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Sumitomo Electric Group Magazine

vol. 10

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

SUMITOMO ELECTRIC
Connect with Innovation

Feature

Innovative Manufacturing

World of Laser Processing Technologies and High-Performance Optical Components

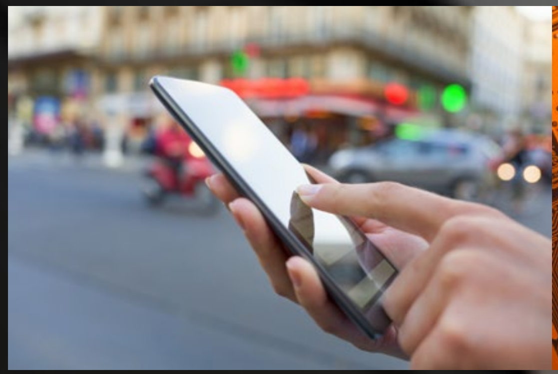
SUMITOMO ELECTRIC GROUP

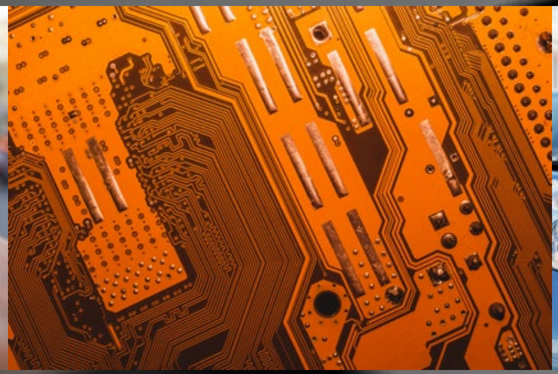
The term laser is an acronym for light amplification by stimulated emission of radiation. A laser beam is an intense artificial light obtained by converting electrical energy into light energy and amplifying it. The energy density of the laser beam is about one million times that of light in the natural world. In 1960 in the United States, the world's first laser oscillation was achieved. Since then, laser performance has improved phenomenally and various laser oscillators and applications have been developed. The features of lasers include monochromaticity, high directivity, light convergence and high energy density. Utilizing these features in the 1980s, laser began to be introduced in the field of materials processing. Lasers enable noncontact, flexible and fast machining (e.g. cutting, welding and drilling). They first penetrated manufacturing worksites in the steel and automotive sectors. Since the 1990s, being recognized as an essential technology, practical use of lasers has advanced in the manufacturing of electronic components for cellular phones and digital home appliances, such as liquid crystal displays and semiconductors, as well as in circuit patterning and other micromachining and the manufacturing of components for 3D printers.

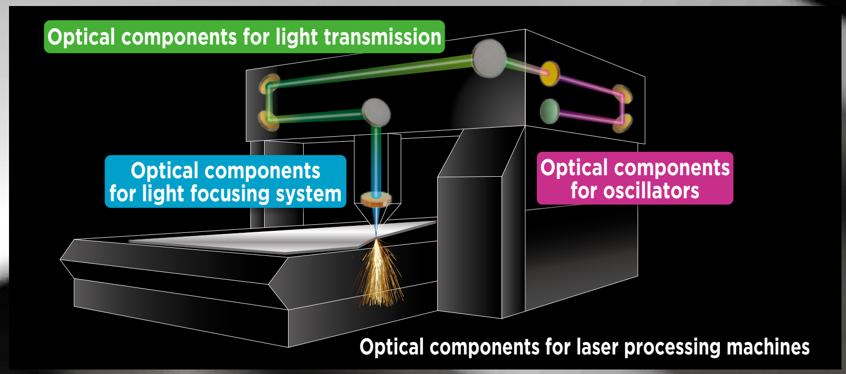
The key components used to exploit the full potential of a laser cutting machine are optical components that include the lenses through which the laser beams converge and mirrors that reflect the beams. The Sumitomo Electric Group developed zinc- selenide (ZnSe) lenses for CO_2 laser cutters in 1985. Since then, Sumitomo Electric has provided diverse types of optical components to meet market needs. The laser is one of the greatest inventions of the 20th century and is said to play a leading role behind the scenes in modern society. Here explores the history and future of the development by the Sumitomo Electric Group of the optical components that support laser processing.

The Laser Revolutionized the Manufacturing Industry

Optical components that support the laser processing technology at its core







Participating in a national project designed to boost the use of lasers

Various product examples developed in-house

Develop lenses that can withstand ultra-high power laser beams!

Development of a ZnSe Focusing Lens for CO_2 Laser Processing

From 1979 through 1984, a national project drawn up by the Ministry of International Trade and Industry (current Ministry of Economy, Trade and Industry) conducted research and development of manufacturing systems incorporating ultra-high performance lasers. The project invited various businesses from different areas of specialization including laser oscillators, mechatronics and system construction. The Sumitomo Electric Group also took part in the project. The Group's mission was to develop optical materials (ZnSe).

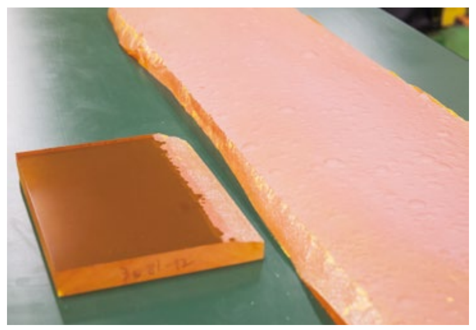
At the time, the only laser capable of delivering a high level of power suitable for laser processing was the CO_2 laser.[*1] To use laser beams, a focusing lens was required to concentrate the beams to an extremely small spot for high energy density. This implied the need to develop a transparent material that would withstand high-power beams. The wavelength of a CO_2 laser is 10.6 µm. One candidate material with high transmittance at this wavelength was the artificial zinc- selenide (ZnSe) crystal.[*2]

*1: A laser oscillator that uses carbon dioxide gas (CO_2) as a medium. The CO_2 laser was put into practical use early to process a wide range of materials such as metal, plastics, fabric, glass, lumber, concrete and paper (by, for example, cutting, welding, drilling, marking and surface modification). The majority of laser processing machines are CO_2 lasers.

*2: Currently, various lasers are available that emit beams of different wavelengths. Accordingly, lenses need to be made of a wavelength-specific high-transmittance material. Typically, ZnSe is used with 10.6 µm wavelength CO_2 lasers, and synthetic fused silica is used with 1.07 µm wavelength fiber lasers.

ZnSe Synthesis Technology Established

In 1980, Hirokuni Namba of the R&D Unit of Sumitomo Electric Industries, Ltd. began to take charge of the development of ZnSe synthesis technology. Drawing on his previous experience in materials research with a focus on superconductors and optical crystal materials, he addressed the challenges of ZnSe synthesis using chemical vapor deposition (CVD) to combine hydrogen selenide gas and zinc vapor. The CVD method was thought of as a thin-film forming technology, feeding a raw material gas onto a substrate placed in a reactor and gradually depositing films through chemical reaction. Forming an ingot (plate crystal) of a sufficient size and thickness for making a lens by continuing the deposition incessantly for several weeks was very challenging.



Zinc selenium (ZnSe) crystal ingot

Zinc selenium (ZnSe) synthesis furnace

"Luckily enough, the company had a wealth of technologies built up previously through research on gallium arsenide, a compound semiconductor. I borrowed a small CVD experimental system that was not being used and conducted preliminary experiments. The experiments provided useful findings for designing a reactor to conduct full-scale research. First of all, to ensure stable crystal production, it was important to design a gas introduction path that could control turbulent gas flows. However, the CVD process involved several different control parameters, such as temperature, flux and gas pressure. Moreover, the project period did not allow the time or support the cost of experimenting with the individual parameters. I observed, analyzed and evaluated synthesized crystals in great detail. Making full use of the knowledge and wisdom on material properties provided by interested people, I racked my brains to work out conditions for the next experiments. Those were extremely hard days. Then, finally in 1984, I had success in producing an ingot (plate crystal) of ZnSe with a sufficient size and thickness that could withstand a high-power laser beam," recalls Namba.

