PLEXIGLAS® and Sustainability: Driving the Change Together

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08. September 2022

PLEXIGLAS®
THE ORIGINAL BY RÖHM

PLEXIGLAS® is one of the world's best-known brands of plastic.

Invented by Dr. Otto Röhm in Darmstadt in 1933 as a sheet product

1935 market launch of PLEXIGLAS® molding compounds

PLEXIGLAS®

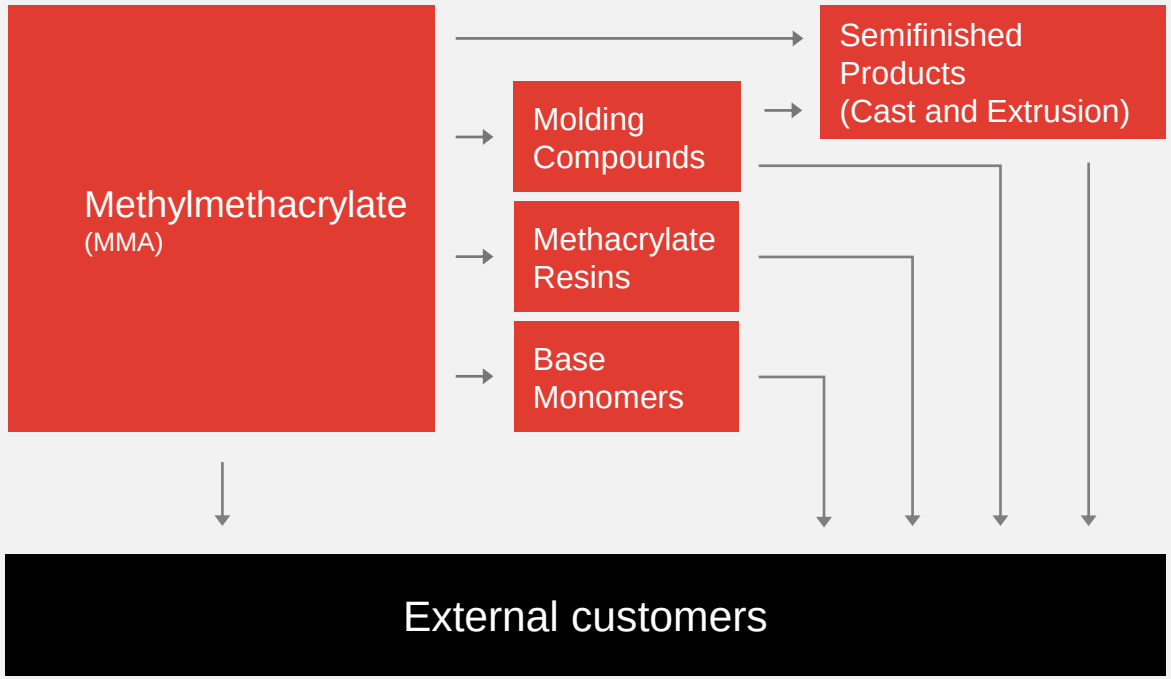
THE ORIGINAL BY RÖHM

PLEXIGLAS® - Röhm is a Reliable Supplier

Through global VERBUND approach

- The Verbund allows **highest quality standard** with integrated processes.
- We respond **quickly and flexibly** to **changes** in our markets.
- **Reliability** and **proximity to customers**.
- Only PMMA supplier in the world with **MMA, PMMA and compounds** produced on 3 continents.

FULLY INTEGRATED VERBUND PRODUCTION



PLEXIGLAS® Molding Compounds

Key properties

PLEXIGLAS® molding compounds are thermoplastics based on polymethyl methacrylate (PMMA) standardized to DIN 7745/ISO 8257

Chemical, physical and technical properties of **PLEXIGLAS® molding compounds**

- high brilliance and excellent light transmittance of 92%
- superior UV and weather resistance
- highest surface hardness of all thermoplastics
- high abrasion resistance
- absolutely colorless and thus utmost precise color matching
- high gloss surface (Class A)
- good heat deflection temperature under load
- high rigidity
- good chemical resistance, fuel resistance
- Surface capable of being polished
- 100% recyclability

Case Study
MINI

MINI 60 years edition
Union Jack taillights shine brightly

Automotive Applications

Source
https://www.plexiglas-polymers.com/en/detail/mini-60-years-edition-union-jack-taillights-shine-brightly-thanks-to-plexiglas-molding-compounds

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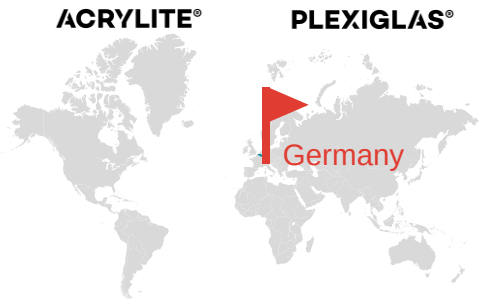

HIGHLIGHTS

- PLEXIGLAS® molding compounds for homogeneous light design – no hot spots
- Different product types to achieve the appearance of the Union Jack

MINI 60 YEARS EDITION: UNION JACK TAILLIGHTS SHINE BRIGHTLY THANKS TO PLEXIGLAS® MOLDING COMPOUNDS

Striking signature lights for a cult car

- PLEXIGLAS® molding compounds for homogeneous light design
- Different product types to achieve the appearance of the Union Jack

Alongside safe lighting, individual design is a key factor for headlights and taillights, as these components are part of the brand identity. To celebrate the 60th birthday of the MINI, the most quintessentially British of all cars has received a unique detail: LED taillights with a Union Jack motif. Taillights with the national flag are a real first in the world of automobiles. The Union Jack light motif first appeared on the 2014 MINI Superleggera Vision concept car. "The positive reception led us to develop the Union Jack light design for the MINI 60 Years Edition," said Sebastian Morgenstern from the BMW Group, who has been responsible for the design of all exterior details on the MINI since 2014. This was not an easy task, however: One tricky aspect of the special Union Jack design only became apparent on the drawing board. And this snag threatened to derail the entire project.

Case Study
Mercedes

Mercedes Headlights
Seeing and being seen

Automotive Applications

Source:
https://www.plexiglas-polymers.com/en/story/seeing-and-being-seen

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ACRYLITE® PLEXIGLAS®

HIGHLIGHTS

- Three different types of PLEXIGLAS® and PLEXIMID® molding compounds used
- PLEXIGLAS® Heatresist FT15 withstands heat stress in the projection modules
- Optimal light transmittance

SEEING AND BEING SEEN

Materials used as optical elements in car headlamps must satisfy stringent requirements—as in the case of the three PLEXIGLAS® and PLEXIMID® molding compounds in the LED Intelligent Light System from Automotive Lighting, which Mercedes-Benz is installing in its C-Class.

Drivers must be able to react promptly to dangerous situations even in poor light or darkness, which is why car makers and suppliers are using ever more powerful illuminants. Whether halogen technology, xenon light, or LEDs, they all have one thing in common: The illuminants need a surrounding material that targets their light on to the road.

In headlamps this function has long been performed by profiled cover lenses. Nowadays light distribution is by means of numerically calculated free-form reflectors or sophisticated projection modules directly in the headlamp. These are therefore distinguished by esthetically attractive clear cover plates.

Intelligent Light

"The different functions of a headlamp place different requirements on the material used," explains Klaus Kratschmann, responsible for ID at Automotive Lighting. In the LED Intelligent Light System, for example, which has been producing Automotive Lighting for Mercedes since 2013, two projection modules jointly take over the low beam function. The flexibility of these modules exceeds the possibilities offered by xenon light: For example, light distribution is adjusted according to the car's speed and the ambient situation. "The headlamp illuminates the road surface in a situation-specific way," says Dr. Ernst-Olaf Rosenhahn, in charge of headlamp innovations at Automotive Lighting. For this purpose the modules are fitted with LED arrays, optical heads, and a projection lens made of PLEXIGLAS® Heatresist FT 15. "The material offers optimal light transmittance for our application," says Henning Weinhold, lighting engineer at AL. In addition, branded polymethyl methacrylate (PMMA) from Röhm prevents the occurrence of optically disturbing color fringes from the periphery of the lenses. The reason is the low optical birefringence of the material and its simultaneously high Abbé number, ensuring that dispersion effects are kept to the minimum.

Case Study
MINI

MINI Story
Two success stories rolled into one

Automotive Applications

Source:
https://www.plexiglas-polymers.com/en/story/two-success-stories-rolled-into-one2

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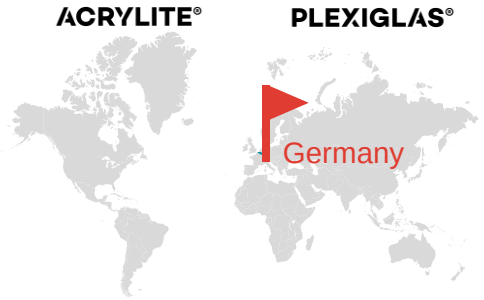

HIGHLIGHTS

- Extremely deep color
- High-gloss surfaces (class A without painting)
- Outstanding surface hardness
- Considerable savings over systems involving coatings and finishes.

TWO SUCCESS STORIES ROLLED INTO ONE

A small car has been a huge success for decades: the MINI. For over 15 years, high-gloss, non-transparent PLEXIGLAS® pillar posts have contributed to the cult car's unmistakeable design.

