



# Fiber composite solutions for advanced lightweight components

*Engineering Passion*

***Krauss Maffei***

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## Process

Process

	Stressability	Temperature resistance/ Operating temperature	Dimensional stability/ Thermal expansion	Surface quality	Size/Format	Complexity/Geometry	Post-mold processing capability	Automation level	Production volume	
<b>IM-SGF</b> Injection molding, short fiber reinforcement	●	●	●	●	●	●	●	●	●	Page 6
<b>IM-LGF</b> Injection molding, long- fiber reinforcement	●	●	●	●	●	●	●	●	●	Page 6
<b>IMC</b> Injection Molding Com- pounder	●	●	●	●	●	●	●	●	●	Page 8
<b>FiberForm</b> Shaping and encapsulating organic sheets with back injection	●	●	●	●	●	●	●	●	●	Page 10
<b>PolySet BMC/SMC</b> Injection molding of polyester BMC/SMC	●	●	●	●	●	●	●	●	●	Page 12
<b>R-RIM</b> Reinforced Reaction Injec- tion Molding	●	●	●	●	●	●	●	●	●	Page 14
<b>SCS</b> Structural Component Spraying	●	●	●	●	●	●	●	●	●	Page 16
<b>FCS</b> Fiber Composite Spraying	●	●	●	●	●	●	●	●	●	Page 18
<b>LFI</b> Long Fiber Injection	●	●	●	●	●	●	●	●	●	Page 20
<b>HP-RTM/C-RTM/T-RTM</b> High-Pressure Resin Transfer Molding	●	●	●	●	●	●	●	●	●	Page 22
<b>Surface-RTM</b> Surface Resin Transfer Molding	●	●	●	●	●	●	●	●	●	Page 24
<b>iPul</b> Pultrusion	●	●	●	●	●	●	●	●	●	Page 26
<b>Wet molding</b>	●	●	●	●	●	●	●	●	●	Page 28

Options

### CellForm

Physical and chemical foaming  
(MuCell™)

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### IMP

In Mold Painting

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## We offer – many solutions

### **Whatever your challenge, we have a solution**

Four main factors determine the property patterns of a component. They also limit the manufacturing processes that can be used:

- Type and length of fibers
- Plastic matrix
- Component geometry
- Production volume

### **Manufacturing expertise in fiber composites**

For many years, KraussMaffei has been working with widely varying processes for manufacturing parts made of fiber-reinforced plastic (FRP). These processes have traditionally evolved from injection molding technology and reaction technology (PUR). Today our process portfolio ranges from injection molding of components with short-glass-fiber reinforcement to high-strength, lightweight parts with a complex mesh structure in a reactive matrix.

We set the highest priority on manufacturing processes that are automation-capable.

### **Process expertise and engineering know-how**

We start working on the component requirements right from the project and development phase, instead of dealing only with the process itself. We support you throughout the entire project phase: from the initial idea, to the start of production, all the way to the first series components.

Our engineers have unique expertise from all fields of plastics processing. We can also supply molds as well as systems for post-mold processing, finishing, and component testing. We are suitable as an ideal partner across the entire development and implementation process.

### **Check out what KraussMaffei can offer you!**




Discover the whole wide world of fiber-reinforced plastics with our processes and machinery and put our expertise to the test.

Consult us about your next project; it is a challenge we will welcome! And you can be sure of our support from start to finish.

# One expert partner over the entire value-adding chain

<b>Twin-screw extruder ZE BluePower</b>	Reliability, flexibility, and high throughputs – these are the key requirements of a solution for compounding. KraussMaffei Berstorff offers proven twin-screw extruders which meet these expectations. The portfolio provides the appropriate solution for the compounding of plastics and other basic materials and the majority of the solutions are standard.
<b>All-electric PX series machines for clamping forces between 500 and 2000 kN</b>	Flexibility, productivity, and maximum user friendliness are the design principles of the all-electric PX series. Custom-fit machines are developed for every manufacturing requirement from a large modular toolbox. A robust mechanical system, high-precision and dynamic drive technologies, as well as intelligent energy management make the PX a reliable, productive, and efficient performer in any injection molding operation.
<b>The CX modular platform - hydraulic and hybrid - from 350 to 4200 kN</b>	The CX series of hydraulic injection molding machines feature a 2-platen clamp design. The ultimate in modular engineering, the CX series offers over 100 clamp/injection unit combinations and over 500 options, making it possible to configure efficient, application-specific, high-performance machines. CX machines are the perfect starting point for today's technology variants – from processing thermosets to multicomponent molding to foam processes.
<b>GX series – the new dimension of injection molding - from 4000 to 9000 kN</b>	With their first-class hydromechanical twin-platen design in conjunction with the single-piston injection system, the machines of the GX series set new standards with respect to performance, usability, and value stability. Thanks to the modular design, the compact twin-platen clamping unit can be individually combined with all available injection units. The GearX locking mechanism and the GuideX guide shoe provide a new dimension to injection molding.
<b>Big, all-hydraulic, MX-series machines for clamping forces from 8500 to 55,000 kN</b>	MX machines are engineered to deliver sustained performance under demanding conditions. For all their size, they are compact, high-performance production systems, featuring fast responses, fast cycles, and high productivity. Versatile and modular, they offer a wide range of solutions, especially for large-format parts.
<b>Global players – the RimStar series</b>	The RimStar MiniDos, Compact, and Modular series provide ideal mixing and metering solutions for every type of PUR processing. Modular engineering and flexible machine configurations mean that RimStar covers the whole spectrum of PUR processes. The RimStar Thermo version is engineered to process epoxy resins and serve as a metering unit for RTM processes.
<b>Metering filled multiple-component reactive systems with the Comet series</b>	Comet is a series of piston metering machines engineered to meter PUR components with abrasive fillers, such as glass fibers or wollastonite. The machines have metering pistons instead of pumps. The abrasive fillers can be added to both the polyol and the isocyanate component.
<b>High-pressure mixing heads for all PUR processing applications</b>	The mixing head is the heart of a polyurethane processing system. High shot rates, good product quality, and highest productivity are a direct outcome of our many decades of experience and our commitment to continuous improvement of the whole range of KraussMaffei mixing heads. Our mixing head portfolio ranges from linear mixing heads to multicolor, transfer, and filler mixing heads.
<b>Mold carriers – from standard to special</b>	Based on standardized modules, KraussMaffei supplies mold carriers with optimal mold closing for almost any application. A range of drive and closing concepts deliver the optimal combination of dynamics and efficiency. In addition to a choice of standard formats, KraussMaffei is also a successful project partner for complex custom solutions.
<b>Expertise in foam, RIM, CCM, LFI, and special molds</b>	KraussMaffei supplies molds and tooling for all processes, including casting, foaming, and back foaming. Each mold is a custom design, application-specific, and optimized for the specific production process. The molds are available in versions made of steel, aluminum, and synthetic resin.
<b>Complete downstream and system solutions</b>	Our complete portfolio of PUR-processing machinery includes fully and semi-automated processing cells for trimming, punching, and milling PUR moldings. Our profound, wide-ranging expertise in tooling enables us to supply complete manufacturing lines engineered for fast processing, reduced waste, and optimized swarf removal.

# Machine overview

<b>Twin-screw extruder in ZE BluePower series</b> Material processing	
<b>All-electric PX series machines for clamping forces between 500 and 2000 kN</b> Injection molding	
<b>The CX modular platform - hydraulic and hybrid - from 350 to 4200 kN</b> Injection molding	
<b>GX series – the new dimension of injection molding for clamping forces between 4000 and 9000 kN</b> Injection molding	
<b>Big, all-hydraulic, MX-series machines for clamping forces from 8500 to 55,000 kN</b> Injection molding	
<b>Global players – the RimStar series</b> PUR processing - wet side equipment	
<b>Metering filled multiple-component reactive systems with the Comet series</b> PUR processing - wet side equipment	
<b>High-pressure mixing heads for all PUR processing applications</b>	
<b>Mold carriers and compression molding – from standard to specially developed for different applications</b> PUR processing	
<b>Expertise in foam, RIM, CCM, LFI, and special molds</b>	
<b>Complete downstream and system solutions</b> Milling and punching systems including cutting tool	

Whatever you aim to achieve in plastics or rubber processing, KraussMaffei is your partner. We are the only company with mastery of the three most important machine technologies, and we link our expertise in these fields to develop new processes and systems.

## Ready for any challenge

KraussMaffei's Injection Molding Machinery Division engineers and supplies systems, including automation solutions, for standard applications and for almost all processing variants. Our main markets are in the automotive, packaging, electrical, electronics, medical technology, and consumer goods industries.

In Reaction Process Machinery, we engineer and supply machines and systems for processing polyurethanes and other reactive materials. Tooling Technologies supplies a complete range of molds and tooling, cutters, and routers. Our customer base is wide, with a focus on the automotive, construction, and the white appliances industries.

In the field of Extrusion Technology we cover compounding, extrusion of pipes, profiles, films and sheets, physical foaming, and the manufacturing of technical rubber products and semifinished tire products. Products from the company's range - from single extruders to complete extrusion lines - are used in industries as diverse as chemicals, automotive, construction, furniture, packaging, and pharmaceuticals.

## Lightweight construction and fiber composite technology – Our core competence

KraussMaffei is not just a machinery and systems expert in automated manufacturing of lightweight fiber composite components, but also has cross-process technological expertise over the whole value-adding chain.

We are the only company in the world to offer the best manufacturing technology for the part specifications and target quantities of our customers while providing them with expert support throughout the entire manufacturing process.

### **Benefits of fiber composite technology at a glance:**

- Wide-ranging fields of application
- Highest component requirements and property profiles
- Wide range of manufacturing processes



# Mobility, energy, environment, lightweight construction – Our solutions are used across the board



## **Sporting goods**

The following processes are used here:  
IM-SGF, IM-LGF, FiberForm, wet molding,  
HP-RTM, CellForm, C-RTM



## **Wind power**

The following processes are  
used here: FCS, C-RTM, HP-RTM,  
wet molding, iPul Pultrusion



## **Rail transport**

The following processes are used here:  
IMC, FiberForm, PolySet BMC/SMC, SCS,  
C-RTM, HP-RTM, wet molding



## **Agricultural machinery**

The following processes are used here:  
IM-SGF, IM-LGF, IMC, FiberForm, PolySet BMC/SMC, R-RIM,  
FCS, LFI, SCS, HP-RTM, C-RTM, wet molding, CellForm





#### • **Aircraft construction**

The following processes are used here: IM-SGF, FiberForm, C-RTM, HP-RTM, wet molding, iPul Pultrusion



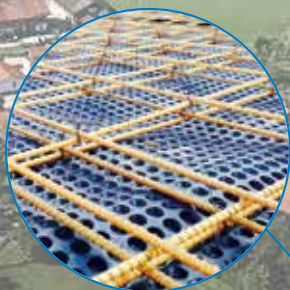
#### • **Car making**

The following processes are used here: IM-SGF, IM-LGF, IMC, FiberForm, PolySet BMC/SMC, R-RIM, LFI, SCS, HP-RTM, C-RTM, wet molding, CellForm, iPul Pultrusion



#### **Construction**

The following processes are used here: IM-SGF, FCS, LFI, C-RTM, HP-RTM, wet molding



#### • **Infrastructure, buildings technology, building construction**

The pultrusion process iPul is used here



#### **Commercial vehicles**

The following processes are used here: IM-SGF, IM-LGF, IMC, FiberForm, PolySet BMC/SMC, R-RIM, FCS, LFI, HP-RTM, C-RTM, wet molding

## Familiar standard

# Injection molding with short fibers (IM-SGF)

Thermoplastics are often reinforced with short fibers, usually glass fibers, to increase the stiffness and strength of the molded part. The ready-compounded pellets normally have a fiber content of 15 to 50 percent by weight. Materials used in series production of technical parts have a fiber content of 60 percent and more.

