



"If we want to change something, we have to take the lead." This is how the beautiful nature of Tsugami Shindo was protected.

Paving a Path Towards the Future

The Pioneer of Tsugami Shindo

Tsugami Shindo is a mountain road that connects the Sea of Japan and Mt. Asahidake in the Northern Alps. Due to the altitude differences, which range from 0 meters at sea level to 2,500 meters in the mountains, it has a wide range of vegetation. The late Ken Ono, a member of Denka's Omi Plant, is the one who created this road.

After joining the company in 1956, Ono worked in limestone mining. During that period, he felt overawed by the mountain range around Mt. Asahidake. However, at the time, it was still uncharted territory. There wasn't even a mountain trail, much less a plan to build a road that would divide nature. "If we want to protect nature, we have to do it ourselves." Dreaming of new frontiers, Ono gathered a group of mountain-loving colleagues and formed a mountain climbing club. Their unprecedented goal was to create a path through the mountains. Ono was motivated by a pioneering spirit and a sense of duty to protect nature.

The plan was launched in 1962, but none of them had any experience. Instead of trying to do the entire 27km of the mountain at once, Ono decided to go one step at a time. At the end of each workday, the club would meet up, gather their tools, and begin cutting through the vegetation. It was backbreaking work. Nevertheless, the sense of accomplishment after the work and the richness of the nature in the undeveloped area made it all worth it. Their labors brought them closer together and they burned with passion for their dream. Ten years later, in 1971, the road was finally opened. Having realized his dream, Ono named the road connecting the Tsuga Forest and the Sea of Japan the "Tsugami Shindo."

"We considered what we needed to be done for the future and took action." This is one of Denka's guiding principles. With a dream and passion, one can overcome even the steepest of mountains. Denka will continue to be a pioneer that paves the way towards the future.

Source: Ken Ono "Pioneering Tsugami Shindo: Betting Our Youth on Our Dream Route." Yama-kei Publishers



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Materials That Pave the Way to the 5G Era

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Production process reforms to share knowledge around the world

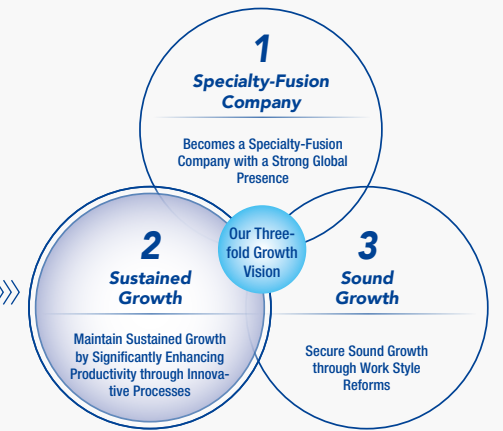
Our Reforms and What Lies Beyond

Denka Group is carrying out production process reforms to achieve “sustained growth by significantly enhancing productivity through innovative processes”—part of the threefold vision under the Denka Value-Up management plan. At each of Denka’s bases around the world, employees are taking on new challenges to improve productivity and free up more time for “creative” work.

Challengers for Denka Value-Up

This issue’s theme:

- Production process reform policies:**
- Revitalizing next generation smart factories with ICT
 - Building and managing data platforms in real time
 - Improving productivity and achieving a high level of operational stability



Denka’s process reforms around the world



Using digital technology to improve productivity and free up more time for “creative” work

The common goal of the Denka Group’s production process reforms is to double labor productivity by 2022 (compared to FY2017). We are aiming to significantly boost productivity by utilizing digital technologies such as AI (artificial intelligence) and IoT (Internet of Things) tailored to each site’s specific circumstances.

Though production process reform, Denka Group is also coming together to change the way that we work. In order to become a company that is truly needed by society, we must eliminate the unnecessary and focus on the essential. By carrying out reforms that will allow employees to switch from routine work to intellectual production, we will establish a system that allows for more “creative” work.



The Frontlines of Production Process Reforms

Here, we will cover the frontlines of the production process, where digital technology is being used to carry out activities tailored to each site.



Mitsuhiro Wada
General Manager
Digital Transformation
Group Technology
DCHA



Ng Hock Cheong
Head of Maintenance
Department
Seraya Plant
Denka Singapore



Tan Chia King
Advisor, Special Projects
Tuas Plant
Denka Singapore

Scene 1 Singapore Denka Chemicals Holdings Asia Pacific (DCHA)

Project Falcon: Realizing a Smart Factory

Stable operations supported by digital eyes

Project Falcon is the DCHA's smart factory transformation plan for its four plants in Singapore. With the support of the Singapore's Economic Development Board (EDB), they have been focusing on four areas: digital infrastructure, smart factories, digital HSE, and value chain management. During this 5-year transformation plan that started in 2017, their goal is to increase productivity through stable operations.

In 2020, the third year of the plan, they have installed sensors in various parts of the plants and established a system to check the operational status of equipment via the cloud. According to Hock Cheong, who's in charge of plant maintenance, the sensors were installed in core facilities that would affect overall plant operations if not functioning correctly, such as cooling towers, steam traps, and centrifugal pumps. Vibration testing and other data is used to prevent wear and tear on the equipment, extending its life and reducing the cost of maintenance.

The digital "eyes" also contribute to ensuring stable quality. At Denka Advantech Tuas Plant, one of the four

plants, cameras have been installed and AI diagnostic image analytics employed to monitor and record the gas flow readings of rotameters. The amount of gas in the burners is an important parameter that determines quality and uniformity of products. Tan, who helped install the system, says, "Previously, we checked this manually, but using cameras has improved accuracy by eliminating human error and inconsistencies."

