanup with a view of Eboshi Rock

Nature in Sagami Bay and Satoyama, **Chigasaki City**

More than 50 years have passed since ULVAC's Head Office and Plant relocated to Chigasaki City.
Here, an illustrated map introduces Chigasaki City and the surrounding abundance of nature.

***This map was created with the help and guidance of Chigasaki City. (The photos were also provided by Chigasaki City.)**

❶ Chigasaki Southern C and Eboshi Rock, two symbols of Chigasaki

The Chigasaki Southern C, modeled after the first letter in the name Chigasaki, is located at Southern Beach Chigasaki, a swimming beach, and has been featured in many songs about the Shonan area. Eboshi Rock, named after the eboshi hat worn by nobles in the Heian period, is located offshore and has become a famous scenic attraction. The Shonan Festival and the Southern Beach Chigasaki Fireworks Display, two of the four largest festivals in Chigasaki, are also held at Southern Beach.

Chigasaki Southern C

Eboshi Rock

❷ Hamaori Festival, on the Chigasaki seashore, marks the arrival of summer

At dawn, approximately 40 mikoshis (portable shrines) from various shrines within the city are brought to the beach. With a type of shout unique to mikoshi carriers in the Sagami Domain, all the carriers make their mikoshis dance wildly across the beach in a joint Shinto ritual to pray for a good harvest. With its long history, this festival has been designated part of the intangible folk cultural heritage of Kanagawa Prefecture, and has also been selected as one of the fifty festivals representing Kanagawa.

Mikoshis descending onto the beach

❸ Raw young sardines, sheets of dried sardines, fishing, beach seining

Fresh young sardines are caught in the fishing grounds off Chigasaki in Shonan. After the young sardines have been rinsed in cold water so that they can be eaten raw, they are packed and shipped to be enjoyed the same day. The ocean around Chigasaki is ideal for all types of fishing, from surf fishing to fishing from onshore rocks or from boats. Ferries also operate at the fishing port, taking fishermen to Eboshi Rock. Beach seining, which is an old-fashioned fishing method, is currently being practiced by three fishing families.

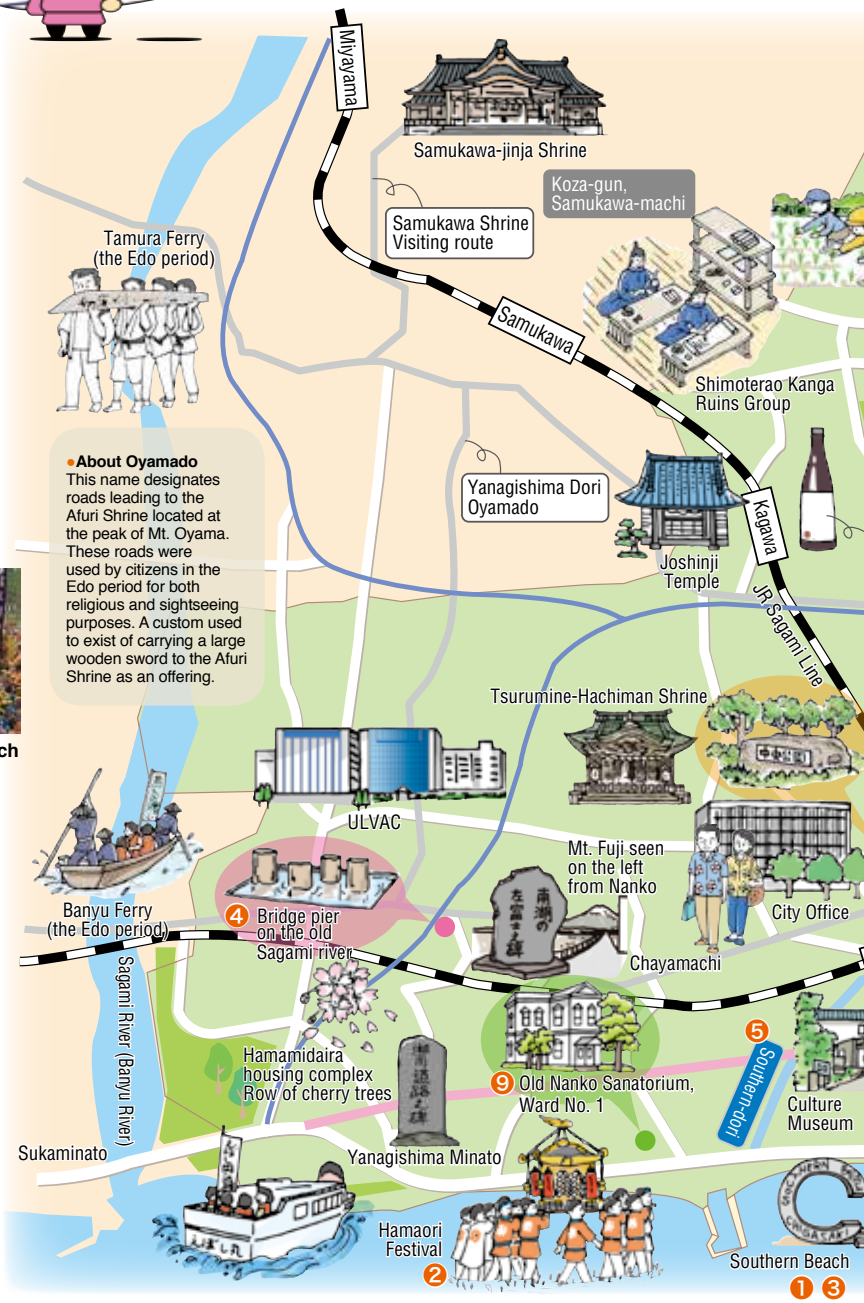
Raw young sardines are not always available for consumption, depending on the catch rate.

❹ Bridge pier from the old Sagami river, which appeared during the Great Kanto Earthquake

During the Great Kanto Earthquake of 1923, this bridge pier emerged from the middle of a rice paddy. The bridge is said to have been built in 1198 by Shigenari Saburo Inage, a senior vassal of Yoritomo Minamoto, for the repose of the soul of his wife. It has been designated a historic landmark and natural monument by the Japanese government.

The discovery of the pier indicates that the Sagami River once flowed through this area.

●Chigasaki's mascot characters Eboshimaro and Mina
Chigasaki City's original PR mascot characters
Eboshimaro: A boy about 9 years old who is a Chigasaki noble and always speaks in the style of a nobleman. Mina: A wave spirit who can create waves in the ocean.



❺ Interesting street names

●Teppo-michi● This road cuts through the eastern seashore in the east-west direction and was given this name (*Teppo* means cannon and *michi* means street) because samurai used it to transport cannons for practice on a cannon field built on the beach in the Edo period.

●Southern-dori● The road leading from the Chigasaki Station to Southern Beach has been nicknamed Southern-dori (*dori* means road) since 2000.

The Four Largest Festivals in Chigasaki
Ooka Echizen Festival: This is a spring festival held to honor the virtuous life of Ooka Echizen no Kami Tadasuke, a famous magistrate of the Edo period. (Saturday and Sunday in mid-April)
Shonan Festival: This festival includes a variety of events and features sports, food, and drink. (Saturday and Sunday in late April)
Hamaori Festival: People carrying mikoshi (portable shrines) dance wildly across a sandy beach, announcing the arrival of summer in Chigasaki. (Marine Day in July)
Fireworks display at Southern Beach Chigasaki : This festival lights up the night sky on the Chigasaki seashore. (Early August)

⑥ Ooka Echizen Festival and Ooka Echizen no Kami Tadasuke

Ooka Echizen no Kami Tadasuke, a famous magistrate of the Edo period who oversaw a place called Tsutsumi, possessed both excellent character and great insight. He gained the confidence of Shogun Yoshimune Tokugawa and served successively in important posts, including as town magistrate of Edo and as commissioner of temples and shrines. He left a great legacy as a judicial official. His many great deeds as a statesman and a man of culture are also well known. The Ooka clan's cemetery is located at the Jokenji Temple, and the Ooka Echizen Festival, held to honor Tadasuke's virtuous life, is a very popular spring festival.


Leading person in the Echizen Parade

●About the Tokaido road
Tokaido, which connects Edo with Kyoto, was the most important main roadway in the Edo period. Chigasaki is located on the Tokaido road between the two towns of Fujisawa and Hiratsuka, where travelers could lodge overnight. In those days, when the Sagami River would rise, travelers would stop at Chaya-machi, within Chigasaki, for lodging.

●Yuzo-dori●The home of Yuzo Kayama, a famous actor, used to be located near the Chigasaki coastline. This street was also called "Uehara Ken Dori" at one time, after Yuzo Kayama's father.
●Rachien-dori●Rachien-dori got its name from German trader Rudolph Rachien, who built a large vacation home on this street in 1932.

