Krauss Maffei
PEOPLE FOR PLASTICS

TURNKEY SYSTEM SOLUTIONS FOR FOAM TECHNOLOGIES

CellForm – foam processes for injection molding

IN PARTNERSHIP WITH INDUSTRY

KraussMaffei is a premium partner for the plastics and rubber processing industries worldwide


Automotive


White Goods


Construction


Life Sciences


Electrical/Electronics

Whatever you aim to achieve in plastics or rubber processing, KraussMaffei is your partner. We are the only company with intensive expertise across the three main engineering fields. And we have a strong track record in integrating this expertise to develop new processes and systems.

Ready for any challenge

Our **Injection Molding Machinery Division** supplies machinery and systems from 35 to 4,000 tonnes for standard applications and for all processing variants, together with fully automated solutions. We have a strong customer base in all the relevant industries worldwide.

Our **Reaction Process Machinery Division** supplies machines and complete systems for processing polyurethanes and other reactive materials. Completing our product portfolio, Automotive Component Systems supplies foam molds, cutters and routers. Our customer base is wide, with a focus on the automotive, construction and white appliances industries.

Our **Extrusion Technology Division** supplies machinery and systems for compounding, for pipe, profile and sheet extrusion, physical foaming, and the production of technical rubbers and intermediates for tire production. Machinery from the company's range – from single extruders to complete extrusion lines – is used in many industries, including chemicals, pharmaceuticals, automotive, construction, furniture and packaging.

People for Plastics

We are the "people for plastics". We are your partners from the first exploratory discussion, through development to commissioning, servicing and operating your system, and final disposal. At all times, you are assured of outstanding competence in planning and engineering, as well as reliable and fast spare parts, service and support.

Adding value for customers

We put our expertise to work for your success. With machine ranges engineered for modularity, we can deliver application-specific solutions based on our wide range of standard modules and specially engineered solutions. This strategy offers customers technical and cost advantages.

Close to customers around the world

As an international company, KraussMaffei has a presence in all the major markets for the plastics and rubber processing industries and employs around 3,000 people worldwide. Our sales and service network keeps us close to all our customers around the world.

Packaging

A choice of efficient solutions for foaming – single-vendor, turnkey CellForm systems

Chemical and physical foaming processes produce lighter parts that are more dimensionally stable and quicker to demold. KraussMaffei solutions for foaming and injection molding are bundled under the name CellForm.

KraussMaffei offers solutions that cover the whole range of chemical and physical foaming processes. We are one of the biggest suppliers for Trexel's MuCell® process. We're also one of the few system partners capable of supplying complete turnkey foam systems as a single vendor.

Better production economics with CellForm

The foaming and CellForm processes work by incorporating pellets or gas into the raw material or melt to act as a blowing agent that lowers the density of the polymer. Essentially, foaming falls into two categories: chemical and physical. In the chemical variant, the blowing agent in pellet form is admixed to the polymer, a chemical reaction ensues and foaming occurs. In physical foaming, a gas is injected into the polymer melt. Physical foaming is probably better known as the MuCell® process, patented by Trexel. Both variants allow the density to be lowered and the holding pressure on the polymer to be eliminated. The benefits are manifold: faster cycles, reduced material consumption and better dimensional stability. CellForm is suitable for making a wide range of parts used in all industries and for nearly all thermoplastic parts. The specific advantages which it confers vary from process to process.

Shorter cycles

Foamed materials have a low viscosity. This makes for faster injection and generally lower melt and mold temperatures. Moreover, cooling times are shortened. Because foaming or gas nucleation occurs inside the mold cavity, holding pressure can be sharply reduced or eliminated altogether. Faster injection, no holding pressure and shorter cooling times all combine to yield cycle times that are up to 40% shorter.

Lower weight, less material consumption

The most obvious advantage of foamed parts is that they consume less material and have minimal weight. The material's lower density translates to savings varying from 5 to 10%, without overly impairing the mechanical properties. For some parts exposed to less mechanical stress, the weight savings can even exceed 10%.