Keep thinking and don't be afraid of mistakes

The Project Falcon is still an ongoing process. Going forward, they plan to install more sensors and work on the Proof-of-Concept for the new systems. The four plants are closely collaborating to promote this project. Wada, who is in charge of the project, says, "Every year, we share our knowledge, review the previous year's activities, and make corrections as we go forward. Although there are some challenges, such as operations and staff training, I believe everything is always unprecedented until it happens for the first time. So, it's important to be constantly thinking of new ideas and not be afraid of making mistakes."



Data is acquired from an AI diagnostic image analytics camera installed near the gas flowmeter, and the measured values are confirmed on a monitor in the control room. The flowmeter valve is then adjusted based on the analysis results.



Yasuhiro Nagasato
Production Dept. 1
Chiba Plant

Scene 2 Chiba Chiba Plant

Upgrading Diagnostics and Training Up Human Resources

Ensuring safe and stable operations of the plant's "main artery"

Since 2017, Chiba Plant has been transforming itself into a smart factory using ICT technology in order to achieve "specialization in key operations" as set forth in Denka Value-Up. Their goal is to detect anomalies in temperature, pressure, flow rate, and vibrations at any early stage by comparing real-time data captured by the sensors to past models of normal operations.

"Our mission is to ensure safe and stable plant operations," says Yasuhiro Nagasato, a member of Production Dept. 1. Styrene monomers are used as raw materials for a variety of products, so this facility is essentially the Chiba Plant's "main artery." "The most important thing is to catch a problem before it becomes serious." Following the launch of full-scale operations in 2018, they have been working on improving the accuracy of predictions by factoring in the plant's operating rate and other factors such as outside temperatures. Meanwhile, they have also installed wireless sensors to improve equipment diagnosis and inspection efficiency.

Introducing ICT technology and developing human resources

Through the introduction of this new early warning system, improved diagnostics methods, and better measures for continuous operations, they are trying to extend the styrene monomer plant's normal two-year repair cycle to four years. However, as a result, there are fewer opportunities for operators to start/stop the plant. To ensure that operators get enough experience, they have introduced training simulators. These simulators allow users to build a model plant on a PC and to experience various non-routine tasks. Nagasato says, "Implementing ICT technology and developing our human resources are equally important for production process reform. We are proud to be involved with the styrene monomer plant and will continue to improve our technical capabilities."

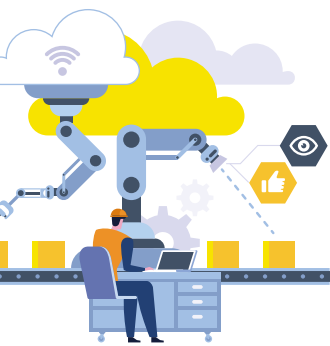
*A basic chemical used as a raw material for plastics, rubber, and paint.



The DCS (Distributed Control System). Plant operations are constantly monitored and adjusted in the operations room.



A worker checks pump discharge pressure in the plant. Providing workers with opportunities to gain experience in the field is important for human resources development.



Scene 3 Fukuoka Omuta Plant

Productivity Tripled with an AI Inspection System

Steady results with AI built on human efforts

In 2018, the Omuta Plant introduced a new AI-based inspection system. Inspections of the ceramic substrates used in power modules were previously carried out manually with workers shining lights on them and looking for defects. However, with deep learning (DL)*, an AI is able to “learn” a vast number of images and store them as data. This data can then be compared with visuals captured by a high-precision camera to identify defective products.

“As we expanded our business, we desperately needed to improve inspection efficiency,” explains Nakamura, a member of the Production Technology Dept. “Gathering image data for the AI to learn was a laborious process. However,

the system’s accuracy improved day by day, and we were delighted when it finally achieved an accuracy level equivalent to that of a human.” Following the introduction of a new mass-production machine in FY2021, inspection efficiency is expected to triple. In February, the Omuta Plant established the Omuta Innovation Hub, which has revitalized communication between departments. Moving forward, they plan to carry out even more process reforms throughout the plant. “We hope to develop and apply this AI technology in fields other than ceramic substrates. We will continue making steady process as a pioneer of production process reforms within Denka Group.”

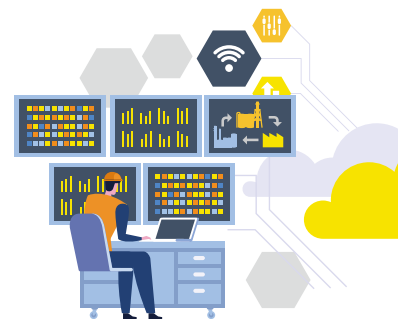
*A state-of-the-art AI technology that identifies patterns in data and uses them to make decisions and predictions.



By visually checking samples (left) and photographing ceramic substrates with a testing equipment (right), we collect image data for the AI to learn.



Yuki Nakamura
Production Technology Dept.
Omuta Plant



Scene 4 Niigata Omi Plant

Checking the Status of the Carbide Chain at a Glance. Increased Productivity through Enhanced Coordination.