For many people, cars are much more than a means to an end, they are status symbols or even an expression of the owner's personality. MINI was seen as a lifestyle brand as far back as the 1960s. It was chic, extrovert and different. Even pop stars like the Beatles had their photos taken in the MINI. So the little car's characteristic design, meant to appeal to potential buyers, has basically remained unchanged. Big round eyes, a chrome-plated radiator grille and a large front windscreen make sure you can always tell a MINI when you see one.

The vehicle's appearance has nevertheless evolved in several stages over the past decades. The biggest change in the brand came in 2001, when it was relaunched by the BMW Group. For the brand's relaunch, the BMW Group revamped the entire car and transformed it into a premium brand. In its modern incarnation, the MINI became much bigger, with a raft of new technology, noble trim and a high-class look. Its designers chose materials that would underline the car's premium character, such as high-gloss elements to create a harmonious appearance.

Behind the scenes at the assembly line

Automobile manufacturers, direct suppliers and materials manufacturers work together closely in today's vehicle assembly processes that are based on the division of labor. The first nontransparent, high-gloss add-on car body parts made from PLEXIGLAS® ready for serial applications were created in cooperation with several companies. The product was developed with direct feedback from the processing company, the machine manufacturer, the toolmaker and the end customer (BMW). This was and remains an important foundation for success.

Glass-like material

Prior to the relaunch, the A-pillar posts of the MINI that frame the sides of the large front windscreen were made of metal and painted in the same color as the car. But that created an optical break. The revamped version took a different approach – a highgloss pillar post in piano black that looked like glass and made the front windscreen appear bigger still. This design was enabled by PLEXIGLAS®, known by its chemical name polymethyl methacrylate (PMMA).

Case Study
Thermomix

Surface finishing for Thermomix
Combine design with functionality

Home Appliances

Source:
https://www.plexiglas-polymers.com/en/story/surface-finishing-combining-design-with-functionality

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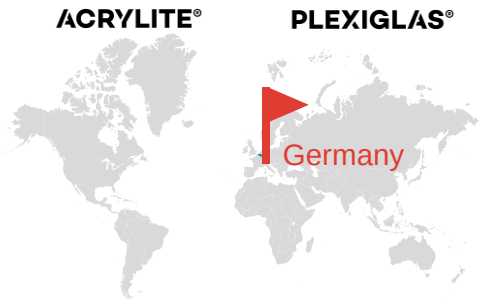

HIGHLIGHTS

- High-gloss surface
- Good looking and tough
- Excellent chemical resistance

SURFACE FINISHING: COMBINING DESIGN WITH FUNCTIONALITY

Vorwerk describes its Thermomix as "the unique kitchen appliance", for which the manufacturer relies on sophisticated technology and first-class materials. PLEXIGLAS® lends the surface of the housing an elegance that endures.

Multifunctional kitchen appliances that weigh, chop, and cook within a single device are now hugely popular; the top brand Thermomix is flying off shelves all over the world. Just 10 months after the current model, the TM5, came on to the market, the millionth such appliance rolled off Vorwerk's production line. "Many of our customers have been loyal Thermomix fans for years, because they know they can rely on our quality," says Dr. Thorsten Gläser, head of Materials Engineering at Vorwerk. The appliance has been designed so as to perform the various functions without elaborate changeover procedures, and is also easy to clean. "For this we rely on the highest engineering skills and first-class materials," says Gläser.

High-gloss surface

For the curved white housing of the device Vorwerk decided on a high-gloss surface finish with PLEXIGLAS®, or, to give it its correct chemical name, polymethyl methacrylate. PLEXIGLAS® molding compounds allow production of components for many different applications that have long proven themselves in, for example, automotive construction and the lighting industry. And they are always inspiring new ideas. As overmolded or co-extruded finishes, they lend their excellent properties also to the underlying material. And it isn't just the functionality that impresses: In the Thermomix housing, for example, the excellent transparence of PLEXIGLAS® results in a seamless and particularly high-gloss surface with a brilliant depth effect. "This gives the housing a distinguished appearance and also a pleasant feel," says Siamak Djafarian, head of the Molding Compounds Product Line at Röhm. "After all, Thermomix isn't just practical, it also looks very good. And our PLEXIGLAS® molding compounds contribute to that."

Case Study
Technokas

Technokas
Daylight Greenhouse

Optical Applications

Source:
https://www.plexiglas-polymers.com/en/story/making-greenhouses-more-efficient

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ACRYLITE®

PLEXIGLAS®

HIGHLIGHTS

- PLEXIGLAS® lenses bundle and direct the rays of the sun onto the collectors, heating up water
- PLEXIGLAS® is capable of reproducing surfaces with tremendous precision

MAKING GREENHOUSES MORE EFFICIENT

A novel technology with lenses made from PLEXIGLAS® molding compounds.

Temperature and lighting conditions in greenhouses need to be as uniform as possible for crops to prosper. For this reason, commercial greenhouse operators generally have to spend a great deal of money on heating, climate control, and shadowing.

The Dutch company Technokas has developed a solution: their Daylight Greenhouse not only consumes less resources than a traditional greenhouse—but it harvests energy as well. The technology also eliminates the need for an additional shading system.

"Conventional greenhouses cannot utilize the entire radiation energy of the sun. A significant portion of the provided energy is lost," says Hans van Tilborgh, one of the three managing directors of Technokas, which has been planning and implementing greenhouse construction projects, climate control systems, and business facilities in the Netherlands for 26 years.

Experts know only a portion of the sun light is used by the plants to grow. "The first thing we thus asked ourselves was, 'How do we make use of the excess energy that a greenhouse absorbs but cannot otherwise utilize?'" Van Tilborgh recalls. The solution? A canopy that collects the direct sunlight and converts it to energy. The diffuse part of the light passes through the roofing and is made available for good plant growth. The Daylight Greenhouse idea was born.

Harvesting energy

More than a decade was required for the engineers at Technokas to develop the initial idea into series-production readiness. A unique roof construction consisting of well-insulated, double-glazed panels with embedded Fresnel lenses is the heart of the new generation of greenhouses. The lenses focus the sunlight onto a collector mounted on a 2-axis sun tracker, which in turn converts the light energy to thermal energy. "The concept wouldn't work without the interaction between the various components," Van Tilborgh explains. "The harvested energy in terms of hot water is then stored and used for heating during night hours or winter months."

Case Study
GEALAN

GEALAN
Protection for Windows and Doors

General Applications

Source:
https://www.plexiglas-polymers.com/en/story/surface-finishing-protection-for-windows-and-doors

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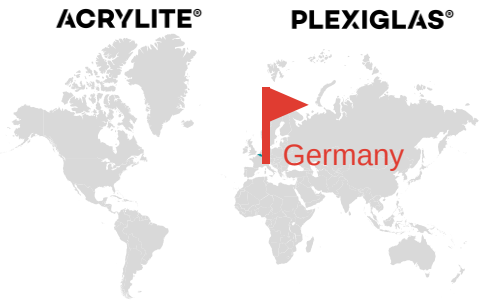


HIGHLIGHTS

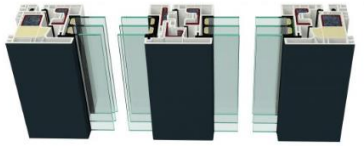
- Substrate material is permanently fused with colored layer of PLEXIGLAS®
- Resistant to weathering, colorfast and easy to clean

SURFACE FINISHING: PROTECTION FOR WINDOWS AND DOORS

Surface upgrading with PLEXIGLAS® molding compound protects the new GEALAN-KUBUS window and balcony door system against all kinds of weather, and enables modern building design.

Gone are the days when window profiles and balcony doors were only available in white. "Various shades of gray are currently on trend among architects and house builders," says Peter Czajkowski, head of architect consultancy at GEALAN Fenster-Systeme GmbH. "But especially for colored profiles, it's very important for the material to be tough and resistant to UV light and weathering. Otherwise, you quickly notice the effects of sunlight and humidity."

To prevent dark gray from turning pale gray further down the line, the company located in Oberkotzau, Germany, protects its latest generation of profiles for windows and balcony doors (GEALAN-KUBUS) with a surface layer of PLEXIGLAS®. The trademarked polymethyl methacrylate from Röhm gives the window a bright pop of color and is intrinsically resistant to UV light and weathering. "The window therefore keeps its high-class appearance in the long term," Czajkowski explains. "That's a key factor for house builders, who don't want the new building or renovated window to look as if it's in need of repair only a few years later."

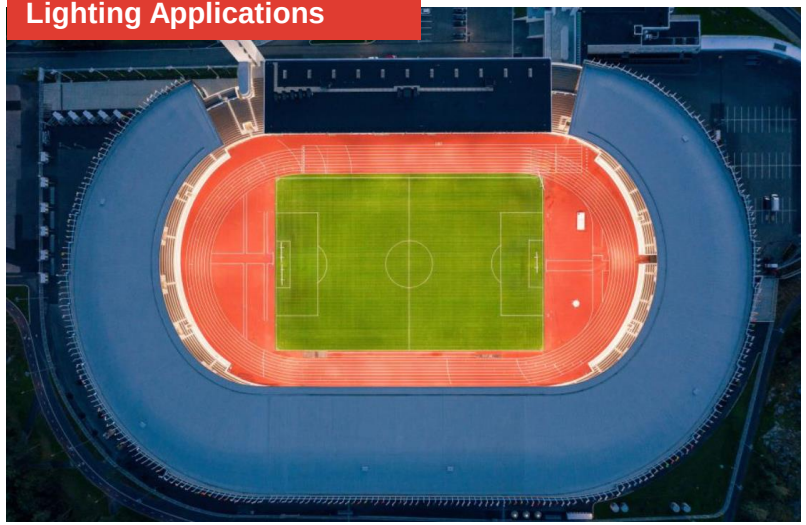


Durable high-quality look
In the GEALAN-KUBUS window and balcony door system, a surface layer of PLEXIGLAS® molding compound makes sure the high-quality appearance is set to last.

