Chemical Recycling of PMMA: Technologies and Strategies for a Sustainable Future

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This study provides an overview of chemical recycling technology for acrylic resin (polymethyl methacrylate, PMMA) and recent efforts toward its societal implementation as a solution to plastic waste. Based on the unique characteristics and market trends of PMMA, the study highlights the efficiency and environmental benefits of a continuous depolymerization process jointly developed by Sumitomo Chemical and JSW, using a twin-screw extruder. Furthermore, it presents specific examples, including regional resource circulation projects and plans for global expansion to establish business models that support the transition to a sustainable society.

Introduction

This article reviews the current state of issues related to plastics globally and in Japan, covering market trends and advances in chemical recycling technology for acrylic resin (polymethyl methacrylate, PMMA). We also describe our company's PMMA chemical recycling demonstration project, efforts toward social implementation, and challenges and prospects for establishing a sustainable, resource-circulating society.

Global and Japanese plastic production and waste issues

As of 2019, approximately 460 million tons of plastic are produced annually worldwide, with the production expected to increase, particularly in emerging economies (**Fig. 1**)[1]. Waste generation has reached roughly 350 million tons (**Fig. 2**)[1], with most plastic waste ending up in landfills or incinerated. Waste generation is projected to rise further toward 2050[2].

In Japan, plastic production (**Fig. 3**) remained at approximately 14 million tons annually from 1997 to 2007 but declined to approximately 9.5 million tons by 2022[3]. The waste disposal volume has also decreased, reaching approximately 8 million tons in 2021[4]. Although recycling rates are high at approximately 86%, the majority of recovery operations involve thermal recovery, which carries environmental impacts such as CO_2 emissions and the production of hazardous substances. The technological development of material and chemical recycling methods is progressing; however, many technical challenges remain, including high recycling costs, maintaining the quality of recycled products, and establishing efficient recycling processes. Thorough implementation of waste separation and raising consumer awareness are also important, and the widespread adoption of appropriate disposal methods for recyclable plastic waste is required.

The economic model of mass production, mass consumption, and mass disposal is unsustainable, contributing to resource depletion, climate change, and waste problems. There is a need for a shift to a circular economy, with an emphasis on recycling from the product design stage, along with improvements in durability and the use of recyclable materials. In Japan, the Plastic Resource Recycling Promotion Act has been enacted, with collaboration between companies and local governments to realize a circular society.

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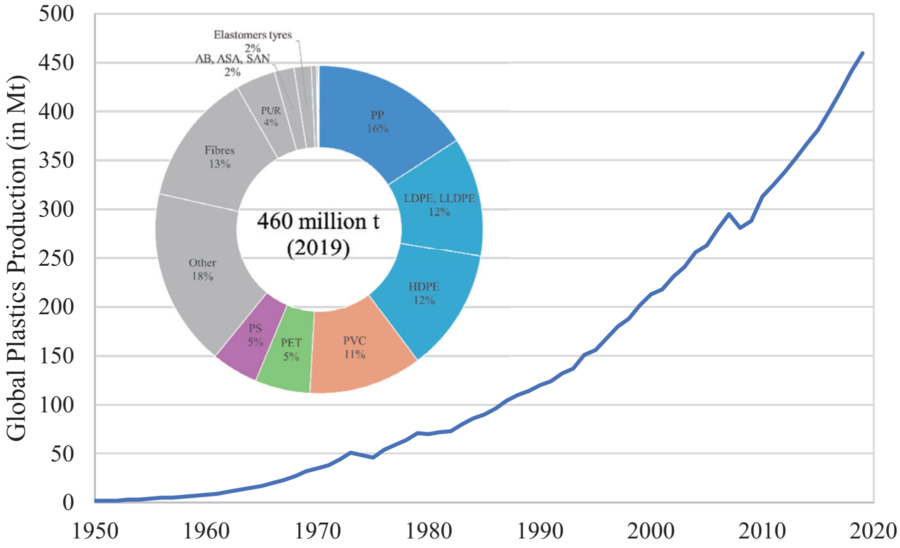

Fig. 1 Global plastic production weights by polymer type from 1950 to 2019 (in Mt)

