MuCell® Processes
TREXEL INC.
MuCell® Process News
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MuCell Is An Important Platform For Innovation

Earlier this year, I wrote an article complaining about the futility of companies who were trying to nurture an "innovative" culture while subjecting their engineers and managers to the tyranny of a "six month payback" criteria for new investment. I argued at the time that this type of financial discipline could only lead to "the lowest common denominator" of innovation and would all but eliminate the kind of breakthrough development needed by global manufacturers.

With the financial crisis receding and with many companies recapitalized, we hope and believe that this counterproductive trend has begun to abate. In this issue of the MuCell News, you will read about several examples of companies that have paid their dues to the process of innovation and have emerged with truly exceptional products, yielding sustainable competitive advantage and enabled by the MuCell Process. These achievements did not come overnight, but were stimulated by the consistency of vision of company leaders, whether at Behr, JCI, VW, TRW, or Hoffer Industries.

Trexel itself has never stopped innovating through its relentless effort to develop new and more user friendly business models, eliminate license fees, or support risk sharing. We have also worked to reduce the cost of ownership of our systems, develop upgrade packages to facilitate the conversion of under-utilized molding machine assets into productive pieces of new technology, and continually distill our know how and applications knowledge to usable forms for our customers. Our most recent publication, The MuCell Processing Guide, is something that would have been impossible even 3 years ago.

While the MuCell value proposition has always been a strong one, offering a combination of dimensional stability, lower weight, faster cycle, and reduced clamp tonnage requirements in most applications, we have now redefined the weight reduction goals for MuCell users. While Phase One users, those who would like to apply the MuCell Process to conventional designs can still count on achieving the array of benefits listed above, we have identified a new MuCell option for advanced users. We call these Phase II Users, and define them as those who use the MuCell Process to break the current design constraints of their plastics parts and substitute a "Design for MuCell" philosophy. These users can now expect to achieve weight reduction (through a combination of new design freedoms and foaming) of 25%. This is the path to true sustainable competitive advantage !

Finally, as users transition to Phase II MuCell we are beginning to see important innovation examples of MuCell being used in combination with other technologies to provide breakthrough product and economic advantages. Included in this list are: 1. Core back molding; 2. Variotherm processes; 3. IML and IMD; and 4. Gas Counter Pressure. You can expect to hear more about these applications, both in this issue and in issues to come.

Sincerely,

David P. Bernstein

Also Inside This Issue:

The MuCell® Process – A Better Way To Design A Door Module

Johnson Controls (JCI) was one of the first MuCell® users in Europe, and their experience led to the new designs for the interior door trim panel for the Mercedes W212 sedan, which entered production in 2009. This SPE Award-winning application was designed from the start to utilize the MuCell® process.

JCI was able to take advantage of several key MuCell design rules which allow: thinner wall construction through lower resin viscosity; rib-to-wall ratios of 1:1, thereby reinforcing thinner wall construction without creating sink marks; elimination of the need to apply pack-and-hold pressure with a high clamp-tonnage requirement, thereby creating a friendlier environment for in-mold decorating.

JCI's strategic focus on the MuCell® process led to an advanced design for the Door Trim Panel, which would not be possible using conventional design rules. The door trim panel consists of three layers, an ABS carrier with PU RIM foam as a central layer, and textile with deep drawn film as the upper layer.

JCI also took advantage of the low injection pressures inherent with the MuCell Process to inject foamed material behind a PP thin film, all in one injection step for the production of the integrated map pocket, thereby eliminating a second processing step along with the resulting waste and trimming specifications. The MuCell process allowed for the part wall to rib ratio to be designed 1:1.

The MuCell® process avoids sink marks and warpage and allows for the design of the map case as one part. To mold the part as one piece with a conventional solid injection molding process would have caused deformations and sink marks on the visible side.

Mercedes W212 Door Trim Panel With Integrated Map Case

MuCell - A Better Way To Design A Door Module

(continued)

The door trim carriers (front and rear) were designed to run on Tandem Molds, which brings tremendous productivity advantages. The key benefit of the MuCell® process when used in conjunction with Tandem Mold technology is that the MuCell® process deletes the pack & hold time and the combination of the two technologies allows cycle time reductions of more than 50 % in comparison to the standard injection molding process using a conventional single face mold.

The idea of the Tandem Mold concept is to have a double daylight mold with each cavity being injected in turn, allowing one part to cool during the injection phase of the other.