Case Study
Siteco

INNOVATIVE SIRIUS® HIGH-PERFORMANCE FLOODLIGHT WITH PLEXIMID® OPTICS

Lighting Applications



Source
https://www.plexiglas-polymers.com/en/story/innovative-sirius-r-high-performance-floodlight-combines-great-brightness-with-pleasant-glare-control-also-thanks-to-pleximid-r-optics-2

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ACRYLITE®

PLEXIMID®
PLEXIGLAS®

HIGHLIGHTS

- Light quality surpasses the standards
- Listed area meets floodlight of the future

Top performance in lighting too

Innovative Sirius® high-performance floodlight combines great brightness with pleasant glare control – also thanks to PLEXIMID® optics

- energy-efficient alternative to traditional floodlight systems
- ideally matched LED system comprising reflectors and high-performance optics made from PLEXIMID® TT50
- PLEXIMID® TT50 is highly heat-resistant and alongside its good optical properties, it also has precise mold surface reproduction

High contrasts for athletes and audience, flicker-free brightness for super-slow-motion replays, intense colors for emotional moments – the lighting in sports arenas and event locations has to fulfill different demands. “Our new Sirius® high-performance floodlight combines great brightness with pleasant glare control and excellent color rendering,” says Wieland Rödel, Head of Sport & Area Lighting at Siteco Beleuchtungstechnik GmbH. “This is quite revolutionary when it comes to LED systems and the first energy-efficient alternative to traditional 2000-watt floodlights.” Core element of the innovative light is a perfectly matched LED system comprising reflectors and high-performance optics made from PLEXIMID® TT50, a highly heat-resistant polymethyl methacrylimide (PMMI) from Röhm.

PLEXIGLAS® Molding Compounds

Long service life time

Single Usage - 1 day to 2 years

Very High production rates,
low price items → consumer materials

Basic Materials

PET, PE, PP … mass plastics

Multi Usage - 15-20 years

High production rates, value
applications performance materials

> 20 years

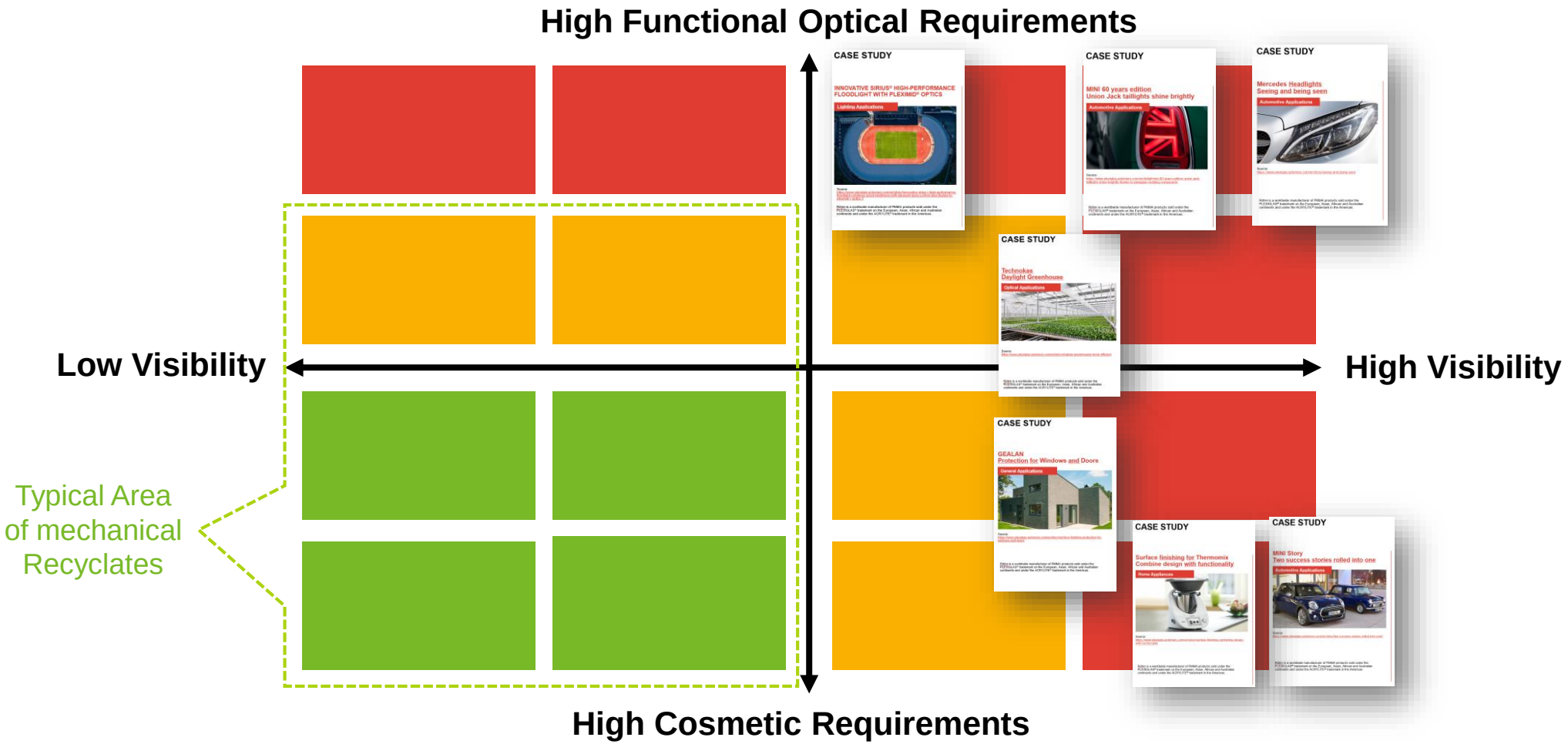
Project Business,
Longterm durable materials, Prestige

Items of value **use** materials of value

PMMA is material of value! PLEXIGLAS® the brand of value!

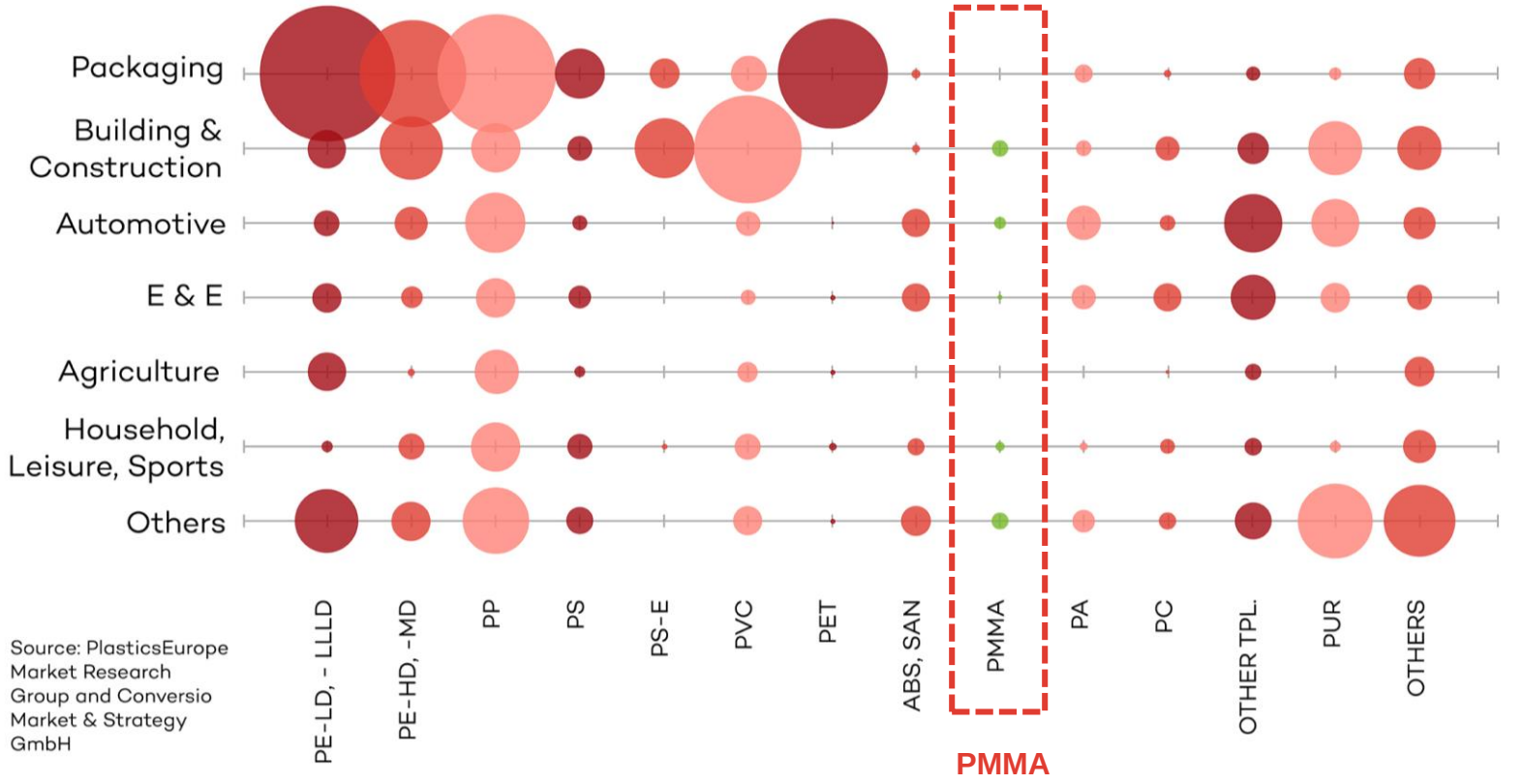
PLEXIGLAS® for Applications with High Optical Requirements

