SUMITOMO ELECTRIC
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Sumitomo Electric Group Magazine

vol.07

**Innovative Development,
Imagination for the Dream,
Identity & Diversity**

Feature

World of Irradiation and Cross-Linking for a Bright Future

SUMITOMO ELECTRIC GROUP

Human Wisdom to Achieve Industrial Application of Electron Beams

–Establishing irradiation and cross-linking process for the first time in Japan–

World of Irradiation and Cross-Linking for a Bright Future

In 1952, Professor Arthur Charlesby, a physicist in the U.K., discovered a highly unique phenomenon: cross-linking of polyethylene was achieved by electron beam irradiation. This heralded the widespread use of the irradiation and cross-linking process in industrial fields. Cross-linking refers to a chemical reaction that creates new intermolecular bonds by irradiating high-energy electron beams on resins such as polyethylene. This attains characteristics such as heat resistance, oil resistance, chemical resistance, and shape memory effects. Today, this is a very important process to improve the characteristics of polymer materials such as plastics and rubber. Products derived from this process are used in various fields including electric home appliances and automobiles.

The Sumitomo Electric Group was quick to pay attention to the irradiation and cross-linking process. It started research in the 1950s, and launched a joint project with Nissin Electric Co., Ltd. (“Nissin Electric”) in 1957 to develop the electron beam accelerator. In 1960, the first electron beam accelerator for research was set up. In the same year, power cables derived from the process were delivered to an electric power company. Subsequently, the group offered various products as a pioneer of the process to variety of manufacturing industries in Japan. To meet the changing needs of the times and society, the process has evolved over the years. This issue focuses on the history of the irradiation and cross-linking business of the Sumitomo Electric Group, and introduces the current applications and a bright future to be achieved by the process.

Irradiation site of an electron beam processing system

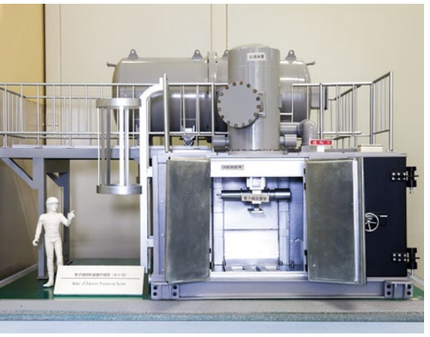
Path to Commercialization of the Irradiation and Cross-Linking Process

–A technology that has underpinned the basic industries in Japan–

Buildings that house electron beam processing systems at Sumitomo Electric Fine Polymer, Inc.

Development of an electron beam processing system; accelerate electrons by applying a high voltage

Soon after the discovery of cross-linking phenomenon in the 1950s, the Japanese government launched studies on industrial applications of radiation (mainly electron beams and gamma rays). The Sumitomo Electric Group started research on the irradiation and cross-linking process by inviting career bureaucrats in the engineering field from the Ministry of International Trade and Industry (currently the Ministry of Economy, Trade and Industry). The objective was to develop new materials and products with unique characteristics such as heat resistance, abrasion resistance, oil resistance and chemical resistance by irradiating electron beams on polymer materials to create cross-linking. Two new organizations were established in the research group. One was the Applied Physics Laboratory to develop an electron beam processing system, and the other was the Product Development Section to study potential products derived from the application of the irradiation and cross-linking process. During the study



Model of electron beam processing system

to develop a system, the staff members of the Applied Physics Laboratory contacted Nissin Electric, a capacitor manufacturer whose engineering capability was highly evaluated, to consider the possibility of joint development. In 1957, the two companies embarked on the development of a system. An electron beam processing system (EPS) is designed to take out electrons accelerated in a high vacuum by a high voltage into the atmosphere. The accelerated electrons are irradiated on polymer materials to trigger a chemical reaction called cross-link bonding. The irradiation and cross-linking process is characterized by high-speed cross-linking (in seconds) compared to other cross-linking techniques that use heat and chemicals. Other advantages include fewer restrictions on the materials subject to cross-linking and low environmental impact.

Development of high-value-added products by utilizing the proprietary material blending technology

The irradiation and cross-linking process is achieved by composite technologies such as high voltage technology, beam engineering technology and high vacuum technology. Sumitomo Electric overcame those technical challenges and set up the first electron beam accelerator for commercial production at its plant in Osaka (Kumatori) in 1964. Basic research and product development were promoted to reform and improve various polymer materials by irradiating electron beams and creating cross-linking bonds. However, there was a concern from the beginning of the development. The equipment cost of the electron beam accelerator was high. It was imperative to improve productivity in an economically efficient manner and develop products.

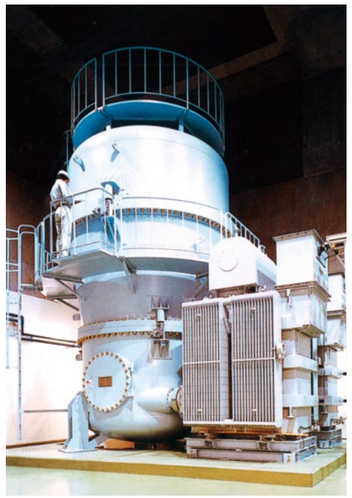
"For the most part, the irradiation and cross-linking business was initiated by 'the seeds of the ideas' instead of 'needs'. However, efforts were made to identify needs that could utilize the cross-linking. Against this backdrop, we have been working to date to develop high-value-added products that leverage our proprietary material composite technology. This technology is one of the major factors that have achieved the widespread use of our irradiated and cross-linked products and ensured differentiation from competitors," said Hiroshi Hayami, General Manager of the Energy and Electronics Materials Laboratory.