*Quoted from Sightseeing Hot Spots, Road Nickname Project, and Chigasaki City website (page introducing the Store Association)

⑦ Northern Chigasaki with its abundance of nature and the Koshikake Jinja Shrine

In northern Chigasaki, satoyama landscapes (woodlands between cities and nature where people and nature exist in harmony) are still vital. Koshikake Shrine, whose thriving trees have been designated a natural monument by the city, was given this name because it enshrines the Koshikake Boulder, said to have served as a place of rest for Yamato Takeru, a legendary prince of the Yamato dynasty, during his eastward expedition. The satoyama-like scenery at Chigasaki Prefectural Satoyama Park, located nearby, makes it a relaxing place for both children and adults.

⑧ Takasuna green space park and Kawakami Otojiro・Sadayakko

When you travel south (towards the ocean) from Chigasaki Station, you come to Takasuna green space park, rich in vegetation, in the middle of a quiet residential area. Another famous site in this area is a house known as Bansho-en. Bansho-en was the home of Otojiro and Sadayakko Kawakami, a popular actor and actress team from a nouveau school of drama popular at the turn of the twentieth century. Otojiro's song "Oppekepe" gained him much fame during the Meiji Era. Sadayakko, his wife, also appeared on stage regularly as Japan's first female actress.


The Plum Festival is held in February every year.


Otojiro and Sadayakko Kawakami (Photo owned by Mr. Shinichiro Kawakami)

⑨ Nankoin and Doppo Kunikida

As a former tuberculosis sanatorium, Nankoin contributed significantly to the development of Chigasaki City beginning in the Meiji period, and it had a major impact on the city's culture and history. Nankoin became well known throughout Japan when Doppo Kunikida, a famous author, was admitted there after being diagnosed with TB in 1908. He spent some time there fighting the disease.


Still-standing Ward No. 1 of the Old Sanatorium
(Part of the site is open to the public.)

●Farm Support Volunteer System

Chigasaki City also has a thriving farming community and a fishery. The purpose of the Farm Support Volunteer System is to promote farming and help address the labor shortage at farms within the city. The program also helps citizens improve their health, do something fulfilling in their free time, and gain a better understanding of agriculture.


Harvesting vegetables in autumn

●Summer is Aloha Wear time! Sister city agreement with Honolulu

Since Chigasaki City is on the waterfront and has a pleasant climate, many Hawaiian shops line its streets. To encourage people to wear Aloha shirts, the Chigasaki Aloha Committee proposed the Aloha Wear Campaign in 2003. One now sees city workers wearing Aloha shirts instead of business suits to work in summer. Chigasaki City also has a sister city agreement with Honolulu, Hawaii and there are many hula dance enthusiasts here. The city even hosted a Hula World Convention one year.


Working in Aloha shirts

ULVAC's **Benefactors ❶** **Without this person, ULVAC might have stopped existing.**

Dr. Yoshijiro Ishikawa, Founding President of ULVAC, Inc.

Impressive financial savvy in support of ULVAC during its startup period

ULVAC, Inc. owes its growth to a large number of benefactors. Yoshijiro Ishikawa is one such person. He was the first president of our company, but his presence was felt in a great many other ways. Without Yoshijiro's commitment, ULVAC might well have met an untimely end.

Tenth anniversary of ULVAC's founding (1962): from left, Jin Imachi, Yoshijiro, Kozo Ishikawa

Dr. Yoshijiro Ishikawa's Background

He was born in 1881 in Tokyo. At the age of 13, he was sent to apprentice at Tokyo Electric Light Company's Kanda power plant. There he encountered Dr. Ichisuke Fujioka, considered a pioneer in Japan's electrical engineering industry, and learned from him. Later Yoshijiro was posted to Shizuoka Electric Light, where he met Dr. Torajiro Ogi of Kyoto University. When he was 18, he joined Nagoya Electric Railway, through the introduction of Dr. Ogi, and in 1901, at age 20, he became a technician at Kyoto Electric Light company, run by Zenkichi Osawa (founder of the J. Osawa Group). Dr. Ogi and Mr. Osawa were lifelong mentors for Yoshijiro. Wishing to continue his studies while he worked, Yoshijio enrolled in the third year of Doshisha General School. In 1904, at age 23, he entered the Third Higher School; in 1907, at 26, he entered the Electrical Engineering department at Kyoto Imperial University. In 1910, at 29, he graduated and returned to Kyoto Electric Light company. There he worked on electricity supply, which had not made much progress. He joined a study tour to Europe and the U.S. in 1911 and 1919. In the U.S., he met with the great inventor Thomas Edison, and subsequently began to serve on the board of the Edison Foundation. He became Vice President of Kyoto Electric Light Company in 1941, and then President of Keifuku Electric Railroad. In 1952, he became founding President of ULVAC (then called Japan Vacuum Engineering Company). He served on the boards of many governmental agencies, organizations, and private corporations until his death at age 88 in 1969. He was decorated with a fifth rank award and later with the Order of the Sacred Treasure, fourth class, among other honors.

● Yoshijiro's financial savvy was the driving force behind ULVAC's founding

On behalf of ULVAC's founders, whom he represented, Yoshijiro Ishikawa approached key figures in industrial circles for investment funding. Those who were asked agreed to give 1 million yen with no conditions attached "because Mr. Ishikawa is starting a company." Moreover, they all added their names to the Board of Directors. One of them was Konosuke Matsushita (the founder of Panasonic Company).

At a time when ULVAC was just beginning its journey and had an uncertain future, the support of six major industrial figures, including Konosuke Matsushita, significantly increased the company's social credibility.

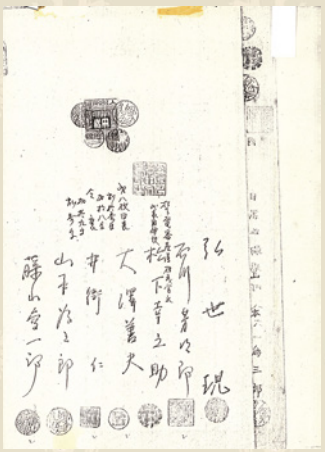
In 1968, fifteen years after its founding, ULVAC built a new headquarters and factory in Chigasaki. At the opening ceremony, Konosuke Matsushita, then Chairman of Matsushita Electric Industry (and also a Board member of our company), stated, "Fifteen years ago (in 1952), when I heard from Mr. Yoshijiro Ishikawa, the current Chairman, that vacuum technology was extremely important for our nation's industries, and that it was necessary to found this company to promote and develop this technology, I was in full agreement and became involved starting from the early days of ULVAC."

● Renowned industrialists supported ULVAC because, in their words, "Mr. Ishikawa is starting a company"

ULVAC was founded on August 23, 1952, as Japan Vacuum Engineering Company. As the name indicated, it was a company that advocated the use of "vacuum technology," which at the time was not commonly utilized in Japanese industry.

The impetus for founding the company came in a letter from Richard Morse, President of NRC Company, a U.S. vacuum equipment manufacturer. The letter was addressed to Jin Imachi, a laboratory researcher who had participated in conferences on vacuum technology (and who later became ULVAC's second President). Morse wrote, "I will willingly support you if you start a vacuum technology business." Colleagues whom Imachi had met at conferences also supported the company's founding. Still, Imachi decided to discuss his aspiration with his brother-in-law, Kozo Ishikawa. Kozo told him, "Founding a company on our own would be too difficult. Let's ask my father for advice." His father was Yoshijiro Ishikawa; in other words, Yoshijiro was Imachi's father-in-law.

Yoshijiro had been Vice President of Kyoto Electric Light, was President of Keifuku Electric Railroad at the time, and held many public positions. He was an engineer who had studied electrical engineering at Kyoto Imperial University. He showed a deep understanding of Imachi's and others'



Signature portion of ULVAC's official incorporation papers, where it was registered as "Japan Vacuum Engineering Company"

ambition to "contribute to Japanese industry through a vacuum company," and promised full-scale backing. He went on to garner the strong support of six leading industrialists.

This was how ULVAC was founded. Despite his advanced age of 71, Yoshijiro took on the position of President, and fulfilled his duties until ULVAC could stand on its own feet.

Yoshijiro's strong spirit led ULVAC to contribute to the vacuum technology industry

One of the colleagues whom Imachi invited was Chikara Hayashi, who can be called ULVAC's "forefather of research and development." On the occasion of the thirtieth anniversary of ULVAC's founding, he commented as follows.

"ULVAC is a very lucky company.

From the start, we had a conviction that vacuum technology would be valuable for the future of industry, and that society would certainly recognize this. But when and in what form this would come about was not something we could determine on our own.

In the initial stages, the world didn't acknowledge our technology. When I think of how we were able to survive our infancy, I can only say it must have been because of luck.

The major reason we have been able to continue for thirty years is because of our founding President Yoshijiro Ishikawa. He was capable of earning the trust of people like Mr. Matsushita, Mr. Gen Hirose (President of Nippon Life Insurance Company), Mr. Yoshio Osawa (Chairman of J. Osawa Group), and others of high social stature. By firming up our company's foundation so that we could receive that support, he played a major role."

Episodes that convey Yoshijiro's humanity

Yoshijiro left the management of ULVAC to Imachi and Kozo, and in general did not interfere. However, he fully backed the company by exerting efforts to seek not only funding, but also product orders from his broad social network.

In 1957, a major metals manufacturer sought to acquire the nation's first vacuum melting furnace, which Chikara Hayashi had developed. Yoshijiro went to the management leaders in person and said, "Won't you let us keep this technology, since we are a company specializing in vacuums?"