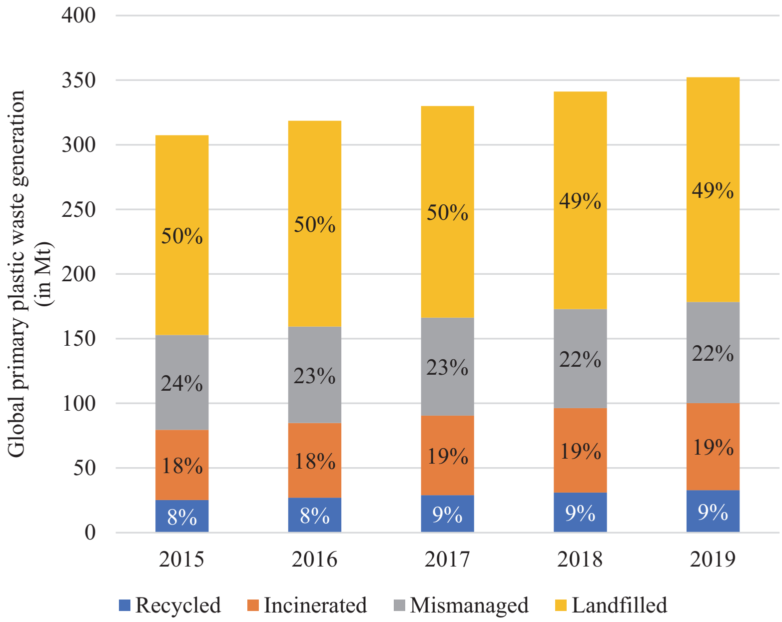

Fig. 2 Annual plastic waste by disposal method worldwide from 2015 to 2019

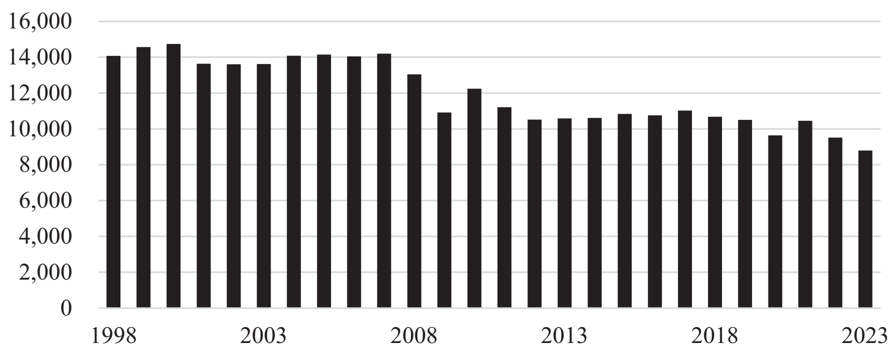

Fig. 3 Domestic production of plastic raw materials (in kt)

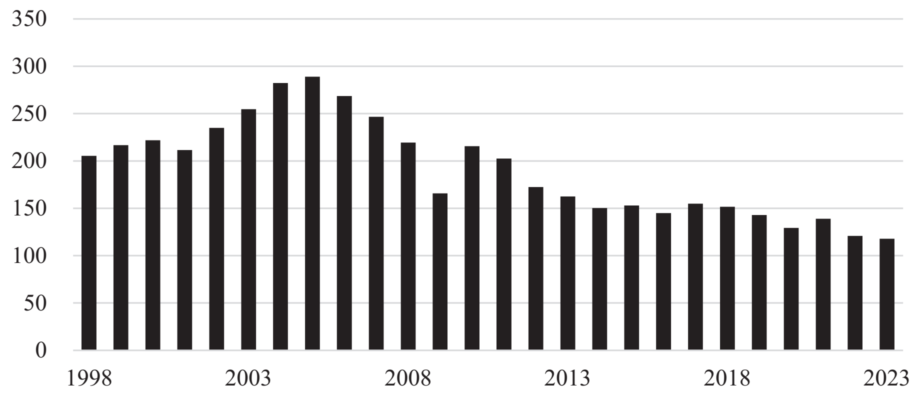

Fig. 4 Domestic production of PMMA (in kt)

Environmental and market trends for acrylic resin (PMMA)

PMMA possesses many excellent properties, including high transparency and weather resistance for outdoor use. Because of these characteristics, it is widely used in applications such as light guide panels for LCD displays, automotive lamp covers, signage, partitions to prevent droplet infection, and acrylic stands for character goods.

Domestic PMMA production (**Fig. 4**) peaked in 2005 at approximately 290,000 tons per year. Since then, production has declined, reaching approximately 120,000 tons per year by 2022[3]. The demand for PMMA overseas, particularly in China, is strong and projected to reach approximately 3 million tons per year by 2027, an increase of roughly 1 million tons compared to the value in 2015[5].

In automotive applications, PMMA is used in rear lamp covers, speedometer covers, and visors. Based on the domestic production of approximately 7.85 million four-wheel vehicles in 2021[6], approximately 3 kg of PMMA is used per vehicle. The automotive industry's focus on lighter vehicles and improved design aligns with the properties of PMMA, driving increased demand.

Growing environmental awareness is also enhancing appreciation for PMMA as a recyclable material.

PMMA recycling technologies and initiatives

1. Overview of recycling technologies

Plastic recycling generally involves two approaches, namely material recycling and chemical recycling.

Material recycling melts and remolds used plastics to reuse them as raw materials. This method reduces energy consumption by reusing plastics as the raw material. However, the product quality depends heavily on the waste plastic quality, which limits its applicability.

Chemical recycling chemically decomposes used plastics back into monomers and chemicals. This approach allows reuse while maintaining the quality by producing monomers that serve as the raw materials for new plastics. Chemical recycling addresses the limitations of material recycling, such as quality degradation and contamination from mixed materials.

PMMA is used in melt-processable molding materials and non-melt-processable casting materials. Material recycling applies only to molding materials, whereas chemical recycling can handle both types.