The highly abrasive ends of the glass fibers stick out of the half-melted pellets and aggravate the wear on the plasticizing unit. KraussMaffei plasticizing units have a level of wear protection to match the application. This ensures that process parameters remain constant over a longer service life.

### Processing of long-fiber-reinforced pellets (IM-LGF)

The use of long-fiber-reinforced thermoplastic pellets (LFT) significantly improves the mechanical property patterns of components. The length of the fibers corresponds to the pellet length; fiber lengths of 12 and 25 mm are common. Long-fiber-reinforced thermoplastics cost much more to manufacture than short-fiber pellets, so it is important to preserve the long fibers by using a gentle processing technique and thereby take advantage of their reinforcing properties.

### Special screws and injection compression molding

Specially designed screws in the plasticizing unit reduce shearing and prevent fibers from breaking as well as excessive wear. Injection compression molding and customized mold geometry for ribs, radii and, above all, the hot runner system reduce damage to fibers during filling and shaping.

### Impact-resistant components with LFT

Adding short glass fibers to a resin matrix produces parts with high rigidity, strong enough to take higher loads. The same can be achieved with long fibers and a low fiber content, meaning a lower weight. LFTs with higher fiber content are preferred for non-visible semi-structural components, such as frontends and instrument panel supports. These components need high impact strength in order to function despite impacts and vibrations. LFT components inevitably have fewer oriented fibers, because the long fibers tend to block each other.

### Multidisciplinary know-how for fiber-reinforced pellets

We combine our expertise in material processing, compounding of plastics, and injection molding to deliver impressive complete solutions. To supply our customers with solutions tailored to their formulations and processes over the whole process chain, we apply our extensive knowledge of processes from all essential application areas and our design skills as an experienced mechanical engineering company. We are experts when it comes to integrating reinforcement materials and fillers, such as glass fibers, talc, carbon fibers, calcium carbonate, barium sulfate, etc.

### Your benefits:

- Short cycle times enable fully automated production of higher quantities
- Improved mechanical properties and high stiffness compared to unfilled materials
- Can be combined with almost any other injection molding variant

## Process

## Injection molding of short and long glass fiber-reinforced thermoplastics

### Description

Many thermoplastics can be reinforced with short glass fibers. The ready-compounded pellets normally have a fiber content of 15 to 50 percent by weight. They are processed in standard injection molding machines where the plasticizing unit has additional wear protection.

By contrast, LFT with fiber/pellet lengths of 12-25 mm needs to be processed in machines with specially adapted screw geometries and usually also with an injection compounding process that avoids damaging the long fibers.

### Features

1. Fully-automated standard injection molding machine, slightly modified
2. Familiar processing method
3. Wide choice of materials from many different suppliers

### Typical applications

Seat shells, instrument panel supports, door modules, technical underhood parts

### Typical annual volumes

300,000 to 600,000 items

## Products of KraussMaffei machines



<b>Component</b>	Transmission element
<b>Material</b>	PA 66 with 50 percent short glass fibers
<b>Technology</b>	Standard injection molding with wear-protected plasticizing unit
<b>Benefits</b>	<ul style="list-style-type: none"> <li>- Withstands high and oscillating mechanical stress; high temperature resistance</li> <li>- Greater design freedom than for metals; acoustic damping</li> <li>- Weighs 50 percent less than an equivalent metal part</li> </ul>



<b>Component</b>	Door module and interior trim of door
<b>Material</b>	Decor: TPO film with flexible foam Substrate: PP with 10 percent long glass fibers
<b>Technology</b>	Injection molding with a fiber-friendly screw; Single-stage process (DecoForm), as TPO film is directly backfoamed
<b>Benefits</b>	Highly cost-competitive, because it combines visible parts and multifunctional parts with enhanced mechanical specifications

# IMC links compounding with injection molding – Unbeatable cost savings in mass production

The matrix polymer is first plasticized and mixed with additives in a corotating twin-screw extruder.

The reinforcing fibers are fed into the extruder, wetted with the molten thermoplastic, which naturally shortens them, and transferred to an injection piston. During the brief injection and holding pressure phase, the compound, which is produced continuously, is collected in a melt buffer. The continuous melt process guarantees consistent material quality.

## Lower production costs with better properties

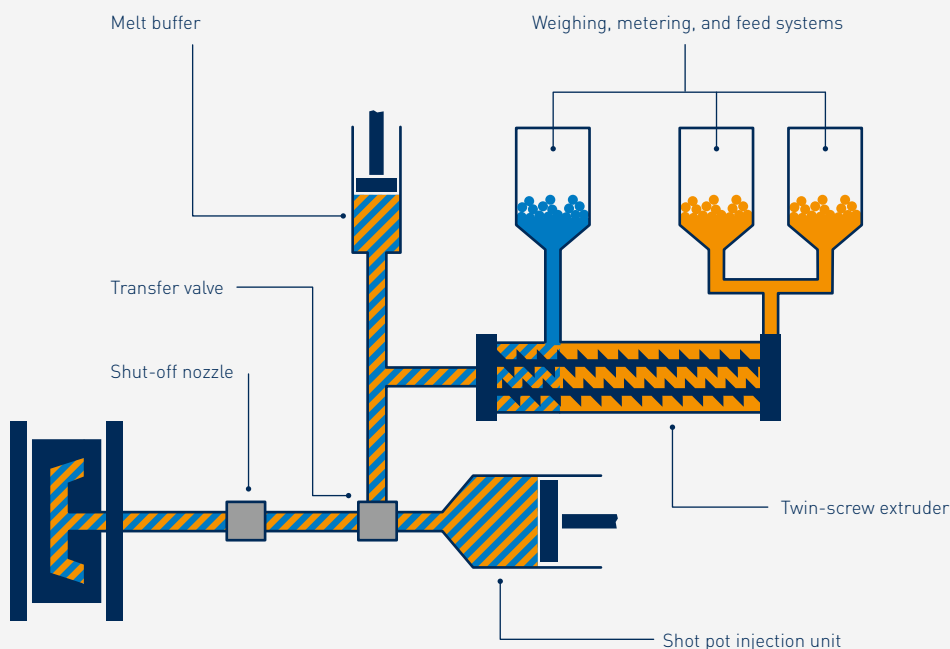
Direct compounding/injection with the IMC saves energy and material costs (0.3 to 1.0 €/kg cheaper than processing LFT pellets). As a result, it has widely replaced LFT in manufacturing semi-structural components. The mechanical properties of finished parts are also better because the process is less destructive to the fibers. The fibers are only processed once (instead of twice if pellets are used) and they are fed into the melt in the direction of processing. Process steps such as pelletizing, cooling, and remelting are omitted.

## Automated and flexible for series production

The IMC process can be highly automated. Together with other key benefits, this makes direct compounding the process of choice for producing big runs of fiber composite parts. The integrated control ensures that the formulation and the material quality are constant and that the process is fully documented. Changes to the formulation are simple, so that the process can be adapted flexibly to meet different part specifications. The IMC system is just one example of productive interdisciplinary collaboration at KraussMaffei – it successfully merges injection molding know-how with expertise in compounding and extrusion.

## Your benefits:

- Short cycle times enable fully automated production of higher quantities
- Long fibers for better material properties and high stiffness
- Lower material costs



## Process

### Direct compounding with the IMC (D-LFT-IM)

<b>Description</b>	The IMC - Injection Molding Compounder - combines continuous compounding, typical of extrusion systems, with injection molding, which is a discontinuous process. This way long-fiber-reinforced thermoplastic components can be produced with better properties and at a lower cost than using pellets.
<b>Features</b>	<ol style="list-style-type: none"> <li>1. Highly automated process</li> <li>2. Flexible adaptation to changing requirements</li> <li>3. Compounding using low-cost standard raw materials</li> </ol>
<b>Typical applications</b>	Frontend carriers, transmission elements, front partitions, battery wells
<b>Typical annual volumes</b>	300,000 to 600,000 items

## Products of KraussMaffei machines



<b>Component</b>	Assembly carrier (frontend)
<b>Material</b>	PP-GF30, long-fiber reinforcement
<b>Technology</b>	IMC direct compounding with metal insert in upper belt for energy distribution in an offset frontal collision
<b>Benefits</b>	<ul style="list-style-type: none"> <li>- As a module carrier multifunctional part; good energy absorption, especially when there is oscillation</li> <li>- Good impact strength due to long-fiber reinforcement</li> <li>- Very cost-competitive process for large series production due to no intermediate cooling and remelting</li> </ul>



<b>Component</b>	Acoustic damping mats
<b>Material</b>	PP EPDM filled with barium sulfate
<b>Technology</b>	IMC direct compounding with addition of filler followed by application of PUR acoustic flexible foam
<b>Benefits</b>	<ul style="list-style-type: none"> <li>- Lower part weight through acoustic-defined wall thickness reduction</li> <li>- Higher filler content and good homogeneity</li> <li>- No trimming waste</li> </ul>

# Thermoplastic structural components with functional integration

To further improve the strength of fiber-reinforced injection molded parts, KraussMaffei combines injection molding with thermoforming of organic sheets.

Fabric made of endless fiber in a thermoplastic matrix is heated, shaped in the injection mold and then back injected. This process can be used to add ribs for extra stiffness and to integrate other functions.

## Fast and highly automated

Cycle times are similar to typical values for injection molding (around 30 seconds) and are chiefly determined by the cooling time in the mold. The process can be seamlessly integrated into an injection molding operation. In other words, FiberForm technology is ideal for manufacturing lightweight structural components for large series production.