Hirokuni Namba
Former Chief Engineer at Hard Materials Division, Sumitomo Electric

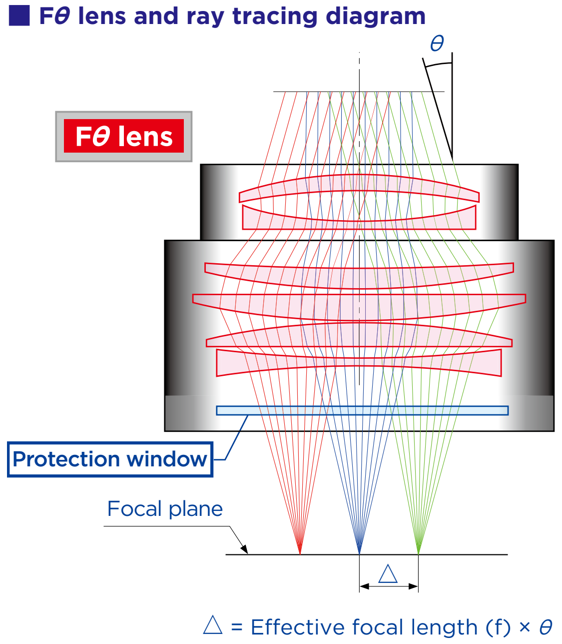
In 1985, Sumitomo Electric installed a line of production equipment for synthesis, polishing and coating and launched the ZnSe lens. In 1990s, it promoted the business on a full scale. However, the results were not satisfactory. At the time, although CO_2 lasers came into wide use for cutting sheet metal, the demand was still small. The ZnSe lens business itself failed to achieve substantial results. Notwithstanding this situation, the staff visited customers frequently, listened to the purposes and uses they required for their CO_2 lasers, and made their best efforts as an optical component manufacturer to respond to those needs. These efforts by the staff laid the foundation for the subsequent optical component business of the Sumitomo Electric Group. It is a shared philosophy for us to propose solutions with customized high value-added products. Various products were developed successively, including parabolic mirrors and water-cooled mirrors for high-power lasers to meet the needs of steelmakers, scanners for welding body sheet steel for automakers and coated products with controlled transmittance and light polarization properties for oscillator manufacturers.

The staff continued groping for ways to expand the business. To achieve satisfactory results, they had to wait until 1996 when they had success developing the ZnSe $F\theta$ lens for CO_2 lasers.

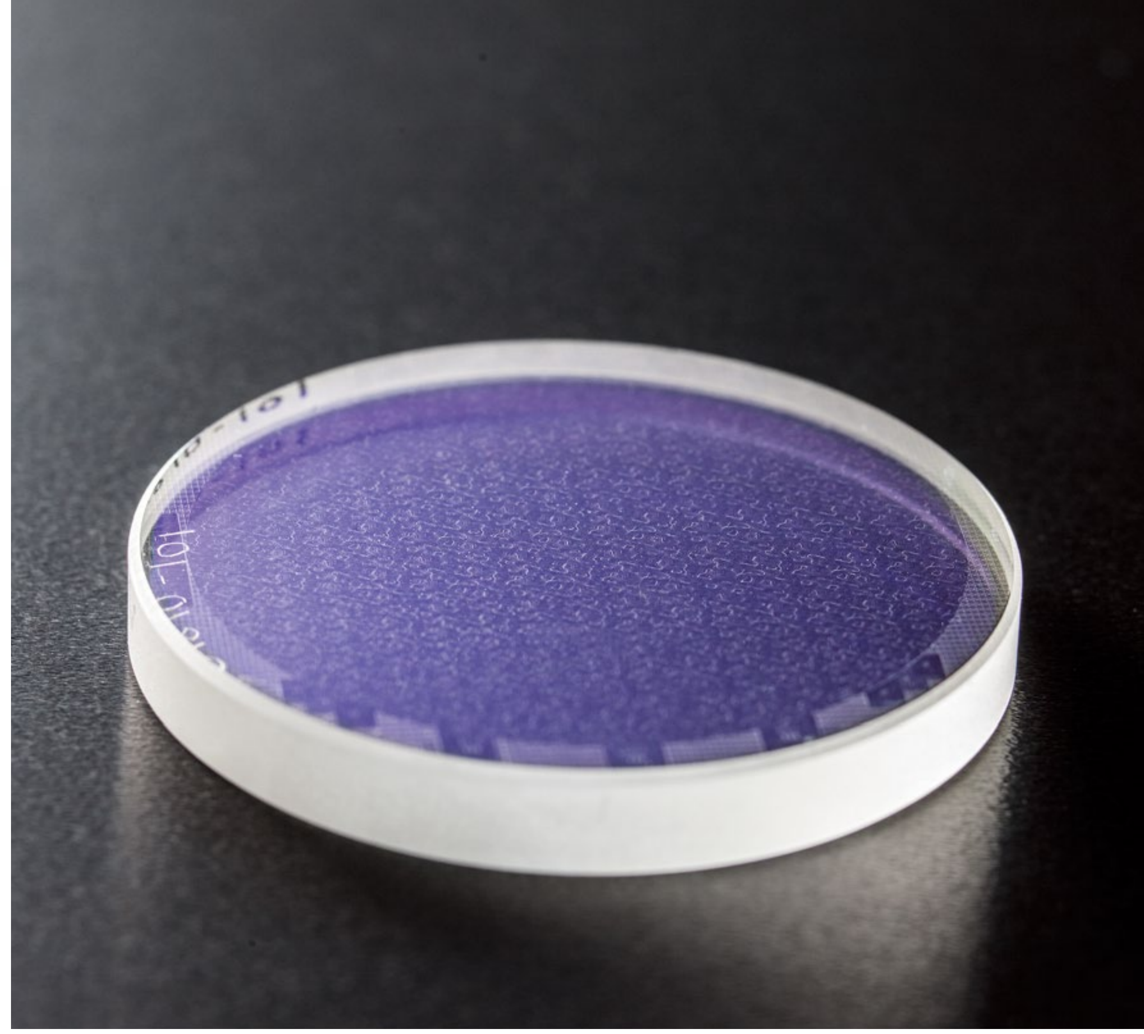
"The $F\theta$ lens for CO_2 lasers was far ahead of our competitors. It was the result of our enterprising spirit and original technology. We were proud of the range of our technologies, which were seen as the world's best at the time, that we used to develop, design and process optical components to meet emerging needs. I believe Sumitomo Electric's technologies still remain the world's best. In the future, I expect those technologies to produce various optical components for lasers, including fiber lasers," says Namba.

Current and former development staff members getting together

■ Fθ lens and ray tracing diagram

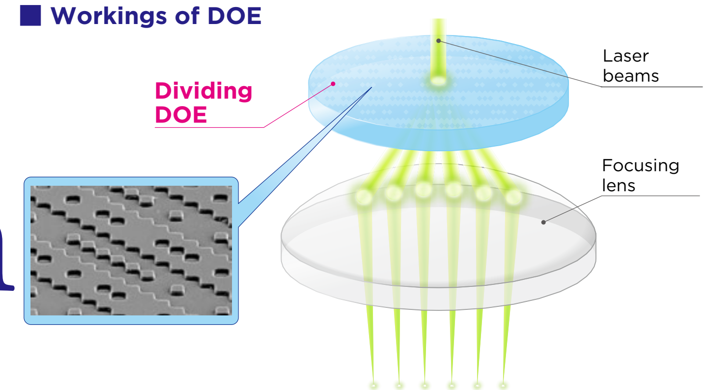


Fθ lens



DOE

■ Workings of DOE



Evolution of optical design technology boosting laser processing technology

Fθ Lens and DOE Delivered through Marketing-First Approaches

High-Performance Fθ Lens Required for High-Speed Micromachining

In today's electronics-based world, demand is high for smaller, lighter and higher-performance electronic devices including smartphones. The process of manufacturing the electronic components incorporated in these devices uses laser processing machines. It is essential for these machines to be capable of high-precision, ultrafine drilling. For example, printed circuit boards in the latest smartphones, whichever the processed portion is, require drilling performed with a hole diameter of 50 µm or less, which is thinner than a human hair, and a hole position deviation of 5 µm or less from the target position. The Fθ lens was developed to enable high-precision drilling at these levels. Even if the laser beams strike the surface at an angle, the lens focuses the beams to a tiny spot almost perpendicular to the flat processing area to achieve uniform holes.