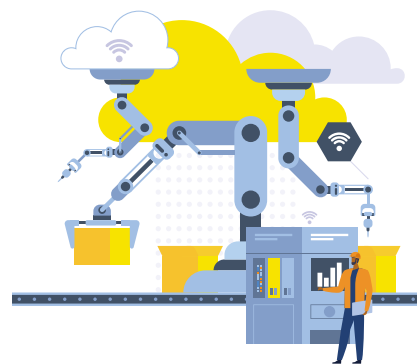
At Omi Plant, a “carbide chain” has been established to produce chloroprene and lime nitrogen, starting from a hydroelectric plant and limestone mines. Since this production line includes various departments scattered across a vast site, sharing information about its operational status was an issue. Therefore, in order to strengthen cooperation, they began working on a system that collects and visualizes information on the operational status of each plant in the carbide chain.

In February 2019, they completed a system that periodically collects data and displays it on digital signage in the Omi Innovation Hub. The sharing of

plant, environment, and safety data allows for earlier detection of anomalies and improved inter-departmental coordination. “Collaboration between departments has improved, making it possible to take quick action when a problem is detected. This information is also available to head office and has led to increased productivity across Denka,” explains Yasuhiro Kyogoku, a member of the Production Management Dept. Moving forward, they will continue expanding the types of data collected and further refine the usage environment to stabilize operations.



Yasuhiro Kyogoku
Production Management Dept.
Omi Plant



Scene 5 Suzhou Denka Advanced Materials (Suzhou) (DAS)

“We are the changemakers.” Using Automatic Transferring Machines to Improve Labor Productivity

Bottom sheet slit* are the core product of DAS. This packaging operation required employees to carry 25kg boxes and lift them onto pallets—heavy physical labor that needed to be repeated many times a day. The company began working on a solution in 2016. After discussions within the department, an automatic transferring machine was installed. This machine reduces the distance that the boxes need to be carried by a third. What is more, it is capable of loading individual boxes onto pallets, reducing the amount of bending and lifting work to zero.

Lihua Zhang, a member of the Electronic Materials

Production Dept., says, “Previously, nobody wanted to do this job. Seeing how much things have been improved with the introduction of a robot has been eye-opening.” Currently, they are working on automating the front-end packing process. Once this is completed, the entire packaging process will become easier, and the number of personnel required will be reduced from eight to four, doubling the labor productivity. Moving forward, they will continue tackling problems and changing themselves for the better.

*A packaging material for electronic components. It is made by cutting raw plastic material to a certain size and winding it up.



Lihua Zhang
Electronic Materials Production Dept.
DAS



All employees can check the status of operations on digital signage (top). When a problem occurs, all departments can access information regarding plant shutdowns, etc. on their own computers (bottom). Minor signs of anomalies not included in reports are also shared, allowing for earlier detection of problems.



Before (top) and after (bottom) the automatic transferring machine was installed. The heavy lifting is left to the robot, realizing better labor productivity.



Production process reforms are monitored from the Omuta Innovation Hub, a new office that facilitates communication.

Denka’s BCP for torrential rains

Omuta Plant

In July 2020, Japan was hit with heavy rains and flooding. Up to 116 mm of rain fell on Omuta Plant per hour. Since the main roads were flooded, the company asked the approximately 500 employees, including part-timers, to stay overnight for safety reasons.

Having recognized the risks posed by production stoppages due to the increase in storms and typhoons, Denka had a business continuity plans (BCP) in place, and these preparations helped to minimize the damage. We will implement further disaster risk management measures in the future to prepare for heavy rains. In addition to securing means of communication and flooding countermeasures, we are working on a system that will allow us to confirm the safety of employees and their families and stockpiling supplies for emergencies. We will also review our disaster prevention system and methods of sharing information with head office departments to ensure the safety of our employees and the stable operation of the plant.



During the flooding, the water was up to our hips (left). Water bars were installed as an emergency measure (right).



Think INNOVATION

Introducing articles that provide hints for innovation

No.05

To Make Unprecedented Discoveries

Physicist



Takaaki Kajita

Born in 1959. Graduated from Saitama University's Faculty of Science. Obtained his Ph.D. at the University of Tokyo. In 1999, he became a professor at the Institute for Cosmic Ray Research. In 2008, he became director of the Institute. In 2015, he was jointly awarded the Nobel Prize in Physics with Arthur B. McDonald for their discovery of "neutrino oscillations," which prove that subatomic neutrinos have mass.

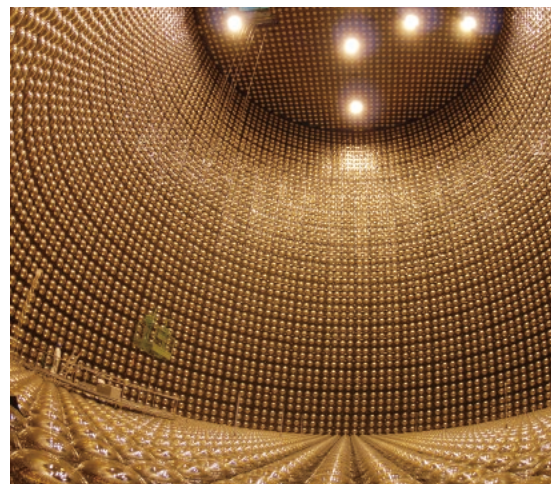
An unwanted stone turned out to be a diamond in the rough

In the mid-1980s, I was studying proton decay with a device called the Kamiokande. Our goal was to prove that protons have a lifespan. To that purpose, we were trying to capture the faint light produced by the decomposition of protons in water. We checked our observational data over and over, but we failed to make any discoveries.