Cross-section through an injection molded part made by the MuCell® process. The foamed center and the compact outer skin form a unit. This type of structure produced by physical foaming is also called integral foam.

CellForm can reduce your manufacturing costs and improve profit margins. Different foaming processes generate different benefits.

The table below will give you some indication about whether foaming is right for your production and if the answer is 'yes' then whether you should consider chemical or physical foaming. KraussMaffei specialists will also be happy to advise you.

Your priorities	Chemical foaming	Physical foaming
Cell structure	+	++
Suitable for standard polymers	+	+
Suitable for technical polymers	0	++
Wide processing window	+	+++
Process repeatability	-	+
Potential weight reductions	+	++
Dimensional stability	++	+++
Surface quality	--	--
Thin wall thicknesses (< 4 mm)	-	+++
Residues in foaming process	-	+++
Gas pressure in foaming process	+	++
Clamping force reduction	+	+
Capital investment	+++	-
Blowing agent costs	-	+++
Application areas	Mainly thickwalled parts produced in small and medium batches, eg, toys, or non-visible parts for home appliances, furniture or recreational products	Technical parts, often thin-walled, produced in large batches, typically for the automotive, electrical and electronics sectors

– low performance 0 neutral performance + better performance

From the table it's clear that, with CellForm, the technical properties of the parts are the top priority. Surface quality can be less than perfect. KraussMaffei offers various options for improving surface quality, for example, dynamic mold temperature control, or the negative compression process.

Greater dimensional stability, less warpage

Foaming, which obviates the need for holding pressure, occurs uniformly throughout the cavity. Sink marks are therefore reduced to a minimum and the melt solidifies under very little stress. The outcome is low-stress, no-warp parts of extreme dimensional accuracy – that are totally reproducible cycle after cycle.

Lower clamping force

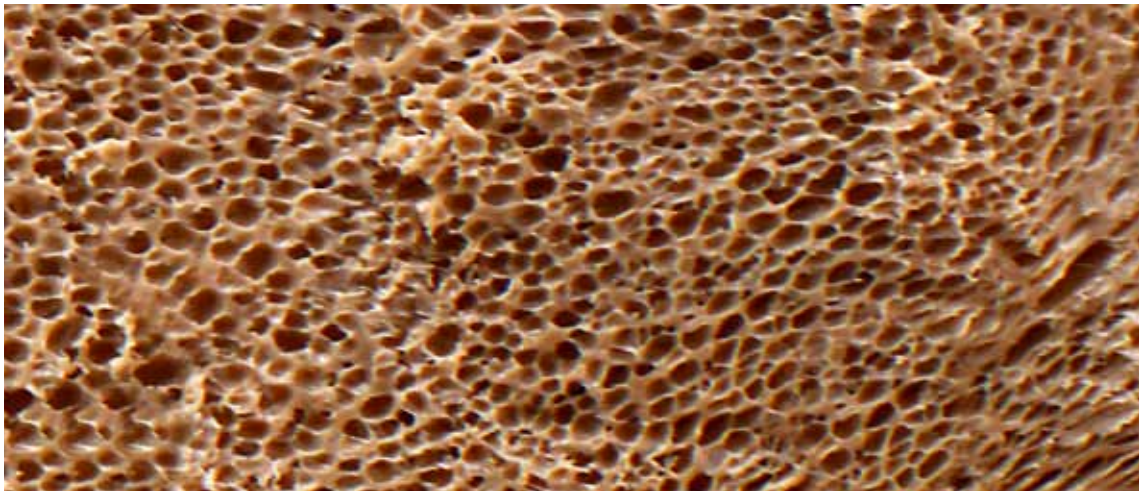
A corollary of the lower viscosity and elimination of holding pressure is that the cavity pressure for foamed parts does not have to be so high. This means that the clamping force can be reduced by up to 30%. This means more flexibility for your business, because the parts can be produced to the same quality on less powerful machines.