2. PMMA material recycling

Advances have been made in the development of material recycling technologies for post-industrial recycled (PIR) PMMA, which is generated during product manufacturing. Sumika Acryl Co., Ltd., which is a member of the Sumitomo Chemical Group, produces recycled acrylic sheets from factory PMMA waste, which has been marketed since January 2023 as SUMIKA ACRYL SHEET™ Meguri™. These recycled sheets have less of an environmental impact than virgin materials and are in high demand among environmentally conscious users.

However, post-consumer recycled (PCR) PMMA, which is recovered from discarded products, often contains a mixture of molding and casting materials, making material recycling challenging. Visual differentiation between molding and casting materials is difficult, and mixing reduces the quality of recycled products. Consequently, the use of PCR material is largely non-existent in Japan, and most waste PMMA is incinerated or downcycled, where it is mixed with other materials, producing lower-value products.

3. PMMA chemical recycling

PMMA has decomposition characteristics that make it ideal for chemical recycling. PMMA decomposition eliminates MMA monomers sequentially from the polymer chain end (**Fig. 5a**). PMMA polymerization and depolymerization reactions are in equilibrium in this mechanism. At high temperatures, endothermic depolymerization[7] dominates, achieving monomer conversion rates exceeding 90% (**Fig. 6**). Other addition polymers undergo side reactions (backbiting) that generate oligomers as irreversible byproducts (**Fig. 5b**), lowering monomer yields. The thermal decomposition of PMMA proceeds via radicals (**Fig. 7**)[8].

1) Random scission

At approximately 400 °C, PMMA undergoes homolytic bond dissociation, resulting in the random scission of

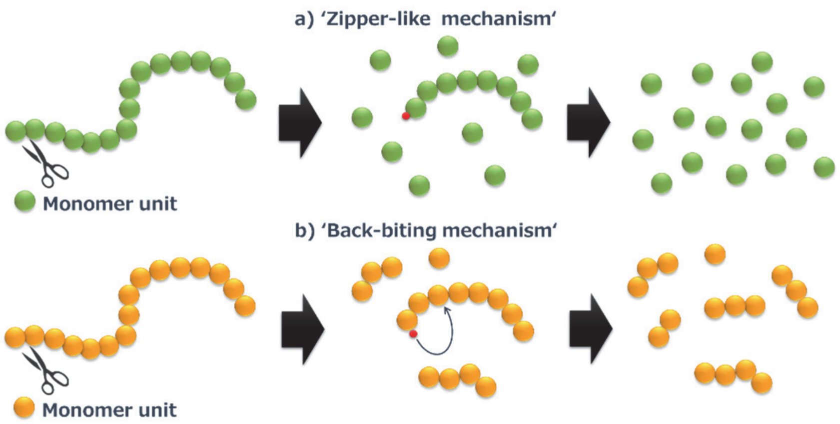

Fig. 5 Polymer decomposition mechanisms: a) Zipper-like mechanism, b) Back-biting mechanism

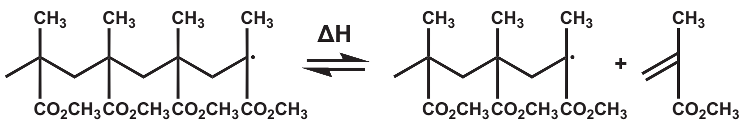

Fig. 6 Equilibrium between polymerization and depolymerization reactions of PMMA (propagating) radical

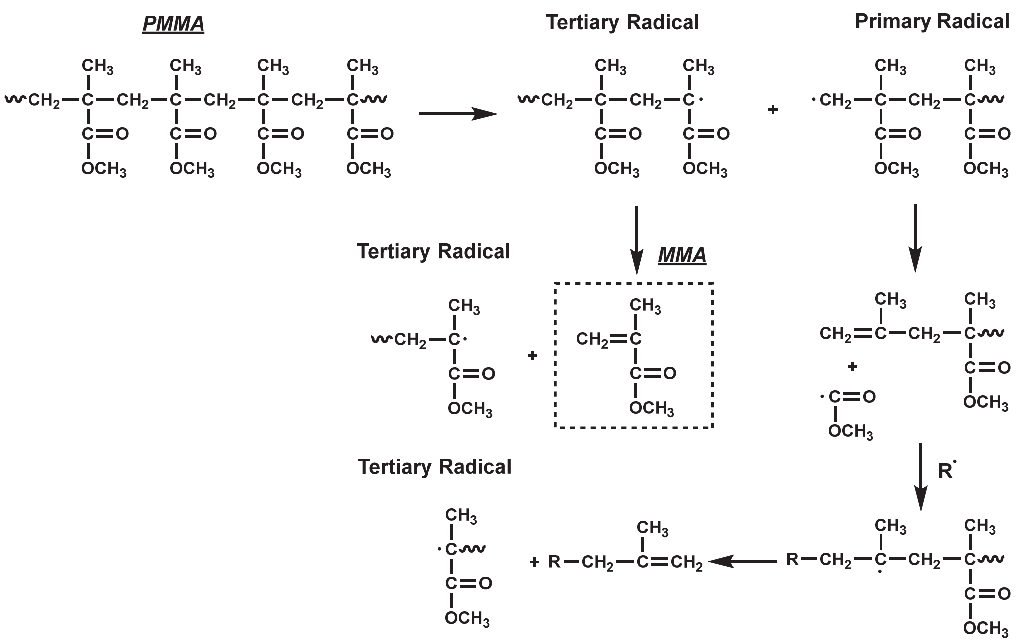

Fig. 7 Mechanism of thermal degradation in PMMA

molecular chains.