So, I set about trying to improve our system for observing proton decay. I created a software program that would remove unwanted interference called "noise" and only extract the proton decay signals. After completing the prototype, I decided to use the noise data to make sure the software was working properly. That's when I discovered something amazing. However, my discovery wasn't about proton decay; it was about neutrinos*. It was clear that there were fewer muon neutrinos than there theoretically should have been.

"Did I err in my calculations?" I thought at first. However, after repeated tests, I determined that my software was working correctly. That was when I realized that I had discovered something incredible. Fewer muon neutrinos indicated the possibility of neutrino oscillation. That would prove that neutrinos have mass, overturning the standing theory at the time. What I thought was an unwanted stone turned out to be a diamond in the rough.

*A neutral subatomic particle that has no electrical charge. They are one of the most abundant subatomic particles in the universe, with hundreds of trillions of them passing through our bodies every second.



Super-Kamiokande detector
©Kamioka Observatory, Institute for Cosmic Ray Research, The University of Tokyo

The leeway to consider possibilities for the future

After that, in 1988, we published "The Possibility of Neutrino Oscillations." In 1996, the Super-Kamiokande was completed, speeding up our research. In 1998, we published "Evidence for Neutrino Oscillations" at an international conference and were subsequently awarded the Nobel Prize in Physics.

Why was I able to discover neutrino oscillations when nobody else could? I think there were two reasons: I took advantage of a lucky find and I had time on my side.

The first important thing is the ability to discern a diamond from a rock. If you can't see what's important in your experimental results and data, then you won't be able to take advantage of good fortune when it comes your way. This also helps you to believe in yourself in the face of criticism. One of the keys to not letting go of good fortune is to stick to your guns.

I believe that "innovation" and "discoveries" are more or less the same thing. The common denominator is finding some-

thing that will prove beneficial in the future. To that purpose, you need leeway. There are many types of leeway, such as financial or emotional leeway. However, what I had in the 80s was the breathing room to conduct my research in peace. We were able to do research with an eye on the future, rather than just chasing short-term results. If we had been under pressure to produce results within a year, I might not have developed that system. The room to look at things from a broad perspective is the starting point for innovation and discovery.

Special Feature

Materials That Pave the Way to the

5G Era

The communication system is now undergoing a dramatic evolution.

It is called "5G*."

The performance of 5G, which far surpasses that of conventional mobile communication systems, has great potential to change our society.

Denka's materials are paving the way to 5G era.

*The Fifth-Generation Mobile communications system.

Amazing
the
World
with Innovation

How will our lifestyles and workstyles change?

What is the value of 5G?

The features of the 5G communication system include: higher speed, higher capacity, multiple simultaneous connections, and lower latency. It is 100 times faster (increased speed and capacity) than the mobile communication systems that we use today. And it is capable of connecting to tens of thousands of devices simultaneously and enabling remote control with reduced time lag. We spoke with Seiichi Sampei, who is at the forefront of this 5G trend, about the true value of 5G.



Seiichi Sampei
Professor,
Division of Electrical, Electronic and
Information Engineering,
Graduate School of Engineering,
Osaka University

Many years of research experience on telecommunication systems. Chairman of the 5GMF Technical Committee.



Virtual yet realistic sports experiences

Monitoring automatic operations remotely

Predicting and detecting anomalies in plant operations by using cameras and sensors

5G unleashes "remote" possibilities

The latency of 5G is expected to reduce to 1/1000th of a second in the future. In a car, there will be little difference between remote control and manual control from the driver's seat. This will allow users to remotely control vehicles, work equipment, and even medical devices.

Building a new society. That's what 5G can do.

The 4G system we use today and the new 5G system were developed for different purposes. The 4G was developed as a communication system to connect to smartphones. On the other hand, 5G is designed to connect to systems related to daily life and industry. It is a system that connects previously unconnected "things" to the internet and aims to expand the IoT that acquires, analyzes and controls information.

5G aims to separate "people" from "experiences," i.e., to break the constraint that operators or participants must be physically present. In 2020, the spread

of COVID-19 has forced us to change our lifestyles to adapt to a new normal. There is still no end in sight for COVID-19, and we are also at risk of new infectious diseases in the future. We are now facing a significant challenge to maintain our lives and industries in the face of restrictions on gathering and movement.

5G can help solve these issues with its three features. In particular, the lower-latency enables better remote control, allowing us to virtually participate in international conferences and musical events from home, to remotely control cars, trains, and ships from a control room, and to automate machinery used in factories and workplaces. By using 5G, we can change the norms of life

and industry by removing the assumption that people need to be physically present. 5G will be an important part of the infrastructure for realizing a new society.

5G will also help us address a shortage of successors in various industries and infrastructure affected by a declining birthrate and aging population. By combining 5G with high-precision sensing technology, we will be able to detect and predict anomalies that cannot be detected by human perception. The impact of the COVID-19 crisis is expected to further fuel these trends. For companies, 5G is an effective technology in managing business-related risks and costs.

Sub6 and mmWave. What will happen in the different frequency bands?

Currently, 4G mainly uses a frequency band below 6 GHz, which is called Sub6. The Sub6 will also be used in 5G. However, as the IoT expands, more and more machines and vehicles will be connected to the internet, and the amount of communication will increase. As a result, this will put pressure on Sub6 frequency band. The solution is to use a high frequency band from 30 GHz to 300 GHz, or mmWave. However, the characteristics of Sub6 and mmWave are different. The disadvantages of mmWave are that they cannot reach over long distances and are

easily blocked by buildings and objects. Therefore, it will be necessary to set up many telecommunication base stations to cover the areas where radio waves cannot reach. In addition, high frequency bands, such as mmWave, tend to generate heat in the electronic devices that receive them. Solving these problems is essential for the spread of 5G. I hope that Denka will develop materials that address challenges unique to 5G and higher frequency bands and provide a stable supply of these materials.