Chemical foaming – homogeneous distribution of blowing agent thanks to expertise in screw design

In chemical foaming, blowing agent pellets are admixed to the plastic pellets in the hopper. The blowing agent must be chosen with the thermoplastic in mind to ensure that the chemical reaction takes place in a controlled manner. The heat applied during plasticizing initiates nucleation and leads to the formation of gas bubbles. Foaming takes place in the cavity, where there is room for the mixture of polymer and blowing agent to expand. There is usually no need at all for holding pressure after injection, as that pressure is provided by the gas. In chemical foaming, the gas bubbles burst at the surface to produce an open cell structure. Chemical foaming is ideal for making thick-walled parts > 4 mm. These would mostly be made with polyolefins.

Blowing agent metering

When highly reactive additives – such as chemical blowing agents – are employed, they must be dispersed uniformly throughout the polymer melt. KraussMaffei offers purpose-built HPS-UN screws that distribute the blowing agent extremely homogeneously and thus ensure high process reliability and consistent product quality. For a cost-effective screw upgrade, KraussMaffei offers HPS-M screws. These screws also boast excellent mixing performance and, unlike HPS-UN screws, can be used in standard barrels.



Foam structure of a part produced by chemical foaming.

HPS-UN screws deliver excellent mixing performance and are ideal for chemical foaming processes.

What you need for chemical foaming

Chemical foaming requires a certain minimum of machinery. Under certain conditions, it is also possible to retrofit existing machines for chemical foaming.

What you need

- Pressure accumulator for enhanced injection performance
- HPS-UN or HPS-M screw

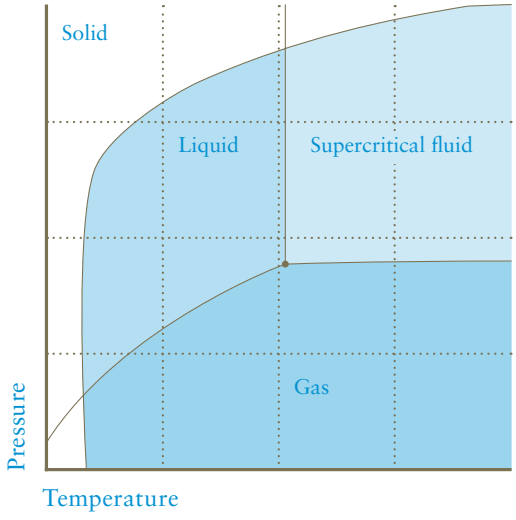
CellForm package

- Active dynamic pressure control
- Safety modifications
- Reduced nozzle contact force during mold movement
- HSVN needle shut-off valve with special monitoring function
- Active dynamic pressure monitoring when safety gate is open

Physical foaming with MuCell® – success comes swiftly with a single system partner

The MuCell® process is probably the best-known form of physical foaming. A gaseous blowing agent – N_2 or CO_2 – is injected under high pressure into the already totally polymer melt in the plasticizing section. The quantity of gas metered in is dictated by the type of thermoplastic. Prior to injection, the gas is a supercritical fluid (SCF), which means that it has the incompressibility of a liquid and the solubility of a gas. This enables it to dissolve completely in the thermopolymer melt to yield an extremely fine monophase system. The combination of active dynamic pressure and MuCell® (also called "MuCell Process Pressure" or MPP) is important to the process. It is responsible for forming and maintaining the monophase system and thus ensuring that the gas stays dissolved in the melt. All MuCell® machines are equipped with a shut-off valve for this reason. Having been injected rapidly, the low-viscosity mixture undergoes a rapid pressure drop inside the mold that generates nucleation seeds. The gas is then released from the melt in a controlled manner and the resulting foaming pressure takes on the role of the holding pressure. The process can be regulated via the pressure and temperature.

The MuCell® process is ideal for making parts with wall thicknesses less than 4 mm.



Phase diagram – typical state changes for a gaseous mix.

Like other gases, nitrogen (N_2) is a supercritical fluid (SCF) under specific pressure and temperature conditions. The SCF dissolves completely in the polymer and is released again as a gas in the mold cavity.

