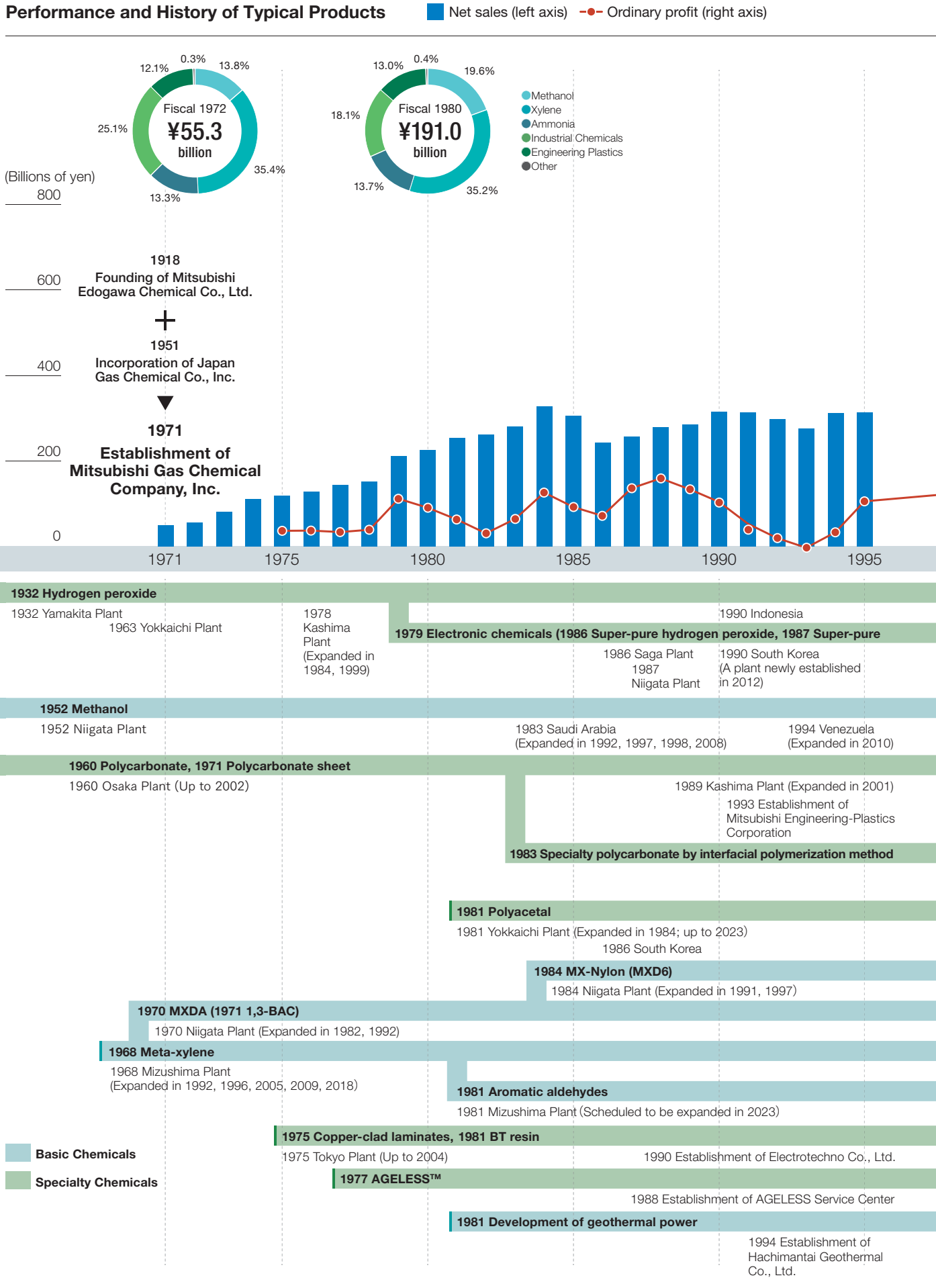
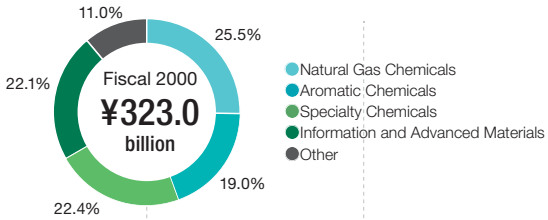
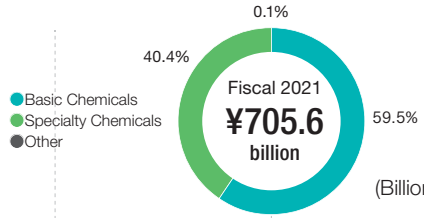
MGC Group's History