It is predicted that we will see the next generation communication system 6G in less than a decade. However, with development still underway, we still have no idea how it will be used or what the possibilities are. Even

with 5G, there are no doubt many applications that nobody has thought of yet. The key to unlocking these possibilities lies not with communication system developers, but with electronic device manufacturers and users. I hope that Denka, which is involved with many companies in its extensive supply network, will be able to discover hints to create the future of communication systems.

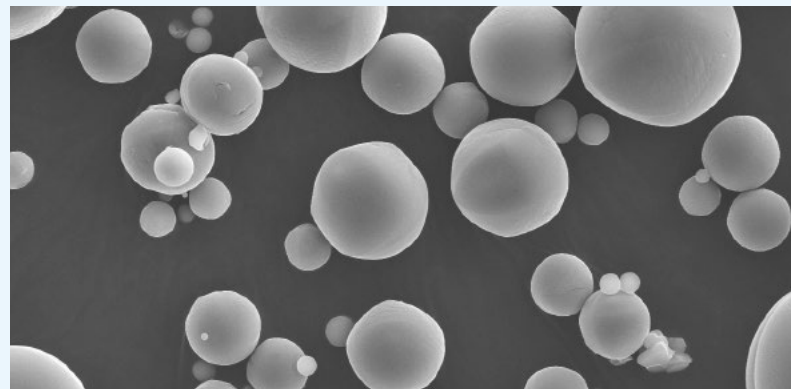
**Amazing
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Denka's Electronic Circuit Board Related Materials

Electronic circuit boards are found in every electronic device, from communication infrastructure such as servers in data centers and antennae on wireless base stations to more familiar devices such as gaming consoles and smartphones. Denka's materials play a large role in the quality and performance of these circuit boards.

Spherical alumina fillers

Help dissipate heat



With increased data transmitted at faster speeds, electronic devices are producing more heat than ever before. To solve this problem, Denka developed spherical alumina fillers, a heat dissipation material, using the high-temperature melting and spherification technologies cultivated through fused silica, a semiconductor sealant launched in 1971. Denka also offers spherical magnesia fillers and hexagonal boron nitride to meet the needs of the expanding market.

What are fillers?

A substance mixed with resin to add functionality. It is possible to add electrical conductivity, improve thermal conductivity, and enhance processability.

Among spherical fillers

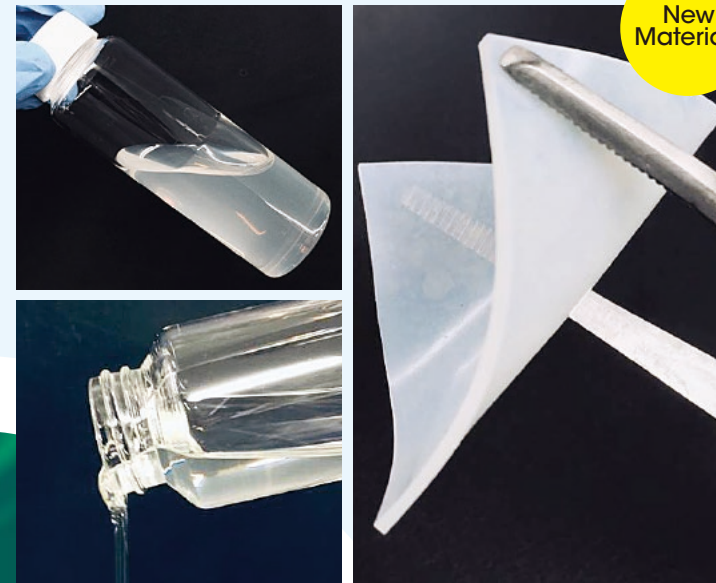
Development **2004** share in the global market **No. 1**

Applications: Mixed with resin, they enhance heat dissipation of copper clad laminates

Top cover tapes and sheet for carrier tape

Protect against static electricity and contamination

Semiconductor integrated circuit parts are covered by top cover tapes and carrier tape sheets during transportation. The challenges are preventing static electricity and contamination by foreign matter. Static electricity can cause the parts to stick to the cover tapes, leading to problems during mounting on circuit boards, and contamination by foreign matter can negatively affect performance. By taking advantage of Denka's integrated approach to everything from raw material composition, development to mass production. We will manufacture products that contribute to the stable supply of semiconductor parts.



*The photos are all LDM.

LDM and LCP films

Help prevent degradation of transmission quality

Circuit boards are made up of layers of resin, copper, and other materials. With the spread of 5G, we will see increased use of higher frequency bands, leading to degradation of transmission quality. Therefore, resin materials such as varnishes and films are used for insulation layers to help prevent this degradation. Denka will create new products for solving various issues that cannot be solved with conventional materials.

Amazing the World with Innovation

Development **202X** Currently under development

Combined with copper foil, they will be used to create electronic circuit boards for 5G



A market leader for approx. 40 years!

Development **1980** Global share Sheets: **40%** Tapes: **30%**

Applications: Protecting semiconductor parts during delivery to semiconductor manufacturers.