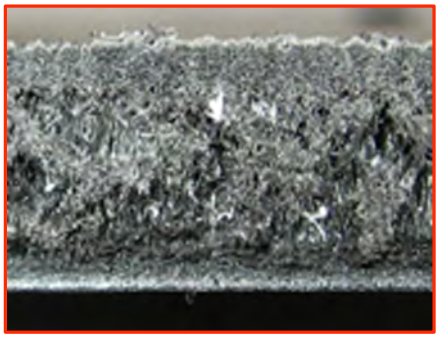
Because of the lower material viscosity with MuCell® the general wall was designed thinner. Additionally the wall to rib ratio was designed 1:1 without sink marks. Although a textile with a foam middle layer covers the carrier itself, sink marks are sometimes an issue with these kinds of products.

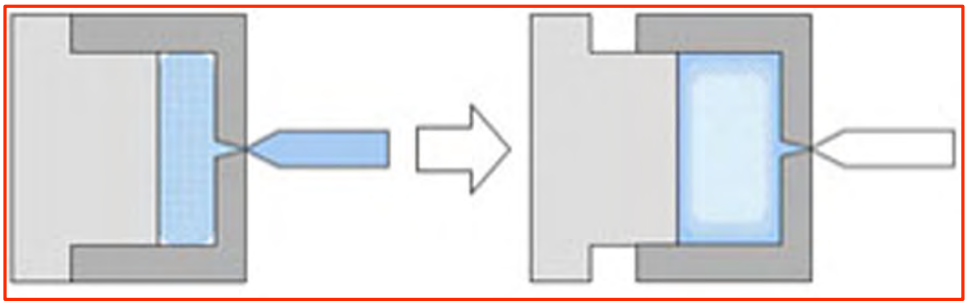
MuCell® and New Process Development

For new vehicles now under design, automakers continue to search for the additional weight reductions they need to improve fuel economy. As one potential solution, machinery manufacturer ENGEL, through their North American operation and Trexel have been working together to develop and commercialize the injection/expansion molding process, also known as the "Core back" expansion molding process.

"Core back" molding has shown the potential to produce structural applications that feature dramatic weight savings. The weight savings derive from the ability to redesign parts based on high-density reductions (expansion of 50% or more) and resulting increased stiffness to weight ratios.

"Core back" expansion molding varies from the traditional injection molding process as, once the foamed resin has filled up the mold, the volume of the mold is increased, causing the foam to expand. This means stiffer plastic parts, with low density and good rigidity, can be made with lower volumes of plastic resin.





In core back molding, once the foamed resin has filled the mold, the volume of the mold is increased causing the foam to expand (see part cross-section).

The combination of these two processes has demonstrated the potential to redesign parts in order to achieve dramatic weight savings in a series of industrial trials. "When you combine Core back and MuCell®" says David Bernstein, President of Trexel, "you essentially saturate the polymer with SCF, or gas in its supercritical state, while keeping the mold closed under pressure, and then precisely open the mold to get maximum expansion. You get a much thicker part, but one that's much less dense, as much as 75% less dense."

MuCell Delivers Better Airbag Cover Design and Performance

The passenger-side front airbag cover is an important, and highly visible part of the overall instrument panel structure that poses a number of unique application challenges. Today, manufacturers in Europe and Asia are using the MuCell process to produce dimensionally stable airbag covers that are free of sink marks, readily paintable, are able to be molded on smaller injection molding presses and that perform exceptionally well (down to -35°C) in low-temperature environments. More importantly, they are using the MuCell process to enable thin wall sections at the tear seams that eliminate the need for a laser cutting step.

TRW Automotive in Europe has used the MuCell process to develop and produce painted front side passenger airbag covers as well as for painted rear torso airbag covers for Volkswagen and Porsche that feature no sink marks, excellent dimensional stability and design freedom unobtainable using traditional solid injection molding. For the airbag cover for Volkswagen's Tiguan TRW Automotive was able to utilize smaller machines for molding (300T vs. 500T for traditional solid molding) using MuCell. Here's how they did it.

The MuCell process offers new and different design opportunities for airbag covers that just aren't possible with conventional solid injection molding. Instead of a separate secondary operation to laser cut the back side of the airbag cover, the MuCell process makes it easy to mold in a tear seam line for the airbag deployment and a living hinge through use of variable wall thicknesses.