This generates primary and tertiary radicals.

2) Unzipping

The tertiary radicals generated by random scission undergo depolymerization, which is known as unzipping, producing MMA monomers. New tertiary radicals form at the polymer ends during the MMA production process, creating a chain reaction for decomposition.

3) Methallyl end generation

Primary radicals form methallyl-terminated species by eliminating carboxylic acid methyl ester groups. Further elimination generates tertiary radicals, initiating a chain reaction of MMA elimination.

4. PMMA thermal decomposition process technology

Thermal decomposition-based recycling has long been a subject of research and development because of its impact on productivity, energy use, recycled MMA monomer quality, and environmental effects. **Table 1** summarizes the features, advantages, and disadvantages of different methods.

1) Pyrolysis-distillation method

This method is one of the earliest PMMA decomposition processes. It was patented by DuPont in 1935[10] and involves heating PMMA in a distillation flask over an open flame until the decomposition temperature is reached in order to recover the monomer. Although historically the most common method, its use has declined because of environmental concerns.

Features

- Simple process: The distillation of decomposition products in a flask is a simple design.
- Monomer recovery: MMA can be recovered by the distillation of decomposition products.

Challenges

- Temperature non-uniformity: Direct-flame heating causes uneven temperatures, which reduce the decomposition efficiency.
- Residue scaling: The accumulation of decomposition residue in the distillation flask lowers the efficiency.
- Yield limitations: The monomer yields tend to be lower than those obtained with modern technologies.

Table 1 Comparison of chemical recycling technologies for PMMA

Technology	Features	Advantages	Challenges
Pyrolysis Distillation Method	PMMA is placed in a distillation flask and heated directly until decomposition temperature is reached.	- Simple process design - Enables monomer recovery	- Uneven temperature distribution affects decomposition efficiency - Residue accumulation reduces efficiency - Lower monomer yield compared to modern technologies
Molten Metal (Salt) Method	Uses molten metals such as lead or tin as a heating medium to efficiently decompose PMMA.	- High heat transfer efficiency enables rapid decomposition - Uniform temperature distribution enhances efficiency	- Impurities from molten metals may contaminate the product - Environmental impact due to handling molten metals - High operational costs for metal reuse and disposal
Fluidized Bed Method	Utilizes a fluidized particle bed to uniformly heat and decompose PMMA.	- High monomer yield - Suppresses by-products through uniform thermal decomposition - Suitable for large-scale recycling processes	- Requires high temperatures , leading to high energy consumption - Complex management of particle size and density - High initial equipment investment
Conical Spouted Bed Reactor (CSBR)	Employs a conical reactor design for efficient particle circulation and low-temperature decomposition.	- Allows decomposition at relatively low temperatures (400–550 °C) - Efficient particle circulation optimizes heat and material transfer - Suppresses by-product generation	- Requires optimization of reactor design and operating conditions, increasing operational costs - Difficult to scale up for large-scale processing
Microwave Heating Method	Uses microwaves to directly heat PMMA for efficient decomposition.	- Enables rapid heating, reducing process time - High energy efficiency - Uniform heating suppresses by-product formation	- Limited implementation in large-scale operations - Challenges in microwave equipment design and operational costs
Twin-Screw Extruder Method	Continuously decomposes PMMA using a twin-screw extruder to recover high-purity monomers.	- Enables stable continuous operation with high productivity - Self-cleaning function prevents residue buildup - Uniform heating prevents overheating, ensuring high-purity monomer recovery	- High initial equipment cost - Reducing unreacted residue

2) Molten-metal (salt) method[9)]

This method uses a molten metal (e.g., lead, which has a melting point of 327 °C, or tin, which has a melting point of 232 °C) as a heating medium in a distillation flask to heat the material above the PMMA thermal decomposition temperature in order to efficiently decompose the PMMA and recover the monomer.

Features
- Rapid heat transfer: The high heat-transfer efficiency of the molten metal enables the efficient decomposition of PMMA.
- Temperature uniformity: The molten metal bath maintains a consistent temperature, which improves the decomposition efficiency.

Challenges
- Metal contamination: Impurities from the molten metal may be introduced into the product.

3) Fluidized-bed (sand-bath) method[9)]

This is a widely studied and efficient method for PMMA thermal decomposition that achieves high MMA yields (98 wt%). An inert gas such as nitrogen or thermally decomposed monomer vapor fluidizes particles (e.g., alumina or sand) as a heating medium, thereby thermally decomposing PMMA efficiently and recovering the monomer.

Features
- Uniform decomposition: Particle fluidization by the fluidized-bed reactor ensures an even temperature distribution and efficient PMMA decomposition.
- High yield: Research[9)] has shown that thermal decomposition using a fluidized-bed reactor can achieve MMA yields of up to 98 wt%.
- By-product suppression: Rapid heat transfer within the fluidized bed suppresses secondary reactions and minimizes by-product generation.