Subsequently, the two companies took different courses. The Sumitomo Electric Group focused on product development by applying the irradiation and cross-linking process, while Nissin Electric focused on improvement of the system. The Sumitomo Electric Group registered the IRRAX® trademark for irradiated and cross-linked products, and commercialized IRRAX® electric wires, IRRAX® tubes, IRRAX® tapes and SUMITUBE® heat-shrinkable tubing by using the electron beam accelerator for research. Meanwhile, irradiated and cross-linked polyethylene was applied to package bags for udon noodles. Sumitomo Electric promoted development of pioneering products for food packaging. Based on the positive feedback from the market, Sumitomo Electric set up a new system in Kumatori and started full-scale industrial production.

Hiroshi Hayami
Executive Officer
Deputy General Manager, R&D Unit
General Manager of the Energy and Electronics Materials Laboratory

Supplying irradiated and cross-linked products to the electronics industry and auto industry

Japan was in its high economic growth period. The economic growth was led by the electronics industry (for home appliances and information equipment, etc.) and the automotive industry. This served as a springboard for the development of the irradiation and cross-linking business of the Sumitomo Electric Group. High heat resistance was required for electric wires used for interconnect wiring of electronic equipment including electric home appliances such as TV sets and air conditioners. The irradiated and cross-linked electric wires played an important role. Electric wires and cables were required to meet the flame retardancy, heat resistance and electrical insulation requirements from the viewpoint of safety. The Sumitomo Electric Group was highly evaluated for supplying cross-linking electric wires that met market needs. Regarding automobiles, high heat resistance and oil resistance were required in the engine bay and for sensors due to the enhanced functionality. Wiring harnesses are assemblies of electric wires that are arranged throughout an automobile. About 10% of the electric wires used for wiring harnesses are cross-linked polyvinyl chloride (PVC) and cross-linked flame-retardant polyethylene electric wires. PVC can be cross-linked only by the irradiation and cross-linking process. The cross-linked PVC electric wires came into widespread use as heat-resistant electric wires for automotive wiring harnesses. Antilock brake system (ABS) sensor cables are noteworthy in the automotive field.



World's largest electron beam accelerator (5 MV)

Mr. Yasuhisa Hoshi, Standing Advisor, Nissin Electric

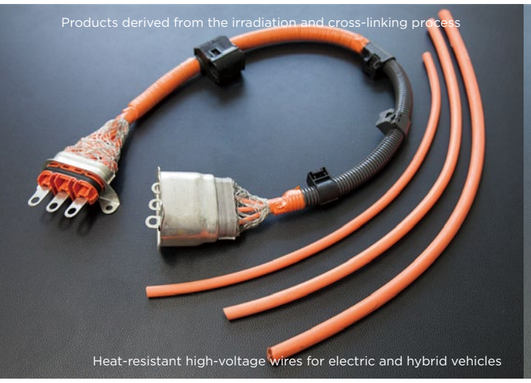
These cables transmit electric signals from the sensors that detect the rotational speed of the wheels to the engine control unit. They are used for wiring in the severe environment adjacent to the wheel wells. The sheath is made from polyurethane resins with improved reliability derived from the process. The commercial application of ABS, which increased the safety performance of automobiles, was underpinned by the Sumitomo Electric Group's cross-linking electric wires. As for the heat-shrinkable tubing, it has been used for various applications such as insulation process of the electric wire terminals, electric field relaxation of power cable terminals, environmental seal for connections and branches of wiring harnesses and corrosion protection for automobiles. Since its early days, the irradiation and cross-linking process has helped Sumitomo Electric offer products in a timely manner to meet the needs of the changing times, and has underpinned the development of the electronics and auto industries that are Japan's key industries.

Meanwhile, Nissin Electric was improving the electron beam processing system in various aspects.

"The electron beam processing system has advanced to meet the needs of customers. We worked to increase the output. In 1989, we developed the world's largest electron beam accelerator of 5 MV. We have since been making continuous efforts to refine auxiliary equipment to improve productivity, reduce the size of the overall system, minimize the need for maintenance and extend the service life. The collaboration between our system and the product development capability of the Sumitomo Electric Group has played a key role in developing the market. We hope to maintain this close relationship to launch into new fields of application toward the next generation," says Yasuhisa Hoshi, Standing Advisor, Nissin Electric.