When solid injection molding is used with different airbag cross-sections, the molded parts are subject to different shrink values due to different pressures in the mold. This causes unacceptable variations in dimensional stability, or in other words, sink marks and warpage that can't be hidden by painting.

Part design in solid molding is typically constrained by the need to push plastic from the gate to the end of the part without freezing off. The part needs to be packed along the entire flow length to obtain the uniform

TRW's airbag designs using the MuCell process for the Volkswagen Tiguan are free of sink marks and feature an excellent visual appearance when painted.

shrinkage required for dimensional stability, and to eliminate sink marks and vacuum voids. These processing limitations impose design restrictions that affect the ability to reduce wall thickness, as would be required to produce an effective living hinge in an airbag cover.

The MuCell process changes all that. With Microcellular foaming cell growth in the mold replaces the traditional pack phase. It isn't necessary to fill the mold "from thick to thin". This means that applications may be designed for function, not for traditional plastics processes. Rib-to-wall thickness ratios can be optimized for performance, not just for sink mark elimination. The creation of a thin wall section (e.g.: living hinge) does not require an increase in clamp tonnage.

The end result is that now airbag covers can be designed with wall thickness variations to put material only where it's needed with the resulting weight savings from more efficient design. Instead of the extra cost and time required for laser cuts, tear seam lines can be molded in with ease and efficient living hinges that don't separate during airbag deployment can be designed. Finally, the different cross sections are not visible following the paint process.

The MuCell process means high performance with efficient design. In other words, you're covered.

MuCell Keeps Moving Forward

By Bill Bregar | PLASTICS NEWS STAFF

SOUTH ELGIN, ILL. (Sept. 24, 7:15 p.m. ET) -- Hoffer Plastics Corp. has started using the MuCell microcellular process to injection mold parts for two hot-selling vehicles from Ford Motor Co. — the Fiesta compact car and the F-150 pickup truck.

Late last year, Hoffer Plastics bought a MuCell-equipped Toshiba molding machine to run both jobs at Hoffer's South Elgin factory. The mechanical sound of the press molding parts is music to the ears of David Bernstein, president and CEO of Trexel Inc.

Nine years ago at NPE 2000 in Chicago, Woburn, Mass.-based Trexel showed its first commercial MuCell systems. Since then, Trexel has sold more than 400 MuCell equipment systems, but MuCell is far more popular in Europe and Asia than in the U.S., where it was developed.

That fact frustrates Bernstein. He wrote in a *Plastics News* column published Sept. 21 that too many North American processors forego longterm investments, instead demanding a quick six-month payback on new technology.

Several years ago, Trexel changed its business model to make MuCell more accessible. Trexel eliminated licensing fees, introduced a retrofit system and began offering installment payment plans for customers in the early stages of MuCell use.

"Our evolution has been towards a user-friendly set of business policies," Bernstein said.

Trexel originally required licensing fees, but Bernstein said many customers balked at the idea of signing such a long-term, legally binding agreement to get new technology.

Eliminating the licensing fees has helped increase sales, especially in Europe and Japan. "Once you buy it, you own it, you can use it wherever you want, for as long as you want," he said.

Hoffer Plastics has become an enthusiastic supporter of MuCell. "Trexel has made it very easy. They have a very easy point of entry and they're easy to work with," said Jack Shedd, vice president of business development for Hoffer.

MuCell Keeps Moving Forward

(continued)

"They helped us tremendously on the equipment and the design standpoint and have been here around the clock to support on us on any issues that we've had."

Officials of Hoffer and Trexel showed off the Ford applications during a Sept. 10 tour of Hoffer's headquarters plant.

Hoffer's expansion into MuCell came in November, during a period of capital investments. The custom injection molder installed the Toshiba press with 610 tons of clamping force to run the MuCell jobs for Ford. On the packaging side, Hoffer also added four new Sumitomo Demag presses — 462-tonners from the high-speed El-Exis line, to mold closures.

MuCell equipment adds microscopic bubbles to the melt by bringing nitrogen gas to a supercritical state, so the gas has properties of both a liquid and a gas and forms a solution with the melted plastic. To describe what happens, Bernstein uses the analogy of a bottle of Seven-Up that fizzes when you open the cap. The gas stays in the solution, under pressure, until the melt exits the barrel through the shutoff nozzle. The sudden pressure drop releases the bubbles inside the mold.

Bernstein said MuCell offers significant advantages: lighter-weight parts that use less resin, faster cycle times, lower molding pressure and temperature, lower melt viscosity and parts with no warping.