Challenges
- High-temperature conditions: Fluidized-bed reactors require high temperatures of approximately 700 °C.
- Particle control: Controlling the particle size and density required for fluidization is important, which increases the operational complexity.

PMMA chemical recycling: Our initiatives

1. Technology features

We are developing PMMA chemical recycling technology in collaboration with The Japan Steel Works, Ltd. (Headquarters: Shinagawa-ku, Tokyo, "JSW"). This technology combines the twin-screw extruder-based continuous decomposition technology[11)] of the JSW with our expertise in MMA monomers and PMMA. This joint technology development allows for the efficient breakdown of used PMMA and recovery of high-quality recycled MMA monomers.

1) Continuous decomposition process: In the extruder system of the JSW, the recovered PMMA is continuously fed into a twin-screw extruder, where depolymerization occurs and the monomer is efficiently recovered. This continuous process ensures a stable supply and high productivity, enabling efficient recycling.
2) Self-cleaning mechanism: The co-rotating twin screws effectively discharge residues and prevent their buildup, allowing continuous operation. This mechanism reduces the maintenance frequency and enhances operational efficiency.
3) Uniform heating and high-purity recovery: The twin screws provide uniform heating of the recovered PMMA, preventing overheating. A short residence time minimizes the formation of impurities and allows the recovery of high-purity monomers.

2. Demonstration facility installation and research and development

In December 2022, a PMMA chemical recycling demonstration facility (**Fig. 8**) utilizing an extruder system was installed and began operation at the Ehime

Fig. 8 Sumitomo Chemical PMMA chemical recycling demonstration facility

Plant (Niihama City, Ehime Prefecture). This facility has accelerated research and development toward early social implementation. This initiative is promoted under the Ministry of the Environment's “Subsidies for Carbon Dioxide Emission Reduction Measures: Demonstration Project for Establishing a Recycling System for Plastics and Other Resources to Support a Carbon-Decarbonized Society.”

The demonstration facility has made it possible to verify the technology under real-world operating conditions, enabling important steps toward optimizing and scaling up the recycling process. Additionally, as part of efforts to promote a sustainable resource-circulating society, we continue the demonstration project across the entire circular supply chain, collaborating with supporting companies involved in the system.

3. Details of PMMA chemical recycling demonstration project

We are advancing a PMMA chemical demonstration project in order to realize a sustainable resource-circulating society. This demonstration project has four main objectives.

1. Ensuring high-quality recovered PMMA and establishing a procurement scheme
2. Establishing a highly efficient thermal decomposition process that contributes to CO_2 emission reduction
3. Achieving the stable production of high-quality recycled PMMA from the recycled MMA
4. Demonstrating the value of the recycled PMMA and quantifying its contribution to a resource-circulating society

To achieve these objectives, we consider the entire supply chain, from recovered PMMA procurement to recycled MMA monomer production and recycled PMMA application development. This approach comprehensively optimizes the PMMA recycling process and takes specific steps toward realizing a sustainable society.

3.1 Quality assurance of recycled PMMA and procurement scheme

The quality of the recovered PMMA directly impacts the quality of the recycled MMA monomer and CO_2 emissions. If foreign materials are mixed into the recovered PMMA, the thermal decomposition process will be less efficient, producing more impurities and increasing CO_2 emissions. In particular, methyl methacrylate-styrene copolymer (MS resin) and polycarbonate resin have physical properties similar to those of PMMA and are often used for the same purposes, making it difficult for consumers to distinguish between them. Consequently, there is a high risk of mixing these materials.

We are collaborating with local governments, recycling companies, and companies with sorting technology to implement a proof of concept (POC) project, including separate collection and sorting. We are also developing technology to separate PMMA molded and cast materials, which is a task conventionally considered challenging. Through these efforts, we are strengthening the quality assurance of the recovered PMMA and establishing a procurement scheme. Moreover, we can enhance the overall recycling efficiency and reduce environmental impact by developing supporting technologies such as mono-material products and design changes to facilitate separate collection.

3.2 Highly efficient thermal decomposition process that contributes to CO_2 emission reduction

In partnership with the JSW, we are developing a highly efficient thermal decomposition technology using a twin-screw extruder. For use in the thermal decomposition process, we optimized the extruder configuration, including the cylinder, heater, gas outlet, undecomposed residue outlet, and screw design of the twin-screw extruder, which is normally used for conventional resin processing. To improve the monomer yield and reduce impurities, we carefully examined the thermal-decomposition conditions, including the cylinder temperature, screw rotation speed, and feed rate, based on the type of recovered PMMA.

We also enhanced the monomer yield and energy efficiency by setting a target monomer quality according to intended use and adjusting the purification conditions accordingly.

We also intensified efforts to minimize undecomposed residue by optimizing the undecomposed residue discharge mechanism.

By combining the four key technologies of resin sorting, extruder-configuration optimization, thermal-decomposition optimization, and purification optimization, the developed process achieves purified MMA monomer yields that are approximately 20% higher than those obtained using conventional technology (based on a calculation by our company) (**Fig. 9**).

CO_2 emissions throughout the product lifecycle can be reduced by approximately 50%, while maintaining the same quality as that of conventional PMMA. This reduction in CO_2 emissions is achieved by chemical recycling-based monomer manufacturing and waste recycling instead of incineration (**Fig. 10**). This technology substantially reduces the environmental impact and contributes to a sustainable society.