## Highly-automated manufacturing cells

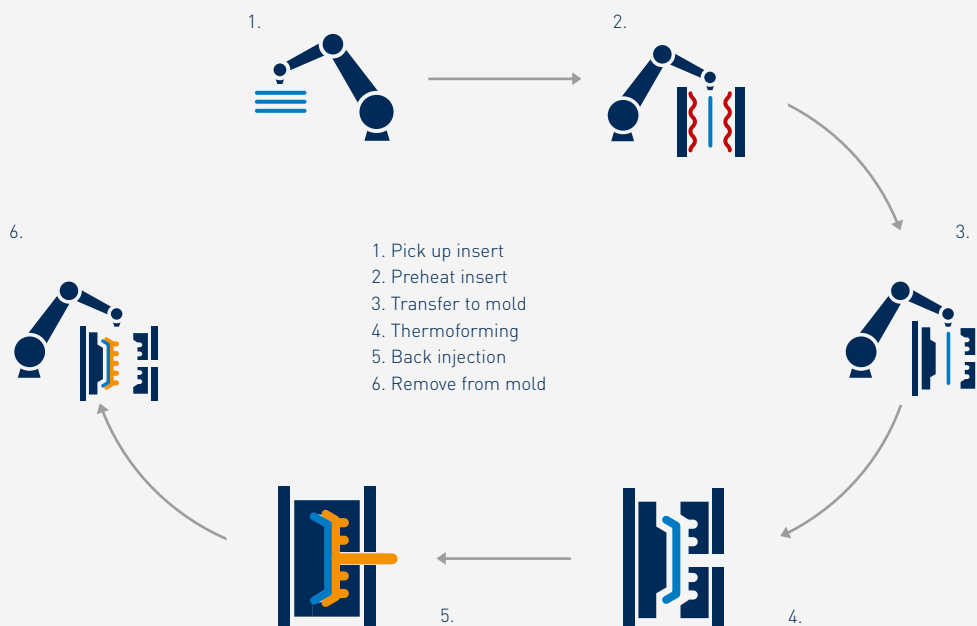
Like standard injection molding, FiberForm can be easily automated. The outcome is compact, fully-automated manufacturing cells.

## Versatile process

Like injection molding, FiberForm can be combined with almost all special manufacturing processes. This opens up infinite potential for functional integration and component design.

## Your benefits:

- Parts are demolded with their final contour, no post-processing required
- Short cycle times, typical of injection molding processes
- Fully automated manufacturing process
- IR oven integrated into MC6 control system





## Process

## FiberForm – Thermoforming and back injection of organic sheets and UD tapes

<b>Description</b>	Forming and back injection of fiber-reinforced thermoplastic semifinished products
<b>Features</b>	<ol style="list-style-type: none"> <li>1. Thermoplastic injection molded parts with fiber reinforcement</li> <li>2. Highly automated and reproducible manufacturing process</li> <li>3. High functional integration as part of the injection molding process</li> </ol>
<b>Typical applications</b>	Seat shells and backs, instrument panel supports, soft top compartments, side impact protection, underbody groups, door modules, technical underhood components, battery mountings, semi-structural components
<b>Typical annual volumes</b>	10,000 to 4,000,000 items

## Products of KraussMaffei machines



<b>Component</b>	Predevelopment project: Door impact beam
<b>Material</b>	PA 6 GF60 + PA-GF 50-50 organic sheet
<b>Technology</b>	FiberForm + formed bolt holes
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– High mechanical strength</li> <li>– Assembly-ready</li> <li>– Short cycle times</li> </ul>



Photo: TAKATA AG

<b>Component</b>	Predevelopment project: Passenger airbag unit
<b>Material</b>	PA 6 GF30 + PA-GF 50-50 organic sheet
<b>Technology</b>	FiberForm
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– Organic sheet can be shaped easily</li> <li>– Cost-effective technology for large series production</li> <li>– High mechanical strength</li> </ul>

## Fully automated processing of BMC/SMC molding compounds

Thanks to their very low viscosity, thermosets are especially suitable for wetting fibers to produce fiber-reinforced plastics (FRP). Due to their high temperature resistance, thermoset FRP parts are still regularly used as substitutes for metals.

Sheet Molding Compound (SMC) and Bulk Molding Compound (BMC) are used for very stiff, precision parts, which are often painted. The broad range of use from low temperatures up to 180 °C enables a diverse field of applications as well as in-line painting of Class A surfaces.

### The raw material that's a little different

The doughy polyester or vinylester-based resins are reinforced with fiber. BMC is often reinforced with short glass fibers, SMC with long glass fibers (25–50 mm). The compounds are supplied ready-to-use.

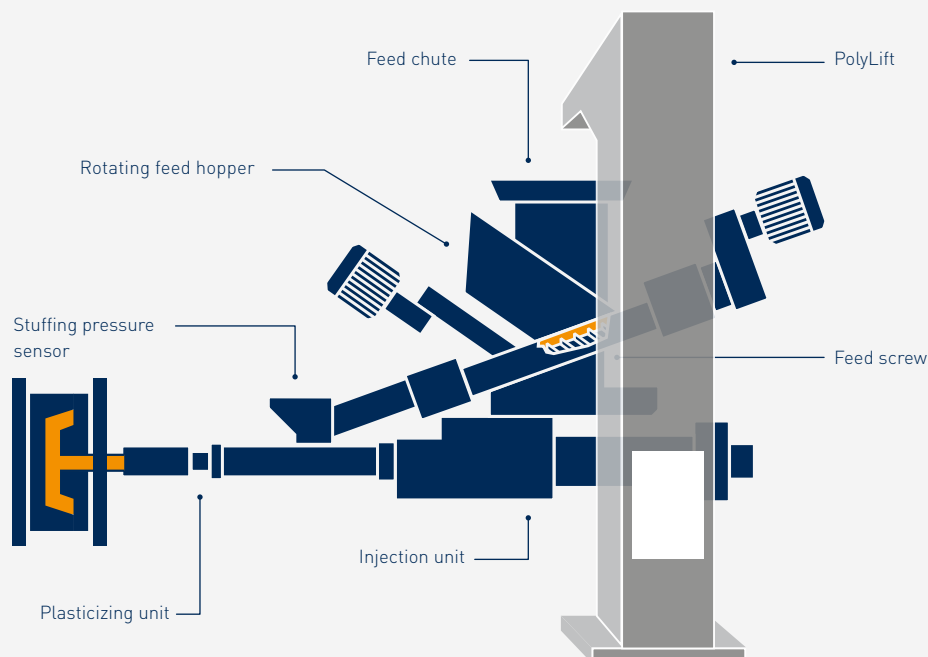
### Unique feed system - reliable injection molding process

The AZ 50/100 automatic feed system and the PolyLift ensure fully automated, bubble-free material feed without any interruptions to the cycle. This increases productivity and the number of good parts.

The doughy material is removed from its packaging and placed directly, without interrupting the production cycle, into the feed hopper of an injection molding machine. The rotating action of the hopper and the feed screw transports the material into the heated plasticizing unit. After injection, the precisely metered thermoset cures in the hot mold to produce the finished part.

### Your benefits:

- Precision feeding thanks to the controlled stuffing pressure and uniform processing conditions
- Refilling processes without interrupting the cycle
- Outstanding material homogenization and fiber-friendly processing
- Fully-automated, bubble-free material feed



**Process****PolySet – Continuous injection molding of polyester dough molding compounds (BMC, SMC)****Description**

PolySet – Process for polyester dough molding compounds that are not free flowing, for small to medium component sizes

**Features**

1. Unique feed method for continuous material transport of the polyester dough molding compounds, regardless of the material's form and consistency
2. Robust construction, long service life even processing highly abrasive materials
3. Special, material-specific machine portfolio for thermosets

**Typical applications**

Valve caps, headlight reflectors, oil sumps, brake pistons, medical equipment, circuit breakers

**Typical annual volumes**

200,000 to 500,000 items

**Products of KraussMaffei machines**

<b>Component</b>	Headlight reflector
<b>Material</b>	BMC made of UP resin with short glass fibers; LS setting for high dimensional accuracy
<b>Technology</b>	PolySet injection molding of BMC
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– Very high reproducibility thanks to good process monitoring</li> <li>– Class A surface with post-mold painting</li> <li>– Excellent dimensional stability over the whole operating temperature range</li> </ul>



<b>Component</b>	Throttle valve housing
<b>Material</b>	BMC made of UP resin with short glass fibers
<b>Technology</b>	PolySet injection molding of BMC
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– Low component tolerance (0.02 mm)</li> <li>– Complex geometries with no post-mold processing</li> <li>– Operating range from -40 °C to 150 °C</li> <li>– Good thermal insulation properties for winter use</li> </ul>

## Perfect surfaces with low wall thickness and highly reactive PUR systems

In R-RIM, short fibers (glass, carbon, wollastonite) or fillers are added to the polyol before processing. The PUR mixture is poured into the closed mold, where it cures quickly.

### R-RIM on wear-resistant machines

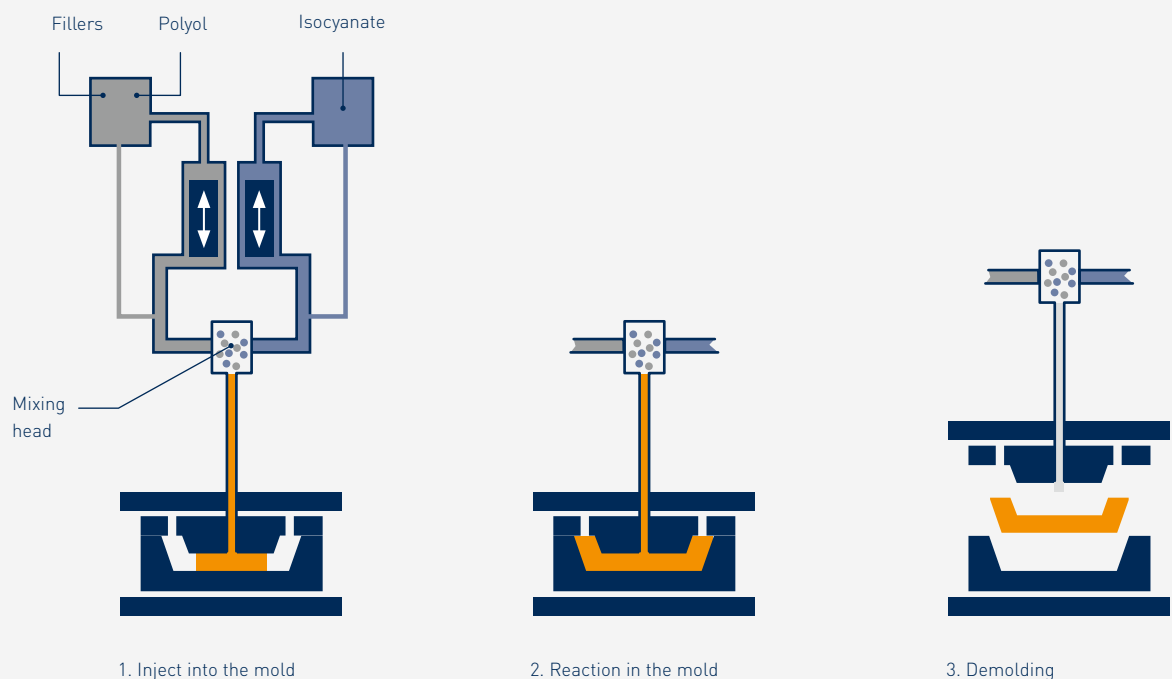
The filler is mixed into one of the PUR components, in general the polyol, in a special premixing station. A piston metering machine is used. In the mixing head, the filled polyol is mixed – intensively and at high speed – with the isocyanate during the shot and the PUR mix is injected into the closed mold. R-RIM is the only process for PUR fiber composite applications where the reinforcing material is contained directly in one component. To reduce the abrasion risk, the mixing head and the metering system for the filled component are treated for wear resistance.