In another instance, in 1960, ULVAC failed to secure an order from a major metals manufacturer for a vacuum melting furnace. Yoshijiro promised, "I'll go and ask the president." He went directly to the top and was able to get the order.

There is a back story to this episode.

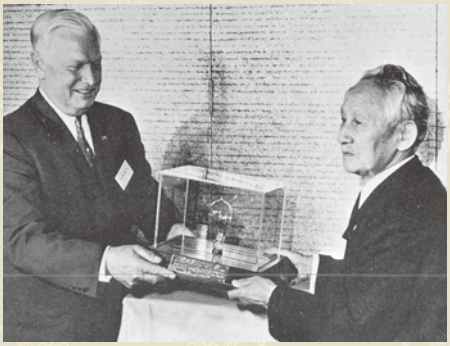
During that president's student days, his father hoped he would study economics at university. But the son wanted to study philosophy. The father sought Yoshijiro's advice.

His advice was, "Your son will eventually go into management. Management requires dealing with people, and philosophy will be very useful background for that. Why not let your son study what he wants?" The father allowed the son to study philosophy.

Such anecdotes show the warmth of Yoshijiro's character and his depth of feeling about the vacuum business.

ULVAC's company creed, established in 1966, was formulated by that era's corporate directors and strongly reflects

C. 1960, Yoshijiro's departure for the U.S. to negotiate with NRC Company. Behind Yoshijiro at the right is Chikara Hayashi.



1964: Presentation of Edison's incandescent light bulb from Edison Foundation Chairman Sisler

On the occasion of the founding of ULVAC's first joint venture company, Japan Reliance, the President of Reliance Electric and Engineering Company and his wife visited Konosuke Matsushita's residence at Yoshijiro's invitation (Yoshijiro is third from the right in the back row; Konosuke Matsushita is to his left).

Yoshijiro Ishikawa's business philosophy.

1. Our company's life is eternal.
2. Our company can thrive through its people and can face ruin through its people.
3. Our company pursues profit.
4. Our company is a public instrument.
5. Our company continues to exist solely because of our customers.
6. Our company values time.
7. Our company's business is the promotion of the comprehensive use of vacuum technology.

ULVAC's **Benefactors** ❷ **Without this company, ULVAC might not have been able to become a general vacuum system manufacturer.**

Mr. Tomotaro Tanabe, Fourth President of Toyo Seiki Co., Ltd.

Toyo Seiki Vacuum Research Corporation

Benefactors who opened the door for ULVAC to become a comprehensive manufacturer of vacuum equipment

Toyo Seiki's current Head Office (Amagasaki City, Hyogo Prefecture)

Former Toyo Seiki Head Office/Plant (Became ULVAC's Amagasaki Plant in 1956.)

As a comprehensive manufacturer of vacuum equipment, ULVAC, Inc. provides a wide range of products, including vacuum components and materials, vacuum pumps and gauges, and other equipment. However, ULVAC did not open the door to becoming a comprehensive manufacturer of vacuum equipment on its own. Rather, the door was opened by the merger with Toyo Seiki Vacuum Research Corporation in 1956.

ULVAC's business operations around 1957

The merger with Toyo Seiki Vacuum Research Corporation expanded ULVAC's product portfolio as follows:

- Equipment for vacuum chemistry (various types of vacuum distillation systems)
- Equipment for vacuum metallurgy
  - Vacuum melting furnace
  - Vacuum sintering furnace
  - Vacuum annealing furnace
  - Equipment for vacuum degassing casting
- Vacuum impregnation equipment
- Various types of exhausting equipment
- CRT continuous exhausting equipment
- Continuous exhausting and drying equipment for electric refrigerators
- Automatic exhausting platform for vacuum bottles
- Ultra-high vacuum exhausting equipment
- Vacuum evaporation equipment
- Vacuum molding machine
- Vacuum pumps and valves
- Vacuum gauges
- Various types of material for vacuum equipment

Imported:

- Products made by NRC (U.S.)
- Products made by Leibold (Germany)

● Toyo Seiki's 110-year history

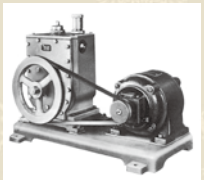
Toyo Seiki Co., Ltd. began as Matsumoto File Limited Partnership Company after acquiring Matsumoto File Manufacturing in Fukuoka in 1908. Its Vacuum Division was established in 1946.

Immediately after the end of World War II, the company became aware of the urgent need to manufacture vacuum equipment, and invited Prof. Seishi Kikuchi of Osaka University, Japan's leading nuclear physicist at the time, to head a research laboratory. Around this time, despite the postwar turbulence, many vacuum system manufacturers were getting started one after another, including Tokyo Vacuum Co., Ltd., Shinko Seiki Co., Ltd., and Kyowa Vacuum Engineering Co., Ltd. Through industrial-academic collaboration,Toyo Seiki manufactured sealed rotary vacuum pumps, vacuum dryers, and vacuum distillation systems. Additionally, as a pioneer in vacuum technology, the company contributed to the pharmaceutical, oil, and chemical industries, among others. For example, Toyo Seiki manufactured penicillin and blood serum, and refined vitamin A from whale liver oil.

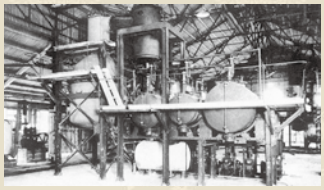
Then, in 1953, the company separated its vacuum division and established Toyo Seiki Vacuum Research Corporation.

Toyo Seiki is now a 110-year-old company that boasts high-level technologies and a long history in ultra high pressure air valves and non-ferrous metal precision die forging. Toyo Seiki's 80-year annals also mention the history of its merger with ULVAC: "In both name and substance, ULVAC is one of the world's leading manufacturers specializing in vacuum technology, and is well known internationally. Back in 1946, Dr. Ryotaro Mitsuda and President Tomotaro Tanabe sowed seeds by betting on the company's future, and the tree of their hope grew and blossomed and came to bear remarkable fruit."

Incidentally, the home/factory of Konosuke Matsushita, one ULVAC's investors, was located in Ohiraki, Fukushima Ward, Osaka where Toyo Seiki's Osaka Plant is located (it was Head Office at the time). It is said that Mr. Matsushita used to come regularly to the Head Office to borrow tools and jigs and hold technical consultations about pressing machines (starting around 1918).



Product made by Toyo Seiki Rotary-type vacuum pump "R-1" (Around 1948)

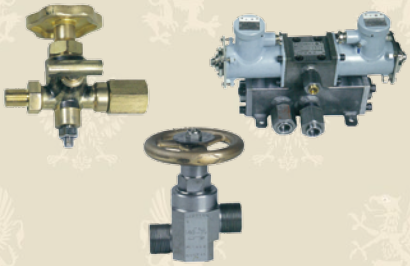


Product made by Toyo Seiki High-vacuum distillation equipment for plasticizers (Around 1949)

Product made by Toyo Seiki Molecular distillation equipment (Around 1948)

1,600-ton forging press


Large forged products made with a 1,600-ton press


High-pressure valves
(Stop valve for pressure gauge, stop valve for oil pressure, solenoid valve for oil pressure)

● The merger with ULVAC was achieved thanks to a bold decision by Mr. Tanabe, President of Toyo Seiki

The following historical account of the merger with Toyo Seiki has been excerpted from ULVAC's 50-Year annals, "A Life Dedicated to Vacuum III," published in 2002.

In November 1956, ULVAC merged with Toyo Seiki Vacuum Research Corporation (capitalized at 5 million yen), located in Amagasaki City, Hyogo Prefecture. This merger turned out to have a significant impact on the development of a nascent company (ULVAC) and Japan's vacuum industry.

For ULVAC, vacuum technology represented a promising business and we were convinced it would come to be seen as a cutting-edge technology essential to industries that were becoming more and more advanced. However, the reality was that Japanese companies were locked in price wars in an extremely small and limited market. That is, instead of competing based on technology, they were competing in a completely futile way that only drained each company's corporate strength. Our company's management staff had misgivings: "Even though the vacuum industry has a promising future, its current state is inhibiting development and there is no possibility for us to make a difference for industries in Japan."

Tomotaro Tanabe, President of Toyo Seiki Co., Ltd., who was managing Toyo Seiki Vacuum Research Corporation (founded in 1908) in Kansai, was one of the people who felt these misgivings. Toyo Seiki Vacuum Research Corporation was established in 1953 by making independent the Vacuum Division established by Toyo Seiki in 1946. Prof. Seishi Kikuchi of Osaka University, who had been focusing on the development of the vacuum industry through academic-industrial collaboration with Toyo Seiki, also shared the misgivings.

Prof. Kikuchi had been a classmate of Ryokichi Sagane and Hiroo Kumagai, both technical advisors to the company, at Tokyo Imperial University. Negotiations over the merger between ULVAC and Toyo Seiki Vacuum Research Corporation concluded in April 1956 against this background, and the merged company formally started work that November.