The basic process was invented in the 1990s at Massachusetts Institute of Technology by Nam Suh, who headed MIT's mechanical engineering department. Trexel supplies the beside-the-press metering equipment and a specially designed screw and barrel that mixes in the gas and keeps the melt pressurized in the barrel at all times, through injection and short recovery.

"It always has to keep the melt behind the shutoff nozzle above a certain pressure, so that the gas does not come out of the solution," Bernstein said.

Makers of 10 injection press brands offer new MuCell-equipped machines: Engel, KraussMaffei, Arburg, Toshiba, JSW, Milacron, Husky, Mitsubishi, Nissei and Dongshin.

Engel Machinery Inc. was the first machinery maker to adopt MuCell. For several other press brands, existing machines and also used presses, Trexel can add MuCell through a modular upgrade.

Hoffer loves those tiny bubbles

Hoffer began molding its first MuCell job — door latches for the F-150 — this summer on a tandem mold. A tandem arrangement was necessary to run all the door latches on the single Toshiba press — front, rear, left and right. The parts are 33 % glass-filled polyester.

The tandem mold allowed Hoffer to reduce the cycle time to mold the different-sized family parts, said Brian Wagner, project management director. "You save the cooling cycle," he said. The synchronized movement of the tandem mold allows the press to run two quantities of plastic and two injection pressures, among other parameters.

Shedd said Hoffer Plastics is not afraid to use new technology. The company also is running gas-assisted molding for the first time, for a handle for a washer and dryer that gets plated. "MuCell gives you the cycle-time reduction and weight reduction, and a low-warp part, on its own. Then you throw in this tandem tooling. Now you 're really pushing the envelope," Shedd said.

After winning the F-150 door latch work, Hoffer Plastics began actively promoting MuCell. That caused Ford to give the molder another job — a door latch presenter for the Fiesta. Hoffer molds the Fiesta part on the same Toshiba press, this time running a regular injection mold. Plant manager Ken Bird said using MuCell cuts cycle time by about 15 percent, reduces part weight and causes less flash.The door latch presenter is molded from talc-filled polypropylene.

Bernstein said Hoffer has actively sold the microcellular technology to win new business. Too many molders limit the process to a single "MuCell job," he said. Shedd said the company has started promoting MuCell beyond automotive, to other markets such as appliances and recreational equipment.

"There's an opportunity for a company like Hoffer Plastics to go out and beat the band on a great technology," Shedd said.

Zotefoams plc Implements MuCell Extrusion Production Line in UK

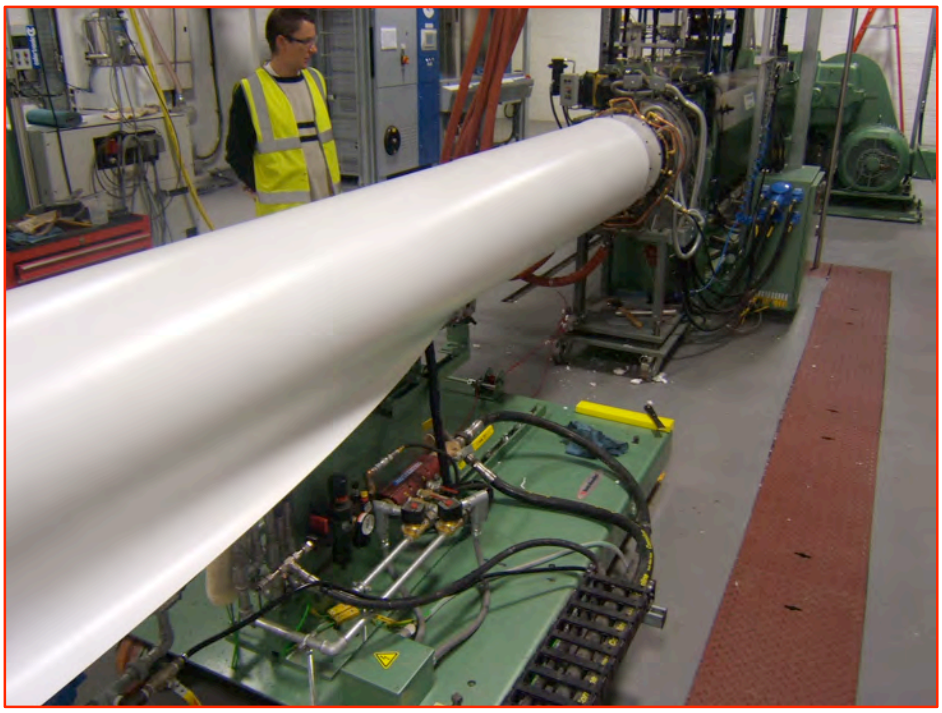
In 2008, Trexel and its partner Zotefoams plc, (Croydon, UK) formed a new company, MuCell Extrusion LLC, with the mission to commercialize and further develop microcellular foam-based extrusion technology.