3.3 Production and quality of MMA monomer from recycled PMMA

The recycled MMA monomers produced at our PMMA chemical recycling demonstration facility have been confirmed to match the quality of conventional fossil-fuel-derived MMA monomers and can be used in the same applications (**Fig. 11**). We have produced cast polymerization and molding materials using the recycled MMA monomers and confirmed that their optical, thermal, and mechanical strength properties matched those of conventional products (**Table 2, Fig. 12**). We have received high praise from clients with strict quality requirements, such as those producing automotive lamp covers and LCD display light guide plates.

3.4 Demonstrating the value of recycled PMMA and quantifying its contribution to a resource-circulating society

Communicating the environmental benefits across the supply chain is important for promoting recycled PMMA in society. By pursuing international sustainability certification systems and providing certified products, we collaborate with stakeholders to achieve a sustainable society.

Product branding also effectively communicates value to consumers. We market products incorporating carbon resource circulation technology under the "Meguri™" brand.

The "Meguri™" brand represents carbon resource circulation and provides consumers with sustainable product choices. This allows consumers to select environmentally friendly products and contributes to a sustainable society. Companies also fulfill their social responsibility and enhance their corporate value by

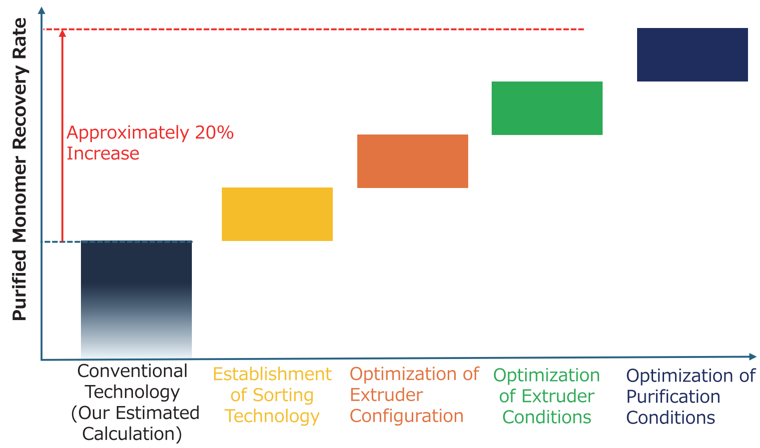

Fig. 9 Sumitomo Chemical PMMA chemical recycling demonstration facility (conceptual image)

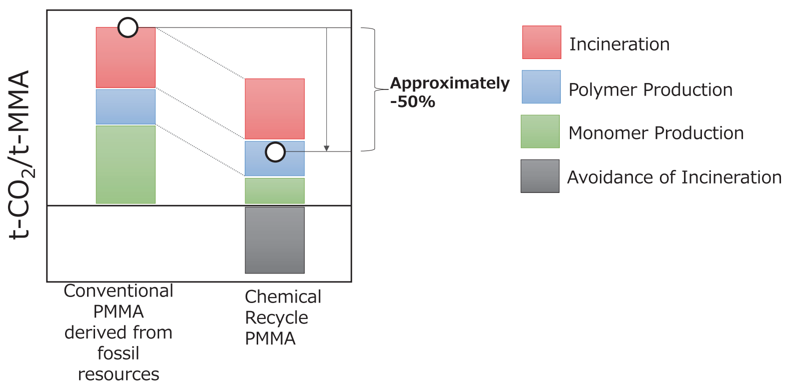

Fig. 10 CO_2 reduction effect through PMMA chemical recycling (conceptual image)

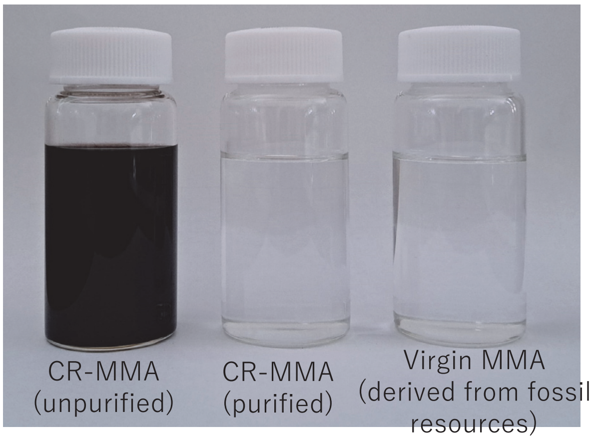

Fig. 11 Photographs of recycled monomers (before and after purification) and virgin monomers