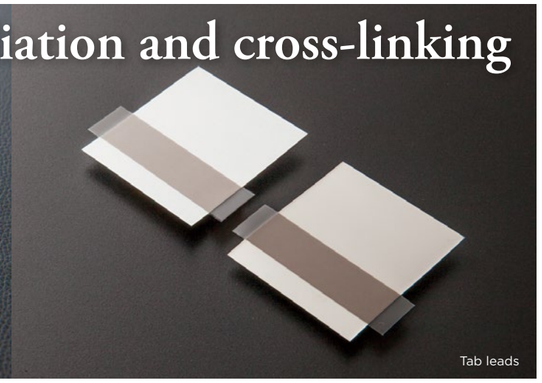
Identifying and meeting the needs of the changing times to develop products

–Current status of the irradiation and cross-linking process and sales network


Heat-resistant high-voltage wires for electric and hybrid vehicles


SUMITUBE®


SUMITUBE®


Tab leads

Products are derived from social needs and the application scope expands from automobiles to various fields

Currently, two divisions are responsible for the irradiated and cross-linked products: Electronic Wire Division and Fine Polymer Division. In the electronic wire business, the irradiation and cross-linking process has been introduced for electric wires that are used in so-called white goods and information appliances. Top sellers include high-voltage wires for cathode-ray tube TVs and flexible high-voltage wires for notebook PCs and LED TVs. In the 2000s, Sumitomo Electric started to supply products to the automotive industry on a full scale. The commitment to the automotive industry has been diversified and accelerated.

"The main field has been shifting from electronics to in-vehicle products. We focus on high-grade electric wires that are uniquely different from commodity products. Notably, the demand for tab leads has been increasing rapidly. Tab leads are used in lithium ion batteries for electric vehicles (see pp.10–11 for details). There has been a new trend for automobiles such as electrification, information and communication. We take full advantage of our high engineering capabilities in as proprietary material composite technology and conductor alloy technology to ensure differentiation from competitors. Meanwhile, we need to carefully design our product portfolio. We will preferentially put resources into other growing markets. One of them is the aircraft field. Electric wires need to meet the high heat resistance and high abrasion resistance requirements. They have been used in many main harnesses for control systems and power systems. The scope of application is expected to expand further. We also hope to actively develop fields in which our superior technology can be utilized such as medical care, robots and data centers. To this end, it is necessary to promote joint development with major customers at an early stage (in the early phase of product planning and development) and market high functionality irradiation electric wire products faster than competitors. This is our basic strategy." (Kiyonori Yokoi, General Manager, Electronic Wire Division)


Kiyonori Yokoi
General Manager, Electronic Wire Division

Efforts to develop materials and applications for SUMITUBE® that has an outstanding market share

The main products of the Fine Polymer business are the SUMITUBE® heat-shrinkable tubing that is characterized by heat resistance, shape memory, oil resistance and chemical resistance. These tubing is used in such fields as electronic equipment, automobiles and aircraft for various applications including bundling of electric wires and harnesses, heat resistance and electrical insulation protection, and environmental sealing and corrosion protection. The heat-shrinkable tubing has a market share of about 70% in Japan. Sumitomo Electric has also marketed various products such as heat-resistant tubing and heat-resistant tape by taking full advantage of the irradiation and cross-linking process.

"We have been working to develop various functional products such as marking products for identifying, protecting and waterproofing cables and harnesses and heat-shrinkable tubing that contains solder or that is provided with copper terminals, by leveraging the superior heat resistance and oil resistance of irradiated and cross-linked products. Regarding the future market, we hope to introduce products in the aircraft field in addition to the electronics and automotive fields, as in the case of the electronic wire business. Rigorous quality standards and specifications have been established in the aircraft field. We are one of the few manufacturers that have met these standards and specifications. We will expand our global market share based on our proprietary material development and application development technologies and the global production system in the four major markets in the world (Japan, the U.S., Europe and China)," said Yoshichika Nishimura, General Manager, Fine Polymer Division.


Yoshichika Nishimura
General Manager, Fine Polymer Division


Toshikatsu Hayasaki
Chief Engineer
Irradiated Products Division
Sumitomo Electric Fine Polymer


Electronic wire manufacturing line and electron beam processing system
Sumitomo (SEI) Electronic Wire, Inc.


Atsushi Shinchi
General Manager, Manufacturing Department Wire & Cable Plant
Advanced Electronic Wire & Cable Division
Sumitomo (SEI) Electronic Wire, Inc.

Distribution network in and outside Japan
Increasingly expected to offer added value

Sales operations for the irradiated and cross-linked products are mainly undertaken by a network of distributors. This sales system has been maintained since the 1970s. In Japan, distributor associations are based in Tokyo, Nagoya and Osaka. In total, 33 companies are members of these associations. Similar networks have been established in Greater China, Southeast Asia and South Korea. Today, distributors (dealers) do not necessarily sell Sumitomo Electric products alone due partly to the changes in customers' needs. They are expected to play roles different from the past.

"It is important to consider the advantages for customers to do business with distributors. If the distributors sell only our products, they can create personal networks only with Sumitomo Electric. They can do business with customers only from our perspective. However, if they sell products of competitors and do business with customers in a comprehensive manner, we can collect information that cannot be obtained by ourselves. The distributors can offer one-stop solutions by selling products of competitors. They are expected to acquire information and build personal networks beyond our scope and to offer added value to customers," explains Yoshitaka Katayama, General Manager, Electronic and Information System Materials Sales Division.

Toa Electric Industrial Co., Ltd. is one of such distributors in Japan. This influential distributor started to work with the Sumitomo Electric Group when the Group started to build the distributors system. It has been promoting business with the vision to "Realize your Monodzukuri" in various industries and fields.