Despite the fact that the new, merged company had started later than other companies in the industry, it was given the name Japan Vacuum Engineering Co., Ltd. (the company name at the time of ULVAC's founding). Its combined capital was 23 million yen, and all 46 employees of Toyo Seiki Vacuum Research Corporation were transferred to the new company. As a result, the total number of employees almost doubled, from 56 to 102.

The former Head Office of Toyo Seiki Vacuum Research Corporation in Amagasaki became our company's Amagasaki Plant (Plant Director: Seiki Kobayashi). In terms of operation, it took over the manufacture of vacuum freeze-drying equipment that our company had developed, as well as equipment for vacuum chemistry, vacuum valves, pumps, and so on. President Tomotaro Tanabe joined Japan Vacuum Engineering Co., Ltd. as a director, and Prof. Seishi Kikuchi decided to continue as technical advisor, along with Eizaburo Nishibori, Ryokishi Sagane, and Hiroo Kumagai.

For FY1956, the new company reported sales revenues of 165 million yen. The merger did not expand our company in size only. The percentage of internally produced parts, i.e., the domestic production rate, increased to 93%. Backed by the new power created by combining the two companies' technologies, we began to establish a structure for taking on the major mission of "contributing to industries."

● Inheriting corporate culture was important to ULVAC even after the merger

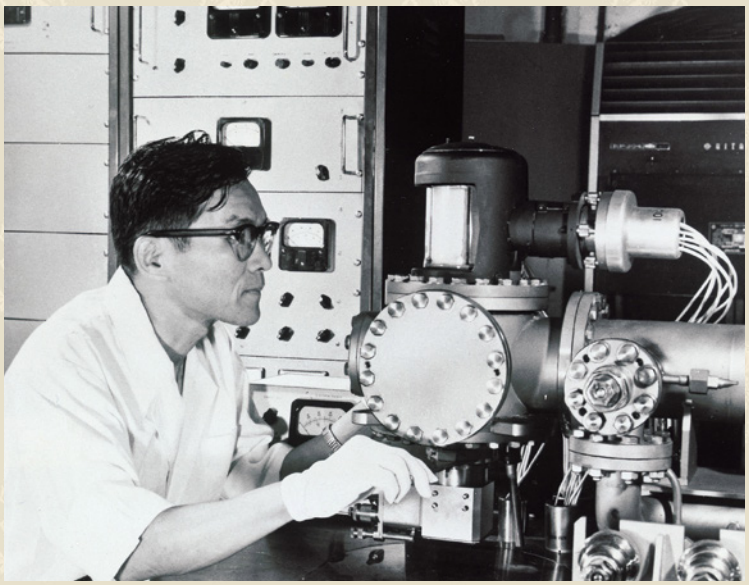
In 1963, ULVAC's Yokohama (Idogaya) Head Office/Plant, which had been partially seized by the U.S. Military, was completely released, and the Amagasaki Plant was consolidated into the Yokohama Head Office/Plant.

Later, in 1988, Kyushu Vacuum Technology was established in the Kagoshima Industrial Park in Kyushu, and the pump-manufacturing expertise nurtured at the Amagasaki Plant was transferred there and has been inherited by present-day ULVAC KYUSHU. A plant that was a subcontractor of the Amagasaki Plant became the present-day Osaka CS Center of ULVAC TECHNO and continues to exist near Toyo Seiki to this day.

Although Toyo Seiki and ULVAC have been proceeding on separate paths, both companies continue to have confidence in their technologies and adhere to their founding philosophies. For ULVAC, which is aiming to become a 100-year-old company, it is important to continue cherishing this DNA.

Dr. Chikara Hayashi, Third President of ULVAC, Inc.

A father of vacuum technology who contributely immensely to Japanese industries



Low-energy electron diffraction (LEED) system and Chikara Hayashi

Our company's third president, Chikara Hayashi, is truly at the heart of ULVAC's identity. His determination to enrich the world with vacuum technology and his engineering DNA are still traits our researchers embody and cultivate. Hayashi achieved many breakthroughs for technology and industry. He was world-renowned as a scholar and collaborated closely with scientists from around the world.

Dr. Chikara Hayashi's background

He was born in Tokyo, but because of his father's occupation, he lived in Taiwan from elementary school through high school. In 1942, he entered the Physics Department (Science Faculty) of Tokyo Imperial University. In 1944, he was assigned as a naval officer to Toyokawa Naval Arsenal in Aichi Prefecture. After the war, he joined a major optical product manufacturer. However, he quit after three days when he saw that his dormmates spent all their time complaining and gossiping. He felt he had not survived the war in order to spend the rest of his life with people like that, that doing so would dishonor his fallen comrades. In 1945, he became a researcher in the Physics Department (Science Faculty) of Tokyo University. When Hayashi was working as a researcher, Hitoshi Imachi of Toshiba Matsuda Research Laboratories (who later became the second president of ULVAC) asked him to join in an effort to start a vacuum company that would contribute to industry and help vacuum technology take root in Japan. Hayashi accepted and participated in the founding of Japan Vacuum Engineering Co., Ltd. He later became the third president of ULVAC, serving in this role from 1971 to 1986. In 1981, Hayashi also served as General Manager of the Hayashi Ultrafine Particles Project, started by the Research Development Corporation of Japan (which later became the Japan Science and Technology Agency (JST)). Since university professors were being selected to head most other projects at that time, it was quite unusual for the president of a private corporation to be chosen.

● Infinite possibilities for vacuum technology

"There will be three stages in the development of vacuum technology. The first stage was the era of learning to create a vacuum. The next stage is the age of vacuum applications (utilization). And the third stage will be the age in which humans fly into space in a capsule and conduct experiments in an infinitely expansive vacuum environment."

This is what Chikara Hayashi wrote around 1960 when he was asked by a magazine about the development of vacuum technology.

Vacuum technology around 1952, when ULVAC was established, was in its dawning period, between the creation of vacuum and its utilization. What kind of person was Chikara Hayashi, who had such a grand vision for vacuum technology?

● A committed researcher and a university startup

Chikara Hayashi, who has spent many years of his life immersed in research, said that he used to be very bad at physics, especially in junior high school. It was not because he lacked intelligence. Rather, because he was very bright, he kept moving from physics into a more philosophical realm, and asking questions such as, "Why is there gravity?" and "Why is there light?" In high school, he said, he read all the philosophy books he could find.

After the war, Hayashi studied nuclear physics in the Sagane Laboratory at Tokyo University, but not because he planned to become a scholar. Hayashi's standard for judging whether something was of value was whether it was interesting, regardless of the prestige of universities or companies.

When he was 29 years old, Hayashi was asked to join in the founding of Japan Vacuum Engineering Co., Ltd. (present-day ULVAC). The company began with only 10 people, mostly researchers, and was an early version of a university startup. While scholars often manage companies in the U.S., this type of scenario was extremely rare in Japan.

For the first 15 years, the company essentially continued to be in the red. Companies that excel in research often run into financial trouble. The company survived despite these odds, thanks in part to the hard work of its employees but especially because of the support of its founding members, including Konosuke Matsushita (Panasonic Corporation founder). Every time the company was close to running out of funds, it asked for an increase in capital and used that money to pay small dividends, managing to limp along by repeating this strategy.

● A sense of mission to enrich the world through vacuum technology

Hayashi, who had a physics background, was extremely good at pursuing what he

instinctively felt was important, but he tended to think that he "had to" investigate it in great depth. However, the world's economy does not run on a 20- or 25-year cycle, which is how long it usually takes for research to bear fruit. If a company does not make new things and create new markets, it will not become a major corporation or make much money. Even so, those involved in developing vacuum technology in Japan at that time tended to focus more on research, which was what gave their lives meaning.

Founding members such as Konosuke Matsushita and Gen Hirose (President of Nippon Life Insurance Company) sometimes used to give advice to Hayashi, who tended to put R&D ahead of business opportunities. Later, Hayashi said the following in his biography:

"Although my position within the company had been rising, I was doing my work out of a sense of mission. I wanted to use vacuum technology to help rebuild Japan's economy and industries. I had a sense of mission that I had to do it for the sake of the Japanese people." ("Benefactors of Japan's Vacuum Technology" Hakujitsusha, page 217)

Chikara Hayashi, Space, and Vacuum

Hayashi had a strong sense of duty, was honest, had associated with people in many fields, and took good care of his employees. He also had a global viewpoint. As president, he often told his employees to be sure to make friends if they went overseas.

Hayashi had also met the astronaut Mamoru Mohri. Since they had both been members of the Vacuum Society of Japan, they had stayed in contact with each other, and an exchange between them was featured in the "Opening Conversation" of the 1993 issue of our company's PR magazine. Mohri, who worked at the High Vacuum Laboratory of Hokkaido University before becoming an astronaut, must have hit it off with Hayashi, who had studied vacuum in a university laboratory.

Furthermore, in Chigasaki City, Kanagawa Prefecture where ULVAC's Head Office/Plant is located, Hayashi served as the first leader of the Chigasaki Chapter of the Young Astronauts Club of Japan. Since astronaut Soichi Noguchi is from Chigasaki City, the Chigasaki Chapter and Chigasaki City together still host a variety of activities to promote "Space City Chigasaki" to a worldwide audience and help people become more familiar with space exploration.