To provide high performance at this level, the Fθ lens is a lens system combining several lenses. Moreover, to control aberration, the Fθ lens generally incorporates aspherical lenses. Takashi Araki of Laser Optics Department of Sumitomo Electric Hardmetal Corporation was involved in the development of the epoch-making Fθ lens.

"The state-of-the-art laser drilling system processes at a rate of 4,000 holes per second. To enable such high-speed processing, the Fθ lens is required to offer a wide processing area

Takashi Araki
Senior Assistant General Manager, Laser Optics Department, Sumitomo Electric Hardmetal Corporation

and light convergence to the smallest-possible diameter (focal point size). However, to provide a wide processing area, the converging beam diameter (focal point size) generally increases, making focal distortion greater in the processing area. In short, there was a trade-off between these two requirements. As a solution to this challenge, it was necessary to use high-precision aspherical lenses and minimize errors in combining several lenses. High-performance lenses are susceptible to manufacturing errors, tending to result in variations in performance. I worked out a robust optical design with sufficient manufacturing tolerances for individual lenses so as not to result in poor light convergence properties, even with manufacturing errors.

Highly integrated circuit (IC) package boards require the highest-precision drilling. In high-density wiring, the drilled holes, if distorted, present the risk of electric conduction failure. The history of the Fθ lens is an achievement of increasingly higher precision drilling made possible by feeding back customers' drilling results to the design and making successive improvements. I am proud that the Fθ lens was developed and has grown as a result of a concerted effort between our customers and us. I believe that the Sumitomo Electric Group holds the world's top technical prowess and market share for Fθ lenses for processing high-performance printed circuit boards incorporated in smartphones and highly integrated circuit package boards. Presently, I am working to increase customer satisfaction by inspecting manufactured Fθ lenses under conditions as close as possible to actual operating conditions," says Araki.

DOE Controls Laser Beams in the Required Manner

A lens or mirror directs the incident beams to converge or reflects them in another direction. Some optical components for laser have other special functions. A typical example is the diffractive optical element (DOE), which uses diffraction of light to control beams in a way not possible with any conventional lens or mirror. For example, a DOE can change the focal shape and intensity in various ways. Moreover, it can divide a beam into many beams. Hirohito Nishi, who has been studying the diffraction theory of light waves since he was a college student, works on designing DOEs.

"Conventional optical designs have been based on the concept of ray tracing (geometrical optics) centering about the diffraction phenomenon. In contrast, DOE designs are based on wave optics, treating light as waves. A DOE has a mosaic-like raised or sunken microstructure on the surface designed through simulation to render a diffraction phenomenon. Wave optics involves highly demanding computational operations. Use of Sumitomo Electric's proprietary design software developed in step with the evolution of the speed and capacity of computers has enabled us to respond to customer design needs in a timely fashion," says Nishi.

The DOE divides one beam into multiple beams and enables simultaneous processing at multiple spots. It contributes to remarkable improvements in mass production capacity for the manufacturing of leading-edge electronic components. It is also effective in improving the quality of laser welding, so its practical uses are progressing in the area of automotive parts.

These high-performance optical components are made possible by constituent technologies that include materials, processing and coating technologies.

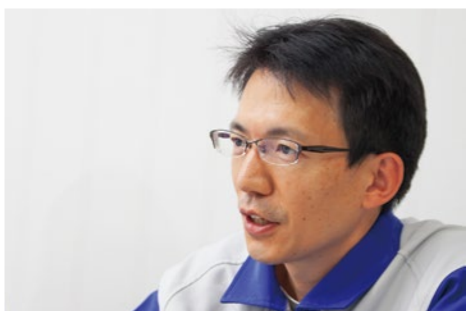
Hirohito Nishi
Laser Optics Department, Sumitomo Electric Hardmetal Corporation

Three key processes: synthesis, processing and coating

Pursuing high quality, high precision and high performance

Moeko Kataoka
Laser Optics Department,
Sumitomo Electric Hardmetal Corporation

Yasuhiro Tsuchiyama
Laser Optics Department,
Sumitomo Electric Hardmetal Corporation



Yukihisa Kusunoki
Assistant Manager, Laser Optics Department,
Sumitomo Electric Hardmetal Corporation

Synthesis Plant in Stable Operation Ensures Product Quality

The ZnSe synthesis technology developed by Namba and others has been steadily passed on. Presently, Moeko Kataoka of the Laser Optics Department of Sumitomo Electric Hardmetal Corporation takes on the mission.

"High-quality ZnSe crystals have low laser beam absorptance. For the latest laser processing machines, the lenses must have a level of absorptance of 0.15% or less. For example, if the incident laser energy is 1,000 W, absorption by the lens should be 1.5 W or less. When the lens absorbs beams and becomes hot, its focal length changes and this change, although slight, defocuses the beam. Simply resistance to damage by the beams, which was the initial development goal, is no longer sufficient. High-precision laser processing can accept no change in the beam focusing properties, even a slight one," says Kataoka.

Plant operation for the production of high-quality ZnSe is not simple. ZnSe synthesized in a batch weighs hundreds of kilograms. The synthesis continues for hundreds of hours. On top of that, once the synthesis starts, no pauses are permitted, even for a fraction of a second. If the process stops and restarts in the middle, optically uniform ZnSe cannot be produced.

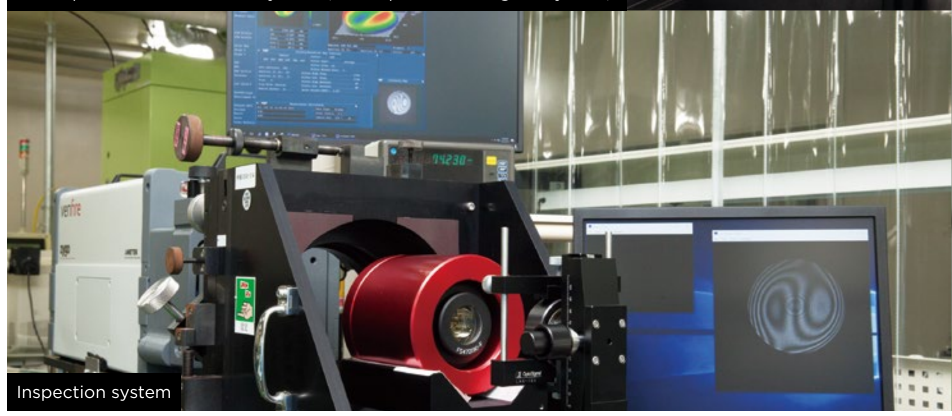
"The synthesis plant uses a flammable and toxic material gas, as in semiconductor production. As such, in addition to the synthesis chamber, all the equipment and systems are placed under constant monitoring, including those for gas feeding, pressure control, exhausts, detoxification and cooling. For constant monitoring of the overall systems and for safe shutdown in the event of a fault, the synthesis plant has a system that incorporates a seismic instrument and an emergency generator. However, if the reliability of the sensors and equipment, which is critical, is low, the result will be frequent shutdown, making profitable mass production impossible. I have conducted long-term field tests on devices, carefully selected error-free sensors and low-failure devices, made the systems redundant, and built a highly reliable plant. My goal is to deliver low-absorptance, high-quality ZnSe by maintaining the optimal parameters and conditions, including the temperature, pressure and gas flow rate. I am now working on introducing artificial intelligence (AI) to detect signs of plant failure," says Kataoka.