"Sumitomo Electric has the strengths to offer products that meet social and market needs and continuously develop new products by staying abreast of the changing times. As a distributor, we must collect information through daily operations and offer it to Sumitomo Electric so that they can maximize their strengths. It is our raison d'etre and responsibility to offer useful information quickly. We will continue to work with Sumitomo Electric and contribute to their manufacturing operations," says Hisanobu Kusumoto, Branch Manager, Nagoya Branch, Toa Electric Industrial.

It should be noted that sales in the markets outside Japan account for nearly 80%. Given that overseas customers will increase, it is essential to build a system for selling products in local markets by involving distributors.

"To sell products to local customers, the products must be sold by local staff. This is an important point. We must train local staff as our human resources. We will optimize our sales system from the global perspective," says Katayama.

The next chapter will introduce specific efforts in China.


Meeting of a distributors association in Japan (Tokai area)


Mr. Hisanobu Kusumoto
Branch Manager Nagoya Branch West Japan Sales Head Office
Toa Electric Industrial Co., Ltd.

Toa Electric Industrial has a vision to "Realize your Monodzukuri" in various industries and fields.


Yoshitaka Katayama
General Manager
Electronic and Information System Materials Sales Division
Electronics Sales Units

World of Irradiation and Cross-Linking for a Bright Future

Staff members of Sumitomo Electric (Shanghai) Electronics, Ltd. who are in charge of sales in China

–Opening up the ever-changing huge market of China–
A challenge to establish a global system

Irradiated and cross-linked products shipped to the global market Manufacturing company established in China in the 2000s

Sumitomo Electric was very quick to launch its irradiated and cross-linked products in markets outside Japan. From the start of the business, it made efforts to penetrate the markets of Southeast Asia, North America, and Europe mainly by exporting products from Japan. To enhance the further penetration of the SUMITUBE® and IRRAX® brands outside Japan, Sumitomo Electric Interconnect Products, Inc. (a sales company) was established in California (U.S.) in 1985. In 1986, a branch of Sumitomo Electric Europe. S.A. (a sales company in Europe) was opened in Hamburg (Germany). To meet the growing needs for local production in North America and Europe, Sumitomo Electric acquired Judd Wire Inc. (U.S.) and started local production in 1988. Subsequently, operations continued to expand. Currently, the Electronic Wire Division operates 12 companies worldwide (in the U.S., Hungary, China, Vietnam, Malaysia, etc.), and the Fine Polymer Division has manufacturing and sales companies in the U.S., Germany, China, and Taiwan. The irradiated and cross-linked products of the Sumitomo Electric Group are shipped to the global market and are highly evaluated in the respective countries and areas. Notably, China has been the focus of much attention because of its significant potential market growth. Sumitomo Electric entered the Chinese market when Japanese electronics manufacturers and automakers started local production in China. Sumitomo Electric established a manufacturing base of the Electronic Wire business in 2001 and of the Fine Polymer business in 2005, respectively, in Suzhou, China. In 2013, the sales groups of the manufacturing bases in these businesses were integrated to establish a sales base in Shanghai.

(Left)
Motoi Matsuo
Vice President
Sumitomo Electric (Shanghai) Electronics, Ltd.

(Right)
Mr. Xu Min Jia
Chief Executive Officer
Shanghai DSYG Enterprise Development Co., Ltd.

Shifting the focus to selling products to Chinese manufacturers in close cooperation with the Huacheng Distributors association

When Sumitomo Electric first entered the Chinese market, it focused on supplying products to Japanese-affiliated manufacturers. Recently, the policy has significantly changed. Vice President Motoi Matsuo of Sumitomo Electric (Shanghai) Electronics, Ltd. explains how the policy in the Chinese market has changed.

"China has emerged as the world's factory. Today, local manufacturers including those in the automotive industry have been increasingly growing their presence. There are growing needs for high-quality and highly functional products. To meet the market changes, we have been actively working to further strengthen cooperation with Japanese-affiliated manufacturers and to sell products to local manufacturers in China. Our sales strategy focuses on highly functional products instead of commodity products. Such market changes are an advantage to us," says Matsuo.

Obviously, competition with local competitors in China has been getting increasingly intense. The key to opening up the market is to "meet the quick changes in the Chinese market," Matsuo explains. At the forefront of the market penetration are distributors in China that were established similarly as in Japan. Many distributors operate in Greater China. The Huacheng distributors Association was established by 18 influential distributors, one of which is Shanghai DSYG Enterprise Co., Ltd. CEO Xu Min Jia explained.

"About 25 years ago, we encountered the superb irradiated products of SUMITUBE®. We decided to become a distributor because we were inspired by the corporate principles of Sumitomo Electric. Today, customers in China demand high-end products. Sumitomo Electric's products are characterized by their consistently high quality and reliability. Although the market share is still low, it has been expanding steadily. Recently, we have won against foreign brands to meet the specifications for a large electric power infrastructure project. As a distributor, we will continue to identify the market needs quickly and accurately and open up the market with Sumitomo Electric," says Mr. Xu.

Sumitomo Electric Fine Polymer (Suzhou) Ltd.

President Satoshi Miyazaki
Sumitomo Electric Fine Polymer (Suzhou) Ltd.

SUMITUBE® products manufactured one after another

Sumitomo Electric Fine Polymer (Suzhou) Ltd. manufactures Fine Polymer products

With the two major manufacturing bases in Suzhou, China, how can we cope with the expanding market?