Visibility and optical & cosmetical requirements



Challenge

European plastics demand by segments



Recycled material

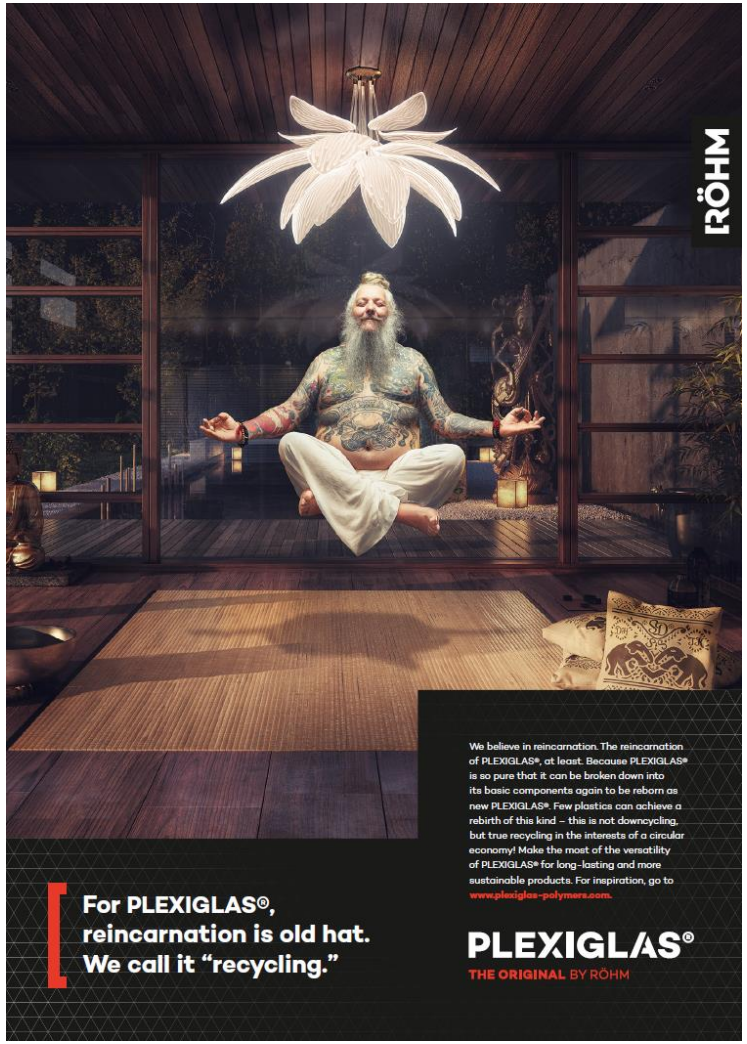
Mechanical | **Chemical**

Circular

Source: https://www.plasticseurope.org/application/files/6315/4510/9658/Plastics_the_facts_2018_AF_web.pdf

Options to recycle PMMA (polymethyl methacrylate)

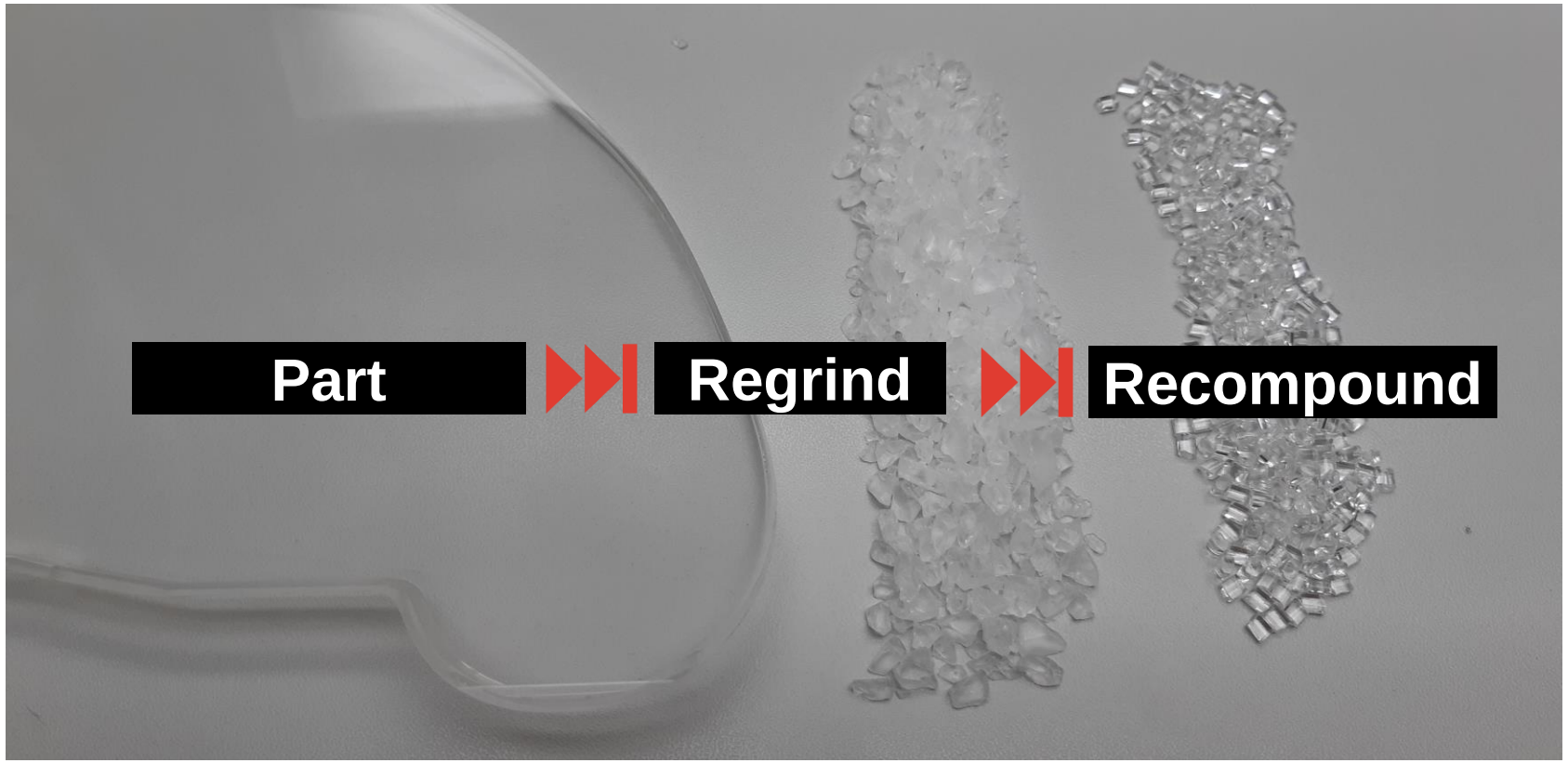
Overview



Mechanical Recycling	Chemical Recycling	Biological Recycling	Thermal Recycling
Grinding & Re-compounding	Conversion back to monomer by cracking of polymer back bone	Composting to CO_2 and Water or any other organic component	Burning to CO_2 and Water
↓	↓	↓	↓
r-PMMA	**r-MMA**	**Not suitable for PMMA**	**Energy**
	Polymerisation		
	↓		
	r-PMMA		
Possible approaches for Röhm		**No target options for Röhm**	