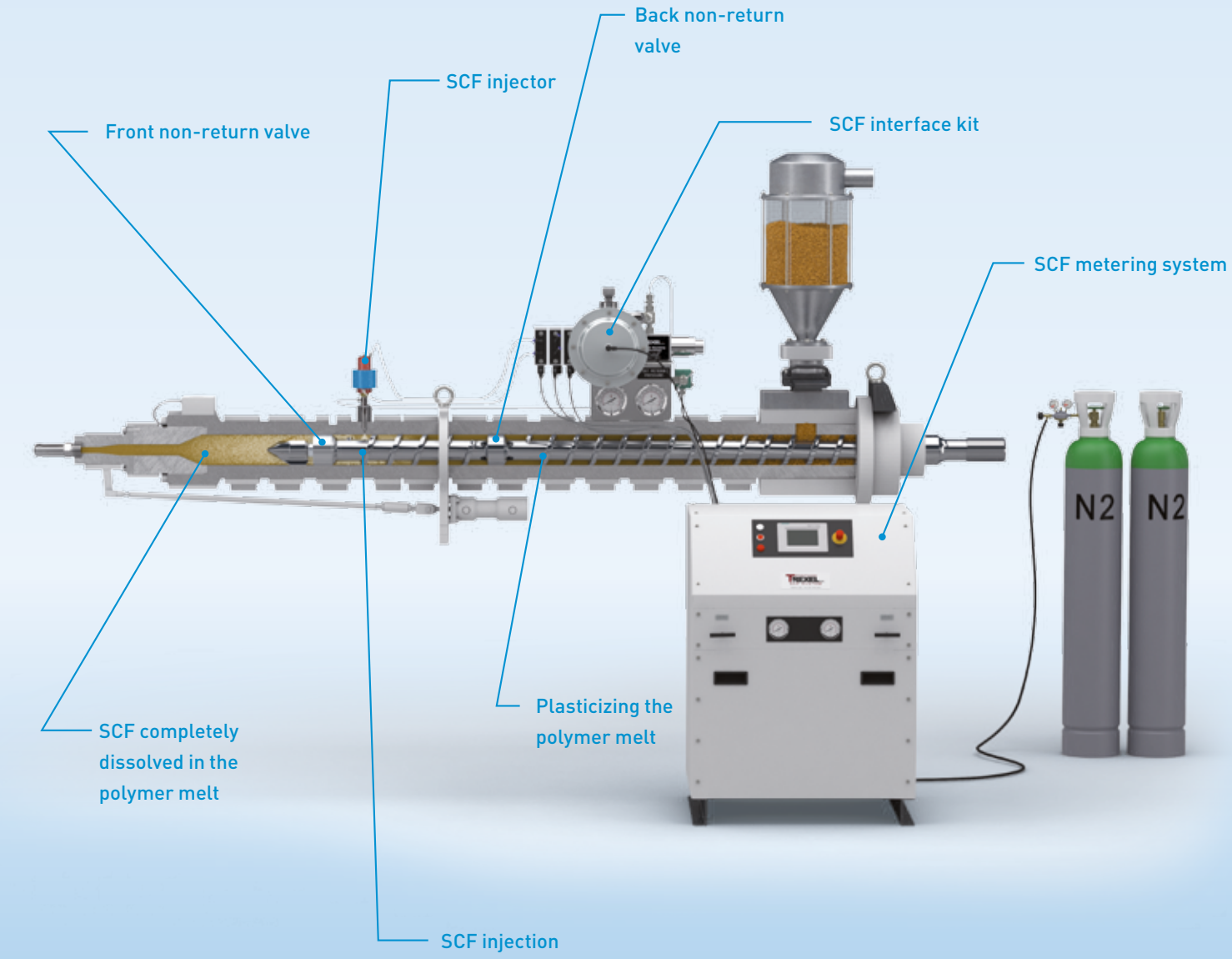


Diagram of plasticizing unit with MuCell® package

The main components of a MuCell® installation are shown in the diagram. The high-pressure gas, usually N_2, is supplied from bottles or a nitrogen installation to the SCF metering unit, where it is transformed into the supercritical fluid state and fed to the interface kit. The kit regulates the momentary mass-flow requirement to the injector. Superfluous gas is returned to the metering unit. The Trexel self-optimizing control system is a fully automated process that generates a constant mass flow and so ensures identical gas content from shot to shot. The SCF is injected through two injectors into the melt via the plasticizing barrel. Injection is triggered by a time or position control signal. A non-return valve in the middle of the screw prevents unwanted expansion of the gas-melt mixture back toward the feed. Expansion toward the front is prevented by the machine shut-off nozzle.