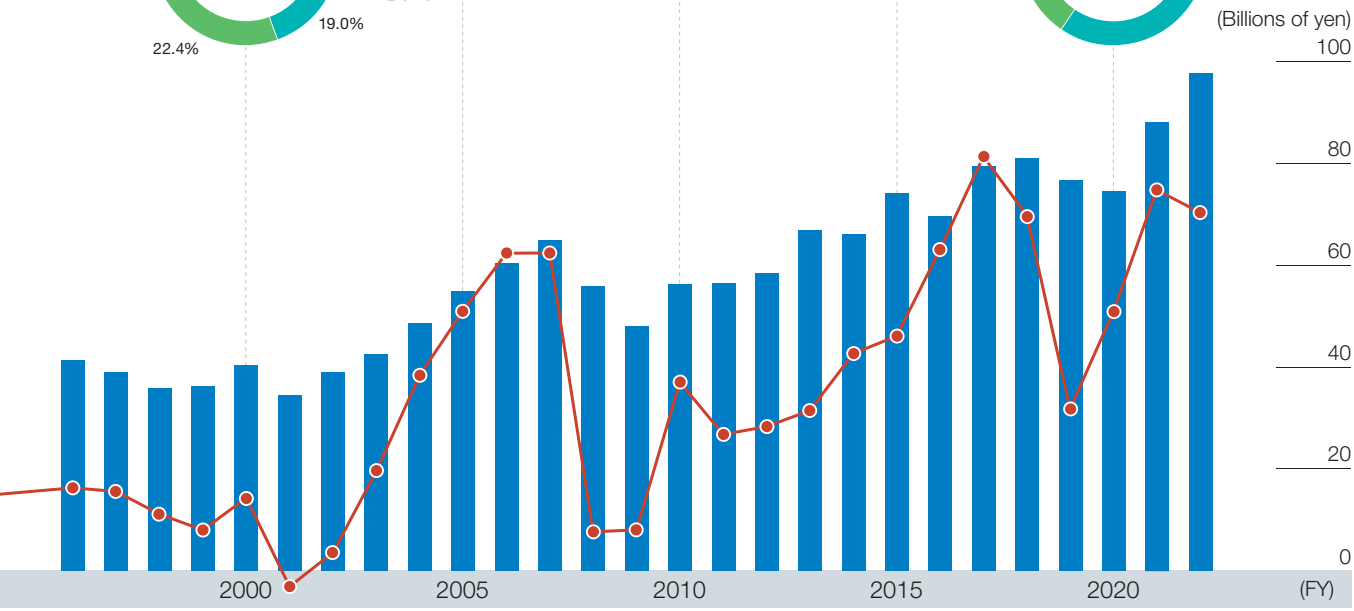
Performance and History of Typical Products



Note: Non-consolidated figures shown for fiscal 1971-1976, consolidated figures shown for fiscal 1977 onward







2009 China (Relocated in 2018)

ammonium hydroxide)

1995 United States (Plants newly established in 2020, 2021; scheduled to be expanded in 2023)
1998 Singapore (Expanded in 2001)
2000 Taiwan

2010 Brunei
2020 Trinidad and Tobago

1997 Thailand (Expanded in 2003)
2005 Establishment of MGC Filsheet Co., Ltd.
2011 China

1998 Lens monomer, 2000 Melt polymerization special PC (Optical resin/polymer)

1998 Naniwa Plant (Expanded in 2001)
2002 Kashima Plant (Expanded in 2010, 2016, 2019, 2022)

1996 Thailand
(Expanded in 2003, 2012)
2002 China

2004 United States

2007 Mizushima Plant (1,3-BAC; expanded in 2017)

(now MGC Electrotechno Co., Ltd., expanded in 2007) (Newly established in 2013; expanded in 2022 in Thailand)