The Possibilities of 5G Are Limitless

Amazing
the
World
with Innovation

Newly developed products for 5G-compatible electronic circuit boards

5G will realize new standards of living and working that were not possible with conventional communication systems. Denka is using its new materials to tackle a variety of obstacles standing in the way.



INTERVIEW



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Does the “microwave” principle diminish the strength of communication signals?

Insulating materials that reduce transmission loss are essential for realizing the full potential of 5G. Transmission loss is energy loss. When electromagnetic waves hit an object, they cause the water molecules in the object to vibrate and produce heat. Microwaves work by the same principle. The higher the frequency, the stronger the molecules vibrate. 5G uses electromagnetic

waves of a higher frequency (mmWave) than conventional 3G and 4G technologies. Therefore, it requires materials with a low dielectric tangent, as these are effective in reducing transmission loss.

Reducing energy loss by removing 1/10,000 unit of moisture content

Low dielectric tangent silica is a filler that suppresses the generation of heat. Even a

1/10,000 unit of moisture content in resin or a substrate can affect transmission loss. Okabe says that he took on the challenge of reducing moisture content by utilizing the ceramic development and manufacturing technologies that Denka has cultivated over the years.

“This silica has been specially treated to reduce the moisture content in its particles. It maintains physical properties such as its thermal expansion coefficient and ease of mixing with resin while also reducing transmission loss when used in substrates.”

Denka has a proven track record with fused silica and spherical alumina. This silica has already been adopted by a major board manufacturer, and customer evaluation is currently underway. Development will be further accelerated in order to begin supplying the market.

A long-neglected material paves the way for the future of 5G

Copper clad laminates, which are made up of layers of resin and copper foil, are used for electronic circuit boards. Yamamoto says that LDM, a type of resin developed by Denka, can improve its functionality.

“Currently, the main resins used in copper clad laminates for high frequency applications are polyimides and fluoropolymers. The former has a high dielectric tangent, resulting in high transmission loss, while the latter has the disadvantage of being difficult to attach to copper foil. In comparison, LDM is easy to attach to copper and has little moisture and low transmission loss due to its low dielectric tangent. In addition, many of the resins

New Materials 1 Transmission loss **Low** ↓ Usability **High** ↑

Low Dielectric Tangent Silica Electrical properties don't change when bent. Not prone to warping and cracking. Great potential for electronic circuit boards.

A substrate material with a low dielectric tangent, low water content, and low transmission loss is needed.

Electromagnetic waves

Low heat generation

Before Conventional material

High heat generation

High moisture content

Substrate

Applications → Antenna base station, etc.

currently used for semiconductor applications are hard resins, which are not malleable and thus prone to warping and cracking. However, LDM is a soft resin that can be used in combination with other resins to prevent warping and cracking, thus making it applicable for a wide range of applications. As such, it can also be used for flexible printed circuit boards (FPCs) and wearable devices.”

In fact, LDM was developed about 10 years

ago but has remained relatively unknown and unused. That is, until a few years ago, when developers came up with the idea of applying it for 5G. And thus, a long-neglected material has been brought to the frontlines to pave the way for the future of 5G.

Supporting thin, soft substrates with LCP film

Due to its low dielectric tangent, heat resistance, and low moisture absorption, LCP film has been attracting attention as a material for flexible printed circuit boards (FPCs). However, Ogawa says that the number of manufacturers who can process it is limited due to the high level of manufacturing technology required.

“LCP (liquid crystal polymer) is a material with a rigid molecular structure. That makes it difficult to turn into a film and can result in a mesh of holes after processing. Additionally, since boards are made of resin and copper, materials with different properties that are bonded together by heating, warping and distortion is likely to occur. However, thanks to Denka's film technology, we were able to produce prototypes that met our customers standards.”

New Materials 2 Transmission loss **Low** ↓ Attach to copper **Easy** ↑
Moisture absorption **Low** ↓

LDM Not prone to warping and cracking. Great potential for flexible terminals and wearable devices.

Low dissipation tangent results in low transmission loss. Can be used in a wide range of applications from flexible to hard.

Doesn't absorb moisture

Elastic

Easy to attach to copper

Copper

Before Conventional material

Fluorine

Polyimide

Difficult to attach to copper

Easy to attach to copper. However, high water absorption and transmission loss

Applications → Smartphones Wearable devices, etc.

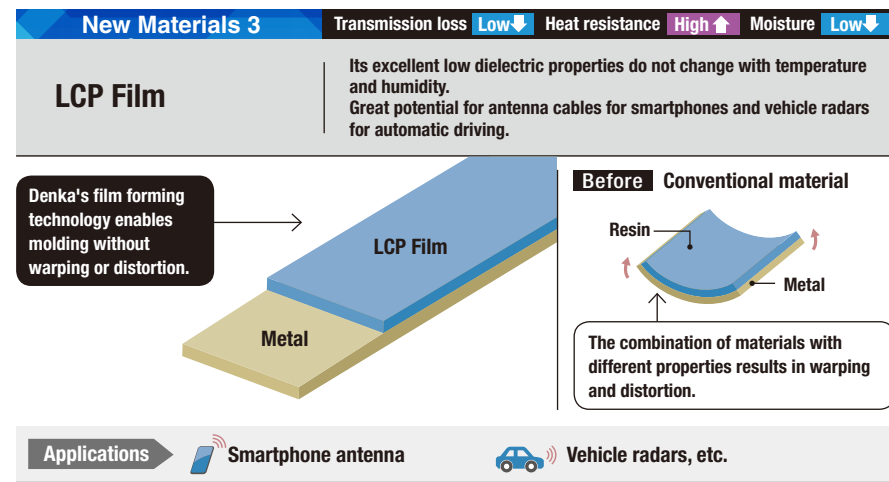
Denka is already planning to sell prototype LCP films for FCPs. Moving forward, the company aims to develop new markets by releasing materials for rigid substrates, which are used for automotive radars and communication base stations, both of which are indispensable for automated driving.