Mechanical Recycling of PMMA

Steps



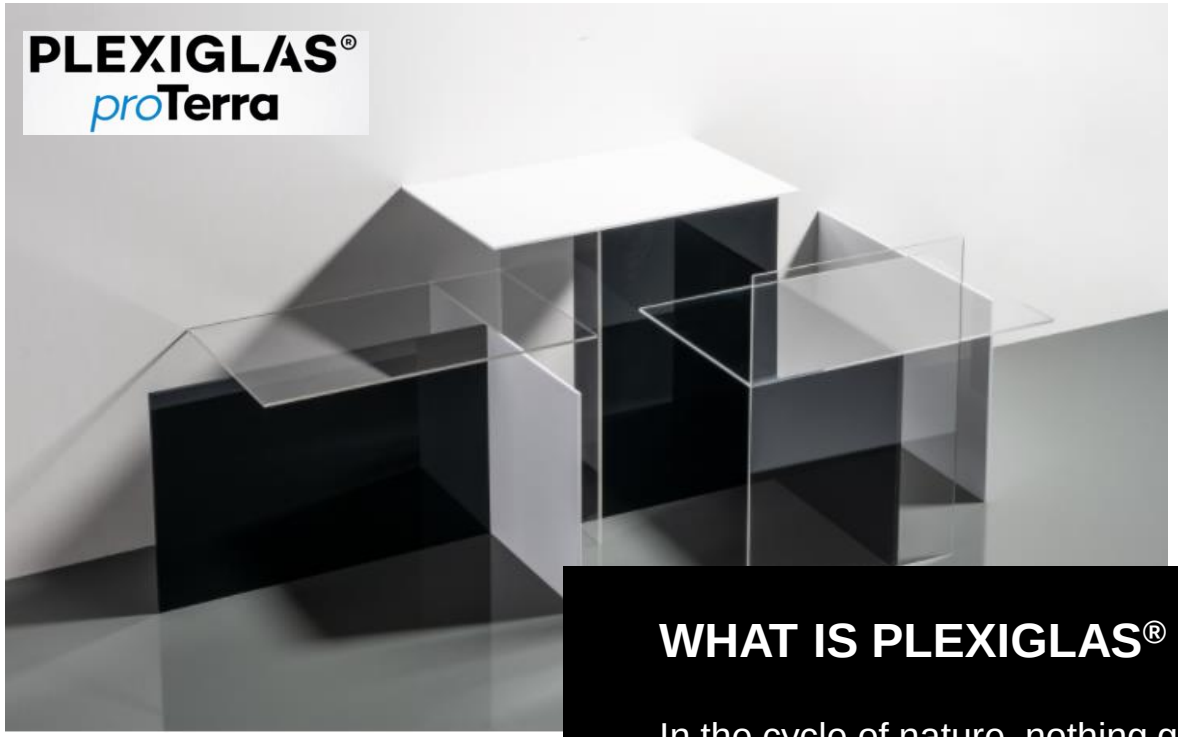
Mechanical Recycling

Grinding &
Re-compounding

r-PMMA

Mechanical Recycling of PMMA

PLEXIGLAS® proTerra



WHAT IS PLEXIGLAS® *PRO*TERRA?

In the cycle of nature, nothing goes to waste. When something decays, something new is formed from these elements. PLEXIGLAS® *pro*Terra follows this example.

No bulk plastics. Instead, a high-performance material made from 90 % recycled PLEXIGLAS®.

Mechanical Recycling

Grinding &
Re-compounding

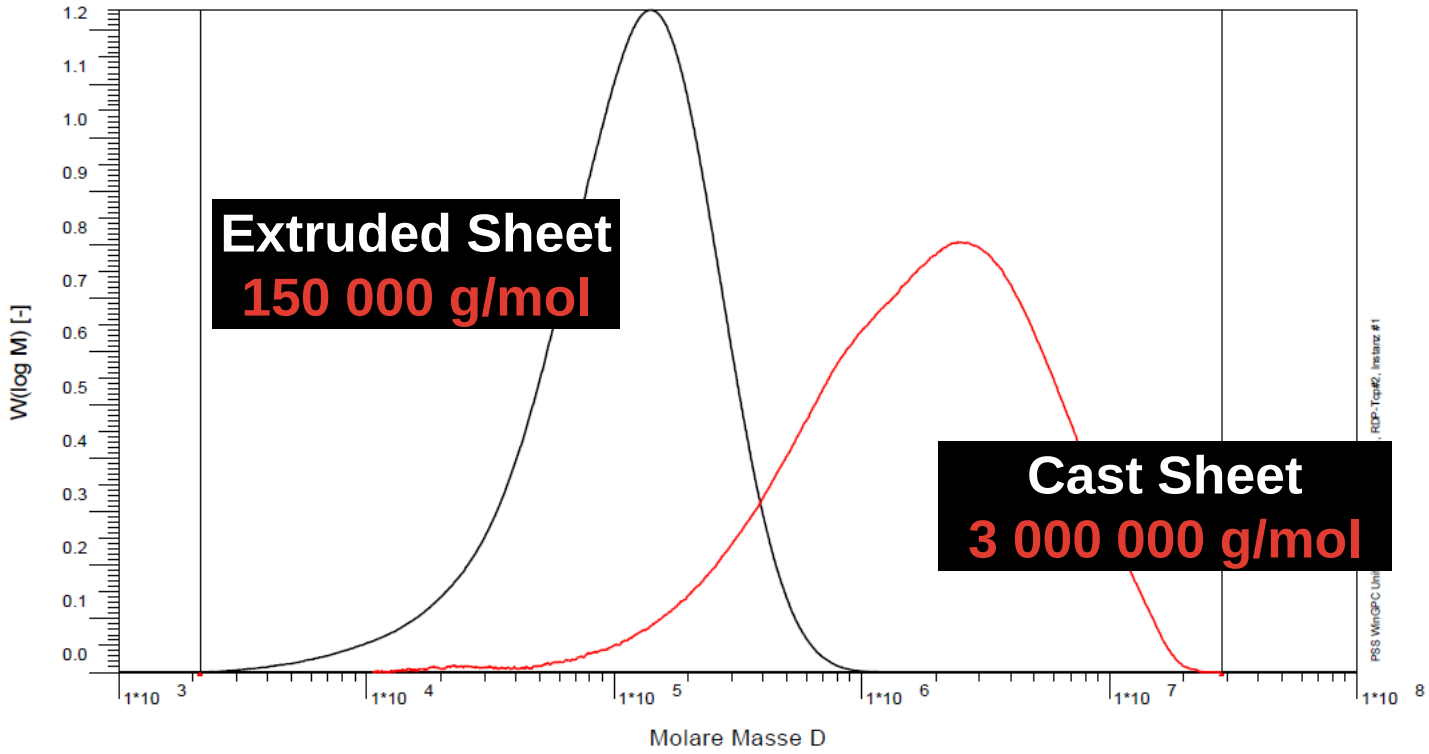
↓

r-PMMA

Recycling of PMMA Backlight Units

PMMA ≠ PMMA

Backlight Unit made of PMMA



Source: Röhm GmbH

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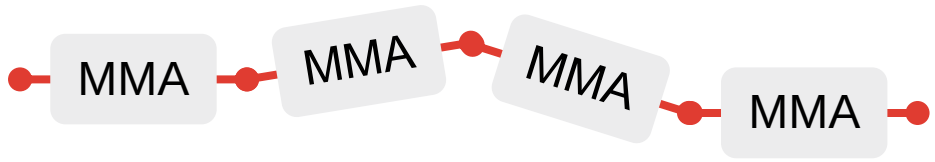
Chemical Recycling of PMMA