### Volume parts for inline painting

The R-RIM process produces parts with excellent material properties. It has proven a cost-competitive process for large series production. Using fast-reacting PUR systems, cycle times can be as short as 90 seconds. Adding short fibers to the resin improves the stiffness, dimensional stability under heat, and the thermal expansion coefficient of the finished parts, making them ideal for car bodywork elements. Stable, reliable production systems and minimal post-mold processing meet the requirements of the automotive industry.

### New lightweight R-RIM technology

An increase in mechanical property patterns is achieved with the use of recycled carbon fibers. The addition of glass microspheres reduces the density which further reduces the component weight. In addition, a Class A surface can also be achieved with the process.



## Process

## R-RIM processing filled polyurethane components

### Description

Fast-reacting PUR components are filled with short fibers, mixed at high pressure and the reactive system is injected into the closed mold

### Features

1. Highly automated process
2. Short reaction and cycle times < 90 seconds
3. Freeflowing materials can be processed into thin walled parts < 2 mm

### Typical applications

Mudguards, door panels, body components, technical underhood components

### Typical annual volumes

10,000 to 100,000 items

#### Your benefits:

- Dimensional stability and inherent stiffness even at high temperatures
- Good paintability, even at temperatures up to 180 °C, inline painting is possible
- Low investment in molds and tooling

## Products of KraussMaffei machines



<b>Part</b>	Car mudguard
<b>Material</b>	PUR system with 22 percent wollastonite
<b>Technology</b>	R-RIM, process on a multi-station system
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– High dimensional stability of the components, tight length tolerances</li> <li>– Greater design freedom than for metals</li> <li>– Adequate flexibility and resilience</li> </ul>



<b>Component</b>	Door sill
<b>Material</b>	PUR system with 22 percent wollastonite and 1 percent hollow glass spheres
<b>Technology</b>	R-RIM process, automated part removal and finishing
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– High dimensional stability</li> <li>– Low weight, wall thickness &lt; 2 mm</li> <li>– Paintable inline</li> <li>– Excellent impact strength</li> </ul>

## Low component weight with high bending stiffness

In SCS processes, layers composed of fiber mats and honeycomb cores are sprayed with unreinforced PUR, inserted into a mold, and pressed into shape.

### Thin layers on lightweight honeycomb cores

This further development of LFI/honeycomb technology reduces the thickness and weight of the cover layers to further optimize the lightweight construction. First a sandwich structure is made by putting the fiber mats on both sides of the honeycomb core. Then the sandwich is sprayed with PUR on both sides. Next the frame holding the sprayed sandwich is inserted into the mold, which is then shut. During pressing, the fiber mats are saturated with PUR and adhere to the fiber core as the PUR cures.

### Core plus outer layers produce extremely light, stiff parts

With substrate and core layers matched as regards material properties and part geometry, it is possible to produce extremely light parts which are also very rigid.

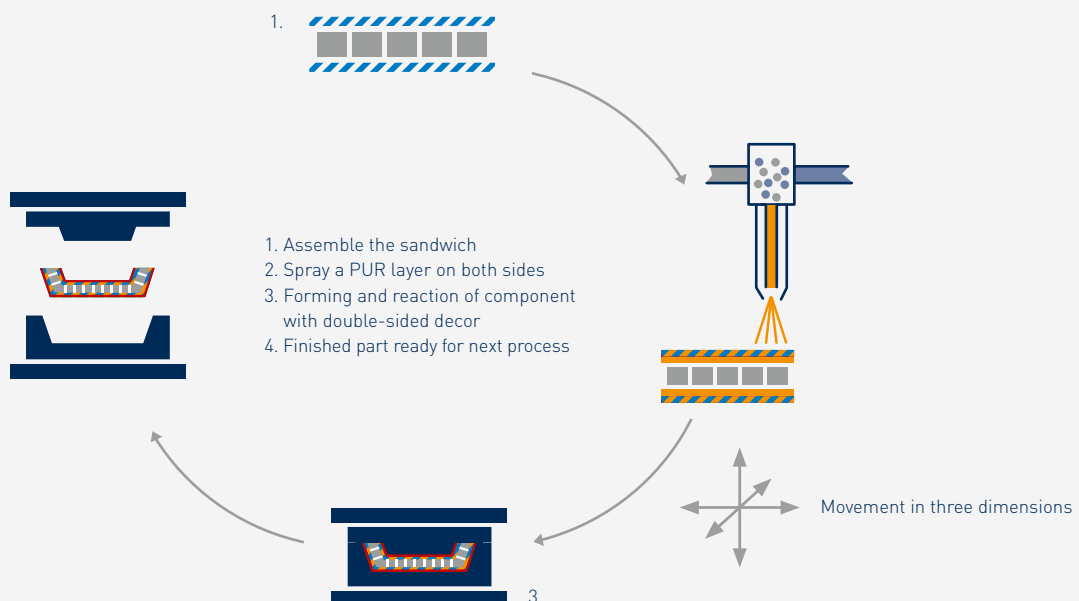
The SCS process has huge potential to produce lightweight parts and this potential is far from being exhausted. Fiber mats containing continuous fibers and thicker PUR layers sharply increase the mechanical strength of the load-bearing edge layers.

### Decorated surface on both sides

In the applications presented here, the decorative elements are positioned in both mold halves before pressing. The SCS process produces parts with ready-to-use surfaces.

### Your benefits:

- Optimized lightweight construction for moderate-strength parts
- Low operating costs, low material consumption
- High-quality finish surfaces possible on both sides





**Process****SCS – Structural Component Spraying with reactive PUR****Description**

Spraying a pre-assembled sandwich with a PUR mixture, transfer to a mold, curing in a closed mold

**Features**

1. Fiber mat in a holding frame sprayed on both sides with PUR
2. Combines easily with in-mold surface decoration
3. Lightweight component with honeycomb core

**Typical applications**

Rear shelves, cargo area floors, large laminated parts, sun roof shades

**Typical annual volumes**

10,000 to 300,000 items

**Products of KraussMaffei machines**

<b>Component</b>	Sunroof shade
<b>Material</b>	Substrate: Glass mat with PUR-paper honeycomb – glass mat with PUR; surface: nonwoven with barrier film on both sides
<b>Technology</b>	Structural Component Spraying (SCS)
<b>Benefits</b>	Cost-competitive one-step process



<b>Component</b>	Rear shelf
<b>Material</b>	Substrate: Glass mat with PUR-paper honeycomb – glass mat with PUR; surface: both sides nonwoven with barrier film
<b>Technology</b>	Structural Component Spraying (SCS)
<b>Benefits</b>	Weight-optimized, rigid component

# Low mold costs, automated material pouring by means of robots, many variants – ideal for small scale production

Fiber Composite Spraying is a very flexible process for small scale production. By applying individual PUR layers, it is possible to produce composite parts that are optimally adapted to their respective application.

Each different layer can be made completely or partially of compact or foamed material, with or without fiber reinforcement. This way nearly any wall thickness can be created. Only one mold half is required for manufacturing. Because of the lower initial investment, FCS is especially suitable for small series production.

## Modular system concept

In the simplest case, it's possible to use just a 2C spray mixing head with the appropriate metering machine. An optional H<sub>2</sub>O metering unit makes it possible to further vary the PUR system between compact or foamed. A 4-component mixing head allows even more variability. Fibers are always metered coaxially into the PUR spray jet, which enables the fibers to be optimally

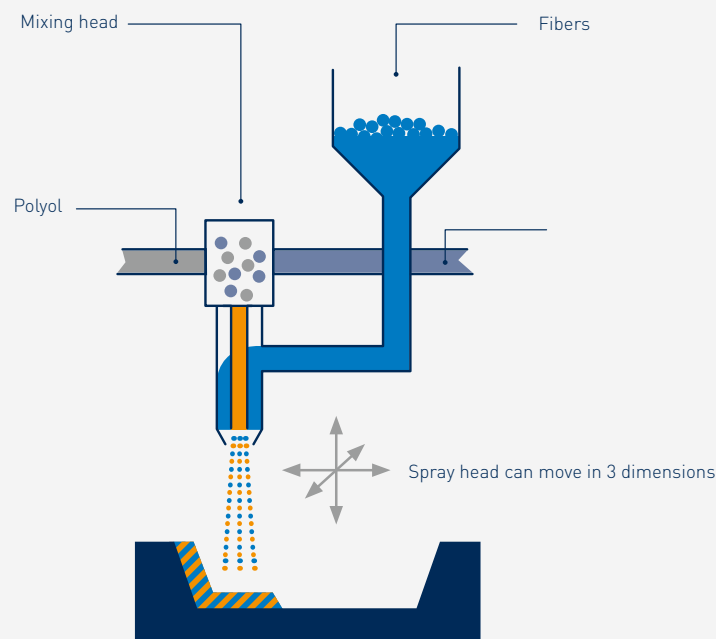
wetted with PUR. The glass fibers can come from rovings and be cut to length during the process, or ready-cut glass can be used. In most applications, fiber length is between 5 and 20 mm and the fiber content in the part can be up to 25 percent.

## Stiff sandwich parts for a minimal investment

The FCS process is ideal for high-strength, very rigid, large-format, visible parts required in small quantities. The process uses only a simple negative mold without a mold carrier. Although this is an automated, highly repeatable process, the tooling and investment costs are minimal. The surfaces of the medium-sized or large parts can be finished with a thermoformed film or using IMP (In Mold Painting).

## Your benefits:

- Cost-effective for small series production, even for very large components
- First-class surfaces through simple process combinations, for example with In Mold Painting (IMP)
- High stiffness and strength thanks to multiple layers



## Process

## FCS – Fiber Composite Spraying

<b>Description</b>	Spraying a layer consisting of fibers and a PUR system into an open mold. Air-cured.
<b>Features</b>	<ol style="list-style-type: none"> <li>1. Variable, application-specific layer structure (filled, unfilled, and foamed layers)</li> <li>2. Spraying into the negative mold – simple, lower-cost molds</li> <li>3. Fiber content up to about 25 percent, fiber lengths between 5 and 20 mm</li> </ol>
<b>Typical applications</b>	Fenders, engine covers, large-format hoods and covers for machines
<b>Typical annual volumes</b>	5,000 to 10,000 items

## Products of KraussMaffei machines



<b>Component</b>	Hood for ambulance
<b>Material</b>	PUR with long-fiber reinforcement
<b>Technology</b>	FCS Fiber Composite Spraying; visible side produced previously in the same mold with In Mold Painting (IMP)
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– Extremely cost-competitive process</li> <li>– Automated production for small series</li> <li>– Premium surface quality</li> </ul>



<b>Component</b>	Car rear shelf
<b>Material</b>	PUR with long fiber reinforcement and higher fiber contents locally
<b>Technology</b>	FCS, partly in multiple layers
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– Stiff, weight-optimized component with a sandwich structure (with honeycomb core)</li> <li>– Variable adaptation of strength (fiber content)</li> <li>– Low initial investment</li> </ul>

# Lightweight components with high impact resistance not just for the automotive sector

In the LFI (Long Fiber Injection) process, continuous fibers from a roving are fed into a cutter, where they are chopped to length and separated into the individual filaments by a blower. Immediately after the cutter, the fibers are wetted with the PUR mixture from the mixing head.