In addition to being an investor in MuCell Extrusion, Zotefoams licensed the technology to make foams for a number of polymers. Zotefoams has now completed installation and is up and running on a new tandem 3.5" x 4.5" extrusion line that can deliver up to 52" wide sheet foams. Initially Zotefoams are running low-density polyethylene (LDPE) materials with plans to expand their product range to other polymers such as polypropylene (PP) and nylon (PA).

David Stirling, Managing Director of Zotefoams, said, "to a manufacturer of high-end foams, the MuCell extrusion process is a hugely interesting technology. It is environmentally friendly, can be retrofitted to existing extrusion lines and offers product features that just can't be made with standard extrusion technology. We see applications in many diverse markets for our new microZOTETM thin foams"

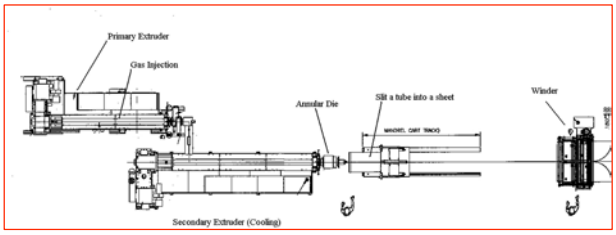
"In manufacturing light density foams MuCell Extrusion technology is particularly useful for applications like seals and tapes where microcellular foam allows surface-to-surface conformance with excellent skin quality and gauge control, all using clean technology," said Mark Lindenfelzer, President of MuCell Extrusion. We are also working on applications with the stated objective of reducing the polymer content of solid or near-solid parts. High polymer costs and a reduction in carbon footprint through minimizing polymer usage are strong drivers for our technology," he said.

"In addition," said Lindenfelzer, "microcellular foam is an excellent choice for thermoforming applications where top load and impact properties are critical.



Thermoforming of microcellular foam allows maximum weight reduction while retaining impact qualities and surface quality in applications like dairy containers, yogurt cups and other packaging applications," he added.

MuCell Extrusion technology brings outstanding physical property performance and aesthetics through its microcellular foam structure. MuCell extrusion foam products feature a microcellular foam structure of under 100 microns, which is up to



10 times more cells per unit of volume than traditional offerings. The benefit to designers and users is a stronger and better looking finished product.

From an environmental standpoint, MuCell Extrusion foams using atmospheric gases (CO2 or Nitrogen) rather than using a chemical reaction or hydrocarbon (HC)-based expansion agents. The technology is cleaner, less expensive to produce (with butane costs range anywhere from 5-8 times higher than CO2) and does not require the added investment and risk (and insurance costs) associated with handling, storing and utilizing environmentally unsound, flammable HCs.

Lindenfelzer, adds, "HC technology is on its way out. It's too expensive, oftentimes dangerous to use and let's face it . . . HCs are environmentally unsound. By comparison, MuCell Extrusion technology uses atmospheric gases and the result is that we can offer cleaner technology that also brings both significant economic and performance advantages."

In fact, MuCell Extrusion technology features a GWP (Global Warming Point) up to 15x less than traditional foaming methods. With no cross-linking required, foams made using the MuCell technology are also recyclable.

In summary Lindenfelzer states, "we have performance, cost, and environmental benefits. This is the technology of the future, available today".

Behr Group Goes With MuCell for Production of BMW 7 Series HVAC system

When you're manufacturing the HVAC system for one of the finest luxury car models in the world, there can be no compromise in your approach to quality. So, when it came time to work with BMW on their HVAC system for the latest BMW 7 Series, Behr turned to the MuCell process to bring the ultimate in quality to the ultimate driving machine.