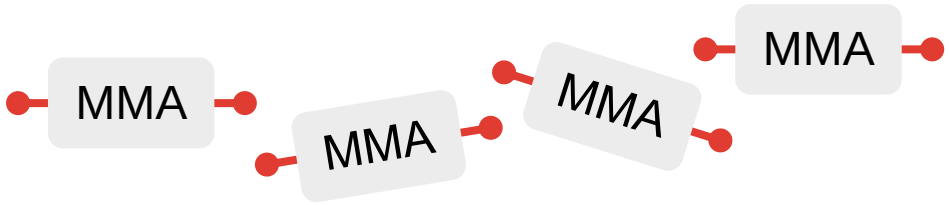
Polymer ➔ Monomer ➔ Polymer

PMMA polymer chain **1**



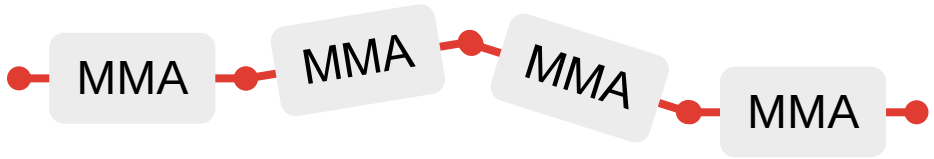
De-Polymerisation

Monomer Units **2**



Purification & Re-Polymerisation

PMMA polymer chain **3**



Chemical Recycling

Conversion back to monomer by cracking of polymer back bone

↓

r-MMA

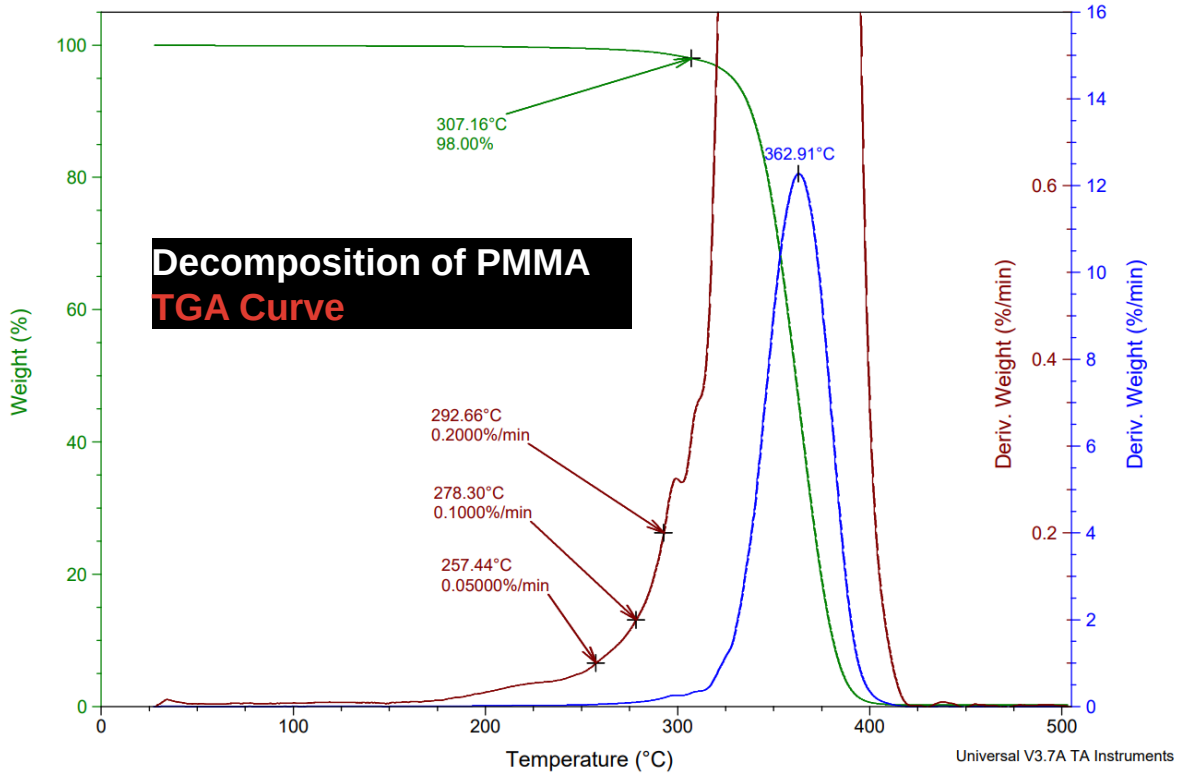
Polymerisation

↓

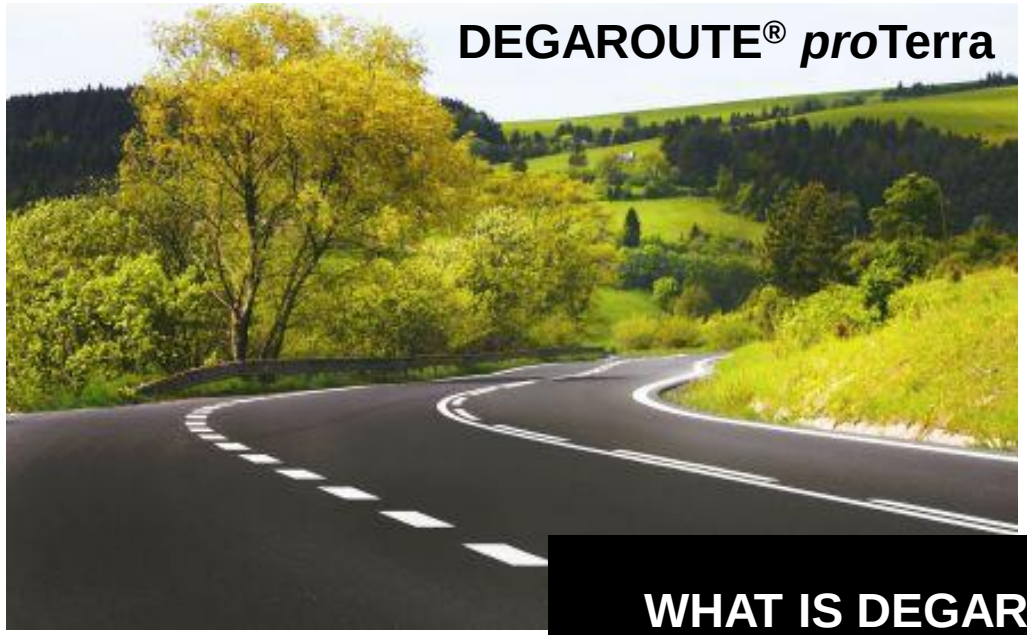
r-PMMA

Chemical Recycling of PMMA

Thermal gravimetric analysis



Chemical Recycling of PMMA



WHAT IS DEGAROUTE® *PRO*TERRA?

Use of chemical recycled MMA Monomers (min. 30%) for Binder

Significantly reduced Product Carbon Footprint around 20 percent

Chemical Recycling

Conversion back to monomer by cracking of polymer back bone

↓

r-MMA

Polymerisation

↓

r-PMMA

TRACK 2030
Vision

Supplying the world with methacrylate innovations to create the goods for a sustainable society

TRACK 2030

Targets

REDUCING THE CARBON FOOTPRINT

We'll only succeed in our efforts to permanently reduce the concentration of CO2 in the atmosphere if everyone plays their part. By 2030, in line with the Paris Agreement, we will reduce the carbon footprint of the products we manufacture and sell by 30% per ton produced compared to 2020. We will achieve this by taking suitable measures to increase energy efficiency and by developing alternative energy sources.

ENSURING CHEMICAL SAFETY

Regulatory, environmental, health and safety requirements for our products and plants are increasing worldwide. We regularly assess the toxicological risk of the substances we process and produce to ensure chemical safety. We also regularly conduct voluntary transport risk analyses for particularly hazardous substances and/or transport routes.

MINIMIZING POLLUTANT EMISSIONS

Pollutants change our ecosystems and harm our health. In the future, we will rely even more on low-emission alternatives for use of our raw materials and further minimize our own pollutant emissions.

PROMOTING THE CIRCULAR ECONOMY

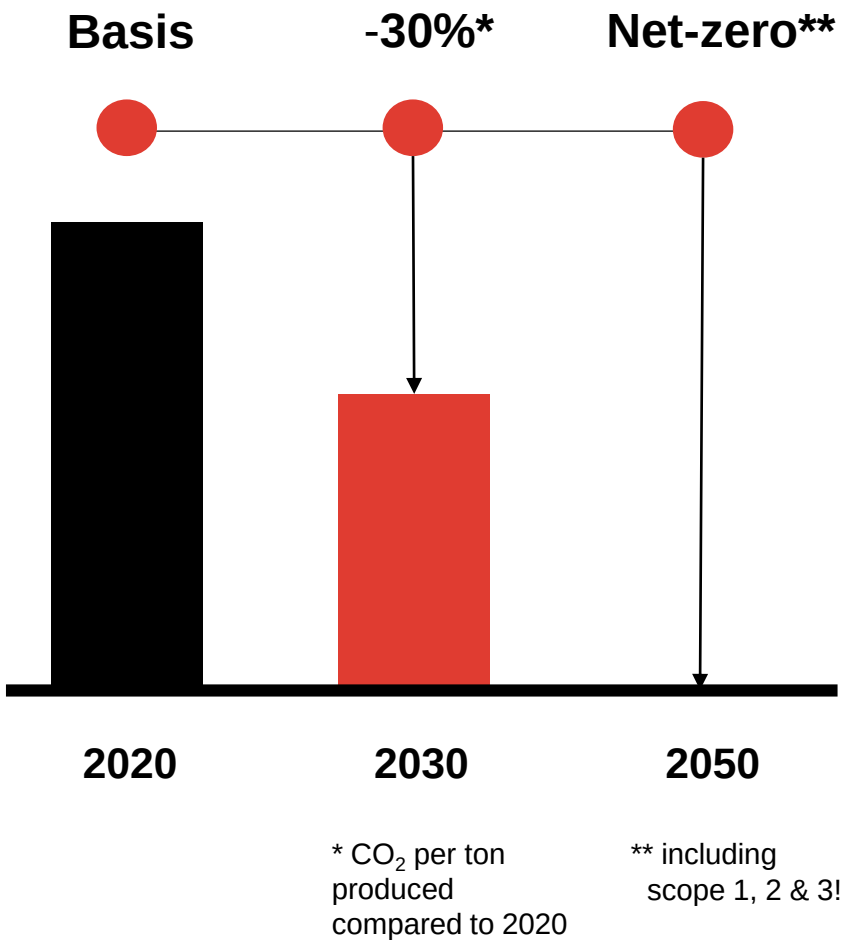
Our primary goal with respect to ensuring efficient and economical use of our raw materials is still to use as few raw materials and as little water or energy as necessary and to avoid as much residue and waste as possible. To ensure that our products remain in the cycle, benefit society and reduce the impact on the environment, we seek suitable solutions and strategic partners to promote the circular economy.

EFFICIENTLY USING WATER RESOURCES

We use water as an energy source, cooling medium and auxiliary material in our production operations. Many of our raw materials and products are transported on the Rhine, which has had too little water for several years. Therefore, we will take additional measures, especially in regions suffering from increased water stress levels, to use water as a resource efficiently and to further reduce demand. We are also committed to water protection.

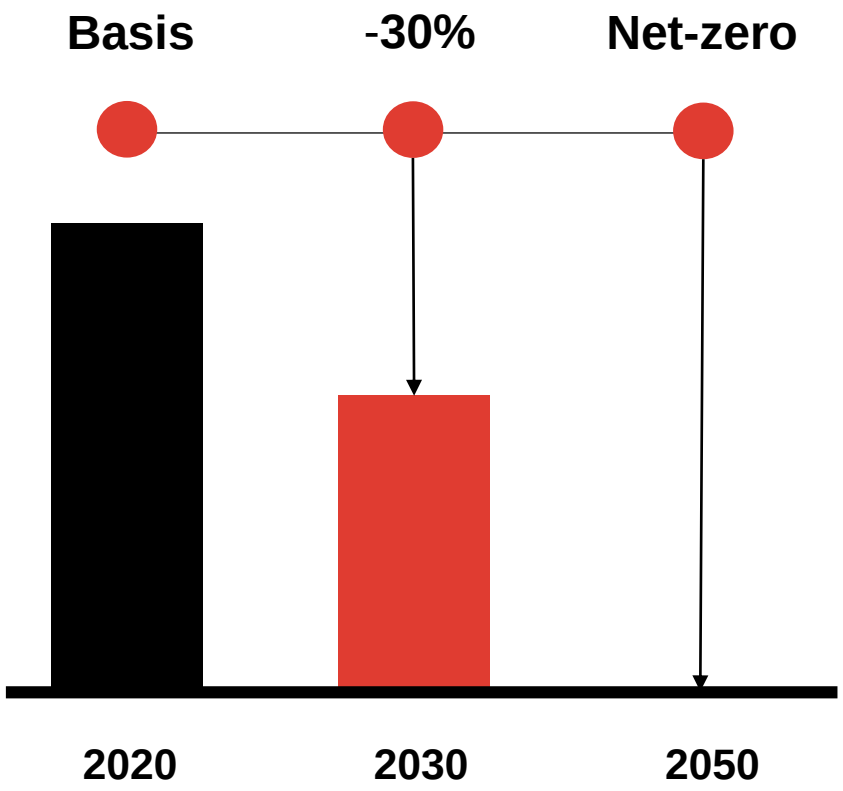
TRACK 2030

Our way to zero Greenhouse Gas emissions



TRACK 2030

Our way to zero Greenhouse Gas emissions



Sustainable Procurement
Decarbonatization of purchased raw materials & services; e.g. ISCC+ Certified Raw Materials