The fiber/PUR compound is poured into the open mold, under robot control, as a sharply focused spray cone. Once the mold is filled, it closes and the compound cures.

## Specific localized properties

The fiber lengths can vary between 12.5 and 100 mm. During the discharge, the fiber content can continuously change between 0 and 50 percent, with 50 percent being the limit for good impregnation. Today the most commonly used PUR systems are either compact or foamed. This means that the property profile of LFI is comparable to that of SMC.

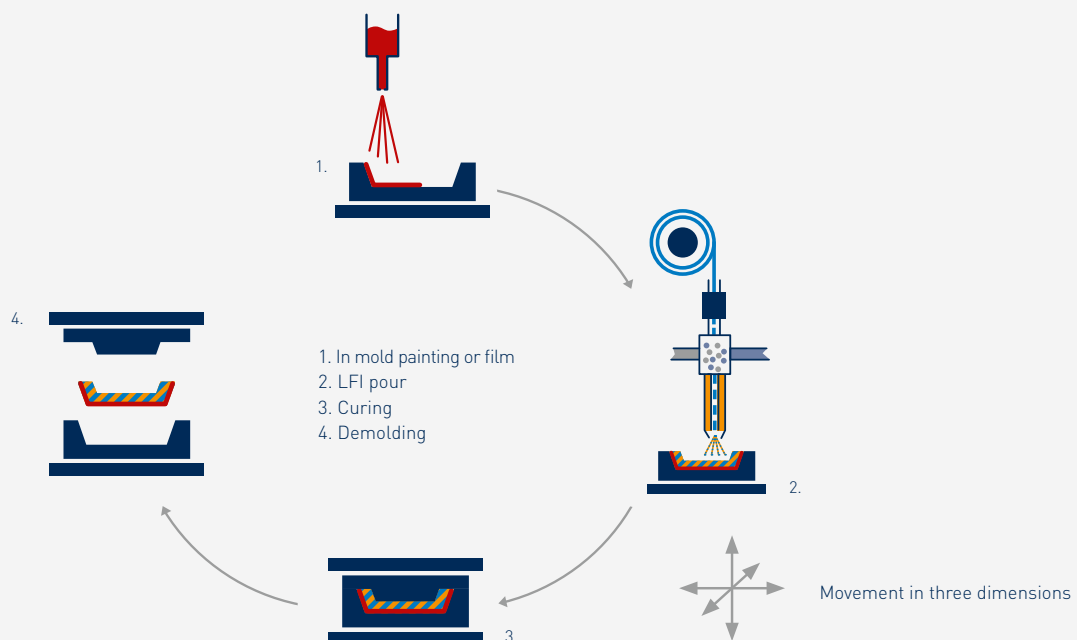
## Stable and very light

Long fibers, freedom to design part geometries, and the variety of PUR systems enable a broad range of applications. LFI parts can vary from a small trim part for a car interior to a large structural part with a Class A visible surface.

Since this is a PUR process where mold cavity pressures are < 10 bar, LFI can be used at the same time to produce a high-strength sandwich element with a honeycomb structure as the core layer. Typical products here are rear trays for cars or very large partitions.

## Your benefits:

- First-class surfaces produced by simple process combinations (IMP, film)
- High strength values (fiber content up to 50 percent, fiber lengths 12.5–100 mm)
- Moderate mold and machine costs



## Process

## LFI – Long Fiber Injection Molding with reactive PUR

<b>Description</b>	Fiber glass rovings are chopped right by the mixing head and wetted with the PUR mixture as it is poured into the open mold. The mold is closed while the PUR cures.
<b>Features</b>	<ol style="list-style-type: none"> <li>1. Fiber content and length can be varied locally</li> <li>2. Easy integration of inserts (e.g. clips and other junction elements)</li> <li>3. Attractively priced raw materials, minimal fiber mixing</li> </ol>
<b>Typical applications</b>	Engine hoods, roof elements, side trims, covers, flaps, instrument panel supports
<b>Typical annual volumes</b>	10,000 to 120,000 items

## Products of KraussMaffei machines



<b>Component</b>	Radiator grill for utility vehicle
<b>Material</b>	PUR with 25 percent long fiber reinforcement
<b>Technology</b>	LFI with thermoformed decor film; fiber length and volume content can be locally adapted to the component requirements
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– Mechanical strength can be varied locally to suit part specifications</li> <li>– Cost-competitive process for volume production</li> <li>– Class A surface</li> </ul>



<b>Component</b>	Combine harvester engine hood
<b>Material</b>	PUR with long fiber reinforcement
<b>Technology</b>	LFI, In Mold Painting for visible side
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– Very large-format structural component</li> <li>– Suitable for impact resistance</li> <li>– Ribbed structure to increase strength</li> <li>– Painted visible part (IMP)</li> </ul>

## Very light, very strong High-performance lightweight components

In HP-RTM (High-Pressure Resin Transfer Molding), the first step is building up a fiber preform.

This consists of layers of carbon or glass fibers; the fabric layers can be stitched or fixed together with a binder to keep them correctly aligned. How the layers are put together depends on the loads the structural component will later be subjected to; preforming could be used. This preform is placed in the mold, the mold is then closed and evacuated. Then a very low-viscosity, reactive epoxy resin, polyurethane, or cast polyamide is injected into the cavity at high pressure ensuring that each individual fiber is wetted and that there are no air gaps.

The C-RTM (Compression Resin Transfer Molding) process differs from the HP-RTM (high-pressure RTM) process essentially by having the resin mixture fed into the mold when it is slightly open instead of closed. Thus the mold is not completely closed during the feeding. Consequently, the preform is already partially saturated by resin. The feeding is followed by a compression stroke, which presses the resin through the preform, causing it to become completely saturated.

### Outstanding strength

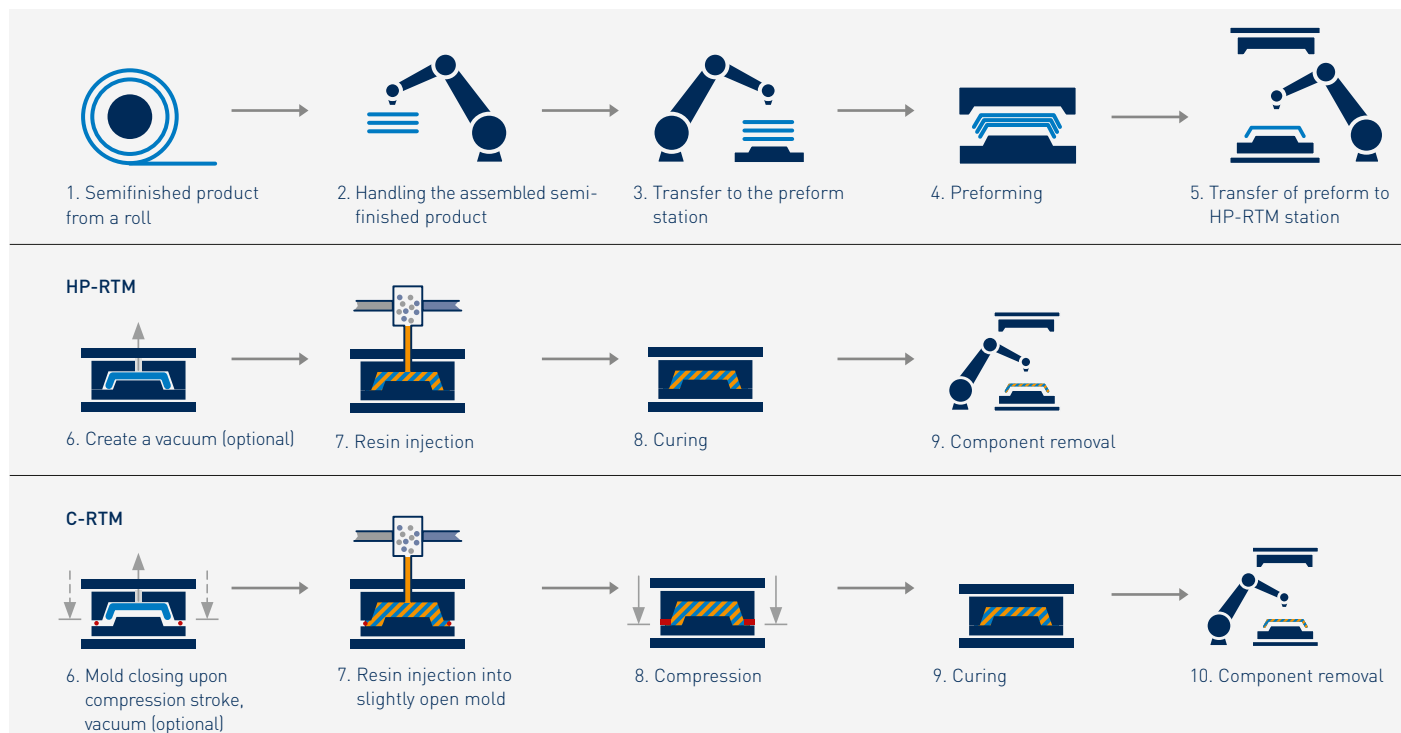
The HP-RTM process produces extremely light structural parts that meet the highest specifications, complying for instance with car crash test standards. This process is already established in the aerospace industry, mechanical engineering, and the automotive industry. The HP-RTM process can produce parts with fiber content up to 50 percent.

### High pressure at heat

Generally, PUR, epoxy, and cast polyamide can be used as the matrix material. KraussMaffei offers the right machine for each of these materials. If PUR systems are processed at temperatures up to a maximum of 80 °C, the epoxy resins or cast polyamides used in HP-RTM require machines modified to process materials at temperatures up to 120 °C.