In 2005, the Behr Group, with headquarters in Stuttgart, Germany began to work with the MuCell process to improve the quality and performance of the key plastic components in its automotive HVAC system applications marketed and sold for use in both passenger and commercial vehicles throughout the world. It's no surprise then that in addition to their work on the BMW 7 Series, Behr recently made the strategic decision to design and produce all future climate control system plastic parts using the MuCell process. Here's why.

A critical challenge to the long-term performance of high quality automotive HVAC systems is the ability of the flapper doors (valves) to remain flat through wide variations in temperature cycles in order to seal properly.

HVAC systems are typically required to operate in a broad range of sometimes harsh temperature environments, ranging from -30°C up to +90°C. The MuCell Process gives these components, typically molded from talc-filled PP, the dimensional stability to perform flawlessly over the temperature range. The result: the MuCell process removes the molded-in stresses that can cause the underlying plastic in the valves to warp as well as providing a better and tighter fit for the evaporator case, which provides both better ease in assembly as well as excellent in-use performance. The MuCell microcellular foaming process also provides some additional noise attenuation for the system.

At the same time, Behr gains manufacturing productivity and saves money by using the MuCell process to reduce the weight of the plastic components.

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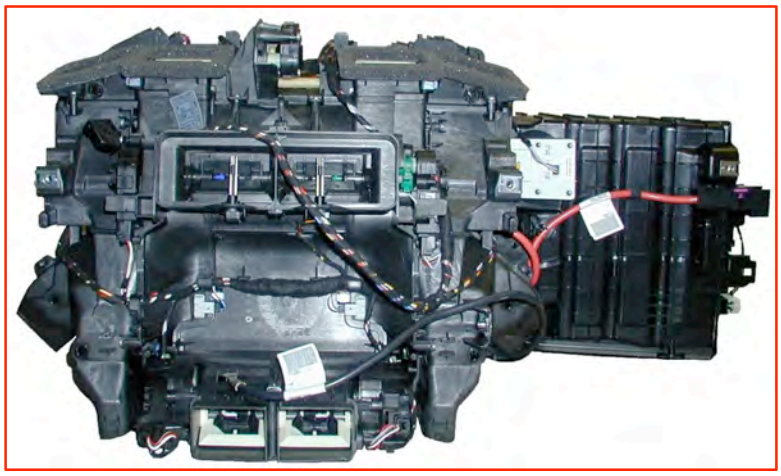

At the same time, Behr gains manufacturing productivity and saves money by using the MuCell process to reduce the weight of the plastic components.

With weight reduction, cost reduction, improved quality and outstanding performance, MuCell helps Behr to build an advanced HVAC system that feels just right on the world's ultimate driving machine.

Do You Have Your Copy Of The New MuCell Processing Guide?

Trexel's new processing guide is a useful tool covers the technical fundamentals, optimization and troubleshooting of MuCell microcellular foam technology as it relates to injection molding.

The new guide is available in Chinese, Japanese, German and English versions. Separate sections of the new Guide are devoted to process set-up, optimization, troubleshooting, start-up and shutdown procedures, a glossary of relevant terms and a troubleshooting summary.

Here is a detailed look at the table of contents, along with the major topics:

Microcellular Molding Fundamentals
- Types of Supercritical Fluids
- Material Effects

Setting Up The Process
- Initial Setpoints

Optimization
- Weight Reduction
- Warpage
- Surface Appearance
- Clamp Tonnage & Injection Pressure

Troubleshooting
- Insufficient Molding Benefits
- Cell Structure Issues
- Processing Inconsistencies
- Correcting Visual Defects

Typical Nitrogen Levels and MPP Settings By Material

Startup and Shutdown Procedures
- Short-term Shutdown
- Short-term Startup
- Long-term Shutdown
- Long-term Startup

Glossary of Terms

Troubleshooting Summary

If you don't already have yours, please contact your Trexel representative today to receive a copy.

Make Sure to Visit Trexel This Year at Chinaplas or K2010

MuCell technology from Trexel will be on display at both of this year's premier plastics events, Chinaplas and K2010 . Make sure you update us on your plans as we get closer to these events. We look forward to seeing you there.

Chinaplas 2010
April 19 – 22
Shanghai New Industrial Expo Center
Pudong, Shanghai, PR China
Booth W1T45

For more information on Trexel at Chinaplas, please contact Patrick Tong at p.tong@trexel.com.

K2010 International Trade Fair
October 27 – November 3
Düsseldorf, Germany
Hall13/A48

For more information on Trexel at K2010, please contact Dr. Hartmut Traut at h.traut@trexel.com.

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