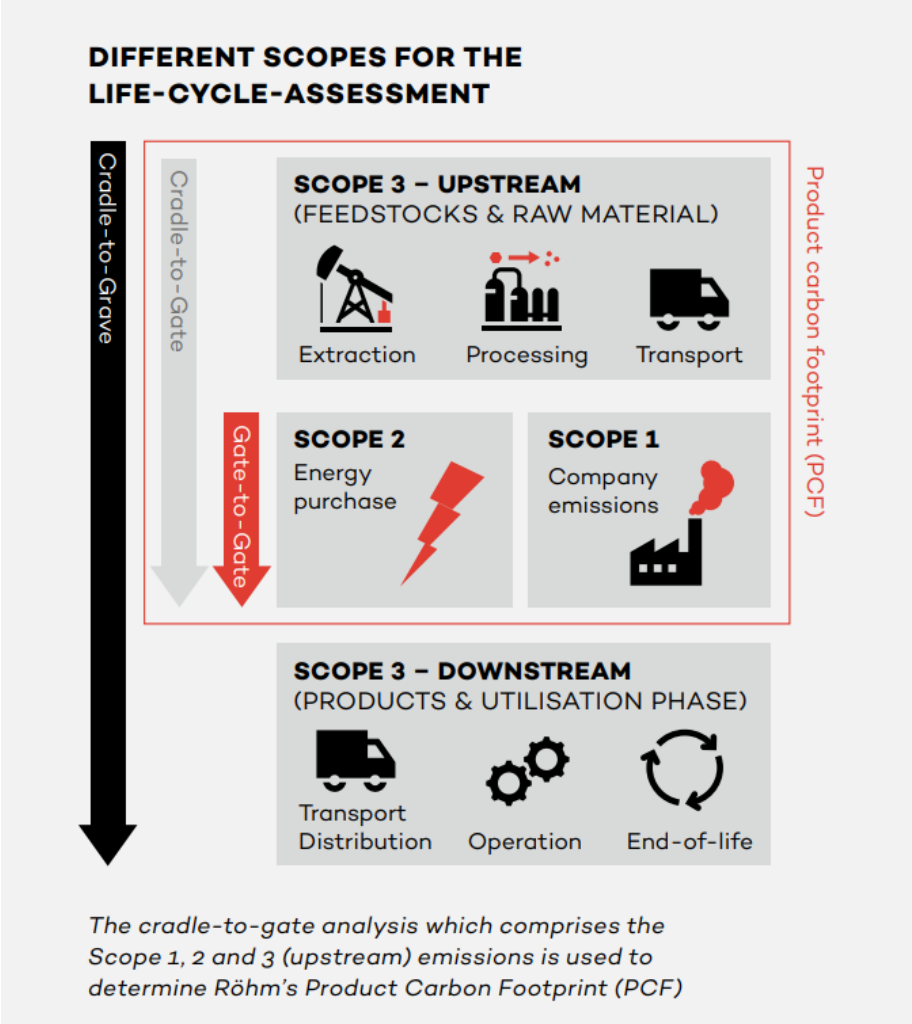
Process Improvements
Reduction of energy consumption, invest in more efficient processes

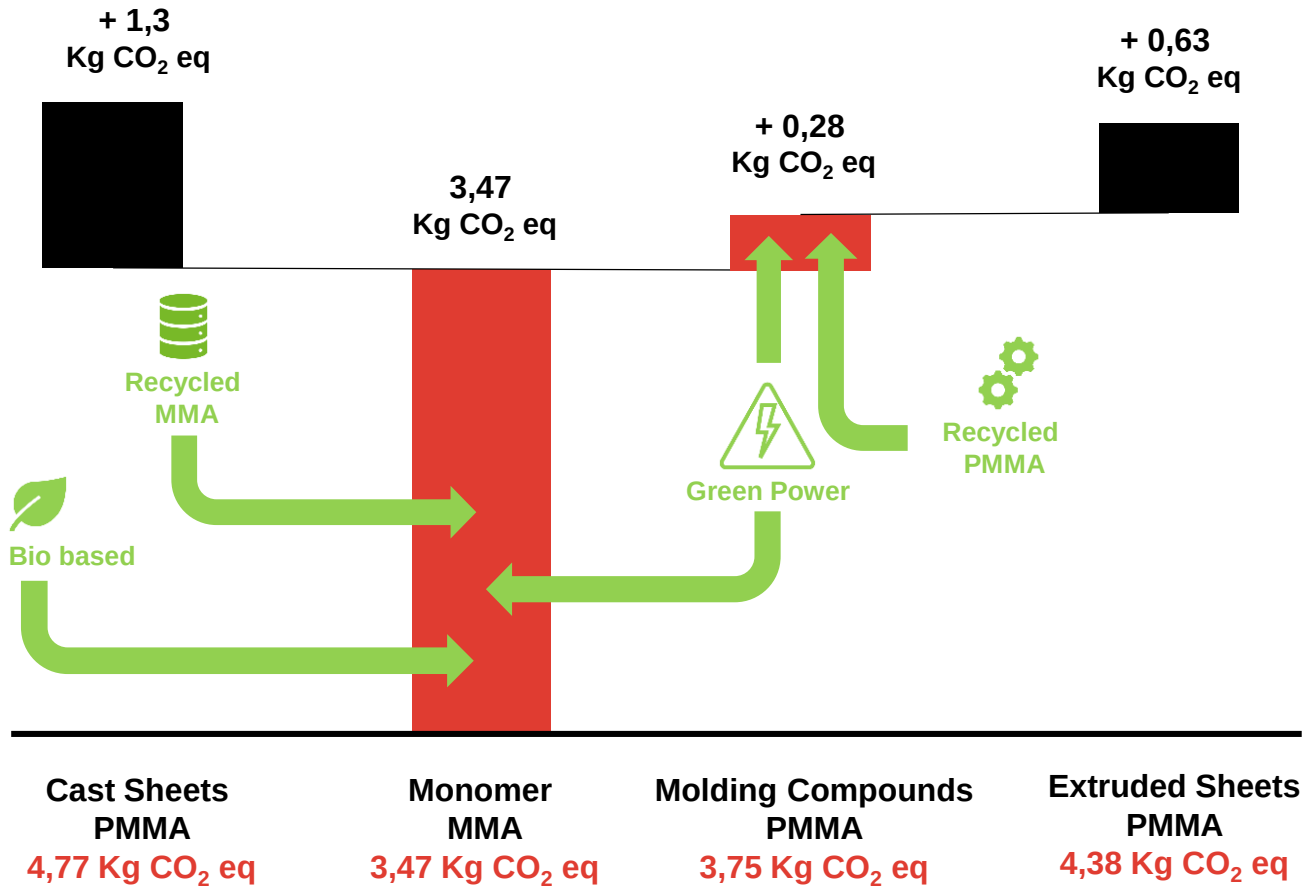
Circular Economy:
e.g. use of recycle PMMA and R-MMA

Green Energy:
Increasing share of green energy

Product Carbon Footprint of PMMA

Possibilities to reduce





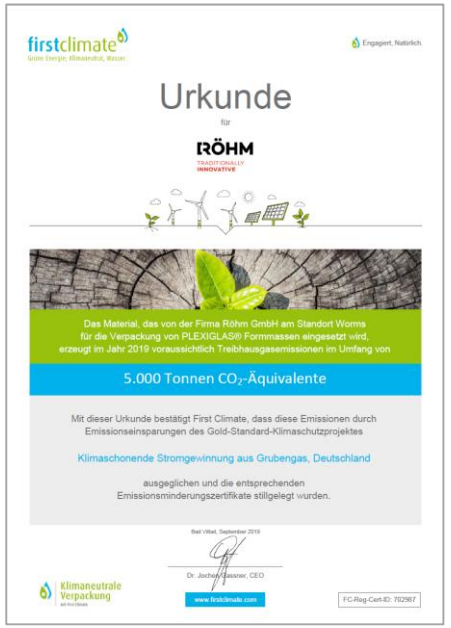
https://legacy.plasticseurope.org/en/resources/eco-profiles

PLEXIGLAS® Molding Compounds

Sustainable by nature

Product

Packaging



BU Molding Compounds uses climate neutral packaging for its granules produced at Worms (Germany)

Processes

PLEXIGLAS® meets standards

The production of PLEXIGLAS® products complies with REACH and OCS goals and is certified in accordance with

- DIN EN ISO 50001 (Energy)
- DIN EN ISO 14001 (Environment)

Real-Time vs Accelerated Weathering

PLEXIGLAS® 8N, Polymethyl methacrylate (PMMA), clear

Real-time

Outdoor weathering
Weiterstadt, Germany

Accelerated

ISO 4892-2,
Method A (daylight filters)