### Your benefits:

- Lightweight parts to meet challenging product specifications, around 50 percent lighter than steel
- Paintable components for visible applications
- Can be fully-automated and is suitable for series production (from preform production to post-mold processing)





<b>Process</b>	<b>HP-RTM – High-Pressure Resin Transfer Molding</b> <b>C-RTM – Compression Resin Transfer Molding</b> <b>T-RTM – Thermoplastmatrix Resin Molding</b>
<b>Description</b>	<p><b>HP-RTM:</b> Fiber mats or fabric are preformed and then positioned in the mold. The mold closes, the resin is injected and cures in the closed mold.</p> <p><b>C-RTM:</b> Fiber mats or fabric are positioned in the mold. Resin is added in the slightly open mold and the reaction occurs in the closed mold.</p> <p><b>T-RTM:</b> Preformed textile semifinished product is infiltrated with <math>\epsilon</math>-Caprolactam reactive mixture. In-situ polymerization and curing to polyamide 6.</p>
<b>Features</b>	<ol style="list-style-type: none"> <li>1. Virtually unidirectional reinforcement with endless fiber</li> <li>2. High-pressure technology allows the use of fast-curing systems</li> <li>3. High fiber contents of up to 50 percent</li> </ol>
<b>Typical applications</b>	Structural components, sidewall panels, floor pans, frontend carriers, crash boxes, carbon-fiber design components, high-performance lightweight fiber composites
<b>Typical annual volumes</b>	10,000 to 120,000 items

## Products of KraussMaffei machines



<b>Component</b>	Roof (visible carbon)
<b>Material</b>	Carbon fiber fabric with epoxy resin as matrix
<b>Technology</b>	HP-RTM
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– Structural component in the visible range</li> <li>– Premium quality sporty carbon-fiber appearance</li> <li>– Trailblazer for other lightweight components</li> </ul>



<b>Component</b>	Roof frame with integrated metal inserts
<b>Material</b>	Fiber hybrid
<b>Technology</b>	T-RTM
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– Weldable, recyclable</li> <li>– Can be functionalized</li> <li>– High notch impact strength</li> </ul>

## Fiber-reinforced visible components paintable without post-mold processing

The surface resin transfer molding process enables cost-effective manufacturing of paintable fiber-reinforced visible components for vehicle manufacturing for series applications.

With surface resin transfer molding (surface-RTM), the component obtains not only its shape in one and the same mold, but also an additional, completely smooth, and paintable surface. The other production steps are similar to those of other RTM processes:

First of all, a preform is established from continuous fiber textiles. This is secured with a thermoplastic tie and inserted into the molding tool. The mold is closed once and evacuated. Then it is opened a fraction to inject the polyurethane matrix system. By closing the mold the fiber material is now fully impregnated with the resin and pressed into the desired mold. Then the mold is opened again by a defined gap. Now the surface material – also PUR-based – is injected to close the high-gloss polished mold again. Following the expiry of the reaction time, the robot removes the completed fiber composite part with its paintable surface from

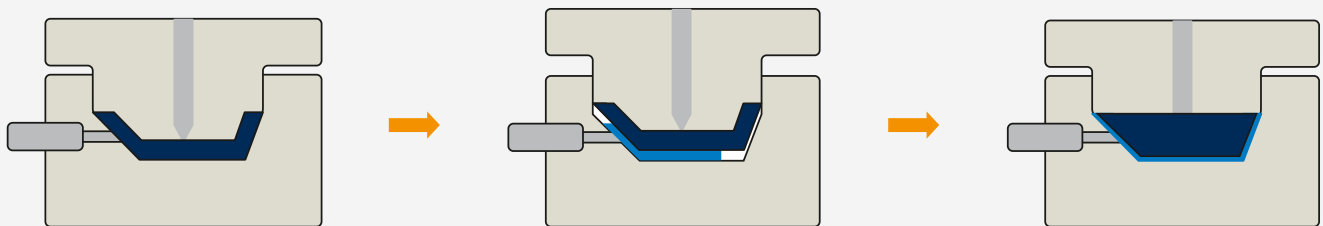
the mold. After it has cooled, the only thing that remains is the trimming, also in a fully automated KraussMaffei milling center.

### Special seal

The surface resin transfer molding mold is equipped with a special seal system. It makes possible the use of a vacuum also with a slightly opened mold. Sophisticated sensors monitor and regulate optimum filling of the mold. This provides information about the component quality.

### Your benefits:

- Premium quality, paintable surface for CFRP automotive outer parts
- Combination of high-performance lightweight components with quality surface finish
- Minimal post-processing (near-net-shape)



#### 1. The preform (reshaped fiber material) is inserted into the cavity

- The cavity is closed
- The preform is completely soaked in resin
- The substrate (PUR and CF) cures

#### 2. The cavity is opened slightly

- The surface material (polyurethane) is injected
- The cavity is closed again

#### 3. The surface material cures

- The component is then re-moved again

## Process

## Surface RTM – Surface Resin Transfer Molding

<b>Description</b>	Flow-coating of the RTM component surface with a polyurethane layer directly in the cavity
<b>Features</b>	<ol style="list-style-type: none"> <li>1. Suitable for series production – cycle times 5 to 7 minutes</li> <li>2. Suitable for large-format, contoured parts (e.g. for utility vehicles)</li> <li>3. Substrates with different clamping surfaces and press tonnages are available</li> <li>4. Paintable components without any further intermediate steps</li> </ol>
<b>Typical applications</b>	Sidewall panels, roof modules, door outer sides
<b>Typical annual volumes</b>	Up to 100,000 items

## Products of KraussMaffei machines



<b>Component</b>	Roof module (Roding)
<b>Material</b>	Carbon-fiber continuous textiles with PUR matrix and PUR-based surface
<b>Technology</b>	Surface-RTM
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– Suitable for external visual field</li> <li>– Paintable without post-mold processing</li> </ul>

## Fiber-reinforced pultruded profiles fully manufactured on iPul machines from KraussMaffei

With iPul a complete system for the industrial manufacture of straight and curved pultruded profiles is available. The production speed up to 3 m/minute and the encapsulated injection box open the process up to diverse applications.

During pultrusion rovings, i.e. continuous fibers of glass, carbon, or aramid, are soaked with the matrix material and then shaped in a heated mold. Grippers continuously pull the cured profile on the other side of the mold. iPul accelerates this process compared to traditional production methods by scales of up to 3 m/minute. At the same time, the closed injection box avoids any unwelcome odors which arise during the manufacture with open baths.

### Straight and curved profiles

In addition to the construction industry, the technology is also an attractive method for manufacturing wind turbines, vehicles, and airplanes. Together with the cooperative venture partner Thomas Technik, the inventor of radius pultrusion, KraussMaffei also offers machines for the manufacture of curved profiles.

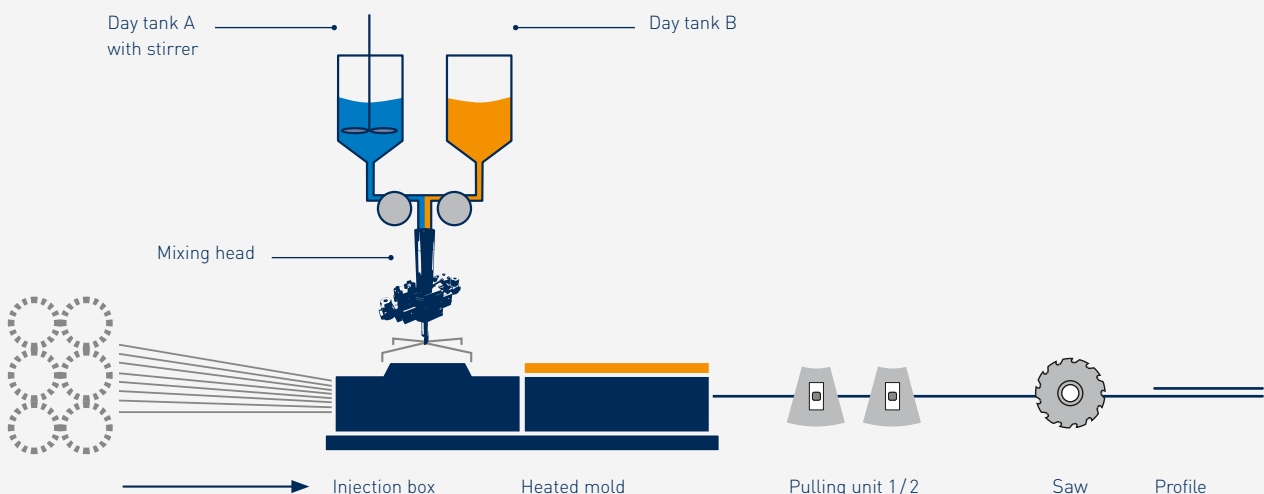
### Core component: Injection box

The core component of iPul is the injection box. The fibers of the final profile shape are already approximated here. The rovings run into the injection box via the fiber routing. There the fibers are soaked in thermoset epoxy resin, polyurethane, or polyamide. The use of fiber fabrics or woven fabrics as a base gives particularly stiff components or surfaces.

The specially developed mixing head in which the individual components of the reactive materials are mixed works cost-effectively at low pressure.

### Your benefits:

- Cost-effective production of structural components with premium quality property patterns
- Complete systems from a single source, tailored to materials and product
- KraussMaffei and Thomas Technik as experienced partners in system development and service



## Process

## iPul – pultrusion of fiber-reinforced profiles

<b>Description</b>	Manufacture of straight or curved profiles made from continuous rovings
<b>Features</b>	<ol style="list-style-type: none"> <li>1. Suitable for series production – production speed up to 3 m/minute</li> <li>2. Suitable for resilient components in the indoor and outdoor area</li> <li>3. Material combinations possible for diverse purposes</li> </ol>
<b>Typical applications</b>	Profiles in the automotive sector, window profiles, concrete reinforcements, airplane frames, rotor blade reinforcements
<b>Typical annual volumes</b>	10,000 to 120,000 meters

## Products of KraussMaffei machines



Photo: Evonik

<b>Component</b>	Concrete reinforcement
<b>Material</b>	Epoxy resin glass fiber
<b>Technology</b>	Pultrusion
<b>Benefits</b>	– Stable and corrosion-resistant alternative to steel



Photo: Covestro/Internorm

<b>Component</b>	Window profile
<b>Material</b>	Polyurethane glass fiber
<b>Technology</b>	Pultrusion
<b>Benefits</b>	<ul style="list-style-type: none"> <li>– High insulation capacity</li> <li>– Dimensionally stable</li> <li>– Corrosion- and chemical-resistant</li> </ul>

## Structural components with and made of recycled material

The wet molding process provides another alternative to the series production of fiber-reinforced lightweight components.

This involves fixing a pile of fiber mats made of carbon or glass fibers in place as an unworked piece, unformed and flat, outside of the mold. Then the reactive resin is thinly applied to the fiber pile in layers. As soon as the fibers are covered with resin, the fiber pile with the layer of resin is transported into the mold and compressed there by closing the mold. This is where the fiber mats are preformed and the component is cured.