The ancient city of Suzhou is a 90-minute drive from Shanghai. Suzhou is home to a cluster of companies from various countries, including the manufacturing bases of the Fine Polymer and Electronic Wire businesses of Sumitomo Electric. The Fine Polymer business is undertaken by Sumitomo Electric Fine Polymer (Suzhou) Ltd., which manufactures SUMITUBE® heat-shrinkable tubing and heat resistant tapes and supplies them mainly to Japanese-affiliated automotive harness manufacturers.

"The automotive industry is the main market on which we focus our resources. We supply our products not only to Japanese-affiliated manufacturers but also to domestic Chinese automakers. China is the world's largest automotive manufacturing country with an annual output of about 28 million vehicles. As the competition is becoming more intense, we will tap this huge market by taking full advantage of our production system that can quickly meet the needs. To differentiate our engineering capability, we will encourage our customers to switch from existing competitors to our products. We also supply our products to the European and Southeast Asian markets. To meet the growing global demand, we will upgrade our production equipment for heat-shrinkable tubing, including introduction of a new electron beam accelerator, to increase our production capacity." (President Satoshi Miyazaki)

President Toshiro Komura
Sumitomo Electric Interconnect Products (Suzhou), Ltd.

The manufacturing company of the fine polymer business is adjacent to Sumitomo Electric Interconnect Products (Suzhou), Ltd. that manufactures electronic wire products.

This company manufactures various products, but it focuses its resources primarily on automotive irradiated and cross-linked products as in the case of the Fine Polymer business.

"We manufacture heat-resistant high-voltage wires for anti-lock braking systems (ABS), electric parking brakes for hybrid vehicles and electric vehicles, and tab leads that are used as lead wires in automotive lithium ion batteries. A new electron beam accelerator started operation in February 2019 to expand the scale of production of electric wires. It is important to cooperate with the sales section to meet the specifications in new fields at an early stage. In the automotive field, there is a lead time of several years until a product is used. We will meet needs more quickly than competitors to expand our share of the Chinese market," says President Toshiro Komura.

The success of the irradiation and cross-linking business depends on the efforts to tap the Chinese market.

Sumitomo Electric Interconnect Products (Suzhou), Ltd. is a manufacturing company of the Electronic Wire Division. A project have set up a new electron beam processing system to meet the needs for mass production.

Electronic wire products waiting for shipment

Sumitomo Electric Interconnect Products (Suzhou), Ltd.

Automotive lithium-ion batteries employ tab leads

–Irradiation-crosslinking and process engineering technology excel

LG Chem's Li-ion battery
(with the tab-lead terminals at the top)
(Photo courtesy of LG Chem)

A module of multiple Li-ion batteries is installed in EVs.
(Photo courtesy of LG Chem)

Headquarters R&D Laboratory of LG Chem

Tab-lead manufacturing system of Sumitomo Electric Wire, Inc.

Key device for vehicle electrification
Lithium-ion batteries and tab lead

The automotive industry is currently undergoing a large paradigm shift, a core of which is the electrification of vehicles and their widespread use on a global scale. Lithium-ion batteries are a key device in electric vehicles. A lithium-ion battery generates DC power through a chemical reaction in which lithium ions move between the positive and negative electrodes. When using this battery, the terminals for connecting these electrodes to the external appliance, or the lead used to draw electricity from the battery, play a very important role. This lead is called a tab lead. Lithium-ion batteries are classified into three types: cylindrical type, prismatic type and pouch (polymer) type. As a pioneer in the tab lead field, the Sumitomo Electric Group started in the late 1990s to supply tab leads for use in smartphones and other consumer electronics. In addition to supplying tab leads for electronic use, the Group is currently making efforts to expand sales of those for pouch-type lithium-ion batteries to be mounted in electric vehicles. The tab leads made by the Sumitomo Electric Group have excellent electrolyte resistance. Since they also comprise an insulation layer that suppresses thermal deformation, they achieve highly reliable sealing performance. The key point in enhancing the heat resistance of tab leads is irradiating the insulation layers (heat-resistant polypropylene). The highly reliable sealing performance of Sumitomo Electric Group's tab leads significantly contributes to enhancing the reliability of the lithium-ion batteries. In other words, the high reliability of lithium-ion batteries is assured through irradiation.

LG Chem, Ltd. is the largest diversified chemicals manufacturing company in South Korea. Since the development stage of their automotive lithium ion batteries, this company has used tab leads made by the Sumitomo Electric Group.

Mr. Geun-Chang Chung
Senior Vice President, Automotive Battery Development Center, LG Chem, Ltd.

LG Chem, a world-leading company in vehicle electrification
High reliability required of tab leads

At present, LG Chem, Ltd. operates in four businesses: basic materials & chemicals, energy solutions, IT and electronics materials, and life sciences. Among them, the company has been particularly committed to the development automotive lithium-ion batteries, the use of which is expected to increase in the near future. The company commenced the development of a pouch-type lithium-ion battery at the beginning of 2000, and began supplying them for automotive use in the late 2000s. Since then, the company has continuously supplied lithium-ion batteries to automobile manufacturers in Europe, North America and South Korea. At present, the company is one of the companies enjoying the top global market share in the automotive lithium-ion battery field.