2004 PharmaKeep™

(now MGC AGELESS Co., Ltd.) (Newly established in 2001, Thailand; 2016, Fukushima)

(now Hachimantai Green Energy Co., Ltd.)
(Started operations in 1994 to supply steam to Sumikawa Geothermal Power Plant)

2010 Establishment of Yuzawa Geothermal Power Corporation (Started operations in 2019 at Wasabizawa Geothermal Power Station)

2015 Establishment of Appi Geothermal Energy Corporation

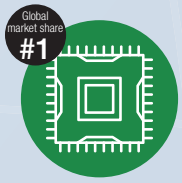
Building Competitive Advantage

Super-pure hydrogen peroxide

Global production capability ensures a stable supply of high-quality products to meet the needs of the most technologically advanced customers

Primary applications

Cleaning agents and etching agents for semiconductors



BT products

Proprietary materials with superior low-reflectivity and electrical properties, able to keep pace with the evolution of the semiconductor market

Primary applications

IC plastic package substrates (smartphones, computers, IT appliances, etc.)

Optical resin/polymer

Balances high refractive index with low birefringence, contributing to enhanced camera functionality

Primary applications

Materials for smartphones and other compact camera lenses
*As a highly refractive resin (concave lens)

Polyacetal resin (POM)

Engineering plastics offering superior wear resistance, low friction and chemical resistance

Primary applications

Automotive components, electronic components, office automation equipment

Meta-xylenediamine (MXDA)

Superior rapid curing, anticorrosion and chemical resistance

Primary applications

Epoxy resin curing agent (paint for bridges, ships and industrial pipes and ducts), raw material for MX-Nylon

MX-Nylon (MXD6)

High gas barrier properties contribute to weight reduction of PET bottles

Primary applications

Food packaging materials, PET bottles, engineering plastics

Aromatic aldehydes

Customized to customers' requirements using proprietary production methods that are efficient and have low environmental impact

Primary applications

Resin additive (agent that renders polypropylene transparent) and fragrances

Methanol

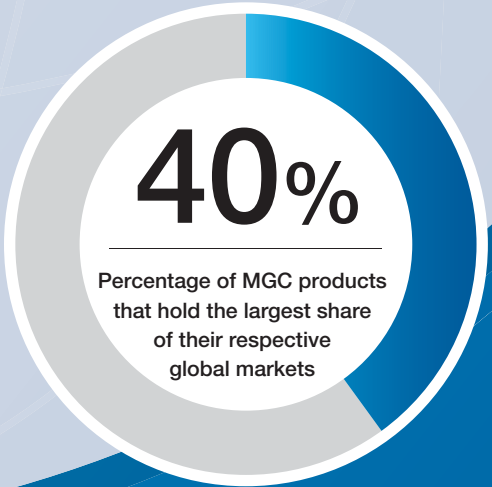
World's only comprehensive manufacturer with proprietary catalyst technology and complete methanol value chain, from manufacture to sales of derivatives

Primary applications

Raw materials for formalin, acetic acid, etc., intermediate materials

Basic Chemicals Specialty Chemicals

(Global market share, etc. are estimates made by the Company)



Creating Differentiated Products through a Beneficial Cycle of Needs and Seeds

Around 40% of the MGC Group's products have captured the top share in their global markets. We have created a number of products with strong competitive advantages in the market. Behind these are our distinctive technologies and resources (seeds), which we have used in dialogue with the markets before matching customer needs identified in dialogue with high-quality information. In this way, we have been working ceaselessly to expand higher functionality product development and solutions. We have strengthened our speedy technology development structure based on a deep understanding of customer needs, and we have established and maintained a leading market share in certain fields. In other words, through a combination of product-oriented and market-oriented approaches, we have created distinctive products that are difficult for other companies to imitate.

Over 90% of our products were developed in-house. Internally, we have created a technology platform for research personnel on the Company intranet. We combine a rich array of core technologies to customize our seeds and develop new products and grades. For high-priority themes, we have also provided an evaluation system for generously allocating research resources.