Soon after the establishment of the Chigasaki Chapter, an incident occurred that showed how well connected and popular Hayashi was.

A group of children led by Chikara Hayashi as chapter leader went to tour NASDA (present-day JAXA) in Tsukuba, Japan. Although the children had been told beforehand that Mr. Mohri was too busy to meet them, they spotted him walking on the campus, and Hayashi negotiated with the Office to see if Mr. Mohri might be able to meet with the children very briefly. Mr. Mohri immediately responded, "If it's just for 10 minutes, I can meet with them." The children were overjoyed by this unexpected turn of events.

Hayashi Vacuum Innovation Fund and the Spirit of our Heritage

Hayashi stuck to the principle of never compromising in R&D and never approving anything incorrect, but at the same time he freely provided support to aspiring researchers. He personally made a donation to the Production Technology Research Laboratory of Tokyo University, where he had studied, and the money is being managed as the Hayashi Vacuum Innovation Fund. The main operations of the Fund are as follows: (1) holding exhibits related to vacuum technology, (2) organizing international conferences related to vacuum technology, and (3) supporting students from Southeast Asia. Regarding (3), Hayashi requested that the students be taught engineering at corporations, in addition to being taught science at the university. Therefore, ULVAC has taken on this responsibility and now accepts interns from overseas. The goal of these internships is to educate young people in vacuum technology and encourage them to be at the forefront of next-generation science and technology.

Hayashi's determinations to let his sense of mission guide his work, to "be useful to society," and to nurture his creative DNA focused on innovative research are at the very roots of ULVAC. Our researchers continue to embrace these strategies nearly 70 years after the company's founding.

Mr. Mohri is in the center of the front row, and Chikara Hayashi is on the far left.

In the 1980s, during a general shareholder's meeting, President Hayashi (right) verbally expressed appreciation to Konosuke Matsushita (left, founder of Panasonic Corporation), who was a founding member and outside director of ULVAC.

Service Business

ULVAC TECHNO, Ltd.

Head office: 2609-5 Hagisono, Chigasaki, Kanagawa, Japan 253-8555
Website: https://www.ulvac-techno.co.jp/
Main businesses: Servicing; equipment sales; sale and purchase of used vacuum equipment; cleaning internal jigs; sales of vacuum materials, parts, and consumables, etc.
Subsidiary: ULVAC Human Relations, Ltd. (Chigasaki, Kanagawa)

Head Office

Providing a wide range of services and solutions with a customer-first policy

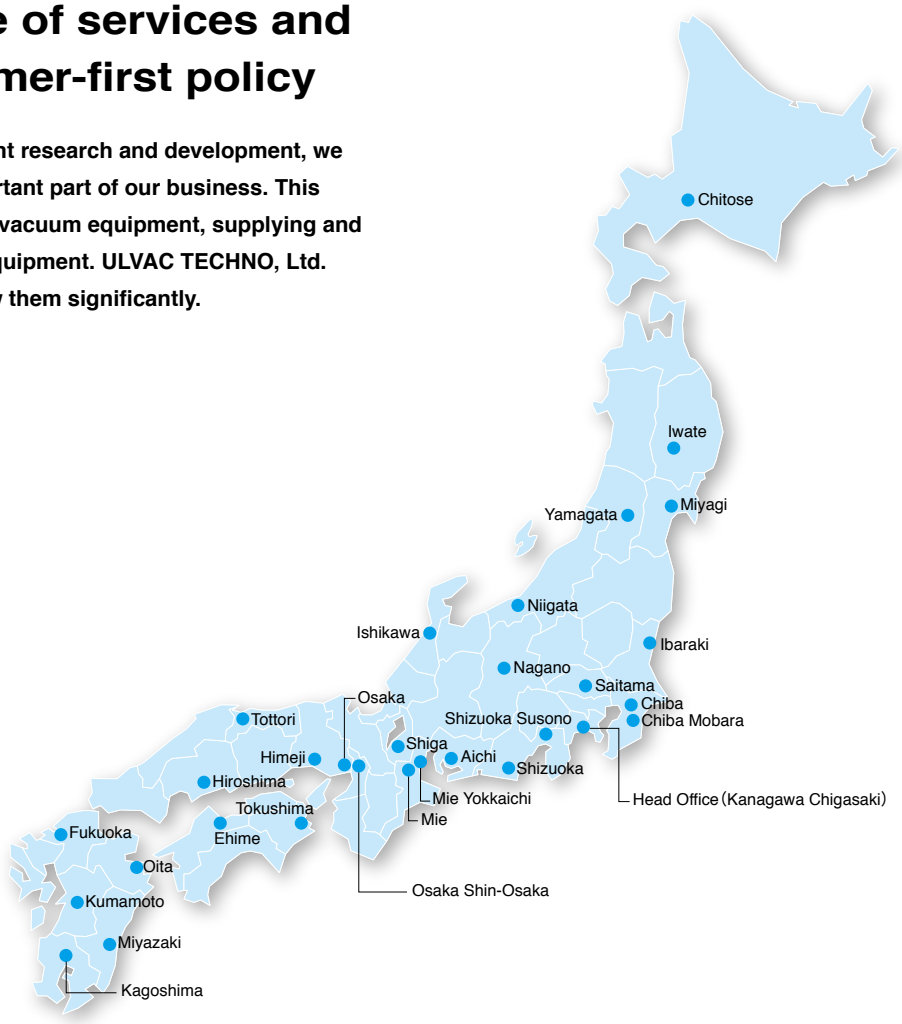
Although ULVAC focuses on vacuum equipment research and development, we also consider customer support to be an important part of our business. This includes servicing and overall maintenance of vacuum equipment, supplying and cleaning materials and parts, and improving equipment. ULVAC TECHNO, Ltd. inherited ULVAC's service operations and grew them significantly.

ULVAC TECHNO, Ltd., which grew from ULVAC's Service Department

ULVAC TECHNO, Ltd. was established under the company name "ULVAC Service Co., Ltd." on January 1, 1979 by splitting off ULVAC's Service Department, with the goal of providing maintenance services for ULVAC-made vacuum equipment. In 2019, the company marked its 40th year.

At its founding, it was the first time a Japanese vacuum equipment manufacturer had split off its Service Department. The main reason for making the Service Department independent was to provide comprehensive service for vacuum equipment being used in daily production activities, and to locate these service operations as close as possible to users. In other words, the manufacturer (ULVAC) focuses on developing and manufacturing equipment that is beneficial to customers, while the service company (ULVAC TECHNO) focuses fully on supporting service customers' production activities. In this way, the customer-first policy is thoroughly implemented.

The criterion for making the division independent was a need to bridge the major differences between a manufacturer and a service company, as described below.



Geographical factors
Manufacturers: Even remote locations are OK if they are convenient for production.
Service: Treat customer convenience as a matter of highest priority.

Organization
Manufacturers: Many departments need to collaborate.
Service: Greatly depends on an individual's work.

Capabilities
Manufacturers: Must have a positive attitude toward technology development.
Service: Experience-based skills and kindness are important.

Evaluation
Manufacturers: Products are evaluated by customers.
Service: Individuals (service technicians) are evaluated by customers.

Work hours
Manufacturers: Holiday work hours may be decided based on the technical capability for automation and mass production.
Service: As a rule, service is provided around-the-clock, but during equipment downtime so as to avoid interfering with customer production.

In this way, ULVAC TECHNO continues to pursue a business model based on an understanding of these differences.

ULVAC TECHNO NOW ● Current State and Outlook

Aiming to build a new customer service structure capable of supporting a next-generation, information-oriented society

ULVAC TECHNO, Ltd.
Kyuya Kobayashi, President and CEO

In January 2019, our company marked its 40th anniversary. For the entire past forty years, under a "Customer-first" policy, our company has been providing comprehensive customer service related to vacuum equipment in the semiconductor, electronic, FPD, medical, and food industries, among others.

At the time of this major milestone, the arrival of an advanced information-oriented society, represented by such technologies as IoT, AI, and 5G, is about to significantly change people's lives and industries on a global scale. We have taken up this change as a major theme in our company, and we are aiming to build a next-generation service structure, described below. We will design the new service structure to be attractive and beneficial to customers, through a reassessment of conventional customer service together with our parent company ULVAC.

1. We wish to open a global call center to solve the problems of users all over the world, using tools such as an FAQ system currently under development (supporting four languages).
2. We are already providing a real-time information service called "Resale-connect," which includes abundant information on used equipment.
3. We are also preparing other globally-oriented services, such as a Quote Support System, Smart Glass, and Remote Diagnosis.

As described above, we are aiming to further advance the maintenance business our company has nurtured over many years, so as to continue to provide high-value-added service to our customers.

Setup closest to customers and customer-first policy

In the 1970s, most service operations involved replacing equipment that broke down. However, this was also the time when attitudes about service were beginning to go beyond mere repair and shift toward preventive service (maintenance) that would support users' production plans.

Against this backdrop, ULVAC set up the Service Section in the Equipment Manufacturing Division in 1971, and in 1974 began to develop it into a dedicated Service Department. The reason why the service operation expanded from a section within the Equipment Manufacturing Division to a separate department was that the significance of customer support had begun to be recognized, as explained above.