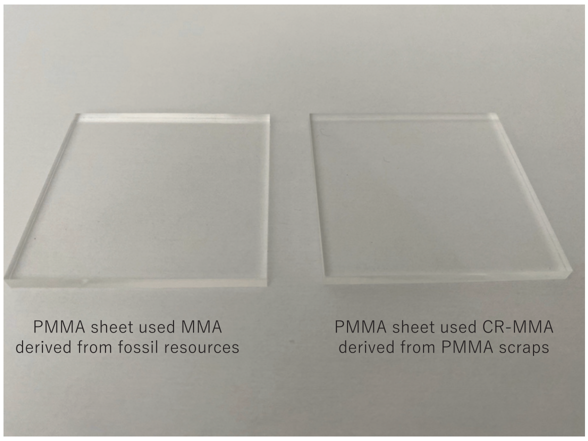

Fig. 12 Images of recycled cast sheet and fossil-derived cast sheet

Table 2 Performance comparison between CR-PMMA and Conventional PMMA

Item	Test Method	Unit	Conventional PMMA	CR-PMMA
Melt Flow Rate (MFR)	ISO 1133	g/10min	2.1	2.2
Vicat softening temperature (VST)	ISO 306	°C	109	109
Deflection Temperature Under Load	ISO 75-2	°C	100	100
Tensile Strength at break	ISO 527-2	MPa	79	79
Tensile Strain at break		%	5	5
Flexural Modulus	ISO 178	MPa	3,300	3,300
Flexural Strength		MPa	136	132
Charpy Impact Strength(notched)	ISO 179-1	kJ/m^2	1.4	1.3
Total light transmission	ISO 13468-1	%	92.4	92.5
Haze	ISO 14782	%	0.5	0.5
YI	ISO 17223	-	0.4	0.4
Density	Water displacement	g/cm^3	1.19	1.19

reducing the environmental impact of their products.

Demonstrating the value of recycled PMMA and implementing it in society is thus a crucial step toward combining environmental protection with economic activity.

4. Global expansion plans

In May 2024, we announced a collaboration with Lummus Technology, a leading U.S. technology licensor. Through this partnership, we aim to accelerate the global adoption of our PMMA chemical recycling technology. Lummus Technology has extensive experience, a proven track record in chemical process technology, and a global network. This collaboration will allow us to expand our chemical recycling technology worldwide and provide sustainable recycling solutions. Specifically, we will support the design, construction, and operation of recycling plants tailored to local needs, promoting recycling technology and market expansion.

Case studies and joint initiatives

1. The MICAN Project of Sumitomo Chemical and Niihama City

In July 2023, Sumitomo Chemical and Niihama City, Ehime Prefecture, launched the “MICAN” (***M****inna de* ***I****ssho ni* ***C****ircular* ***A****ction* ***N****iihama*, “Circular Action in Niihama – Everyone Together”) local resource recycling project for PMMA droplet prevention panels. This project brings together businesses, citizens, and local governments to promote circular action for a recycling-oriented society. PMMA droplet prevention panels were widely used to counter COVID-19. However, after COVID-19 was designated a Category 5 infectious disease on May 8, 2023, the disposal and storage of

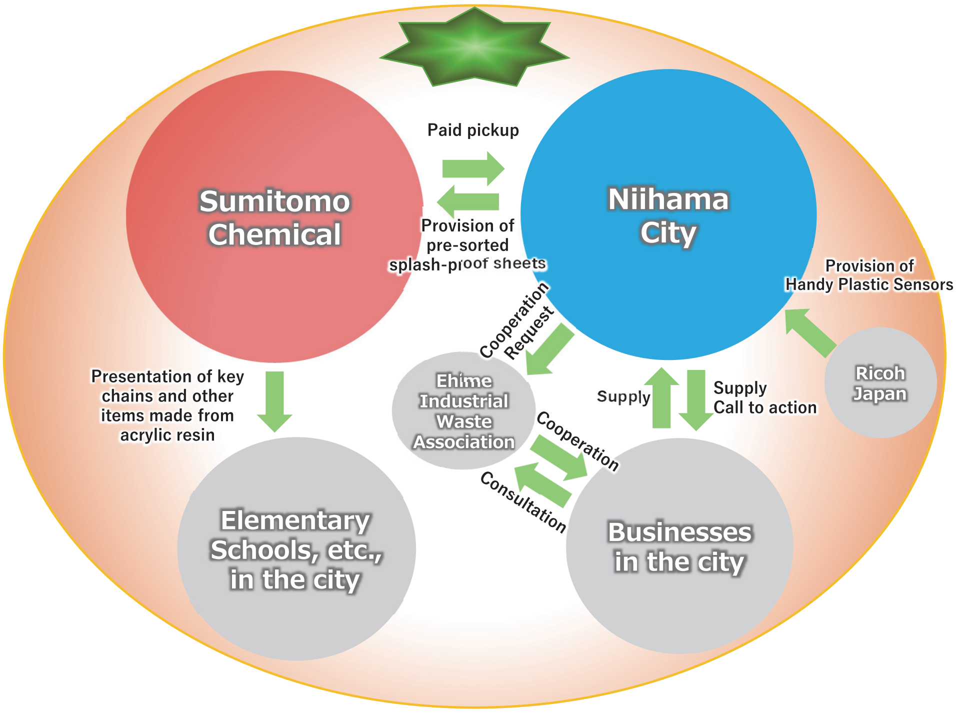

Fig. 13 Overview diagram of the MICAN Project

used panels became a new challenge. MICAN uses the PMMA chemical recycling demonstration facility at Sumitomo Chemical's Ehime Plant to promote effective resource use in the local area. Through this initiative, used droplet prevention panels are efficiently collected and recycled, and commemorative gifts and keychains are distributed to local elementary schools, raising environmental awareness and encouraging specific action toward a sustainable society (**Fig. 13**).