Coating oven

Central control board for synthesis

Mass-produced ZnSe lenses

Absorptance measurement system (developed as an original system)



Inspection system

Lens processing system equipped with a robot arm

Aspherical Lenses with Extremely Low Aberration

Generally, lenses used to focus beams are spherical. However, spherical lenses are unable to focus light to the diffraction limit, which is the theoretical minimum diameter, due to their inherent aberration (optical errors). A solution to this challenge is an aspherical lens. Using its cutting technology that features diamond cutting tools and ultra-high precision turning lathes, which it acquired through the development of the Fθ lens, the Sumitomo Electric Group developed a ZnSe aspherical lens for focusing light with minimal aberration. Yasuhiro Tsuchiyama of the Laser Optics Department was in charge of the development of the aspherical lens.

"My recent achievement is the development of an aspherical lens made of synthetic fused silica glass as a focusing lens for fiber laser sheet metal cutters that are rapidly coming into wide use. ZnSe is a relatively soft material and therefore can be cut to form an aspherical surface. Meanwhile, synthetic fused silica is too hard to cut. A new technology has been built to make it aspherical by grinding and polishing. It was also necessary to develop a measurement technique for inspection to check whether the material has been finished to the designed aspherical shape. Aspherical lenses are required to meet a 0.5 µm level of geometrical accuracy or better, which is comparable to the area of an athletics field that has an unevenness of less than 1 mm. To make this geometrical accuracy possible, precision polishing and geometrical measurement technologies have been established at a high level, while also providing quality assurance. Many processing machine manufacturers have selected the product. The aspherical lens has become essential for laser processing machines," says Tsuchiyama.

Young development staff having freewheeling discussions

Efforts Made for Thorium-Free Film Development

Lens surfaces are provided with a coating to prevent the surface from reflecting beams, because even a slight reflection of the light of a high-power laser poses the risk of burning nearby parts. The conventional coating material for ZnSe lenses was thorium fluoride. As advantages, the material absorbs little of the beam and can be vacuum deposited with ease. However, thorium is a radioactive substance. In 2009, the Japanese government issued guidelines that require actions to be taken to ensure safety when handling an amount exceeding a specified level. In line with the recent increasing environmental awareness, the Sumitomo Electric Group undertook development of a thorium-free antireflection coat that uses no thorium fluoride. Yukihisa Kusunoki of the Laser Optics Department was in charge of the development.

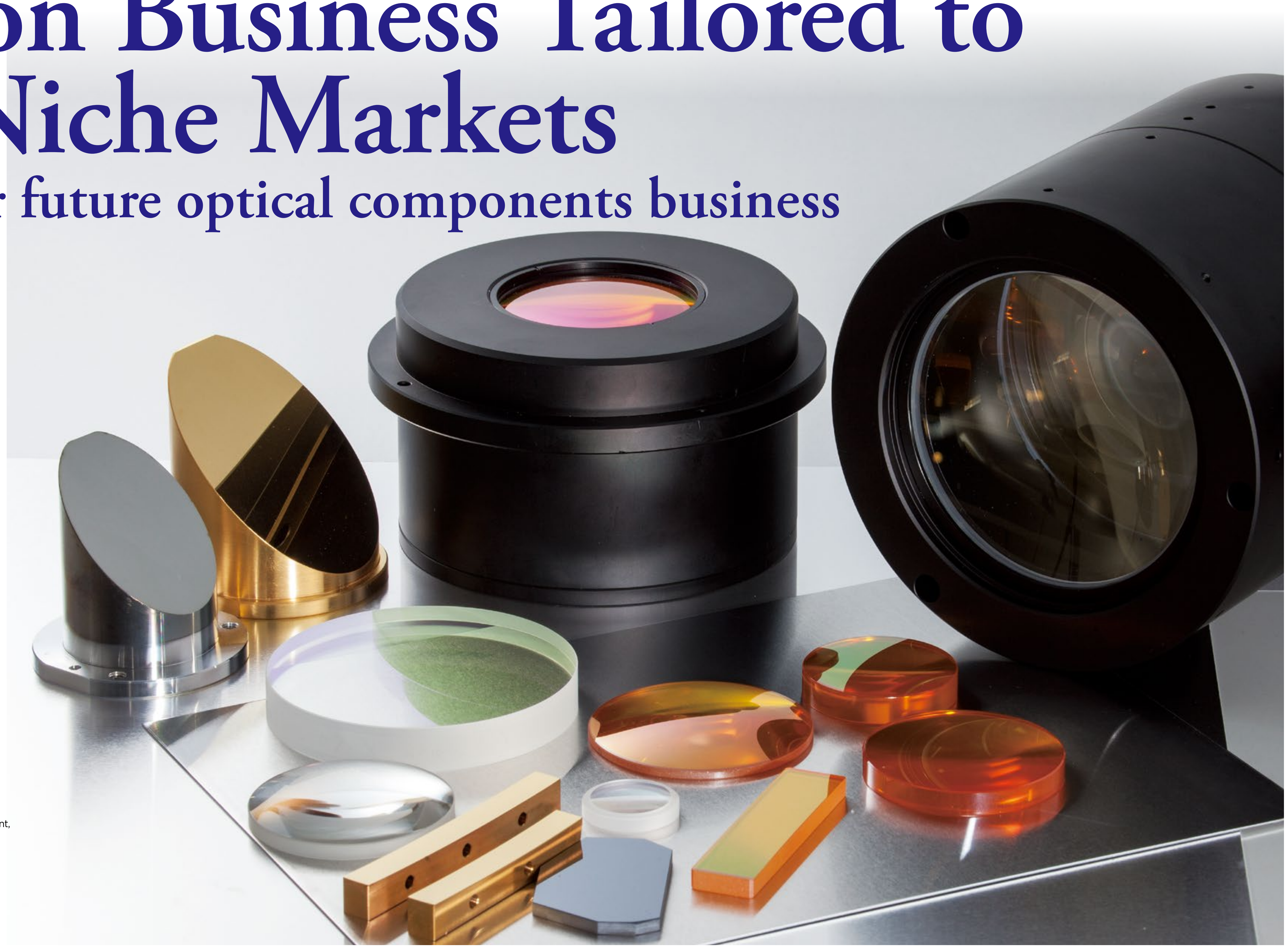
"The biggest challenge was reducing the beam absorptance of the newly developed coating to a level equivalent to or lower than that of conventional coatings using thorium. I read the existing literature extensively. However, no such material exists as a single compound. The development came to a dead end. It was around that time that the idea of blending multiple compounds to give an original composition came into my mind. It was a significant breakthrough," recalls Kusunoki.

Kusunoki and others searched for candidate substances and explored blending ratios for them. Thus, by designing an optical thin film to reduce absorptance and optimizing the manufacturing conditions, they developed a lens using a thorium-free film and put it on the market.

"In the early stages of development, although the product had no problems in terms of its initial properties, the coating sustained damage during extended use on customers' laser processing machines. This problem was experienced frequently and we had difficult times. However, we improved the coating whenever necessary and were able to eliminate the thorium-based process completely from the Company, passing rigorous evaluation tests conducted in-house and outside. Our competitors' optical components still use thorium. The newly developed technology, in my view, demonstrates Sumitomo Electric's competitive edge," says Kusunoki.