TECHNOLOGY FOCUS

Injection molding machine and MuCell® peripherals in perfect harmony

Single-source supplier

The MuCell® process is licensed from Trexel. KraussMaffei has successfully employed MuCell® technology for many years and is one of Trexel's major clients. The fact that we are the only company in the world to market MuCell® directly underscores our engineering expertise. This means you can order your MuCell® system as a complete system directly from KraussMaffei – without the need for additional third-party agreements or friction losses as the project progresses, and including all usage rights.

Total operator safety and a reliable process

The MuCell® controller features a special safety gate monitor that allows the dynamic pressure to stay active even when the safety gate is open. The pressure on the gas-laden melt is not relaxed. This has the benefit of keeping the startup phase itself very short and simple. And it extends the uptime of the MuCell® installation while offering a constant high level of safety for the operator.

Plasticizing unit optimized for MuCell®

MuCell® plasticizing unit, like all KraussMaffei plasticizing units systems, is made in-house to full Trexel specifications. The screws have an L/D ratio of 23 for reliably generating the polymer/SCF monophase system. They are wear-protected for a long service life and consistent processes. The screws themselves feature an intensive plasticizing section

The KraussMaffei equipment is perfectly matched to the Trexel system components. This guarantees a stable and reliable process in all phases of the cycle.

and a downstream intensive mixing zone. In the barrel, the plasticizing zone is followed by the gas injector (up to two may be installed), which is connected to the SCF metering unit. A second shut-off valve prevents the gas from expanding prematurely in the barrel back toward the feed opening.

Locking system for controlled conditions

For cold-runner molds, the injection units of the injection molding machines are equipped with needle valve nozzles. The nozzles are of an extended type to ensure perfect mating and will reliably prevent unwanted expansion into the cold runners. Where molds have needle valve nozzles, a pivot pin needle valve can be provided on the machine side.

MC5 for total control

All the functions of the Trexel controller are fully integrated into the KraussMaffei MC5 machine controller. All values, such as flow-through rate, injector opening time, pressures, etc. are grouped together on MuCell® pages. Key process parameters can be monitored via tolerance bands in the customary MC5 manner. This provides for centralized set-up and monitoring of the entire injection molding process and adds an additional level of process safety.

Optional MuCell® package – retrofit in stages

There is very little involved in readying a new machine today for fast and easy retrofitting somewhere down the line. This is one way to future-proof your investment from the outset. Many of the machines which you already have can be upgraded with a MuCell® package. The list below details what you need for retrofitting a MuCell® package.

What you need

· Pressure accumulator for enhanced injection performance
· Active dynamic pressure control system, including proportional valve control
· Reduced nozzle contact force
· Nozzle closure actuation during mold movement

Preparations for CellForm and MuCell®“

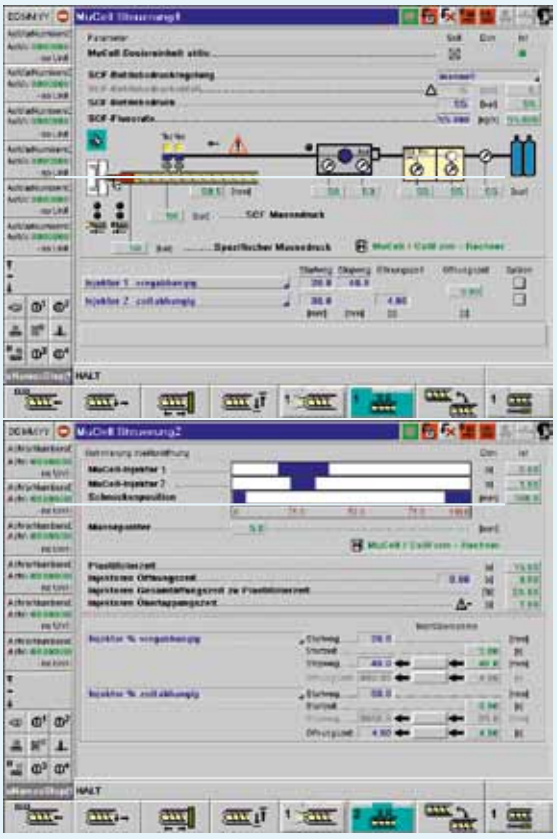
· Interface for MuCell® peripherals
· Safety modifications
· HSVN shut off nozzle with additional monitoring
· Active dynamic pressure control for open safety gate