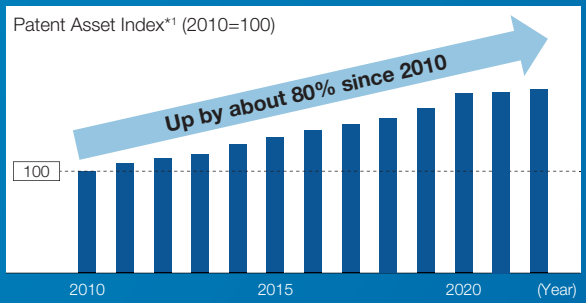
The Expected Future	Advanced semiconductor technology	Supply chain rebuilding	Circular economy	Dealing with emerging countries	Expanding presymptomatic needs
	Developments in CASE	Dealing with the environment and climate change	Shift to smart cities	Advanced medical technology	Tightened food supply and demand
Target Area	ICT	Mobility	Energy	Infrastructure	Medical/Food
Business Opportunities	• Increased demand for raw materials for components for cameras and electronic devices • Expanded need for materials that lead to weight savings • Expanded use of solid-state batteries	• Shift to renewable energy • Development of CO_2 recycling technology • Expanded demand for infrastructure in emerging countries • Progress in use of IoT/AI technology		• Antibody drugs to become mainstream in drug discovery field • Diversification of allergy diagnostics • Response to food loss problem	
Product Examples	Optical resin/polymer	Carbon fiber composite materials	CO_2-derived methanol	Geothermal power generation	Allergy test chips
	IC plastic packaging BT materials	Solid electrolytes	CO_2-derived polycarbonate	MXDA	Oxygen absorbers
Technology Platforms	**Catalysts** • Superacid • Solid catalyst • High-pressure technology	**Polymer Science** • Condensation polymerization • Bulk polymerization • Oxidative polymerization • Polymer design • Films and sheets • Resin processing	**Biotechnology** • Continuous cultivation • Breeding • Antibody drug technology		
	Synthesis • Air oxidation • Liquid-phase oxidation • Hydrogenation	**Functional Products** • Oxygen absorbers • Varnish manufacturing • Chemicals for semiconductors	**Process engineering/ analysis (common)**		

Target Areas and Technology Platforms

The Group has five technology platforms: catalysts, synthesis, polymer science, functional products, and biotechnology. MGC's catalyst technology originates in the development of a catalyst for methanol synthesis and has been applied in the commercialization of many original chemical synthesis processes. On the other hand, polymerization technology acquired through downstream development is also used in functional design of mechanical and optical properties. We develop new functional products by combining multiple raw materials into compounds. Moreover, a raft of biotechnologies are being developed from the culture technologies accumulated while promoting R&D into microbial proteins using methanol as a raw material. The differentiated products created from this technological foundation will provide effective solutions to emerging issues in target areas that the Company is focusing on.

Patents are one type of intellectual property that we produce through daily research and development work. Our total patent value continues to grow as we focus on R&D themes that will meet the needs of the times.

Total Patent Value



*1 An index that visualizes the technological strength and influence of an applied patent in global terms, obtained by objectively evaluating quality (value based on how often the subject patent is cited worldwide) and quantity (number of applications)
Source: H. Ernst and N. Omland, World Patent Information, vol. 33, pp. 34-41 (2011)

The DNA of a Company Built on Technology

From the 1950s to the 1970s, Japan's chemical industry experienced the post-war economic boom and entered a period of growth. In most cases, companies were producing new products by licensing technology from overseas. Mitsubishi Gas Chemical was established in 1971 through an equal merger of two manufacturers, both among the few in the industry at that time who were focusing on technologies developed in-house.

One of the predecessor companies, Japan Gas Chemical Co., Inc., was incorporated in Niigata City in 1951 as Japan's first natural gas chemical industry manufacturer. Since methanol derived from natural gas was cheaper and of higher quality than existing products, Japan Gas Chemical quickly became a leading manufacturer of methanol. In 1957, it launched Japan's first operation for producing ammonia from natural gas. Such initiatives made for highly competitive business. Entering the 1960s, Japan Gas Chemical also entered the petrochemical business, and started commercializing its in-house developed xylene separation/isomerization technology. It developed the world's first HF-BF_3 method, and applied the technology at the Mizushima Plant, which started operations in 1968. Japan Gas Chemical also focused on nylon MXD6, which has excellent gas barrier properties against oxygen and CO_2 and promoted the development of meta-xylenediamine (MXDA).