Challenges in evaluation and measurement

New developments sometimes face the challenge of a lack of established evaluation and measurement methods. "LCPs, which have excellent dielectric properties and exhibit a thermotropic liquid crystalline phase, have a unique molecular structure and are difficult to dissolve in solvents. Therefore, it is impossible to analyze LCP using conventional methods, and we struggled to come up with a new approach." (Ogawa)

"As a soft material, LDM is easily deformed, so obtaining accurate dielectric tangent measurements was difficult" (Yamamoto)

"Low dielectric tangent silica is difficult to measure as a powder in the mmWave range, so we evaluate it by mixing it with resin. However, the processing accuracy of the resin can influence the results. For our other silica, the



thermal expansion coefficient and other physical properties generally stay the same, but this silica's properties change depending on the size of the particles. That makes it difficult to predict results and obtain reliable data." (Okabe)

From raw materials to development and mass production. Denka's collective strengths

Three young researchers struggling to overcome problems. They say they were able to reaffirm the collective strengths of Denka Group by evaluating each other's prototypes and providing

feedback. "Fillers and films. Denka is unique in that it can approach problems from both sides." (Ogawa) "Combining new products with existing products or other new products can lead to new exciting possibilities in material creation." (Okabe) "Collaborating with the Business Development Dept. helped us to quickly and accurately identify market needs." (Yamamoto)

The electronic materials field moves quickly. Some are already considering 6G. Leveraging the Group's collective strengths, Denka will continue to shape the future of these new communication systems.

With the evolution of communications systems,

new ways of living and working will appear.

Denka's new materials will help

pave the way for the future of 5G.



Amazing
the
World
with Innovation

DENKA TOPICS

Introducing Denka Group news topics from April to June 2020

Jul. Company-wide policy for work style reforms formulated



In July, we formulated a company-wide policy for work style reforms. In light of the new normal brought about by the spread of COVID-19, we at Denka are pursuing new ways of working with the goal of becoming a company that is truly needed by society. We will seek the essential aspects of our work and encourage everyone to choose optimal methods to improve overall productivity.

Jul. Measures against COVID-19

We have taken several actions to prevent the spread of COVID-19. After filing for approval in July, we received permission to manufacture and sell a new COVID-19 rapid antigen test in Japan. Marketing of this kit began this August. We have also been working with the Taiwanese company PlexBio on an AMED grant project concerning COVID-19. We will continue working to improve the COVID-19 testing system.



COVID-19 rapid antigen test kit QuickNavi™-COVID19 Ag

Jul. Completion of the Omi Plant's Seiwa employee dormitory for bachelors



Outside the dormitory

Inside the dormitory (cafeteria)

On July 15, the new Seiwa Dormitory for bachelors was completed in Omi Plant. This facility was renovated to provide a better living environment and work-life balance for young employees. The new facilities include high-speed internet access and a system that allows employees to order meals with their smartphones. We hope the new facility will serve as a place where residents can socialize, relax physically and mentally, and invigorate themselves for tomorrow.

Aug. Donation of 10,000,000 yen to Omuta City for 2020 heavy rain disaster relief

We donated 10 million yen to Omuta city in Fukuoka Prefecture for disaster relief for the torrential rains that occurred in July 2020. Mr. Watanabe, Omuta Plant Manager, officially donated the money at a ceremony on August 6. The gift will be used for relief and reconstruction of the disaster-affected areas.



Mr. Watanabe symbolically presenting the donation

Aug. Investment of approx. 3.7 Billion yen toward GHG emission reduction goal

In August, we decided to invest approx. 3.7 billion yen in the Chiba Plant, our core petrochemical production facility, to install highly efficient gas turbines and generators for in-house power generation. This investment represents part of our efforts based on ESG management to reduce greenhouse gas emissions by over 12,000 tons per year. Improving energy efficiency will also help the plant improve its cost competitiveness. We will continue our efforts to preserve the environment and contribute to realizing a sustainable society.



A full view of the Chiba Plant

Sep. Endorsed TCFD recommendations to further promote climate-related information disclosures

On September 14, we announced our endorsement of the Task Force on Climate-related Financial Disclosures (TCFD) recommendations to strengthen our governance based on ESG management. The TCFD's recommendations encourage companies to disclose financial information on climate-related risks. While participating in the consortium run by TCFD with other companies and financial institutions, we will promote disclosure of climate-related financial and management information through our website and other media.



No complaints!

クレームゼロ!!



Japan

Ken Sato
General Affairs Division
Denka Azumin Co., Ltd.

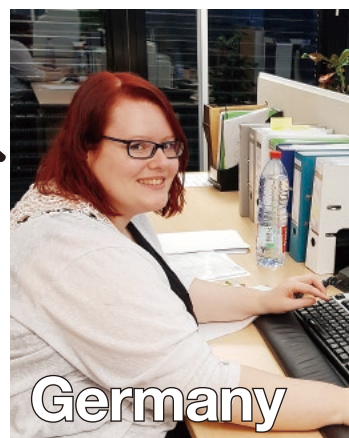
I want to drive all over the country after COVID-19 pandemic ends!