MuCell® package

· MuCell® plasticizing unit
· MuCell® software

MuCell® peripherals:

· MuCell® gas-metering unit (SCF system)
· MuCell® interface kit
· (Pressure control module, injector, lines)
· All usage rights are included



All process parameters can be set from the MC5 control panel using the special MuCell® control pages.

CUSTOMER BENEFITS

CellForm: business and technical benefits reinforce each other

Foaming technologies, and especially the MuCell® process, are a great way to reduce material costs and boost productivity. In KraussMaffei, you have a single-source supplier with the essential engineering and process expertise to help you make the most of these benefits – whether you are looking to prepare a machine for foaming, purchase a system or retrofit an existing machine.

Economic gains from greater productivity

Shorter cycle times, lower material consumption and smaller clamping forces all combine to minimize your unit costs. CellForm maximizes the efficiency of your machines in the long term.

Technical gains from higher part precision

MuCell® parts are produced accurately and reproducibly. They are free from sink marks, stresses or warpage. This makes them ideal for assembly processes. The lower part weight supports lightweight designs without serious compromises on mechanical strength.

Life cycle support from your system partner

As the exclusive systems partner for Trexel, KraussMaffei not only offers you a single source for all the hardware and software. Partnering with KraussMaffei means turnkey, standardized systems and comprehensive accountability from our company. We will assist you with readying and upgrading your existing equipment. To give you the agility to quickly adapt to market changes. Today, tomorrow – count on it.

TYPICAL CELLFORM APPLICATIONS

CellForm products are used in many industry sectors, especially in producing automotive and technical parts

Water pump housing

Housing parts can be made with less material, feature excellent dimensional stability and withstand high pressures.

Door modules for car interiors

Weight reduction is a key issue for motorists. The MuCell® offers significant weight savings.

Mounts for printer cartridges

For the electronics industry, MuCell® offers excellent dimensional stability and cycle times up to 25% shorter.

Valve covers in car engines

Parts under the hood must be absolutely perfect and, especially, free of warpage. MuCell® offers unerring reproducibility and simplifies downstream processes, such as welding and assembly.

Wall elements

Wall elements can be made much faster and with less material by chemical foaming.

Automotive door lock housings

Production economies – door locks can be produced with 30% less clamping force and 25% faster by physical foaming.

SERVICE WORLDWIDE

Service, support and spare parts – when you need them, where you need them

Rely on us for a fast and competent response to all your service needs anywhere in the world. Whatever you need – from troubleshooting and training to spares or repairs – we're on the job.

We're dedicated to supplying service quality on a par with the outstanding quality of our machines and systems. We offer far more than spare parts and hotlines. We'll work with you to choose the best and most cost-effective solution for your operation. We'll help you test new applications and we'll plan customized service packages.

All-round service

Our service offering is broad. We'll configure your system, install and commission it, train your staff, plan measures to minimize your downtime risk and maximize productivity, and carry out maintenance, repairs and upgrades. You'll find us fast, reliable and competent. Our hotline is manned by highly-trained and experienced service technicians.
If necessary, we'll get a technician to you quickly. Remote diagnosis, interfacing directly with your machine's control system, can be a practical alternative. Spares for all important wear parts are available at short notice. We're continuously expanding our service network to speed up spare parts shipment. Talk to us about the right service solution for your business.