1952 Methanol manufactured from natural gas

1968 Xylene separation technology using superacid HF-BF_3

The other predecessor company was Mitsubishi Edogawa Chemical Co., Ltd.,*2 which was founded in 1918 and in 1927 became the first company in Japan to succeed in manufacturing formalin. In 1933, Mitsubishi Edogawa Chemical began production of hydrogen peroxide using a proprietary electrolytic process. The product was used in applications such as bleaching paper. In 1937, Mitsubishi Edogawa Chemical started production of Japan's first laminate materials for printed circuit boards. In 1961, it started production of polycarbonate (PC) using a proprietary interfacial polymerization method. The company maintained a high market share in the PC market, while continuing to grow as a company with strengths in formalin derivatives and engineering plastics.

1927 Formalin manufactured

1933 Hydrogen peroxide manufactured using the electrolytic process

With Japan Gas Chemical handling the upstream side of the methanol business using natural gas as a raw material and Mitsubishi Edogawa Chemical having strengths in raw materials such as methanol derivatives on the downstream side, their merger was seen by many as inevitable and logical. The merger was expected to enable efficiency gains through joint procurement of resources and raw materials and the building of an integrated production system, as well as the demonstration of competitive advantages over the long term due to their mutually complementary technologies. Furthermore, the start of the 1970s, when the Company was established, was an era of increasingly strong international competition in the chemical industry. In this business environment, retaining our identity as a chemical manufacturer with a distinctive technological orientation required massive investment in research and development and investment in production facilities. The merger created a structure capable of carrying out such an investment strategy.

The two companies had each developed world-first and Japan-first businesses through their unstinting efforts, and their DNA has been passed down to the Group's employees today. We are proud of our corporate culture of originality and pioneering spirit, which are the foundation of our value creation.

*2 The company's name at the time of its foundation was Edogawa Barium Industry Co., Ltd.

Creation of Markets Based on a Differentiation Strategy

The oil shock of 1973 occurred just after the Company was launched. The event had a major impact on the management of chemical companies as it caused energy and electricity prices to soar and sparked an economic downturn. Furthermore, the impact of the yen's appreciation and the reverse oil shock starting in 1985 was even more serious for the Company. The advantage of using natural gas produced by the Company in Japan as a raw material was virtually eliminated, while market competition became more intense for our other earnings pillar, hydrogen peroxide. Reforming our business structure to enable increased functionality and added value in our product lineup became an urgent task.

Anticipating these environmental changes, in 1983 the Company led the industry by starting production of methanol in Saudi Arabia. To maintain competitive pricing, we dramatically overhauled our production site strategy, moving our production sites away from consumption areas and closer to raw material sources.

1983 Saudi Arabia (methanol)

1990 Indonesia (hydrogen peroxide)

1997 Thailand (engineering plastics)

2010 Brunei (methanol)

2020 Trinidad and Tobago (methanol)

2024 Netherlands (MXDA/construction site planned)

Moreover, the late 1970s to the 1980s was also an era of expansion for the electronics-related markets. We established a specialist department for electronic-materials and prepared a structure that could respond immediately to new needs from customers. BT resin was commercialized around this time, and sales grew rapidly as it was adopted for use in laminate materials for IC plastic packaging. Today, BT resin continues to contribute to miniaturization and performance gains for electronic devices around the world. In hydrogen peroxide, to meet the needs for higher integration of semiconductors, in 1986 we developed super-pure hydrogen peroxide with a metal ion concentration of 1 part per billion or less. Also in 1986, we reorganized our research and development structure and made large-scale capital investments. We strove to create markets in Japan and overseas through application development of existing products.

Meanwhile, in polycarbonate (PC), which had mainly been used for miscellaneous items and construction materials, we continued to expand demand for new applications, including eye wear in 1990, optical film for LCD panels in 1999, and automotive materials in the 2010s. The oxygen absorber AGELESS™ experienced rapid growth in the 1980s, providing an example of success in a different field from that of conventional chemical products as a result of market expansion efforts made by the Company's sales engineers.