Solution Business Tailored to Core Niche Markets

Strategies for future optical components business



Sumitomo Electric's line of optical products including lenses and mirrors

Cultivating Markets through Multifaceted Sales Efforts

The Sumitomo Electric Group optical components are the culmination of its technical excellence. Now the focus is on how to expand the Group's market, Tsugutoshi Okuno of the Direct Sales Accounts Department of the Hardmetal Division talks about future sales strategies.

"In recent years, the use of laser processing has become extensive. Its applications are not limited to smartphones and automobiles. Almost all manufactured products and incorporated constructional elements are delivered using laser processing. Demand is rapidly growing for purpose-built machines customized to specific processes. In past years, Sumitomo Electric's optical components have been applied to general-purpose machines built by major manufacturers of laser processing machines for sheet metal and printed circuit boards. Currently, we are directing our efforts toward winning orders for high value-added customized products designed for various purpose-built machines. By proposing and providing ideal optical components fulfilling specific individual needs, we help our customers improve their productivity and product quality. Our efforts include building a network in the laser processing industry and collaborating with system integrators who manufacture purpose-built machines, as well as with related device manufacturers. In addition, we are strengthening our relationships with parts manufacturers who use purpose-built machines. Thus identifying new laser processing needs, we work on developing suitable optical component products to fulfill these needs."

Tsugutoshi Okuno
Senior Assistant General Manager, Direct Sales Accounts Department, Hardmetal Division, Sumitomo Electric Industries, Ltd.

Erina Yamamoto
Sales Division, Takara Sangyo Co., Ltd.

Yu Yasuda
Sales Division, Takara Sangyo Co., Ltd.

Takara Sangyo Co., Ltd., a member of the Sumitomo Electric Group, also plays a part in promoting sales of the optical components. Ms. Erina Yamamoto of Sales Division of Takara Sangyo says, "The first step in our sales activities is to ascertain the exact goals that our customers want to achieve using lasers.

"Our customers' true challenges and needs become clear after repeated interviews. One important aspect of the intermediation between clients and the development departments of the Sumitomo Electric Group is to work out the final shapes of products by coordinating the specification requirements and product feasibility. It is sheer joy for me to see that optical components made possible through these repeated negotiations help produce state-of-the-art products all over the world, including the electronics devices and automobiles launched each year. As for the future, my goal is to acquire the capability to open new sales frontiers that will create new markets and industrial sectors, by actively introducing the Sumitomo Electric Group's optics technology to new customers," says Ms. Yamamoto.

Takara Sangyo Co., Ltd. will contribute to the overseas sales expansion for optical components vigorously promoted by the Sumitomo Electric Group. Ms. Yuu Yasuda of Takara Sangyo participated in Photonics West, the world's largest optics technology exhibition held in San Francisco in the United States. She says: "I really felt the size of the global market for optics-related products. I am committed to actively building positive relationships between new overseas users and the Sumitomo Electric Group, thereby contributing to the overseas sales expansion now being promoted so vigorously by the Group."

Meanwhile, Takara Sangyo is taking new approaches to improving customer satisfaction. Their efforts include procuring items not carried by other companies in the Sumitomo Electric Group, such as laser beam power sensors, and proposing integrated systems that combine those items with the Group's products.

Moving Forward with and beyond the Optical Solutions Business

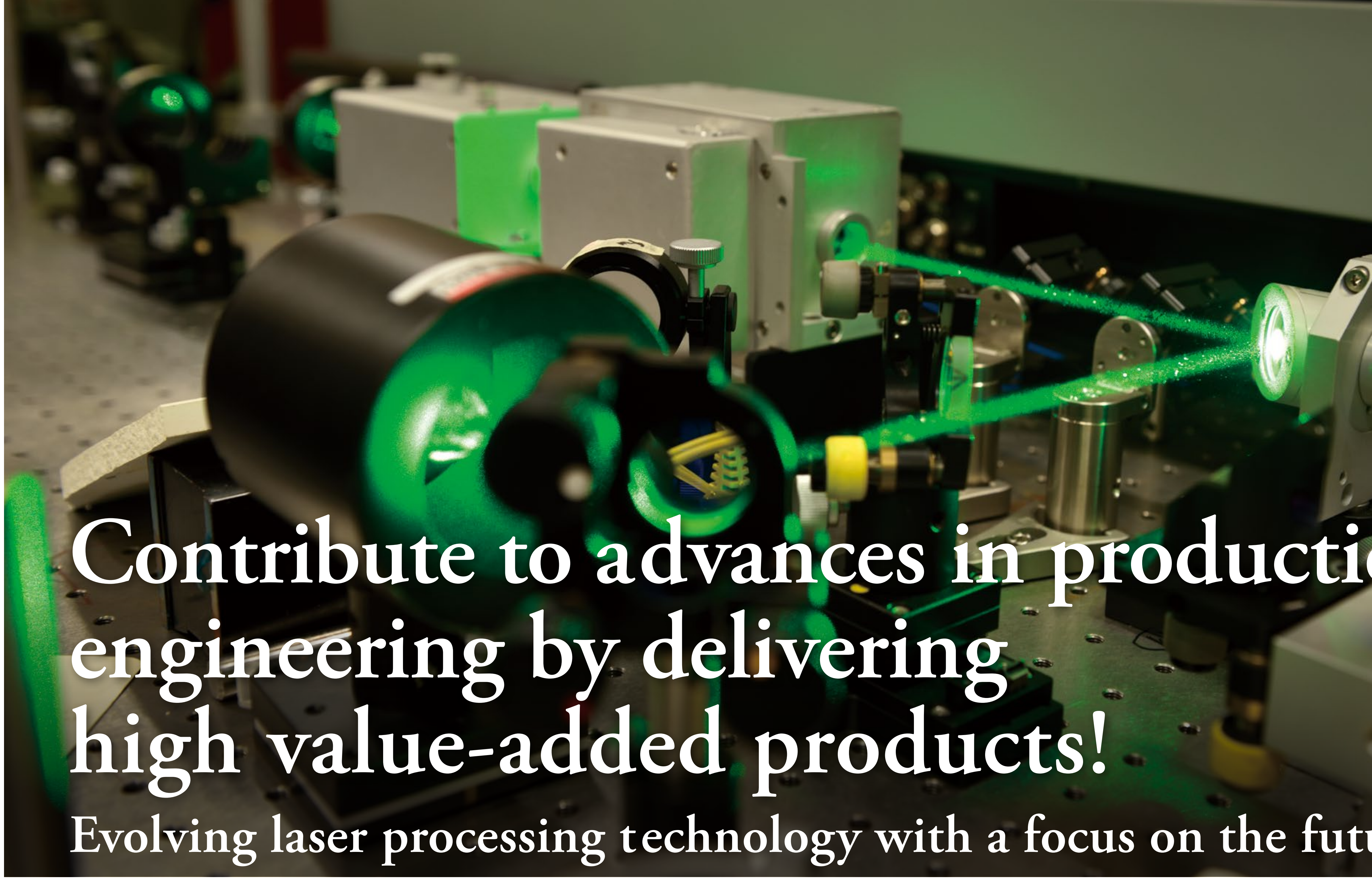
In sync with the sales staff, the development staff is also working vigorously. Keiji Fuse, Department manager of the Laser Optics Department of Sumitomo Electric Hardmetal Corporation believes that marketing-first approaches lead to progress in laser processing technology.