Customer trials and prototyping in our test lab

The Injection Molding Division operates a test lab fitted with the latest machinery and equipment. We can run trials, produce prototype parts and fine-tune processes on your behalf. We can work with you to test and evaluate processes, machines and equipment in order to identify the best approach for a particular project. Our highly-qualified application engineers are there to help you.

Training with high hands-on content

Courses are held in our lab and training centre, or, optionally, on your premises. We offer clearly-structured basic and advanced training in operation, process control and maintenance for KraussMaffei injection molding machinery. On request, we'll plan and hold special courses on topics of your choice. All participants spend a high proportion of their training working hands-on with original KraussMaffei machines. A well-structured training program produces skilled operators and technicians, which will positively impact your up-time and productivity.

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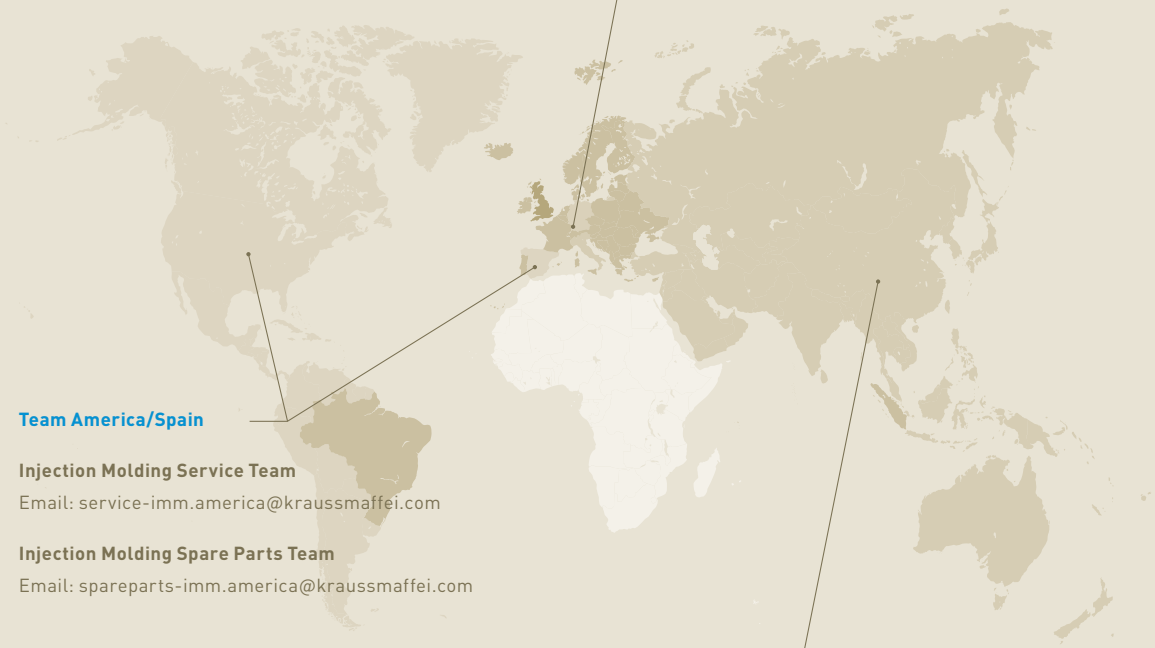

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KraussMaffei is a premium partner for the plastics and rubber processing industries worldwide. KraussMaffei machines and systems are used wherever plastics and rubber are converted into products. As a knowledge-driven technology company, we build on many decades of experience and a strong commitment to research and development.

Chemical and physical foaming processes produce lighter parts that are more dimensionally stable and quicker to produce. KraussMaffei solutions for injection molding with either type of foaming are bundled under the name **CellForm.** KraussMaffei solutions cover the whole range of chemical and physical foaming processes. We are one of the biggest suppliers for Trexel's MuCell® process. KraussMaffei is your system partner. We are single-vendor suppliers for the MuCell® process – you get a complete turnkey system including all usage rights.

1.0 WE. 1st edition 09/10 . SGM 046 A PRO 09/2010 EN ··· KraussMaffei reserves the right to make technical changes ··· Printed in Federal Republic of Germany.

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