Geun-Chang Chung, Senior Vice President at the Automotive Battery R&D Center of LG Chem, spoke of the reasons for using tab leads made by the Sumitomo Electric Group as follows: "Safety is very important in manufacturing automobiles. To ensure the safety of automobiles, the pouch-type batteries need to be sealed perfectly; requiring tab leads to maintain extremely high quality and reliability. We highly evaluate the stable quality and high reliability of Sumitomo Electric products as well as their supply capabilities." Twenty years have passed since the initial development of tab leads, and the market environment has been changing drastically. "Today, many companies provide tab leads with high performance, intensifying competition. We expect that the Sumitomo Electric Group will demonstrate even further its capabilities in the production of tab leads that meet customers need."

Against the backdrop of intensifying market competition for lithium batteries, LG Chem is now aiming to develop high-capacity compact lithium-ion batteries as one of the world's leaders and to establish appropriate production systems to respond to the increasing demand for electric vehicles.

"LG Chem is now rapidly expanding its lithium-ion battery production capacity. In order to support our increasingly high-speed production lines, we would like the Sumitomo Electric Group to promote technology development to achieve large-sized tab leads for high-capacity batteries and to narrow the seal width while maintaining the durability. In the future development, we may face unexpected problems. At that time, we hope we can investigate the cause of the problem together and devise a solution."

The Sumitomo Electric Group will respond to the request from the LG Chem by improving the performance of tab leads drawing on its irradiation-crosslinking technology and process engineering technology.

Drawing on expertise in injection molding, optical wiring and material development to offer products that meet the needs of society

Tab leads are made by irradiation and cross-linking. The demand for tab leads is expected to expand. What is the future potential of irradiation and cross-linking? We asked Hiroshi Hayami, General Manager of the Energy and Electronics Materials Laboratory, who is at the forefront of this field.

Hayami says, "Except for tab leads, most of the irradiation and cross-linking products are long, such as electric wires and heat shrink tubing. We have been applying irradiation and cross-linking to injection molding products. For example, engineering plastics are expected to be used for the sliding parts of gears and washers. We are particularly interested in plastic lenses that have solder heat resistance. They have been commercialized as lenses that are not subject to heat deformation even at temperatures for soldering electronic parts to substrates. The lenses are expected to come into widespread use as optical wiring components in equipment because they allow transmission of infrared rays. We will continue to develop the irradiation and cross-linking process from various approaches and apply it to new products."

The Sumitomo Electric Group launched irradiation and cross-linking products in a timely manner in line with the development of electronic equipment (including electric home appliances) and automotive electronics. We remain committed to developing irradiation and cross-linking products that meet the needs of the changing times, as exemplified by tab leads, by taking full advantage of the material development technologies that have been refined through many years of operation. The irradiation and cross-linking process developed by the Sumitomo Electric Group will help "link" the present to a bright future.

World of Irradiation and Cross-Linking for a Bright Future

Sumitomo Electric
The Professionals

"I use my skills and knowledge to connect an ultra-fine gold wire to optical devices. To ensure optimal connection, I have continued to improve my skills to attain higher levels. Having been promoted to a meister, I will pass on the skills that I have acquired to younger engineers."

id
Featured person

Akihiro Miura

Yokohama Support Group
Support Dept.
R&D Planning and Administration Div.
R&D Unit

1979 Joined Sumitomo Electric
Assigned to the Power Cable Group at the Yokohama Works

1986 In charge of the semiconductor process and manufacturing
Yokohama Research Div.
R&D Unit

1994 In charge of development of optical devices (to date)
Yokohama Administrative Section
Business Process Quality & Internal Control Promotion Dept.
R&D Group

2010 Certified as an expert

2018 Promoted to a meister

Wire bonding between parts using an ultra-fine wire of about 20 μm in diameter

Taking Full Advantage of Imagination and Creativity

Outstanding skills that underpin the development of cutting-edge optical communication devices

24 years of experience in implementation of optical devices
Ever-evolving optical transceivers

The Yokohama Works that I work for was established as a development and manufacturing base of communication cables in the Kanto area. At present, it deals with information and communication-related products such as optical fibers and cables, optical connecters, fusion splicers, optical amplifiers, and optical and electronic devices. At first, I was assigned to the production site of power cables. There was a turning point in 1986, eight years after I joined the Company. A new device business was launched at the Yokohama Works, and I was engaged in manufacturing. In 1994, I was involved in R&D related to the implementation of optical devices to manufacture optical transceivers. However, I did not have any experience in this field, so I had to learn from scratch. I took on a new challenge, which was intriguing and exciting. Since then, I have worked on the development and implementation of optical devices for 24 years.

Optical transceivers are one of the priority optical products on which Sumitomo Electric focuses its resources to develop. Electric signals input into an optical transceiver are converted into optical signals on the transmission side, and optical signals are converted into electric signals on the reception side. This is a key device that determines the quality of optical communication. Optical transceivers have been improved continuously to reduce their size, power consumption and cost and increase the transmission speed to meet the needs for higher speed and larger capacity of optical communication. For example, we offer ultra-compact optical transceivers for 100 Gbit/s transmission. Optimal wire bonding between parts is an important technique to maximize the performance of these new products.