"Sumitomo Electric has developed a framework that enables it to propose and provide an extensive and comprehensive range of optical components from fundamental products such as lenses and mirrors to high-performance products such as Fθ lenses and DOEs. Specifically, since the 1990s, the Company has aimed to provide entire optical system solutions combining optical components in an ideal manner according to customer needs. Sumitomo Electric has a history of developing various optical components and optical system products in collaboration with its customers and has great achievements. While the business has focused on the domestic market, inquiries from overseas customers have been increasing. In cooperation with its overseas affiliates and agents, Sumitomo Electric is strengthening its framework and promoting sales. For the future, we aim to make proposals to provide follow-up services for overall processing machines including laser oscillators and peripheral devices, not only related to their optical properties, but also their laser processing characteristics. The result of our work to help our customers achieve business success means that Sumitomo Electric will be valued more highly and be the company of choice. I hope that these efforts will lead to the development and widespread use of laser processing technology, contributing to the growth of society," says Fuse.

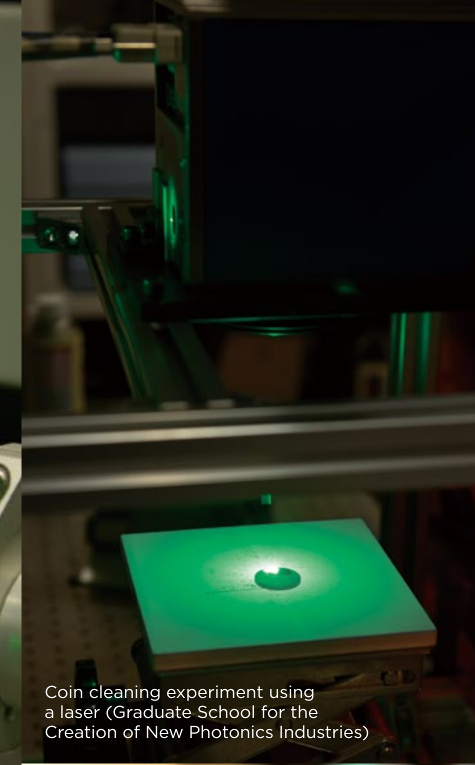
Keiji Fuse
Department Manager, Laser Optics Department, Sumitomo Electric Hardmetal Corporation

Contribute to advances in production engineering by delivering high value-added products!

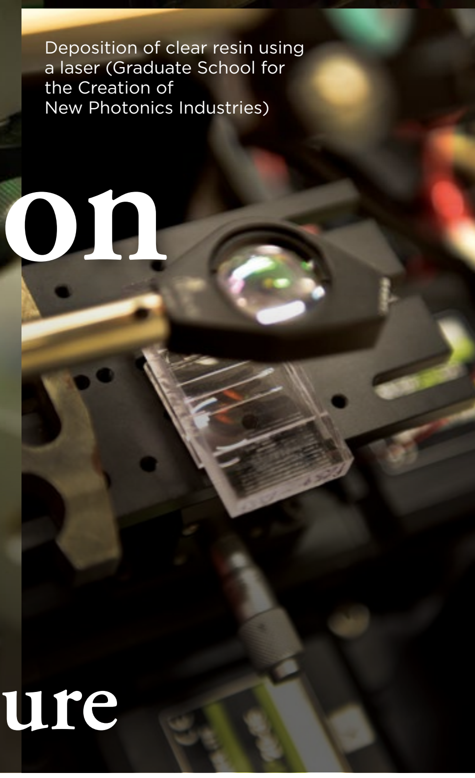
Evolving laser processing technology with a focus on the future



Laser wavelength conversion system under experiment (Graduate School for the Creation of New Photonics Industries)



Coin cleaning experiment using a laser (Graduate School for the Creation of New Photonics Industries)



Deposition of clear resin using a laser (Graduate School for the Creation of New Photonics Industries)

Nozomi Ushijima
Executive Vice President & General Manager, Advanced Materials Business Unit, Sumitomo Electric

Active Overseas Operation and Use of Laser Technology for Production Engineering

The Sumitomo Electric Group's optical components lead manufacturing, meeting the demands of the times. Nozomi Ushijima, General Manager of the Advanced Materials Business Unit talks with hope about the future prospects of the Production Group.

"First of all, it is important to provide high value-added products. I believe that our proprietary products, which remain unmatched by our competitors, differentiate us from the competition. Germany and the United States are leading countries in laser technology. The technology has been flourishing recently in Taiwan, Korea and China. Sumitomo Electric has been actively tapping these markets. It has already shipped lenses to major laser processing machine manufacturers abroad.

We are also working on deploying our laser technology to production engineering within the Sumitomo Electric Group. For instance, materials for Sumitomo Electric's tungsten-carbide cutting tools and synthetic diamond tools are extremely hard and are difficult to machine. Notwithstanding their hardness, these materials can be shaped in a noncontact and highly flexible manner through the use of laser processing. Laser processing is a very useful technology in the drive to provide higher-performance cutting tools to society. Used actively, Sumitomo Electric's optical components technology can be the driving force toward that goal."

The Graduate School for the Creation of New Photonics Industries

An Interview with Mr. Akihiko Tsuboi, a Leading Figure in Laser Processing: "What is demanded is a technology that enables light to be controlled freely."

The Graduate School for the Creation of New Photonics Industries is located beside Lake Hamana in Hamamatsu in Shizuoka Prefecture. The school opened in 2005 with the aim of using photonics science and technology to train human resources capable of creating innovative industries. Mr. Akihiko Tsuboi, Vice-President and Professor on the Graduate Course for the Creation of New Photonics Industries is a leading person who has worked for industrial application of laser processing for about 30 years since the early phases of CO_2 lasers. He was interested in the potential of the laser when he was an employee at a major auto parts manufacturer. Subsequently, he founded a venture specializing in laser processing. Mr. Tsuboi helped many manufacturers to put the technology into practical use and led the progression and wide use of laser processing technology in Japan.

"Laser processing technology still has a long way to evolve. Seeds of novel ideas have emerged one after another, suggesting the technology's profound potential," says Mr. Tsuboi.

Presently, Mr. Tsuboi serves also as the Director of the Applied Laser and Innovative Technology Institute in the Tsuruga Comprehensive Research and Development Center of the Japan Atomic Energy Agency. He promotes research to apply laser processing to decontamination and structural cutting for reactor dismantling. This application makes the maximal use of the advantages of the laser, which are noncontact and high-power operation. It is also a challenge of extremely great social significance. The laser processing machine that is currently at the development stage for use in reactor dismantling uses the world's highest 100 kW class ultra-high power laser, which was previously inconceivable. Mr. Tsuboi points out:

"Streamlining or productivity improvements cannot be made possible simply by introducing a laser. Lasers are not almighty. Initial investment for a laser is large. The wisdom of an engineer who has a good command of the technology is important. Given that an oscillator that emits laser beams is analogous to the engine of an automobile, lenses and other optical components are analogous to the drive unit. A car fails to move if the drive system is out of order. Similarly, I consider that the optical system is the core of laser processing. What is important is the manner in which the oscillator, optical components and processing conditions are combined in building the overall processing technology for each application."