Then, in 1979, ULVAC TECHNO was established under the name ULVAC SERVICE.

The 1980s was the decade in which the Japanese semiconductor industry blossomed and achieved world preeminence. In semiconductor manufacturing, around-the-clock operation is the norm. Therefore, a breakdown in vacuum equipment can be fatal to production activities.

ULVAC TECHNO, which had just been established, learned to cope with such situations quickly. The company located service offices near semiconductor manufacturing plants and handled regular maintenance operations.

This service office expansion began in earnest in the mid-1980s, with the company establishing service offices near semiconductor manufacturing plants throughout Japan, including in Kyushu, Chugoku, Shikoku, Kinki, Chubu, Hokuriku, Joshinetsu, Kanto, and Tohoku. 16 offices opened in 10 years.

Conducting a wide-ranging solution business

Starting in the mid-1990s, the content of the service business began to change. In addition to simple maintenance of vacuum equipment, users began to demand service quality improvements and consistent service menu enhancement.

In 1994, ULVAC TECHNO absorbed another ULVAC Group company and began selling vacuum materials. With the addition of material sales to the business menu, which had previously included maintenance operations and sales of consumable parts, the company changed its name from ULVAC SERVICE to the present-day name ULVAC TECHNO.

Taking this as an opportunity, the company began improving its service quality and consistently enhancing its service menu. In other words, it began to develop a broad range of solution services one after another. As a result, ULVAC TECHNO now supports customers with the following operations:

Overview of our solution business

- Calibration and repair of measurement instruments used in vacuum equipment
- Smooth resolution of vacuum pump problems
- Submission of proposals to improve semiconductor and FPD manufacturing equipment
- Improvement of vacuum equipment used in general industries
- Sales of vacuum equipment parts and vacuum materials
- Purchase and sales of used equipment
- Refurbishing and cleaning vacuum equipment parts
- Providing surface treatment, focusing on alumite
- Dispatching resident service engineers
- Providing maintenance service support to group companies overseas

Mask Blank Business

ULVAC COATING CORPORATION

Head Office/Plant: 2804 Terao, Chichibu, Saitama, Japan 368-0056
Website: http://www.ulcoat.co.jp/
Main businesses: Hard mask blanks for semiconductors, large mask blanks for FPDs, glass MEMS, etc.
Subsidiaries: FINE SURFACE TECHNOLOGY CO., LTD. (Chichibu, Saitama), ULCOAT TAIWAN, Inc. (Taiwan), ULVAC Coating Technology (HEFEI) Co., Ltd. (China)

ULVAC COATING CORPORATION
FINE SURFACE TECHNOLOGY CO., LTD.

ULCOAT TAIWAN, Inc.

ULVAC Coating Technology (HEFEI) Co., Ltd.
(Architectural illustration)

World's First Hard Mask Blanks, Contributing to Semiconductor and Electronics Industries Worldwide

Mask blanks are essential materials to manufacture semiconductor integrated circuits (ICs). Without mask blanks, it would not be possible to enhance the functions of information devices such as computers, smartphones, automobiles, home appliances, and medical equipment. ULVAC developed mask blanks and commercialized them utilizing its vacuum thin-film technology for the first time in the world. ULVAC COATING CORPORATION has taken over the business and has been supplying mask blanks to users all over the world.

Materials development using ULVAC's own vacuum equipment at the origin of mask blanks

It was the latter half of the 1960s. ULVAC was developing materials by utilizing vacuum equipment it had fabricated internally. Chikara Hayashi, who was Vice President at that time, encouraged these efforts and provided instruction in support of them.

One material created was a hybrid thin film made of chromium cermet (a type of chromium oxide compound metallic material), which was being applied to sunglasses to block direct sunlight. While the engineers were wondering in what other applications the material's characteristics could be utilized, it was left forgotten in the corner of an exhibit room, without ever having reached the commercialization stage.

Then one day, a chance occurrence changed the course of events. A manager from a major electric appliance manufacturer happened to notice the sunglasses and said, "Since this chromium film blocks UV light, it might be usable in masks for making ICs." This comment piqued the curiosity of the engineers involved.

Right away, our company's engineers began to investigate the status of the masks being used for ICs. They found that an emulsion method based on photographic plates was being utilized to manufacture them.

■ **Through its products, the ULVAC COATING Business Unit is contributing to cutting-edge fields worldwide.**

ULVAC COATING NOW ● Current Status and Outlook

Supporting Customers with a High-quality, Global-scale with Stable Supply System.

ULVAC COATING CORPORATION
Yoshinori Kida, President and CEO

This year marks the 40th anniversary of our company, which was established on the same day as ULVAC TECHNO, Ltd., another company within the ULVAC group. Both companies were split off from the parent company, ULVAC. Since its establishment, our company had been operating with the goal of manufacturing mask blanks for semiconductor ICs. In 2000, we also began manufacturing mask blanks for FPDs. Our product currently commands a market share as high as 50% in that sector.

With the recent emergence of the next-generation advanced information-oriented society, represented by such things as IoT, AI, and 5G, mask blanks for semiconductors and FPDs are becoming increasingly important.

Our company is committed to supporting customers with a high-quality, global-scale, stable supply structure. We will accomplish this by working with ULCOAT TAIWAN, Inc., established in Taiwan in 2002, and ULVAC Coating Technology (HEFEI) Co., Ltd., established in China in May 2018 with production planned to start in spring 2020. Together, we will manage the entire series of processes critical to mask blank manufacturing, from polishing, cleaning, and film deposition to resist coating.

In mask blank manufacturing, increases in FPD resolution and levels of integration in semiconductor ICs are driving us to develop products that will meet anticipated market needs. Against this backdrop, our company is strengthening its collaboration with its parent company ULVAC, which makes vacuum equipment, in order to become a comprehensive mask blank manufacturer.

Development of world's first mask blanks and rollout to the global market

Advances in semiconductor ICs would not have been possible without the miniaturization of circuit patterns using photolithography processes. Photomask technology plays a central role in photolithography. And mask blanks are the basis for photomasks. As the name implies, mask blanks are blanks before circuit patterns have been created. They are currently used not only in semiconductor ICs, but also in flat panel displays (FPDs).

Mask blanks can be classified into two types according to the material used: hard masks and emulsion masks. In the late 1960s, hard masks had not yet been commercialized, and emulsion masks were the mainstream. Emulsion masks were made by coating a glass substrate with silver halide emulsion, used in photographic plates. The problem with emulsion masks was that since their coating surfaces were not transparent, they were not suitable for aligning multiple layers. As devices were becoming more highly integrated, users were demanding mask blanks that could be more accurately aligned.

The conclusion that ULVAC reached was as follows: "Since the light source used in the IC manufacturing process is UV light, visible light will not cause any problems no matter how much of it is allowed to pass through the mask blanks. In other words, if films can be created that allow visible light to pass but not UV light, they can be aligned by the operator while the masks are being checked visually. By using the chromium film we recently developed, we can create mask blanks that sufficiently compensate for the shortcomings of the emulsion blanks."

In 1970, we successfully developed hard mask blanks based on chromium film. These were initially named "ST masks" and represented an unprecedented, spectacular achievement. ST stood for "see-through," indicating the characteristic of chromium film that blocked UV light, but allowed visible light to pass.

ULVAC SI Division split off to form independent ULVAC COATING CORPORATION

In 1971, ULVAC established its SI Department to focus on manufacture and sales of ST masks. The following year, the department was upgraded to the SI Division. Incidentally, SI here stood for Surface Instruments. It was given that name with the intention of utilizing vacuum equipment to create a variety of thin films and make a profitable business from them.

ST masks (hard mask blanks) became so popular that our company was receiving requests for quotes from Japanese semiconductor manufacturers as well as from the U.S., which was considered the home of the semiconductor industry.

Around that time, ULVAC's internal newsletter "Vacuum Times" included the following write-up:

"It has been a year and a half since the SI Division began manufacturing and selling the world's only chromium oxide mask, and the product has become popular not only in Japan but also all over the world. Requests for quotes are beginning to come in from the U.S., the home of the electronics industry, and there are great expectations for purchasing agreements to be signed in the future."

ULVAC's mask business began to grow almost too quickly, aided by the rapid market expansion of the electronics industry occurring at that time, which centered around semiconductor devices.

In early April of 1978, the proposal to make the SI Division independent was approved. A decision was made to place the new company's head office at its current location (2804 Terao, Chichibu). That October, the name "ULVAC COATING CORPORATION" was selected, and the SI Division formally split off on January 1, 1979.

ULVAC COATING later established a local subsidiary in Taiwan. It is currently planning to establish another local subsidiary in China to manufacture mask blanks.

Developing the technologies needed for a smart society: ULVAC announced its PZT piezoelectric thin-film sputtering technology for next-generation MEMS sensors/actuators, and began selling systems for use in mass production.

— ULVAC, Inc.

Sputtering system SME-200

In July 2019, ULVAC, Inc. announced its proprietary PZT piezoelectric thin-film mass-production technology, based on a low-temperature sputtering process the company had been developing as a contribution to next-generation MEMS technology. ULVAC has begun selling systems for use in mass production.