After that, in the overseas methanol business, we expanded our production sites to countries with natural gas reserves, such as Venezuela in 1994 and Brunei in 2010. In 2020, we started production in Trinidad and Tobago, strengthening our global supply structure. For super-pure hydrogen peroxide, we expanded our production sites in consumption areas, moving into South Korea in 1991, the United States in 1996, Singapore in 1998, and Taiwan in 2001.

In 2000, we introduced the internal company system to thoroughly implement selection and concentration. We established a system to allow each internal company to make investment decisions quickly at its own discretion. This improved Group financial soundness and accelerated our business activities. While withdrawing from nonperforming businesses, we proceeded further with globalization and market creation.

In building up a competitive advantage, we recognize that the common point for both upstream and downstream products is the creation of new growth markets based on the MGC Group's unique management resources and differentiation strategy.

Increasing Product Performance and Expanding Applications

Share of sales: Large | Medium | Small

	Decade	~1950	1960	1970	1980	1990	2000	2010	2020
Hydrogen peroxide	Paper pulp, fiber, and industrial applications								
	Cleaning semiconductors, etching								
	Disinfection and sterilization								

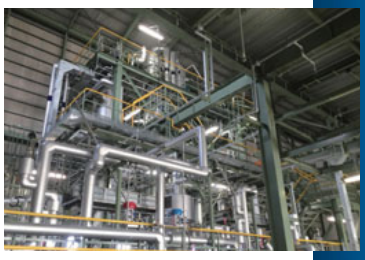
	Decade	~1950	1960	1970	1980	1990	2000	2010	2020
BT materials	Printed circuit substrate materials for calculators and clocks, etc.								
	IC plastic package substrate materials								
	Chip LED substrate materials								
	High-frequency applications								

	Decade	~1950	1960	1970	1980	1990	2000	2010	2020
Optical materials	Organic photoconductors (OPCs)								
	Spectacle lenses								
	Smartphone camera lenses								
	Automotive camera lenses								

Creating Value to Share with Society

In September 2015, the Sustainable Development Goals (SDGs) were adopted by the United Nations Summit, and a large number of organizations worldwide began activities based on them. The 17 ambitious goals of the SDGs cannot be achieved by individual companies working alone. Therefore, the SDGs became a link connecting diverse organizations. As a distinctive chemical manufacturer, we believe the MGC Group is able to accelerate proactive initiatives toward achieving the SDGs by teaming up with companies and organizations in other industries. As a first step, in 2021, the 50th anniversary of our establishment, we announced the Group's Mission, "Creating value to share with society." Then, we started our Medium-Term Management Plan, which looks ahead to the future around 2050 and aims to "shift to a profit structure resilient to changes in the business environment" and "balance social and economic value."

In the process of formulating the plan, we discussed our path toward creating long-term value based on the SDGs and the Japanese government's declaration that Japan will realize carbon neutrality by 2050. This discussion concluded that to achieve the SDGs and contribute to the formation of a decarbonized society, it is crucial that we accelerate our research and development for advancing chemicals and materials in fields such as fossil fuel alternatives, ICT and mobility, medicine, food management, and infrastructure. In particular, global demand for realizing carbon neutrality should be viewed as a tailwind for the MGC Group, rather than a headwind, since we have extensive knowledge and solutions in these fields, and the technological foundation to support them.