Craftsmanship of wire bonding
Requiring high precision of ±5 μm

I am responsible for studying the possible wire bonding between parts and optimizing the layout of parts toward mass production of optical products such as optical transceivers. Wire bonding refers to a process to electrically connect an electrode on a circuit board with an electrode of an electronic part by using an ultra-fine wire of about 20 μm in diameter. The characteristics of parts are significantly affected by the wire length and the bond condition. Namely, wire bonding determines the performance of optical transceivers and the quality of communication. Obviously, wire bonding is performed based on a design drawing, but an automatic wire bonder cannot optimize the wire bonding while checking the characteristics of the parts that have been increasingly integrated and implemented in higher density. I connect ultra-fine wires with high precision within ±5 μm and study the feasibility of mass production based on my skills and knowledge that I acquired during 24 years of experience. The key point is to create the optimal shape for connection and minimize the wire resistance. In fact, this is a highly specialized skill.

Wire bonding is a versatile technique that is used for various applications such as connection between parts that are arranged on a flat surface, between parts that are arranged with a level difference or between parts that are some way apart from each other, as well as more difficult special connection methods such as ribbon wiring for high-frequency signals and stitch wiring between three electrodes. However, there is no well-established or standardized method. It is necessary to identify the peculiar characteristics of parts and equipment based on experience and to optimize wire bonding based on manual skills. The specifications for mass production are determined based on wire bonding and parts layout to market the products. This connecting a wire skill requires craftsmanship. It is an honor to have been certified as the only meister in the company for my advanced skills.

Training younger engineers with enthusiasm

A mission to train younger engineers
A never-ending process to improve skills

I have been certified as a meister not only for my skills but also for my commitment to training younger engineers, which is my important mission. As a trainer, I have passed on techniques to four engineers during the eight years since 2010 when I was certified as an expert. I will carry on this mission even after certification as a meister. Patience is the key to developing human resources. During training within a limited timeframe, I am often tempted to show how to perform wire bonding properly, but I must be patient not to do so. It is quite normal that trainees cannot do it right at first. Trainees should experience the process including mistakes. They can acquire skills only through experience. I am convinced that the efforts to share and pass on my skills to many engineers will directly result in high evaluation of our optical device products in the market.

Recently, I have been engaged in the development of a full-color laser module by taking full advantage of the technique that I have acquired. This product is being used as a projector light source of a robotic mobile phone. In my career as an engineer, I have had a new sense of satisfaction because I have been given an opportunity to deliver a product for general consumers. I assume that imagination and creativity are required because the technique to connect a wire is a manual skill. To achieve optimal wire bonding, I use imagination and creativity and work patiently without giving up until the last moment. That is my style of work. Improvement of skills is an endless process. My skills are not 100% perfect. I remain committed to acquiring more knowledge and brushing up on skills to attain higher goals as an engineer.

Enjoy High-Definition and Vivid Images More Easily with 4K Broadcasts

–Sumitomo Electric to offer a set-top box for 4K satellite broadcasting in April 2019–

On December 1, 2018, 4K/8K satellite broadcasting started in Japan. 4K/8K broadcasting offers higher-definition and more vivid images than conventional hi-vision broadcasting. The Ministry of Internal Affairs and Communications expects that 4K/8K broadcasting will be widely accepted and that many viewers will enjoy 4K/8K programs on commercially available TV sets by 2020 when the Olympic/Paralympic Games will be held in Tokyo. In fact, 4K/8K broadcasting is likely to be deployed on a full scale. Against this backdrop, Sumitomo Electric has developed the Cable Plus™ STB-2,*1 a set-top box for cable TV operators that supports 4K satellite broadcasting and voice commands.

A set-top box is a terminal that converts the cable TV broadcasting signals into a form that can be displayed on TV. The Cable Plus™ STB-2 supports 4K satellite broadcasting. Equipped with a triple tuner, the set-top box can record two programs at the same time*2 while allowing the user to watch another program. Android TV™ allows the user to download various applications from the Internet and to enjoy movies, music and games and obtain information for daily life on TV. Google Assistant™ is also supported to enable operation by voice command to a remote controller included in the package or a Google Home™ speaker. The content search by speech input enables the user to search the broadcast programs, VODs and contents on the web at the same time.

Cable Plus™ STB-2, a set-top box for 4K satellite broadcasting

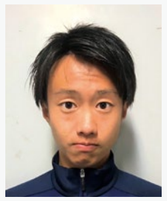
The Cable Plus™ STB-2 will be offered to cable TV operators across Japan through KDDI Corporation from April 2019 in stages.

*1 The Cable Plus™ STB-2 does not support 8K broadcasting.
*2 Some operating conditions must be met for simultaneous recording. An external hard disk (separately available) must be connected to the Cable Plus™ STB-2. TV programs can be recorded on a DLNA-supported recorder on the same home network.

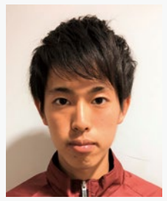
Training Globally Competitive Athletes

–New athletes including Yuki Koike and Shuhei Tada join the Athletics Club of Sumitomo Electric–

(From the left) Sumitomo Electric Chairman & CEO Masayoshi Matsumoto, Yuki Koike, Shuhei Tada, Shunto Nagata and Coach Yasuyuki Watanabe



Hiroyuki Sakaguchi



Hiroki Nagayama

Sumitomo Electric has been supporting track and field athletes with the aim of "training globally competitive athletes." Five promising sprint and long distance runners including Yuki Koike (200 m gold medalist in the 2018 Asian Games) and Shuhei Tada (4 × 100 m relay gold medalist in the 2018 Asian Games) have decided to join Sumitomo Electric. A press conference was held in December 2018 to commemorate their joining the company.* At the press conference, Chairman and CEO Matsumoto expressed his expectations: "I hope that they will become world-class athletes, and play active roles and give excitement to the Japanese people in the 2020 Olympic Games in Tokyo." Each athlete expressed their strong determination to complete in the international events. Sumitomo Electric hopes to contribute to promoting track and field in Japan and developing local communities through the support of sports. The Athletics Club will do its best to meet your expectations. We appreciate your warm support.