PZT piezoelectric thin-film mass-production technology is crucial to the fabrication of micromirror devices (optical devices) for use in VR, AR, and MR systems, as well as in LIDAR devices, all of which support a smart society. Vast improvements in reliability have made device commercialization possible, and by optimizing equipment operation, we have reduced running costs. We have now begun selling systems that incorporate the world's most advanced mass-production technology.

This technology makes it possible to reduce the size and power consumption of MEMS devices, improve their performance, decrease their production cost, and integrate them with semiconductors (CMOS). This integration is expected to expand the potential for use of MEMs devices in sensors and actuators used in spacial information sensing and 3D image displays.

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ULVAC-Osaka University Joint Research Laboratory for Future Technology opened on the Osaka University campus

— ULVAC, Inc.

On November 1, 2018, ULVAC, Inc. and the Graduate School of Engineering at Osaka University established the ULVAC-Osaka University Joint Research Laboratory for Future Technology (hereafter referred to as the "Joint Research Laboratory") in the Central Terrace Building of the University's Suita Campus.

Through Osaka University's industry-academia collaboration framework, the Joint Research Laboratory aims to 1) promote mutual exchange among researchers and build an R&D network, 2) contribute to scientific advancement and the resolution of technical issues in the medical engineering field, and 3) develop highly creative university human resources. By positioning the Joint Research Laboratory as a key location for conducting basic research, ULVAC aims to employ its own in-house technologies to create new value, which include applications for next-generation FPDs, creation of semiconductor quantum dots for use in artificial photosynthesis, and ultra-high-speed freeze-drying technology for medical applications such as cell preservation.

Central Terrace Building at the Suita Campus of Osaka University

Research themes

(1) Development of cryogenic regenerator material using rare earth nitrides
(2) Development of alloy powders with controlled anisotropy and material
(3) Establishment of a cell preservation method that uses ultra high-speed freeze drying technology

Research organization

Director: Prof. Takao Yamamoto (Osaka University, Graduate School of Engineering)
Assistant Director: Dr. Hirohiko Murakami (General Manager and Senior Fellow of ULVAC's Future Technology Research Laboratory)
Eleven people total: the two listed above along with instructors and researchers (including part-time staff)

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In appreciation of Chigasaki: ULVAC Global Festival 2018

— ULVAC, Inc.

On Saturday, November 10, 2018, ULVAC Global Festival (ULFes) 2018 was held for the second year in a row at the ULVAC, Inc. Head Office/Plant. It is becoming an annual event.

Since 2018 marked the 50th anniversary of the 1968 completion of the Chigasaki Plant, "In appreciation of Chigasaki" was selected as the theme of this ULFes. Executive committee members, consisting mostly of new employees, were put in charge of planning and operation, and their youthful energy and creative ideas made ULFes a lively event slightly different in style from the previous year. Activities included the Gourmet Grand Prix skillfully hosted by ULVAC group companies, performances and stage events by local junior and senior high school students, factory tours, vacuum experiments, and a giant raffle, all of which were very popular with both children and adults.

It was a warm, sunny autumn day and approximately 5,000 visitors attended. The festival went very smoothly, thanks to the generous support and collaboration of all participants and sponsoring organizations.

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People enjoying the festival

Mascot characters drawing cards at the Giant Raffle (left), vacuum cannon demonstration (right)

Liquid nitrogen generator donated to the Giant Panda Breeding Research Base in Chengdu, China

— ULVAC CRYOGENICS INCORPORATED

President Takeshi Haginouchi of ULVAC CRYOGENICS INCORPORATED (left) and Vice Chairman Wang Gesheng of the Giant Panda Breeding Research Base

In November 2018, ULVAC CRYOGENICS INCORPORATED held a ceremony to donate a liquid nitrogen generator to the Giant Panda Breeding Research Base in Chengdu, China. The generator is capable of easily generating liquid nitrogen from the ambient air.

Liquid nitrogen generator

At the ceremony, President Takeshi Haginouchi of ULVAC CRYOGENICS INCORPORATED personally presented the document describing the donation. In response, Vice Chairman Wang Gesheng of the Giant Panda Breeding Research Base expressed his appreciation, saying, "For the time being, we will use the donated liquid nitrogen generator to preserve panda sperm, eggs, cells, etc., but eventually we would like to use it to protect and breed endangered animals besides the panda."

In 2009, ULVAC CRYOGENICS INCORPORATED began selling 4K cryocoolers in addition to conventional cryogenic pumps. In 2014, it bought out the products of the Low-Temperature Equipment Division of Iwatani Industrial Gases Corp., moving itself definitively into the low-temperature equipment business. Since the liquid nitrogen generator is a versatile product, it is expected to be used in a wide range of fields, and the recent donation for the purpose of protecting an endangered animal species represented a significant social contribution.

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Recognized in FY2019 as a "White 500" company for the second consecutive year by the Ministry of Economy, Trade and Industry

— ULVAC, Inc. and its group companies

Public health nurse Kamio (ULVAC Health Insurance Society) (left) and public health nurse Ohira (ULVAC)

Just as in FY2018, ULVAC, Inc. was recognized in FY2019 as a "White 500" company (in the large-company category) for its outstanding health and productivity management. The award was given jointly by the Ministry of Economy, Trade and Industry (Japan) and Nippon Kenko Kaigi. This fiscal year, ULVAC EQUIPMENT SALES, Inc. of the ULVAC group was also recognized as a White 500 company in the small- and medium-sized enterprise category.

The White 500 Recognition System was designed to acknowledge companies of all sizes for their outstanding efforts in health and productivity management, based on initiatives addressing local health issues and the health-promoting initiatives advocated by Nippon Kenko Kaigi.

In the belief that ULVAC can only create value when all employees are healthy and energetic in mind and body and demonstrate their fullest potential, the ULVAC group is working to foster health that supports manufacturing.

As part of this initiative to create a workplace where all employees pursue their dreams, enjoy what they do, and always look forward to coming to work, we are implementing a variety of projects. These include an organizational revitalization program led by our company executives and managers, an event that measures physical strength correlated with age, an on-campus multi-stage relay race, and an inter-departmental walking contest. As a result, the number of employees who walk regularly has been increasing each year, and the difference between our company's Health Age® and actual age has reached -2.86. Additionally, health surveys of our employees have shown that the number of employees who work energetically has been increasing each year. It was found that regular exercise helps employees feel stronger, more alert, and more willing to take on challenges.

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UL-fit RUN! Long-distance Relay Race held at the Head Office/Plant

— ULVAC, Inc.

As part of its efforts to create an environment in which all employees pursue their dreams, enjoy what they do, and always look forward to coming to work, ULVAC, Inc. held the First UL-fit RUN! Long-distance Relay Race as a White 500 recognition commemoration event at the Head Office/Plant site on February 9, 2019.

97 people participated from group companies and partnering companies

Although the event was held in the dead of winter, no snow fell that day. A total of 97 ULVAC group employees from 14 teams competed in the race, fostering communication that transcended departmental and company boundaries. In a questionnaire-based survey following the event, 97.1% of the participants reported that the race had been a positive experience for them and that it had increased their perception of unity in the workplace.

Since the positive feedback exceeded organizers' expectations, a second relay race is already being planned in the hope that even more employees will participate.

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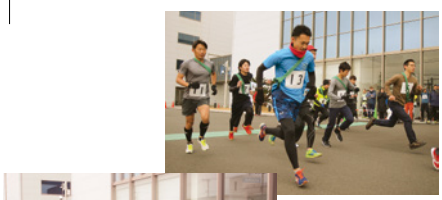

Heated competition in cold weather

Building unity in the workplace

Oxford Instruments (UK) and ULVAC collaborate to provide atomic-scale processing solutions to Japan's power device and RF device markets

— ULVAC, Inc.

In January 2019, ULVAC, Inc. concluded an agreement to become a Japanese distributor for Oxford Instruments Plasma Technology (OIPT, a trading name of Oxford Instruments Nanotechnology Tools Limited, Oxford, UK). This was an important step towards collaboration between the two companies.

OIPT began operating in Oxford, UK in 1959 as a commercial spin-out company from Oxford University. Three years later, the company succeeded in commercializing the world's first superconducting magnet. More recently, OIPT has developed an atomic-force microscope incorporating cutting-edge technologies and enhanced solutions based on super high-sensitivity digital cameras. It is actively pursuing innovations in a wide range of fields, from solid-state physics, materials, and bioscience to earth sciences.

Regarding the agreement with ULVAC, Managing Director Mike Gansser-Potts of OIPT said, "We have very high expectations for our collaboration with ULVAC, and are planning to provide our proven atomic-scale processing solutions to the power device and RF device markets in Japan."

Tetsuya Shimada, ULVAC Executive Officer and General Manager of the Advanced Electronics Equipment Division, commented, "This collaboration is extremely significant. OIPT's ALD/ALE process technology and expertise, which complement ULVAC's product portfolio, will enable us to provide complete solutions."