Mr. Akihiko Tsuboi
Vice-President and Professor on the Graduate Course for the Creation of New Photonics Industries, the Graduate School for the Creation of New Photonics Industries

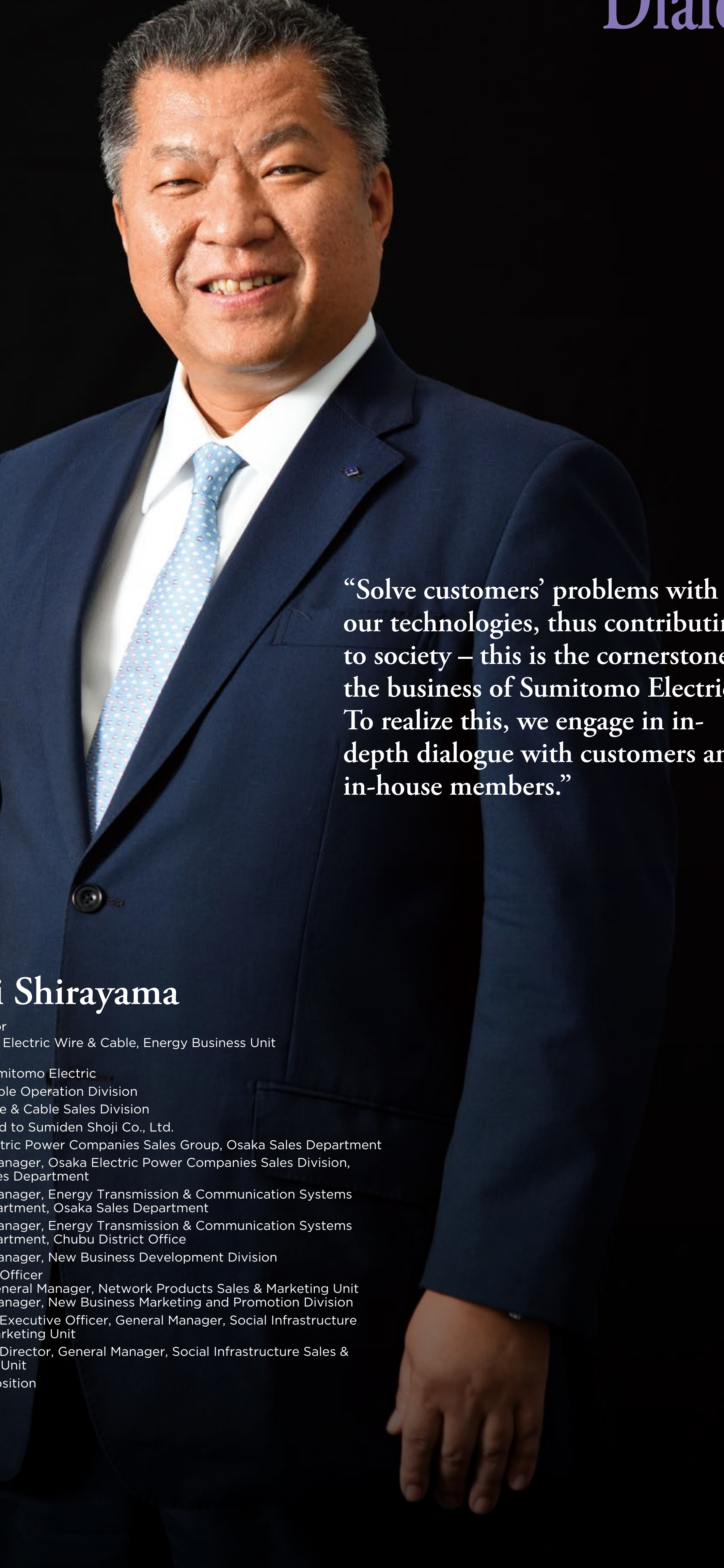
Mr. Tsuboi and the Sumitomo Electric Group have collaborated as business partners since the 1990s. For future laser processing, it is appropriate to ask what elements optical components need to have and what expectations exist for the Sumitomo Electric Group.

"Laser processing is employed in various fields. People at manufacturing worksites seek to carry out the desired processing in a flexible manner. For instance, they want to control the laser beam shape or divide the beams in the middle of processing a workpiece. Laser oscillators are important; at the same time, controlling the optical system plays a major role. Demand exists for the technology or product that can actively and freely control the beams; this involves knowing the beam profiles accurately and optimizing the energy distribution. Expectations are high for the Sumitomo Electric Group's superb optics technology and product lines."

Regarding future prospects, he continues: "The Sumitomo Electric Group has already built customer trust as an optical component manufacturer and is ahead of its competitors in engineering prowess. This is beyond doubt. The Group's technologies will spark a great transformation and evolution in every aspect of laser processing."

The Sumitomo Electric Group will continue to meet the challenges involved in exploring novel areas of optics for the laser to reach its full potential.

Sumitomo Electric
The Professionals



"Solve customers' problems with our technologies, thus contributing to society – this is the cornerstone of the business of Sumitomo Electric. To realize this, we engage in in-depth dialogue with customers and in-house members."

id
Featured person

Masaki Shirayama

Managing Director
General Manager, Electric Wire & Cable, Energy Business Unit

1985: Joined Sumitomo Electric
1986: Wire & Cable Operation Division
1987: Osaka Wire & Cable Sales Division
1996: Transferred to Sumiden Shoji Co., Ltd.
2001: Chief, Electric Power Companies Sales Group, Osaka Sales Department
2004: General Manager, Osaka Electric Power Companies Sales Division, Osaka Sales Department
2007: General Manager, Energy Transmission & Communication Systems Sales Department, Osaka Sales Department
2008: General Manager, Energy Transmission & Communication Systems Sales Department, Chubu District Office
2012: General Manager, New Business Development Division
2013: Executive Officer
Deputy General Manager, Network Products Sales & Marketing Unit
General Manager, New Business Marketing and Promotion Division
2014: Managing Executive Officer, General Manager, Social Infrastructure Sales & Marketing Unit
2017: Managing Director, General Manager, Social Infrastructure Sales & Marketing Unit
2018: Current position

Dialogue, Communication, and Unwavering Passion

To solve customers' problems with our technologies

Experience of a big project at a young age

In my university days, I spent much time travelling around Japan by motorbike and was not a very industrious student. But as a student specializing in economics, I developed a logical way of thinking. When searching for a job, I wanted to do something through which I could contribute to society in a tangible way, and thought that I could do so by working at a manufacturer. The main reason why I joined Sumitomo Electric was that while interacting with my university's alumni working at the company, I felt that my personality would make me suitable for working there and that I would be able to fully demonstrate my capabilities. In addition, I heard that the company had a corporate culture in which even young employees were entrusted with important responsibilities.

In fact, even when I was young, I was assigned a number of important Japanese power infrastructure projects. I was appointed as the first Sumitomo Electric staff in charge of a project for the divided and privatized Western Japan Railway Company (JR West). In addition, I was engaged in a project for the Honshu-Shikoku Bridge Authority, and also served as a sales representative of power cables for Kansai Electric Power Company (KEPCO). In particular, my experience as the person in charge of power transmission for the big KEPCO project of installing the Anan-Kihoku DC trunk power line laid the foundation for my subsequent career. In the project for installing the trunk line for power interconnection between Kansai and Shikoku, an approximately 50 km-long submarine cable with the world's highest capacity of DC 500 kV was adopted. The project involved a wide variety of the latest technologies available in those days, including high-speed installation and embedment equipment. Sumitomo Electric served as the coordinator of the joint project promoted by four electric wire and cable manufacturers. My role was to design the entire scheme and figure out how to realize it, though I was still in my 20s. Since I did not have sufficient experience or expertise back then, I emphasized dialogue. I expected that nothing would proceed if I tried to think by myself. Explore answers by engaging in in-depth dialogue with customers and in-house members, and find optimum solutions by forming ties between people – this approach later developed into my approach as a sales representative.

Overwhelming market share achieved through solid teamwork

In 2001, when J-Power Systems Corporation (JPS) was established as a joint venture of Sumitomo Electric and Hitachi Cable, Ltd. (presently Hitachi Metals, Ltd.), the power cable business of Sumitomo Electric was split up. This led to the removal of power cables from the list of the items that we handled at the Osaka Electric Power Companies Sales Division, with the number of staff members in the division reduced to five. As the manager of the division, I needed to consider how to overcome the situation that we had almost nothing to sell. In that environment, I paid attention to fiber-to-the-home (FTTH), which was beginning to spread. I considered the possibility of installing optical fiber and making the FTTH service available. In those days, the key players in the field were the telecommunication carriers, but power companies, namely our customers, were also keen to make inroads into the market. This meant that competition for obtaining service users had already been launched between telecommunications carriers and power companies. I set and shared targets with the members of my division, and engaged in enthusiastic efforts to present proposals to our customers to solve their problems regarding cost and time reduction for making the FTTH service available. As a result, we successfully obtained an outstanding top market share and established firm partnerships with our customers. This experience convinced me that even a small team could surely achieve a breakthrough if the team demonstrated solid teamwork and continued to push forward toward its target. We worked under the slogan "Passion (Make It through with Passion), Aggressive (Be Aggressive in Finding Solutions), Speed (Act at a Surprising Speed), and Specialty (Improve Yourself Every Day)." These words represent everything that all of us in the division valued in those days. In particular, we focused on "Speed," because speed itself is an excellent service and is the basis for earning trust from customers. For example, to address customers' needs by reducing the time for making the FTTH service available, we launched a design center, thereby developing and providing products quickly.