* Koike joined the Company on December 1, 2018, and four others will join the Company in April 2019.

Operation of Redox Flow Batteries Starts in the Wholesale Power Market

–Verifying the technique to improve economic efficiency through composite operation of storage batteries in California–

QUARTERLY

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Topics from the future-shaping Sumitomo Electric Group

Expectations are high for storage batteries in various aspects such as ensuring quality of electric power in response to the growing supply of renewable energy via grid connection, attaining efficient operation of electric power, and offering solutions in time of outage. Sumitomo Electric has been developing redox flow batteries, which are large storage batteries characterized by their safety and long service life. Recently, Sumitomo Electric and the New Energy and Industrial Technology Development Organization (NEDO) have started an electric power bidding and trading demonstration project in the wholesale power market in California, U.S. using redox flow batteries to verify the most profitable operation techniques.

California has set ambitious targets for the introduction of renewable energy. Senate Bill 100 (SB 100) was enacted to make the state's electric power completely free of greenhouse gas emissions by 2045. These developments have been accompanied by emerging problems including rapid fluctuations in demand during morning and evening hours and declining power quality due to the shift to photovoltaic power generation. As it is imperative to manage these fluctuations, the state law requires electric power companies to introduce power storage equipment. Thus, a new program has been designed for the wholesale power market to ensure adequate revenues from the storage batteries.

In this demonstration, electric power bidding and trading started in the wholesale power market established by California Independent System Operator using redox flow battery equipment set up in California. To cope with the growing amount of renewable energy, this market requires regulation capabilities to offer short-term output (in kW) such as frequency regulation and supply capabilities to offer long-term electric energy (in kWh) such as energy supply time-shift. The operation of redox flow batteries is free from restrictions in terms of the depth of charge and discharge and the number of charge and discharge cycles. This implies that the redox flow batteries are suited to meeting the charge and discharge requirements in both short-term output and long-term electric energy. Thus, redox flow batteries are expected to attain multi-purpose and flexible operation by outputting power to concurrently meet both short- and long-term fluctuations.

This demonstration aims to flexibly combine multiple trading markets, such as the ancillary service market to procure short-term supply capability and the wholesale power trading market to procure long-term supply capability, to maintain the quality of electric power, verify the most profitable operation techniques depending on the season or specific hours, and increase the economic value of redox flow batteries.

For more information about Redox flow batteries, visit https://global-sei.com/products/redox/

A Picture of Sumitomo Electric in Those Days

1949

Entering the Automotive Wiring Harness Business

Harness assembly line at the Sayama Works of Sumitomo Wiring Systems, Ltd. (opened in 1965)

Making Progress with Japan's Reconstruction

Sumitomo Electric entered the automotive wiring harness* business in 1949. The Company had learned that the U.S. military stationed in Japan would be procuring wiring harnesses to repair jeeps in Japan. Sumitomo Electric did not have any experience in these products. However, the relevant personnel including those who were responsible for designing and manufacturing the products made strenuous efforts. Eventually, the Company succeeded in delivering wiring harnesses for 500 jeeps. Subsequently, it stopped production temporarily, but resumed the wiring harness business in 1959. Anticipating the future potential of the auto industry, it decided to make a full-fledged entry into the business. To operate this business, Sumitomo Electric was responsible for sales, and Tokai Electric Wire Co., Ltd., one of its affiliates (currently Sumitomo Wiring Systems, Ltd.), was responsible for production. In the 1960s, production expanded quickly due to motorization in Japan. In 1966, Sumitomo Electric developed a high-voltage automotive wire in cooperation with Tokai Electric Wire, and received orders in the following year.

In 1995, Sumitomo Electric and Sumitomo Wiring Systems established a joint venture named Harness System Technologies Research, Ltd. (currently AutoNetworks Technologies, Ltd.) to further enhance R&D and created a "trinity" system.

Based on this system, a Group-based project was launched to develop an aluminum wiring harness in 2006 as many countries sought to curb CO_2 emissions. The Company staked its future on this major project. Sumitomo Electric's superior overall engineering capability was highly evaluated, and the aluminum wiring harness was used in automobiles for the first time in 2010. At present, Sumitomo Electric supplies aluminum wiring harnesses to automakers in and outside Japan. The aluminum wiring harnesses are used around the world to help reduce the weight of automobiles and reduce CO_2 emissions.

* Wiring harnesses are arranged throughout an automobile. They are important products to transmit energy and information. They are the automobile equivalent to the blood vessels and nervous system in the human body. For details, refer to the special feature of vol. 02 of id: "Aluminum Wiring Harness: Key Factor in Change of Automobiles and Auto Future".

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Information and videos not posted in this magazine are found on the "id" special site
https://global-sei.com/id/

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