### Manufacturing with recycled fiber mats

Recycled fiber mats can be used in the wet molding process. The manufacturing process for the fiber mats can reuse materials such as the waste product from cutting fiber mats made of continuous fibers. In the process, the individual fibers are coated with a binder and formed into mats again. However, the fibers are no longer aligned, but instead statically distributed. The flow resistance would be extremely

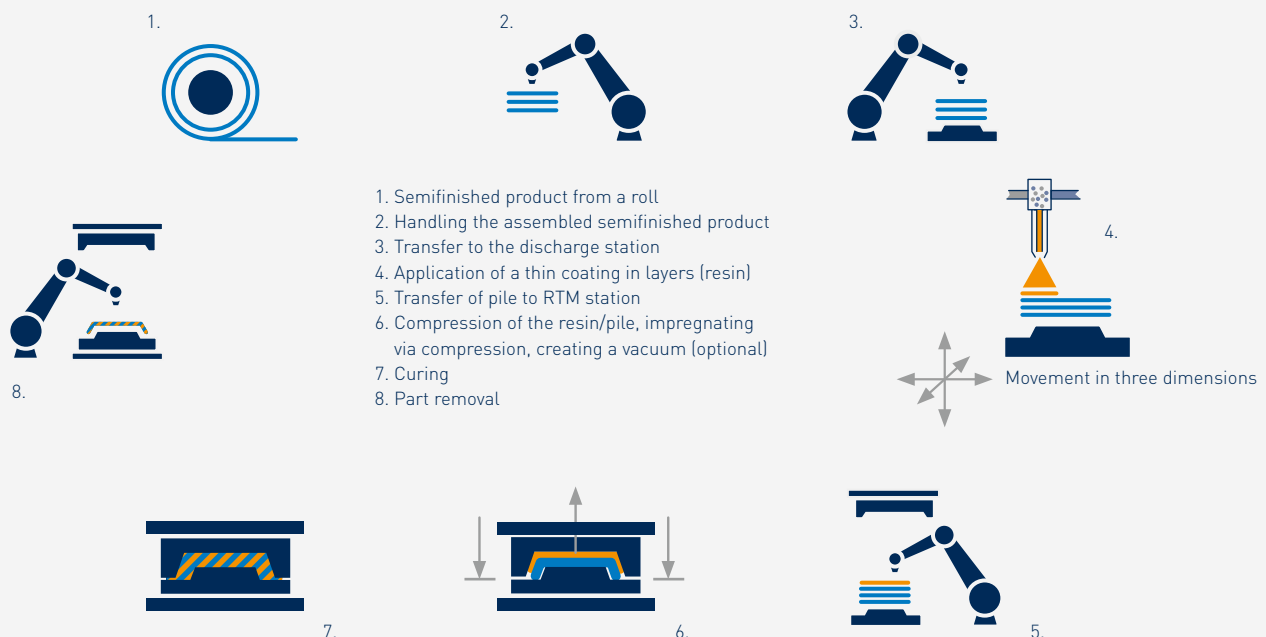
high for impregnation in a closed mold, which is why the resin is added outside of the mold.

### Short cycles and fast reaction times

Whatever the material being processed, KraussMaffei machines are ideally suited for processing fast-reacting systems; the mixing heads are all engineered for high-pressure processing. This leads to a very good mix of fast-curing resin systems. The mixing head is self-cleaning. We also offer an extra module to meter in an internal release agent directly at the mixing head. This ensures an overall process that is fully-automated and cost-effective.

### Your benefits:

- Lightweight parts to meet highest specifications, around 50 percent lighter than steel
- Can be fully-automated and is suitable for series production





## Process

## Wet molding

<b>Description</b>	Resin is added to an unformed fiber pile or fabric mats outside of the mold. Transport of the fiber pile into a mold where the component is preformed.
<b>Features</b>	<ol style="list-style-type: none"> <li>1. Processability of, for example, recycled material</li> <li>2. Lower compression molding tonnages are required because of the far lower cavity pressure</li> </ol>
<b>Typical applications</b>	Manufacturing of 2D-3D components
<b>Typical annual volumes</b>	10,000 to 200,000 items

## Products of KraussMaffei machines



<b>Component</b>	Transmission tunnel reinforcement
<b>Material</b>	Carbon fiber with epoxy resin
<b>Technology</b>	Wet molding
<b>Benefits</b>	Manufacturing complex geometries without a preform process



<b>Component</b>	Upper floor panel
<b>Material</b>	Carbon fiber with epoxy resin
<b>Technology</b>	Wet molding
<b>Benefits</b>	Manufacturing complex geometries without a preform process

## Generate foam structures in lightweight injection molding

MuCell™ : Blowing agent reduces weight and improves precision molding. MuCell™ is a physical process for foaming of thermoplastics. It uses nitrogen or carbon dioxide as blowing agents. For this purpose, the gas is transformed into a supercritical fluid (SCF), fed into the plastic melt towards the front of the barrel, and mixed with the melt.

During the injection process, the SCF expands and produces a component with a microcellular foam structure (<100 µm) in the core and a solid outer layer.

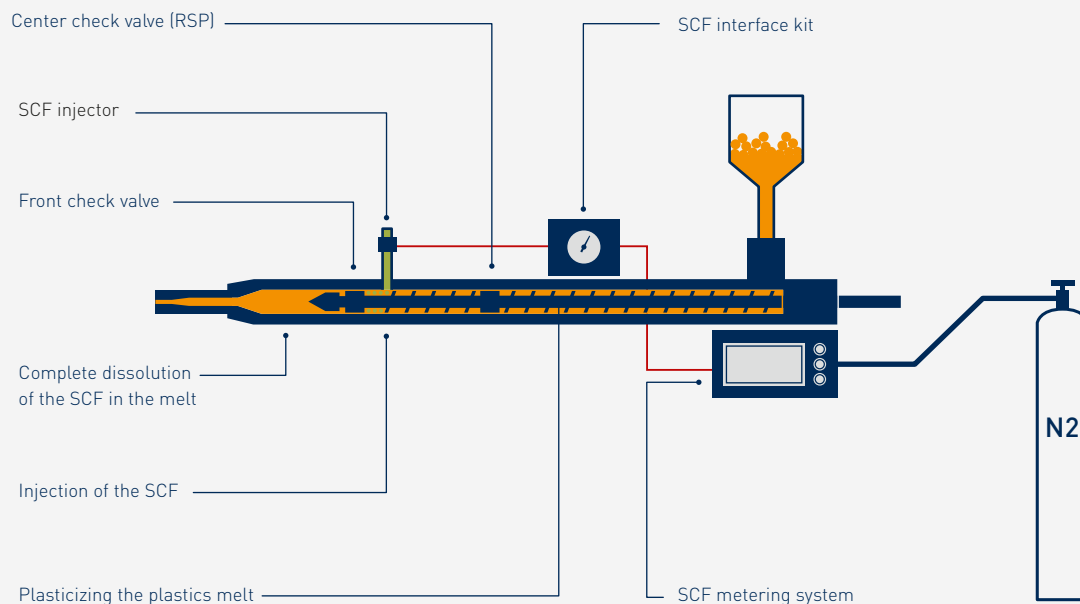
Even with low amounts of blowing agent, the MuCell™ process offers clear benefits:

- Weight reduction from lower density
- Higher dimensional stability and fewer sunk spots as the blowing agent expands
- Shorter cycle times thanks to a higher injection speed and elimination of the holding pressure time
- Lower clamping forces due to reduced material viscosity and elimination of the holding pressure

Using MuCell™ in conjunction with a foam stroke can result in very high degrees of foaming with a high bending stiffness and uniform wall thicknesses.

### Your benefits:

- Reduced component weight
- Shorter cycle time
- Lower clamping forces



## High-quality painted surfaces straight from the mold – Painting integrated into the manufacturing process

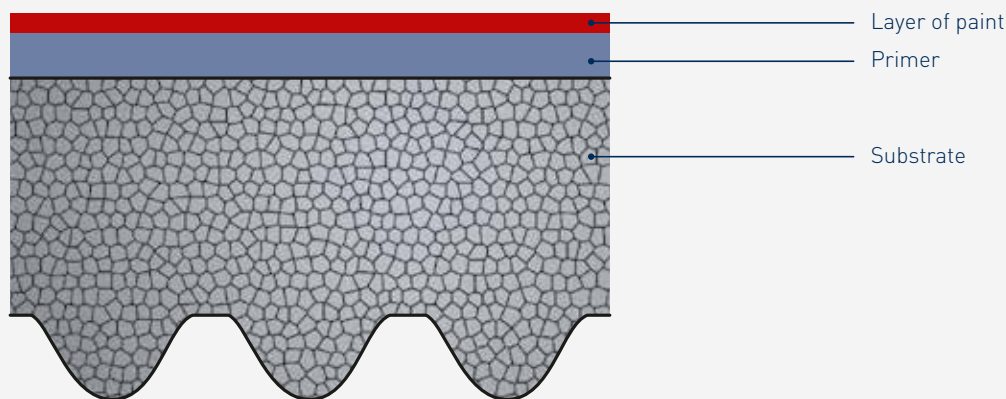
Colors galore in a straightforward process: In Mold Painting. In the IMP process, a paint and/or primer system (barrier coat) is sprayed into an open mold cavity either manually or by a robot. The spray system can consist of one or two components.

The IMP technique allows for flexible color management and fully meets most product specifications. The substrate material is either injected or sprayed, e.g. using LFI or FCS technology, into the mold after the paint layer. The combined system then reacts in the closed mold to give a resilient, uniform surface finish.

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### Your benefits:

- Process with one or two components
  - Flexible color management
  - Durable and uniform surface
- 



## System and processing expertise from idea to production

Partnerships are often launched during purely informative discussions on all sorts of occasions.

### The first idea

The very first sketches and ideas define some of the parameters for the production process. Even at this early stage, our specialists are on hand to support our partners with advice and help them work out appropriate and flexible solutions. Feasibility studies also take into account possible production processes and downstream operations.

### Process delivers specific component properties

As a component takes on shape and size, reliable material data is essential in order to design for different load cases. Especially for fiber composite structures with anisotropic characteristics, process trials are important for validating the production process and component properties.

### Prototyping and fine-tuning

In our TechCenter we have facilities for producing prototypes and preproduction parts. This learning phase also shows up further optimization opportunities for the production process.

### Solutions for series production

Once the component and the production process have been agreed, we will work with you to develop the best production solution. The degree of automation, post-mold processing, and coordination of downstream operations are all important considerations. We will then quote for a solution optimized with respect to capital investment and unit manufacturing costs.

### Project and implementation phase

Our experienced project engineers are on hand to give you support, from planning and implementation to on-site production start-up, and will even assume responsibility for the project management if desired.

### Production support

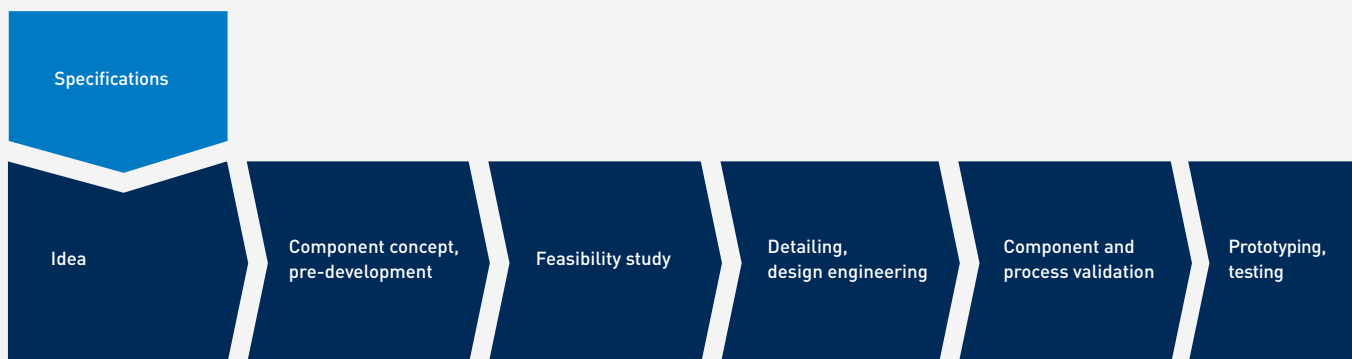
At the start of production (SOP) and during the start-up phase, highly-skilled experts support you with their knowledge of processes and machinery. This ensures a smooth start of production and simultaneously trains the personnel in your plant.