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  Oxford Instruments Plasma Technology
  Marketing Communication
  TEL: 03-6732-8961

ALD high-volume manufacturing solution Atomfab®

Oxford Instruments announces the sale in Japan of Atomfab®, ALD high-volume manufacturing solution for GaN power device passivation

— ULVAC, Inc.

In July 2019, ULVAC, Inc. began selling OIPT's Atomfab®, a plasma atomic layer deposition (ALD) high-volume manufacturing (HVM) solution for the GaN (gallium nitride) power device industry in Japan.

GaN devices are enabling the use of next-generation efficient power electronic devices in applications such as energy-saving home appliances, 5G networks, electric vehicles, and renewable energy conversion. Although GaN devices were previously efficient and demonstrated high performance, they faced manufacturing yield and scalability challenges that needed to be addressed.

For OIPT, one of the key challenges was to achieve consistently high-quality gate passivation, and Atomfab® delivered this solution with high throughput and low Cost of Ownership (CoO).

1. Performance: Excellent passivation and dielectric properties enable the demanding device performance critical for key applications.
2. Plasma: Remote plasma delivers a reproducible GaN interface. Atomfab® precisely controls the plasma to protect the underlying sensitive GaN substrate.
3. Pace: High throughput is delivered by a high deposition rate process on a high uptime HVM platform specifically developed for GaN power applications.

The significantly reduced cost per wafer that Atomfab® delivers is enabled by numerous technical

Children marvel at the experiments 46th Chigasaki Space Classroom

— ULVAC, Inc.

On March 2, 2019, the 46th Chigasaki Space Classroom was held at the ULVAC Head Office/Plant.

Since the previous Space Classroom (in 2017) had so many applicants that participants had to be chosen by lottery, the number of children admitted was increased for the 2019 session.

Employees from the Research and Development Division and General Administration & Personnel Department acted as instructors. The children experienced seven kinds of vacuum experiments, including shooting a vacuum cannon and making aerated chocolate.

Although the Chigasaki Space Classroom was long (two hours including the vacuum experiments and factory tour), most of what the children saw and heard was new to them, and they all showed keen interest from start to finish.

We hope the Space Classroom will encourage the children who attended to become interested in vacuum technology. ULVAC needs a future reserve army!

Overview of the Chigasaki Space Classroom

The Space Classroom, held regularly since 2008, is organized by the Chigasaki Chapter of the Young Astronauts Club of Japan, and is hosted by the Chigasaki City Board of Education. In general, professors from JAXA and members of the Science Circle at the University of Tokyo have been acting as instructors. Chikara Hayashi, the third president of ULVAC, was the first leader of the Chigasaki Chapter of the Young Astronauts Club of Japan. He helped establish the Chigasaki Space Classroom thanks to his friendships with astronauts and people at the National Space Development Agency of Japan. After retiring from ULVAC, he established the Hayashi Fund.

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innovations, including a patent-pending fast remote plasma source.

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Portable suctioning system developed through industrial-academic-government collaboration for use in areas affected by natural disasters developed through industry-academia-government collaboration

— ULVAC KIKO, Inc.

In March 2019, ULVAC KIKO, Inc. in cooperation with the University of Miyazaki Hospital, Emergency Medicine and Acute Critical Care Center (hereafter referred to as "University of Miyazaki Hospital") developed a portable suctioning system that can be used following a natural disaster.

Under the Eastern Kyushu Medical Valley concept formulated in 2010 through industry-academia-government collaboration in the region, Miyazaki Prefecture had been working to develop medical equipment and services by identifying local corporations whose superior technologies could help meet medical needs at the University of Miyazaki Hospital. The portable suctioning system was created through these efforts.

Normally, in hospitals and medical clinics, wall suction is provided in order to suction mucus and blood during surgery. Suctioning begins when the adapter of the suction (bottle) is connected to the wall. However, the equipment can be damaged by disasters such as earthquakes, and power outages caused by disasters can render wall suction unusable. Therefore, the hospital's medical staff asked for a portable suctioning system that could be connected to the adapter of the suction bottle even in such conditions.

When we consulted the medical-engineering liaison, we were referred to the University of Miyazaki Hospital. A case had been reported to the liaison regarding a medical facility in Kamaishi City, Iwate Prefecture in which the in-wall suctioning system had been damaged and made unusable during the Great East Japan Earthquake of March 11, 2011. This was how joint development of the system started.

Since the portable suctioning system we developed has the same insertion port as wall suctioning systems and is powered by a battery, connecting the adapter of the suction (bottle) provides a maximum of 90 minutes of continuous suction. The unit is compact and highly portable, so it can be used not only following a disaster, but also at schools and a variety of facilities that are not equipped with in-wall suctioning systems. This portable system with the same type of insertion port as the in-wall suctioning systems is the first of its kind in Japan.

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Ground-breaking ceremony for a new plant at ULVAC Coating Technology (HEFEI) Co., Ltd.

— ULVAC COATING CORPORATION

Ground-breaking ceremony for the new plant

Architectural illustration

In May 2018, ULVAC COATING CORPORATION (Head Office: Chichibu, Saitama) established ULVAC Coating Technology (HEFEI) Co., Ltd. (hereafter referred to as "ULH") in Hefei City (Anhui Province), which is the central base for FPDs in China. A ground-breaking ceremony for a new plant was held that September.

ULVAC COATING CORPORATION began in January 1979 by splitting off from ULVAC, Inc. for the purpose of developing and manufacturing mask blanks for semiconductor ICs. Beginning in the 2000s, the company also applied its proprietary mask blank technology to developing large mask blanks for FPDs. It currently commands a 50% share of the world market in that sector. In 2002, ULVAC COATING CORPORATION established ULCOAT TAIWAN, Inc., a fully-owned subsidiary in Tainan City, Taiwan. ULVAC is now contributing a steady supply of mask blanks on a global scale.

The recently established ULH location is intended to provide a local supply of large mask blanks for FPDs in China, and to contribute to FPD manufacturers through photomask manufacturers in China. The start of production is slated for spring 2020.

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ULVAC Group

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ULVAC KYUSHU CORPORATION
ULVAC TOHOKU, Inc.
ULVAC KIKO, Inc.
ULVAC EQUIPMENT SALES, Inc.
ULVAC CRYOGENICS INCORPORATED
ULVAC-PHI, Inc.
TIGOLD CORPORATION
ULVAC COATING CORPORATION
Nisshin Seigyo Co., LTD
ULVAC Human Relations, Ltd.
SHINKU CERAMICS CO., LTD.
FINE SURFACE TECHNOLOGY CO., LTD.
REJ Co., Ltd.
SHOWA SHINKU CO., LTD.

■ China
ULVAC (China) Holding Co., Ltd.
ULVAC (NINGBO) Co., Ltd.
ULVAC (SUZHOU) CO. LTD.
ULVAC Orient (Chengdu) Co., Ltd.
ULVAC Automation Technology (Shanghai) Corporation
ULVAC Tianma Electric (Jingjiang) Co., Ltd.
ULVAC (Shenyang) Co., Ltd.
ULVAC (Shanghai) Trading Co., Ltd.
ULVAC Materials (Suzhou) CO., LTD
ULVAC Opto-electronics Thin Film Technology (Shenzhen) Co., Ltd.
ULVAC CRYOGENICS (NINGBO) INCORPORATED
ULVAC NONFERROUS METALS (NINGBO) CO., LTD.
ULVAC Research Center SUZHOU Co., Ltd.
Hong Kong ULVAC Co., Ltd.
ULVAC VACUUM EQUIPMENT (SHANGHAI) CO.,LTD.
ULVAC Coating Technology (HEFEI) Co., Ltd.

■ Taiwan
ULVAC TAIWAN INC.
ULTRA CLEAN PRECISION TECHNOLOGIES CORP.
ULCOAT TAIWAN, Inc.
ULVAC AUTOMATION TAIWAN Inc.
ULVAC SOFTWARE CREATIVE TECHNOLOGY, CO.,LTD.
ULVAC Materials Taiwan, Inc.

■ South Korea
ULVAC KOREA, Ltd.
Ulvac Korea Precision,Ltd.
Pure Surface Technology, Ltd.
ULVAC CRYOGENICS KOREA INCORPORATED
ULVAC Materials Korea, Ltd.
UF TECH, Ltd.

■ Southeast Asia
ULVAC SINGAPORE PTE LTD
ULVAC MALAYSIA SDN. BHD.
ULVAC (THAILAND) LTD.

■ North America
ULVAC Technologies, Inc.
Physical Electronics USA, Inc.

■ Europe
ULVAC GmbH

ULVAC WEBSITE:
https://www.ulvac.co.jp/en/
VACUUM MAGAZINE:
https://www.ulvac.co.jp/wiki/en/

ULVAC

Innovation Begins in a Vacuum

ULVAC's Vacuum Technology









We take for granted the tablet displays that we use everyday, but they would not work without the vacuum technologies supplied by ULVAC. The vacuum technologies that we have developed over the past 60 years are used in a wide range of areas, including semiconductors, electronic devices, flat-screen TVs, solar cells, automobiles, pharmaceuticals, and food products for Smart Society.

"The Ultimate in Vacuum Technology"
We will continue to push the envelope of vacuum technologies in step with innovations in related technologies.

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