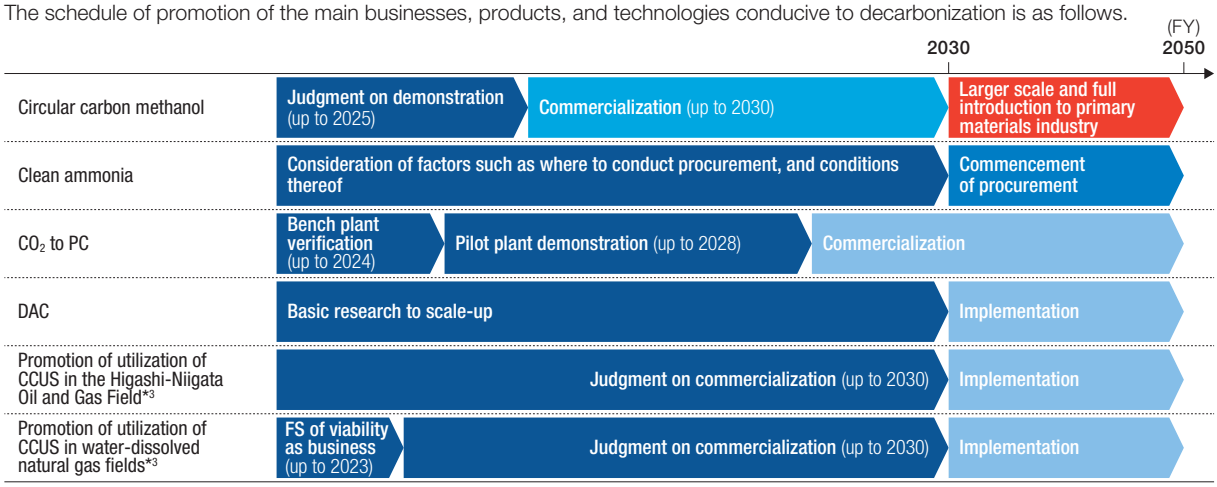


Circular carbon methanol pilot facility (Niigata Plant)

In 2020, we ended the internal company system that we had introduced in 2000 and radically changed our organizational framework with a view to overall optimization. We will continue to focus on creating products that enable us to approach solutions to global-scale challenges, and we will continue to direct the combined capabilities of the MGC Group towards creating value to share with society.

Development of Products and Technologies Conducive to Decarbonization

The schedule of promotion of the main businesses, products, and technologies conducive to decarbonization is as follows.



*3 Injection of CO_2 and utilization in increased production of oil and natural gas (EOR/EGR)

Clean Ammonia

Discussions are being held with four domestic chemical manufacturers for the stable securement of clean ammonia*4, expected to serve as a next-generation energy source. Furthermore, CCS*5 surveys are being conducted in Indonesia by PAU, an ammonia manufacturer in which MGC has an indirect investment.

*4 The collective term for blue ammonia, which combines CCS storing CO_2 emitted at the time of ammonia production underground, and green ammonia, which uses renewable energy hydrogen as a raw material for ammonia

*5 Technology for capturing and storing CO_2

Promotion of Utilization of CCU*6

MGC is engaged in the manufacture of polycarbonate using CO_2 as a raw material. The Company has succeeded in the development of a process that emits less CO_2 in the manufacturing process than existing manufacturing methods, and will conduct verification thereof in a bench plant until 2024, with plans to complete demonstrations in a pilot plant on the scale of 2,000 tons of DPC and 600 tons of PC by 2028. Ultimately, the aim is the commercialization and social implementation of the process.

*6 Technology for capturing and utilizing CO_2 as a resource

Promotion of Utilization of CCUS

MGC participated in a large-scale CCS demonstration test by NEDO in Tomakomai. Injection of CO_2 underground commenced in 2016, and a total of 300,000 tons of CO_2 was stored underground by 2019.

Furthermore, MGC is considering the injection of CO_2, mainly generated at the Niigata Plant, into the Higashi-Niigata Oil and Gas Field to increase production of oil and natural gas by utilizing EOR/EGR (enhanced oil/gas recovery).

Value We Aim to Create

In the Medium-Term Management Plan, we established a vision for the next five to ten years of each business sector. We believe that we can play a role in transforming industry and society to unlock their potential through the creation of new value through MGC's unique products to help solve social issues.

Contribute to Development of ICT/Mobility Society

In the ICT area that is one of our target areas, DX through the utilization of AI, IoT and other technologies is expected to advance in the future. The importance of chemicals used in the high-performance semiconductors that form the foundation for these is also continuing to increase. Meanwhile, in the area of mobility, new ingredients and materials that match the needs of computerization and low environmental impact are required. The MGC Group is strengthening proposals for material development and solutions with a view to such next-generation needs.

Electronic Chemicals

Global semiconductor demand will continue to grow in the future, and the electronic chemicals essential for their manufacture are also expected to see significant growth. The MGC Group seeks to further increase the purity of electronic chemicals used in the semiconductor cleaning process, while contributing to the miniaturization and increased functionality of semiconductors.

Optical Resin/Polymer

The optical materials offered by the MGC Group are primarily used in camera lens materials for smartphones and so forth. In the area of ICT and mobility, applications and markets such as sensing devices for visualization of objects not perceptible to the naked eye are expected to expand.