Joined the company in 2007. As Head of General Affairs, he is responsible for managing inventory, raw materials, and partner companies, purchasing equipment, and improving operations.

To prevent heat-sealing errors on plastic bags, we have introduced a temperature monitoring system. Mistakes can be caused by seal adhesion or inadequate temperature adjustments. However, since we seal approximately 1,000 bags per hour, it can be difficult to monitor all of them, and a member of staff always needs to be present. Our new system hasn't yet been optimized, but it has already reduced the burden on staff. We will aim for further improvements by working together with staff on the production floor.



How are things in Germany, Susan?



Germany

Susan Miekow
General Affairs Dept.
Denka Chemicals G.m.b.H

Celebrate the small achievements

I love baking cakes and reading manga!

Joined the company in 2019. She is responsible to managing order Germany and coordinating with the Japanese, Singaporean, Chinese and U.S. offices.

We are currently looking for creative ways of creating a working environment that prevents infections. Due to the COVID-19 pandemic, some of our Japanese colleagues returned to Japan and we introduced a telework system, which changed our work styles dramatically. Since August, we have been gradually returning to the office. I'm very happy to be able to work with everyone again. This situation allows us to see each other and appreciate the little things, which is what really matters.



Improving business operations using remote technologies

How are things in Shanghai, Min?



Shanghai

Min Jinyi
Sales Dept.
Denka Infrastructure Technologies
Shanghai Co., Ltd.

I love music!

Joined the company in 2008. As a Deputy Sales Manager, he is responsible for acquiring new users and aims to create a highly motivated team.

We are using WeChat and Web conferencing tools to follow up with customers. On-site compounding and guidance are essential for sales of special cement additives such as quick-drying cement and extracts, so we have been implementing new communication methods in cases where business travel is not possible due to COVID-19. In extract sales, we use distributors to sell to local dry-mortar manufacturers, so we don't have to travel to them.

リモート活用による業務の見直し!

How are things in Singapore, Tan?

Adapting to New Technologies



Singapore

Tan Wei Yi
Special Cement Additives
Denka Infrastructure Technologies

I love watching the city from tall buildings!

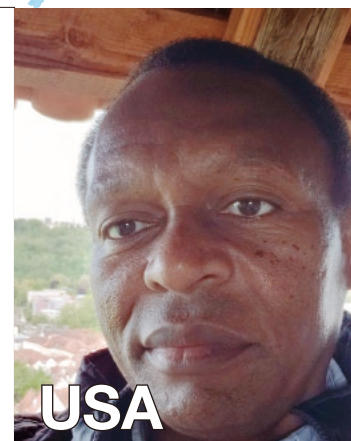
Joined the company in April 2018. Responsible for sales and marketing in ASEAN and providing technical support to clients. Sometimes he visits construction sites to get direct feedback on products.

We are currently preparing to construct the largest 3D concrete structure in Southeast Asia in Singapore. As a construction materials manufacturer, we are constantly researching and developing materials and gradually improving construction methods by using the latest technologies, such as 3D printing, to reduce the burden on the work site. Moving forward, we intend to create exquisite structures with ascetically pleasing designs.



Business Expansion

How are things in the USA, Jules?



USA

Jules Dim
Electronics and Innovative Products
Denka Corporation USA

I enjoy watching TV and playing soccer and volleyball!

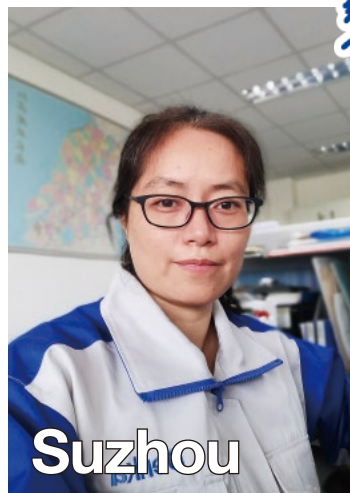
Joined the company in August 2015. As manager of Electronics and Innovative Products, he is responsible for promotion, sales, and new business development of power electronics, semiconductor, and automotive materials in the Americas.

As a result of the COVID-19 pandemic, many annual exhibitions and face-to-face business meetings were canceled or postponed. Therefore, we decided to use our database of previous exhibition contacts to ensure the continuation of our existing business and

the creation of new opportunities. Although these are difficult times, we have been working hard to capture shares of growing markets such as electric vehicles.



How are things in Suzhou, Xu?



Suzhou

Xu Lijuan
General Affairs Dept.
Denka Chemicals Development Suzhou Co., Ltd.

I love jogging! I'm also interested in calligraphy.

Joined the company in March 2011. As a member of both general affairs and accounting, he is responsible for payments and human resources. He also follows up with R&D through general affairs.

We have started a new employee health initiative to take walks during lunch breaks. I feel that this light physical activity improves our moods, gives us opportunities to communicate, and strengthen our connections. Since Chinese New Year, we have also been implementing COVID-19 preventative measures such as checking temperatures, washing hands, wearing masks, ventilation, disinfection, and improving hygiene awareness among employees.

楽しく、明るく、元気で!



LINK GLOBALLY, LINK FUTURE

Group members around the world, working toward the future of Denka

The Denka Group has 6,000 employees around the world. We posed the following question to members from different countries.

Theme Recently Started Initiatives