Untiring efforts to establish ourselves in the global market

Afterwards, I was in charge of new business development and social infrastructure sales. For example, I was involved in the data center business, which made me once again confirm my working style. I ensured that various products and services were

developed based on what were needed at data centers, meaning that we focused on appropriately identifying customers' problems and solving them with our technologies. With an increase in the amount of information to be handled, many optical fiber cables were needed at data centers, making our customers want to store such cables at high densities in their limited space. After identifying the problem, we soon developed new products, resulting in strong relationships with our customers.

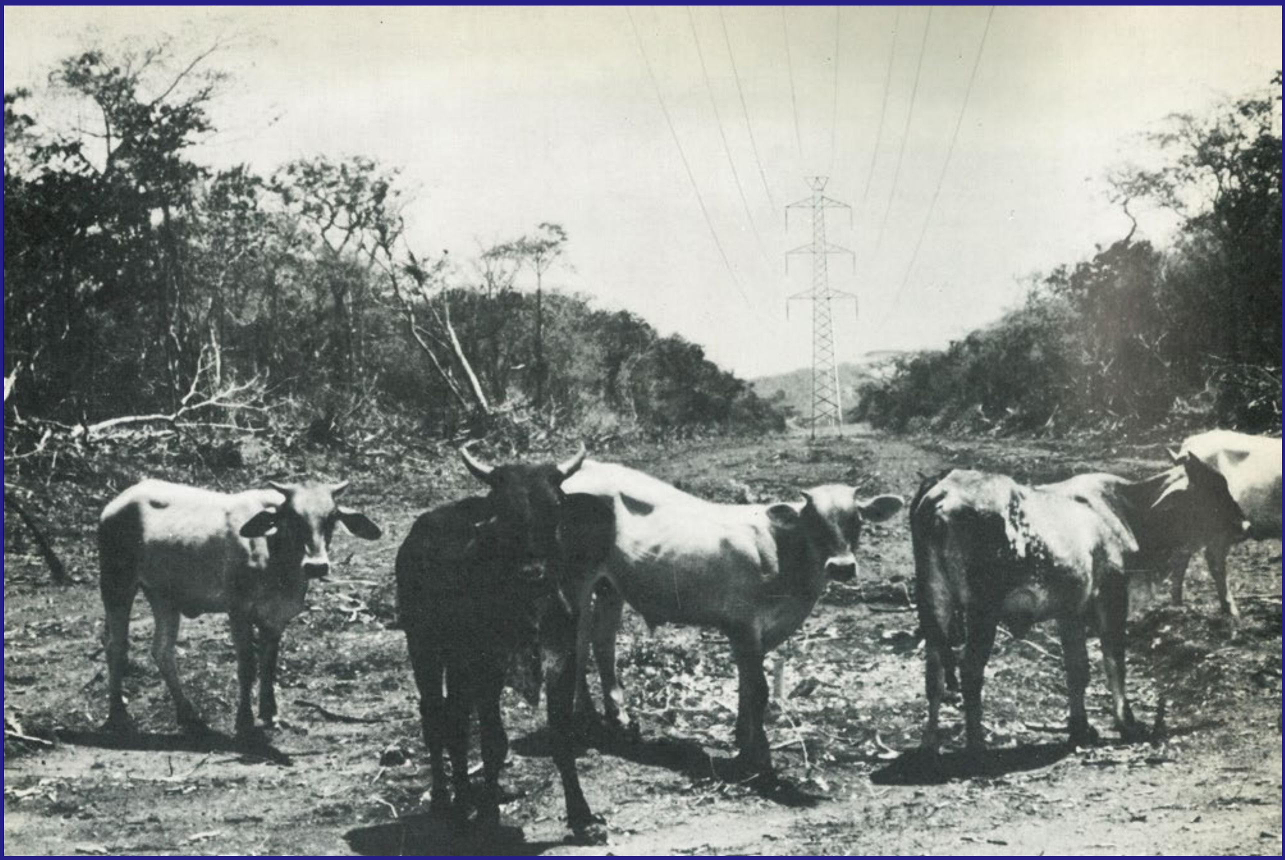
Presently, I'm responsible for the power cable business. Our strong point lies in our capability to provide an all-in-one package of our long-accumulated, distinctive technologies, materials, equipment and systems. We will continue to make inroads into promising markets where we can demonstrate such strengths. Today, the number of large projects involving the installation of submarine cables for flexibly supplying and consuming power internationally is increasing. The main market is in Europe. Recently, we completed the U.K.-Belgium Interconnector Project,* using a DC cable with low transmission loss. Our insulation technology, which is the world's most advanced, was evaluated highly. We would like to continue to take on challenges without hesitation regarding projects for which our strengths could be utilized. In addition, we are also striving to go global in the volume zone market, or the land cable market. We plan to reinforce our manufacturing capability in terms of quality and cost and cultivate markets centered on India and Asia, which are showing remarkable economic growth.

In all of these efforts, our mission is to solve customers' problems with our technologies, thereby contributing to society. To fulfill this mission, we need to establish relationships of trust with our customers. This is true in all phases of a relationship between a company and a company, an organization and an organization, or a person and a person, and all such relationships are underpinned by dialogue. If you engage in in-depth dialogue with a customer, you will be able to identify the customer's problem and present a proposal for solving it. I believe that those with dialogue skills, communication ability and unwavering passion will play the main role in the future of Sumitomo Electric.

A Picture of Sumitomo Electric in Those Days

1963

First Overseas Conductor Project (Venezuela)



Conductors installed in Caroni, Venezuela

Construction Laying the Foundation of Our Overseas Business

In 1963, we won an overseas conductor project for the first time – the Caroni conductor project in Venezuela, South America. Designed to cover 650 km from a power station to the capital Caracas with two lines of 230 kV conductors, the project consisted of three sections. We received an order for the second section (the line was 132 km, requiring 345 pylons and total construction cost was 800 million yen). We were entrusted with all the work for the second section, including measuring line lengths, providing materials, such as conductors, pylons and insulator units, conducting foundation and assembly work for the pylons, and erecting bridges. The management and supervision of the entire project and the communication with staff members based in Japan were all handled by only two employees: one from Sumitomo Electric and the other from Taiyo Densetsu Co., Ltd. (presently Sumitomo Densetsu Co., Ltd.). Spanning a jungle and a grassland stretching as far as the eye could see, the second section was successfully completed two years later, ahead of the other parts.

It was around that time that we established the first-ever pylon destructive test facility in Japan on the premises of the Laboratory. By doing so, we subsequently accelerated our research on and rationalization of pylon design, leading us to enhance our international competitiveness.

In 1967, we also founded the a construction Method Laboratory to provide special training programs for engineers specializing in power facility construction and overseas conductor construction. These experiences greatly contributed to our subsequent success in winning orders for large overseas projects, such as those in Peru in 1978, in Columbia in 1981 and 1984, and Chile in 1983 and 1986. Even though each of these projects was handled by a single employee, all of them were completed successfully before their deadlines, resulting in a high evaluation of our engineering and material management capabilities.

id vol.10

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https://global-sei.com/id/

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