This initiative has been highly praised, and the Japan Chemical Industry Association awarded the RC Jury Special Award at the 19th Responsible Care Awards.

2. Use case of MMA monomer obtained through chemical recycling technology

We supply sustainable MMA monomers obtained through chemical recycling to Star Jewelry Co., Ltd. for acrylic jewelry made entirely from recycled materials (**Fig. 14**). Developing and selling sustainable jewelry reduces its environmental impact while providing consumers with tangible evidence of the value of recycling.

3. Use case of PMMA material obtained through chemical recycling technology

We have begun selling PMMA polymer material made from MMA monomers obtained through chemical recycling. LG Display and Nissan Motor Co., Ltd. have adopted this technology, accelerating the social implementation of chemical recycling in the MMA supply chain.

These sales represent the first mass production of PMMA by our company after overcoming technical challenges such as stabilizing the raw-material quality and establishing process control, and we are supplying PMMA for high-quality applications in the electronics and automotive industries. Specifically, we supply materials to LG Display for LCD backlight light guide plates and to Nissan Motor Co., Ltd. for headlamp lenses.

Fig. 14 Practical examples of chemically recycled MMA monomers provided by Star Jewelry

4. Use case of recycled acrylic sheet produced via material-recycling technology

Our subsidiary, Sumika Acryl Co., Ltd., provides SUMIKA ACRYL SHEET™ Meguri™, which is an acrylic sheet produced using material recycling technology, to Koizumi Lighting Technology Corp. (**Fig. 15**). We have also granted Koizumi Lighting Technology permission to use the Meguri™ mark, promoting awareness of the value of recycling among consumers.

Through these initiatives, we apply our chemical and material recycling technologies across various fields to advance specific efforts toward a sustainable society. We aim to demonstrate the quality and market value of recycled materials while balancing environmental-impact reduction with economic activity.

Future of PMMA chemical recycling

1. Importance of technological innovation

Technological innovation in chemical recycling is crucial for achieving a sustainable society. Advances in this technology can greatly reduce environmental impact compared with conventional waste treatment and enable efficient resource use. Developing efficient and environmentally friendly recycling processes will substantially address waste challenges and build a circular economy. For example, AI-based optimization can monitor the entire recycling process in real time and maximize efficiency. Moreover, the real-time monitoring of recycled material quality ensures strict quality control and the reliability of the recycled materials. This ensures that the recycled materials match conventional virgin materials in performance, enhancing their market value. Developing technologies to control the temperature of the decomposition process and improve energy efficiency is also important. Such innovations will enable a stable supply of high-quality recycled materials while reducing energy consumption. They will also reduce operating costs and further mitigate the environmental impact.

Because of its decomposition characteristics, PMMA is particularly suitable for chemical recycling and serves as a valuable demonstration model for innovation. We hope that these advancements in PMMA recycling technology will influence the chemical recycling of all plastics, marking a major step toward a sustainable society.

2. Global collaboration

Global collaboration is essential for the widespread adoption of PMMA chemical recycling. A consistent recycling process can be achieved worldwide by standardizing the technology while accommodating national regulations and market requirements. International cooperation is also necessary to promote technology sharing and human resource development. This includes sharing technical information via conferences and workshops and enabling experts from different countries to collaborate on technological advancement. Promoting the transfer of technology between developed and developing countries will help create a global recycling network, improving the efficiency and lowering the costs of the recycling process. Additionally, harmonizing international regulations will facilitate the cross-border distribution of recycled materials and support the expansion of the global recycling market.

Fig. 15 Practical examples of "SUMIKA ACRYL SHEET™ Meguri™ " provided by Koizumi Lighting

3. Establishment of sustainable business model

Establishing a sustainable business model for PMMA chemical recycling requires balancing the economic benefits and environmental protection. Stimulating the demand for sustainable products through branding and consumer education enhances the market value of recycled materials. Government policies providing incentives for recycled material use can further promote the adoption of such materials. Maintaining economic competitiveness also requires improving the efficiency and reducing the costs of the recycling process. Automating recycling equipment and improving the energy efficiency will decrease the costs and increase the price competitiveness. Optimizing the entire recycling process will involve strengthening supply chain cooperation and achieving efficient resource circulation.

Technological innovation, global collaboration, and sustainable business models together will shape the future of PMMA chemical recycling. Specific steps will be taken toward a sustainable society, enabling both environmental protection and economic growth.

Conclusion

We use our PMMA chemical recycling demonstration facility to promote technology verification for commercialization and social implementation projects. We also utilize product branding for marketing activities. Reducing the environmental impact is a key management priority, and we will continue to expand the Meguri™ product line across the group, contributing to a circular economy.

As a chemical company supporting the petrochemical industry, we are committed to developing technologies that reduce carbon consumption and achieve carbon neutrality (net zero), recognizing our role in providing solutions for a carbon-neutral society by 2050. We will continue to develop technologies with the goal of transitioning to a resource-circulating society.

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