### Service

After the production start we continue as your reliable partner.

### Your benefits:

- Single-source system solutions
- Support your project as a partner
- Individualized handling of projects and solutions



## TechCenter for lightweight construction and fiber composite technologies

New ideas for components often also require new or adapted production processes. For an idea to be successful, the associated production process has to prove itself in practice.

### Machine and process expertise

With its unique combination of injection molding and reaction process machinery, the KraussMaffei TechCenter makes it easy to test, optimize, or advance your processes using experimental carriers or initial prototypes under real-world conditions. A team of process developers, application engineers, and technicians is at your service in the TechCenter. Thanks to different perspectives, the close cooperation between experts in the fields of injection molding machinery and reaction process machinery produce synergies and new ideas from which you will profit.

### Watch this space

Our TechCenter for injection molding and reaction process machinery covers an area of 4000 square meters and is populated with over 25 machines and systems for various production processes.

### Open and yet discreet

Mutual trust is a must when it comes to new processes and developments. To ensure the necessary confidentiality and to protect our customers' know-how we reserve separate production areas for each customer during trials and tests.

### Your benefits:

- Test development processes as experimental carriers or prototypes
- Interdisciplinary fields for new ideas
- Test options for various manufacturing processes

Series preparation

Production planning

Production support

Training, practice

Maintenance,  
service, retrofitting

Customer satisfaction

## Your visions take form with our PUR and compression molds

The combination of best possible process and mold technologies brings your vision of a structural component into shape.

For working with thermosets and semifinished products, KraussMaffei can supply the complete manufacturing system - the processing machinery including the mold technology - from its own resources and ensure that the principal components interact perfectly. A bonus of dealing with just one partner for the whole system is streamlined project completion that saves you time and reduces hassle.

### Tooling technology for forming and shaping

Fiber composites are often processed in the form of semifinished products. KraussMaffei's modular mold concepts can be configured to mold any specific type of semifinished product. This mold technology enables us to offer turnkey system solutions to manufacture a huge range of products - as prototypes and for series applications:

- For glass fiber-reinforced structural components
- For parts made of natural fiber composites
- For LFI processes
- Molds for a wide spectrum of foaming and casting processes

### PUR mold technology - fine-tuned for each specific application

KraussMaffei molds can be adapted to a large number of different processes. This opens up new options for producing structural components. Each mold is specially engineered for a specific application and fine-tuned to production requirements:

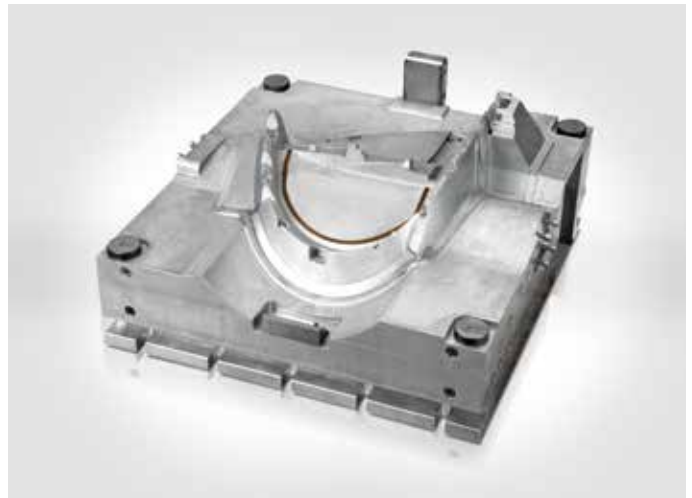
- Temperature control matched to process requirements
- Extra wear protection where necessary, for instance, if you're processing abrasive materials
- Optimal ejector concept for damage-free part demolding
- Seal technology to suit the product
- Optional integrated trimming solution

### Your benefits:

- Turnkey system solutions for prototypes and series applications
- Wide variety of PUR molds for various processes
- Optimum mold design for your production requirements



Heated press mold for fiber composite parts



Molds for the LFI process

## Powerful systems for trimming fiber composite components

In mass production, stable and fully automated processes are very important for parts to be manufactured cost-effectively. KraussMaffei offers you comprehensive solutions for trimming your products.

Our solutions for trimming composite fiber components range from engineering to prototyping all the way to finished series solutions. KraussMaffei relies exclusively on the use of robot solutions for this. These enable good access to the component and efficient processing with up to three milling spindles. In-house-fabricated product holders ensure high cut precision and low variation in manufacturing tolerances.

The milling of fiber composite components, especially CFRP components, presupposes a lot of experience in selecting a milling tool. This is where the entire cost-effectiveness of the process is defined. For years, KraussMaffei has been designing and delivering punching and milling solutions for the plastics processing industry and has experience from various tasks, including milling several thousand vehicle components for a renowned vehicle manufacturer.

Therefore we are capable of determining what the ideal mold is for your application. By means of conducting our routine process simulation, we determine the cycle time to be expected. Then it is easy to predict the manufacturing costs.

Our robot cells are not only flexible, but also highly mobile. Conversion of the cell in manufacturing can be accomplished in a few minutes and usually requires only slight adaptations to the program or none at all.

The systems are programmed via offline systems, which enable trimming trajectories to be created quickly and efficiently as well as adaptations with precision down to 1/100 mm. Taking into consideration the task description, a pure teaching of these trajectories is very elaborate and time-consuming.

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### Your benefits:

- Proven technology
  - Individual, process-neutral advice
  - The most cost-effective solution for every task
- 



Robotic milling machine for helicopter seats



## TechCenter for lightweight construction and fiber composite technologies

Lab tests are major milestones for developing new components until they are ready for series production. KraussMaffei provides in-house component testing and can apply the findings gained from this to optimize manufacturing cells and PUR molds flexibly and immediately, without losing time.

A system partnership with KraussMaffei shortens your communication paths and ensures significant time savings on the way from design study to volume production.

### ISO-accredited test center

Our test lab is accredited in accordance with DIN EN ISO/IEC 17025:2005 and is specifically equipped to test components and assemblies for automotive interiors and exteriors. We have the facilities and the in-house expertise to test safety-critical chassis and structural components, electronic control devices, and pyrotechnical safety restraint systems. On request and after intensive consultation, we will also develop customized testing programs.

### Extract from the KraussMaffei testing portfolio

**Vibration & shock:** Electrodynamic vibration testing equipment enables us to simulate all mechanical loads as defined by national and international standards or to OEM specifications. If required, temperature and climate profiles can be imposed on the vibration.

**Climate, sunshine, heat and cold:** our test lab is equipped to simulate extreme weather and temperature conditions with precise repeatability and assess their impact on test samples.

**Temperature shock:** The temperature shock test provokes the mechanical stresses which can occur when components made of materials with different thermal expansion behavior are exposed to extreme temperatures, which can ultimately destroy the component.

**Corrosion:** the corrosive properties of salt spray atmospheres and condensate can damage materials and surfaces. Especially in the automotive segment, corrosion resistance is a significant sign of quality and safety.

### Your benefits:

- Customized testing program
- No lost time, since the results flow directly into optimizing manufacturing cells and PUR molds
- Various options for testing the components







## Further information which might also interest you



Are you looking for more information about HP-RTM processes? KraussMaffei offers you turnkey production lines for large-scale production.

### Everything from a single source:

Together with our partners, we are able to cover all stages of the process chain - from unwinding the semifinished product (e.g. CFRP fabric) through to final processing of the finished fiber composite component - as turnkey solutions incorporating a high level of system expertise.

### You can also learn about:

- PUR metering machines for processing reactive systems, particularly polyurethane
- Our mixing heads for the various processes and technologies
- Versatile PUR mold carriers and systems



You can find our brochures and flyers on other topics online at: [www.kraussmaffei.com](http://www.kraussmaffei.com). On request, we would also be happy to send you information and technical data for our products free of charge.

# KraussMaffei

## A strong brand in a unique global group

### Cross-technology system and process solutions

Whether in Injection Molding, Reaction Process Machinery or Automation – the KraussMaffei brand stands for pioneering and cross-technology system and process solutions in plastics processing worldwide. For decades, our expertise, innovative ability and passionate commitment to plastics engineering have been your competitive edge. As a cross-industry system provider, we offer you modular and standardized systems as well as solutions customized to your needs.

### There for you around the world

With our worldwide sales and service network, we offer our international customers an excellent basis for a successful business relationship. Due to the close proximity to our customers, we are able to answer your individual inquiries very quickly. We work out the best possible technical and economical solution for your product and production requirements together with you. Test our machine technology for your applications and let our experts put together an individualized service package for you.

### Individualized service

Our employees from customer service, application technology and service help you with your questions and needs on every topic dealing with machines, systems and processes – around the globe, quickly and with a high level of expertise. We have developed an extensive customized service spectrum with our lifecycle design, which accompanies you throughout the entire lifecycle of your machines and systems. Take advantage of the personal interaction and flexibility we offer in our practically oriented seminars. We carry out customer-specific trainings either at your location or at our sales and service locations.

## KraussMaffei Group

### Comprehensive expertise

#### Unique selling proposition Technology<sup>3</sup>

The KraussMaffei Group is the only provider in the world to possess the essential machine technologies for plastics and rubber processing with its KraussMaffei, KraussMaffei Berstorff and Netstal brands: Injection Molding Machinery, Automation, Reaction Process Machinery and Extrusion Technology.

The group is represented internationally with more than 30 subsidiaries and over ten production plants as well as about 570 commercial and service partners. This is what makes us your highly skilled and integrated partner. Use our comprehensive and unique expertise in the industry.

You can find additional information at:  
[www.kraussmaffei.com](http://www.kraussmaffei.com)

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KraussMaffei at: [www.kraussmaffei.com](http://www.kraussmaffei.com)



The KraussMaffei Group has a global presence. Countries with subsidiaries are marked in dark blue. In the white-colored regions, the Group is represented by over 570 sales and service partners.

# Fiber composite solutions for advanced lightweight components

In many sectors, component specifications are being ratcheted continuously upward. Typically, customers want higher mechanical strength and lighter weight.

KraussMaffei is not just a machinery and systems expert, but also possesses expertise in the entire value-adding chain for automated manufacturing of lightweight fiber composite components, regardless of the process.

We are the only company in the world to offer the best manufacturing technology for the part specifications and target quantities of our customers.

You will find KraussMaffei the ideal partner as you work to transform your visions into reality.