Methanol

Methanol, currently used as a chemical raw material, is also expected to be utilized as a hydrogen transport medium. MGC, which is the only comprehensive manufacturer of methanol in the world, is currently promoting initiatives to commercialize a circular carbon methanol production process using CO_2 as a raw material, called Carbopath™.

BT Materials for IC Plastic Packaging

The MGC Group's laminate materials have maintained the world's top market share by improving IC plastic packaging performance, optimizing form factor, and ensuring ease of use. MGC will continue to contribute to the early diffusion of ultra-high-speed communications and the advent of IoT society through promoting research that anticipates trends in the semiconductor industry.

Engineering Plastics

Polycarbonate (PC) and polyacetal (POM) are materials that have contributed to making automobiles and electronic devices more lightweight and extending their life. In recent years, they have been used instead of existing materials in a wider variety of industries. MGC has started development of PC manufacturing technology using CO_2 as a raw material.

Foamed Plastic

Foamed plastic, being lightweight with excellent vibration absorbency, contributes to the improvement of both collision safety and fuel efficiency, mainly as an automotive material. As the shift to EVs accelerates, areas in which it is used are expanding, such as rear seat cushion material and front seats.

Solve Energy and Climate Change Problems

Taking advantage of our many years of experience developing natural-gas fields and producing methanol, we are working to commercialize our carbon-negative*1 technology. We are concentrating effort on R&D related to methanol synthesis from CO_2 as well as on CO_2 capture, utilization and storage. We also endeavor to contribute to addressing issues related to energy and climate change in a way that is unique to the MGC Group as a chemicals company, such as the use of methanol and ammonia as a hydrogen carrier, geothermal power generation, which no other company in the chemicals industry is doing, and materials development to help extend the life of wind power-generation equipment.

*1 State in which absorption of greenhouse gases (GHG) is greater than emissions of same in business operations.

Solve Medical and Food Problems

In light of accelerating global population growth and aging, the MGC Group is expediating development of product groups that will lead directly to the enhancement of preventive and predictive medicine and the improvement of medical productivity. As for addressing food-related challenges, in 1977 we began marketing an oxygen absorber that extends the storage life of foods, and have been improving it for over 40 years. Taking full advantage of the management resources of the Group, we will continue to develop advanced technologies to help extend healthy life expectancy and support sustainable food management.

Energy Resources and Environmental Businesses

The MGC Group is a unique chemical manufacturer in the geothermal power generation business, and is also participating in natural gas power generation projects. In the future, we aim to contribute to realizing new energy systems that combine CCS technology, for the capture and storage of CO_2, and CCU technology, which utilizes it as a resource.

Oxygen Absorbers

AGELESS™, a quality-improving agent preventing food deterioration by absorbing oxygen, brought about a revolution in the storage and transportation of food. Going forward, we will focus on development of fresh food applications with the aim of reducing food waste and loss, and contributing to addressing the hunger problem. Applications in pharmaceutical and industrial areas are also increasing.

Antibody Drugs

Based on our culture technology, we have established basic manufacturing techniques for antibody drugs, and perform contract process development and manufacture of bio-pharmaceuticals. From the perspective of security, the importance of domestic production of pharmaceuticals is increasing, and we will contribute to the stable supply of pharmaceuticals as a reliable domestic manufacturing base.

MXDA

MXDA has properties for preventing the deterioration of metal. It is used as an epoxy curing agent in coatings for construction and industrial pipes, and its applications have recently expanded to include maintenance of wind power. MGC is also engaged in the development of high-efficiency DAC*2 technology using MXDA.

*2 Direct air capture is a technology that captures CO_2 directly from the air.

MX-Nylon (MXD6)

MX-Nylon, which has superior gas barrier properties, is a material that reduces food waste and also contributes to the weight reduction of PET bottles and automotive components. At present, we are actively engaged in environmental initiatives such as the reduction of GHG emissions through the transition to plant-derived raw materials.

Aromatic Aldehydes

Aromatic aldehydes are used in diverse applications including fragrances and resin additives. MGC's manufacturing process has the advantage of high purity due to it being able to efficiently extract target substances. For this reason, demand for these products, which can be safely used for applications such as food packaging and fragrances, is increasing.