Real-Time vs Accelerated Weathering

Non PMMA material, UV Stabilized

Real-time

0 years	0.5 year	1 years	2 years	5 years	7 years	10 years

Outdoor weathering
Weiterstadt, Germany

Accelerated

0 hrs	500 hrs	1,000 hrs	2,500 hrs	5,000 hrs	7,500 hrs	10,000 hrs

ISO 4892-2,
Method A (daylight filters)

Sustainable Product Design

Lever for sustainable products

Material

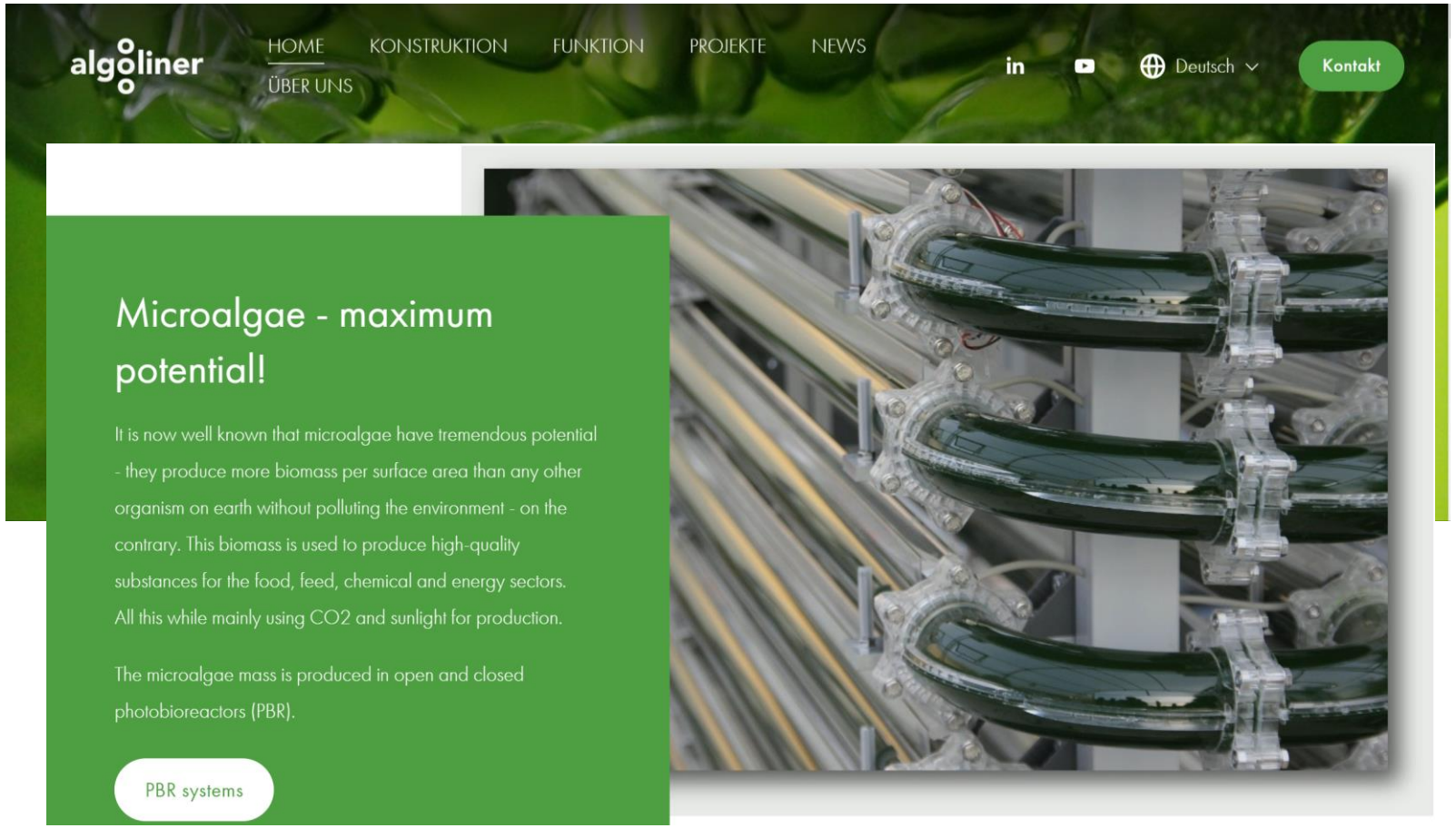
- should be **100% recyclable** after usage phase.
- should offer **long term performance** over Product Life time to improve the Life Cycle Assessment
- should not contain any critical substances
- **Recycling content**, when feasible

Component / Part

- Create **repairable design** (e.g. snap fits/ screws instead of welding)
- **One component – one material strategy** instead of one part made out of several materials
- **Avoid hard coating or paint processes** to reduce VOC and CO2-Footprint

Sustainable by Design
Bioreactor from ALGOLINER

- All components are made of PLEXIGLAS®
  (Tubes, Connectors, Fixtures)
- PMMA based ACRIFIX® adhesive to connect parts
- Fully recyclable
- On Site extrusion
- PLEXIGLAS® enables bioplastics



https://www.plexiglas-polymers.com/de/story/algoliner-revolutioniert-die-kultivierung-von-mikroalgen-mithilfe-von-plexiglas-r-formmassen-und-einer-mobilen-fabrik-story

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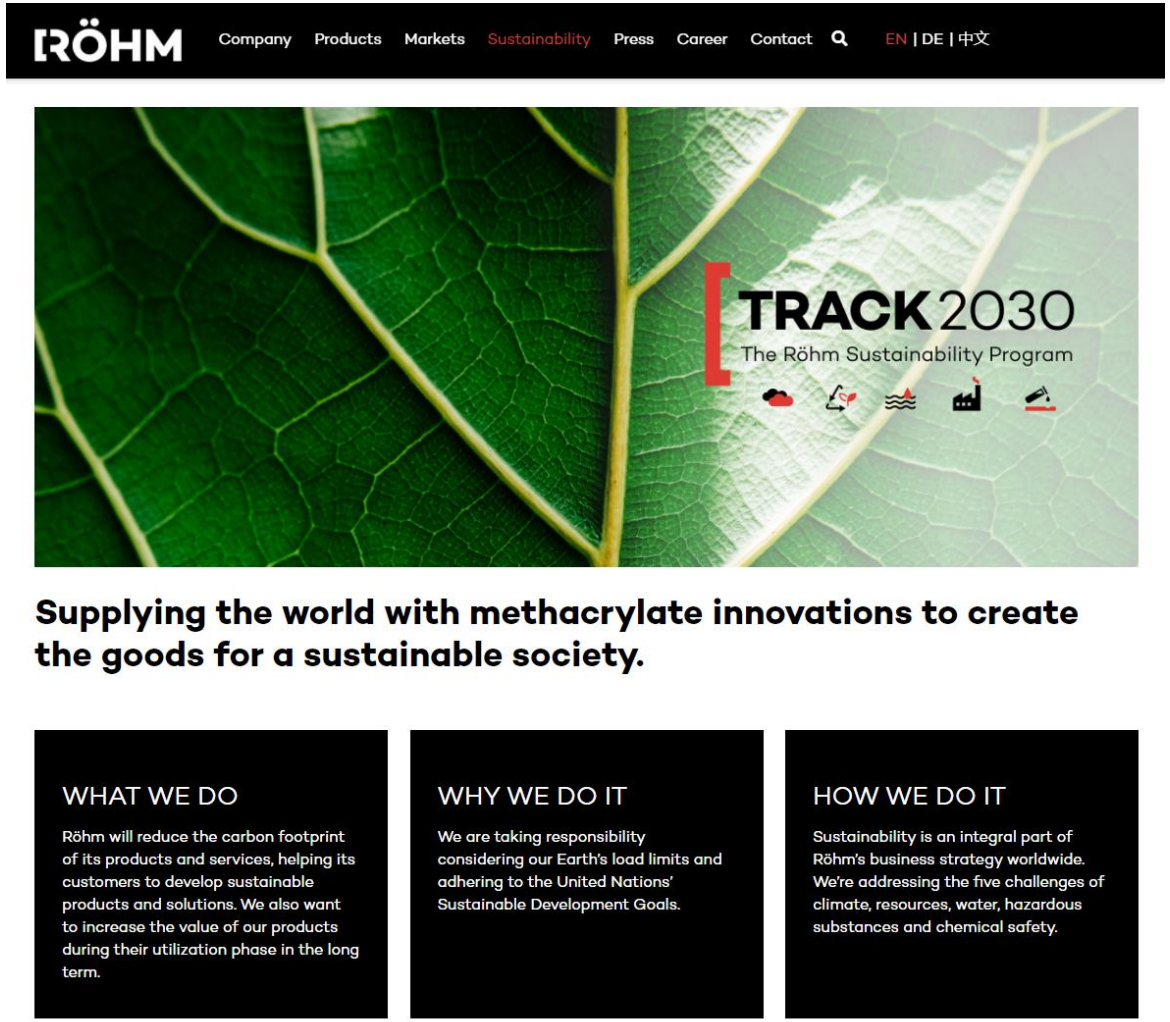
More information



Discover more about our sustainability program and activities on our webpages

https://www.roehm.com/de/nachhaltigkeit

https://www.roehm.com/en/sustainability

SILVER 2021 ecovadis Sustainability Rating

Operation Clean Sweep®

Responsible Care
Verantwortung hat Zukunft

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