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Injection WORLD


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Novares buys MPC in US

Automotive moulder Novares has acquired Miniature Precision Components (MPC), a US maker of highly engineered plastic components and integrated modules for vehicle powertrains. Novares has separately acquired all of its joint venture company in Wuhan, China, by buying the final 30% stake from its partner, Yazhong, via its Chinese subsidiary, Noveastern.

MPC makes automotive parts and modules, including crankshaft covers

MPC turned over $265m in 2018 and has five US sites in Wisconsin and Tennessee, plus one in Mexico, employing 1,600 people. Novares already had eight US sites. Buying MPC, the company said, "nearly doubles the size of Novares' engine business, giving it a critical size and a global reach to position itself amongst the top global powertrain parts suppliers", as well as greater customer proximity. Ford, General Motors, FCA, Nissan and Toyota are MPC's main automotive customers.

In addition, MPC offers components for system-critical powertrain and under-the-hood applications such as engine and transmission sealing, air and fluid management and emissions control, plus 3D suction blow moulding and moulded foam capabilities.

The combined company will have sales of about €1.5bn per year and a total of 47 plants in 22 countries, employing 12,000 people. Novares has a goal to reach annual global sales of €2bn in 2020 "through targeted external and internal growth operations as well as organic innovation", according to CEO Pierre Boulet.

As well as buying its Chinese JV, Novares has relocated the production plant from Wuhan to a more modern site at the Shanghai General Motors Suppliers Park. This now also houses the former Wuhan Technical Centre. The move brings Novares closer to General Motors and other automotive OEMs in the region, such as DPCA, Ford, Honda, Renault-Nissan and Dongfeng.

The JV itself dates back to 1997 and was originally created to supply Citroën and Dongfeng with parts for the ZX car. It turns over €32m/year and employs over 300 people, making interior plastic components and trunk trims, exterior pillars and cowl tops, air intake systems and manifolds, cam covers, oil sumps, thermostat housings and beauty covers.

› **www.novaresteam.com**
› **www.mpc-inc.com**

Anomatic buys CP in Ohio

Anomatic, a producer of metal packaging for the cosmetics industry based in New Albany, Ohio, has acquired injection moulding firm CP Technologies from its founder, Dr Charles Amata. President and CEO Scott Rusch called this "an ideal fit that will further the company's position as a worldwide leader in beauty and personal care packaging".

CP makes moulded plastic components and assemblies for multiple industries from a 2,900 m^2 facility near Columbus airport and 8 km away from Anomatic's site. This has 22 injection moulding presses from 55 to 500 tons clamping force. The company's key injection moulding capabilities are structural foam moulding, overmoulding and insert moulding.

› **www.anomatic.com**

Left to right: Srikanth Padmanabhan, Managing Director of Motan-Colortronic Plastics Machinery India; Karin Stoll, Consul General for the Federal Republic of Germany in Chennai; and Sandra Füllsack, CEO of Motan Group

Motan moves in India

Motan-Colortronic Plastics Machinery, an Indian subsidiary of German ancillaries group Motan, has moved to new premises in Chennai, where it has tripled its production and storage space, and has also increased its product portfolio. The facility was officially opened in the presence of Karin Stoll, the German consul-general in India, Motan CEO Sandra Füllsack and other dignitaries.

"Now, we not only cover the increasing demand for high quality peripheral units and systems, but also provide shorter delivery times", said managing director Srikanth Padmanabhan. "Also, with the new products we can now also serve additional segments, such as extrusion and compounding."

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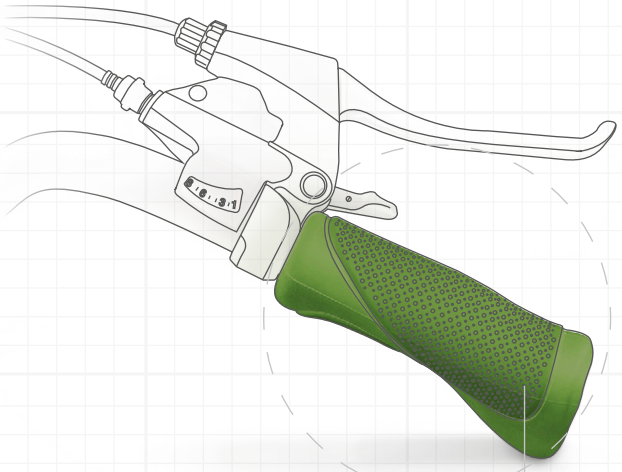

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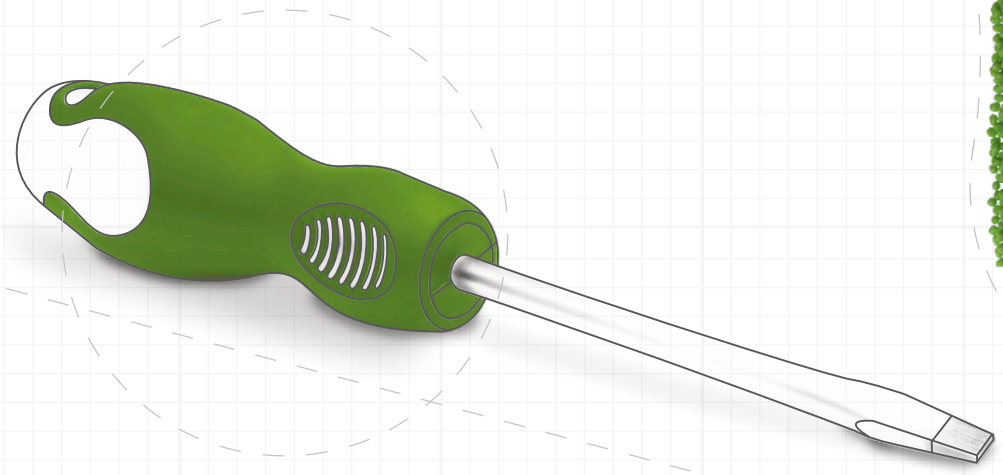

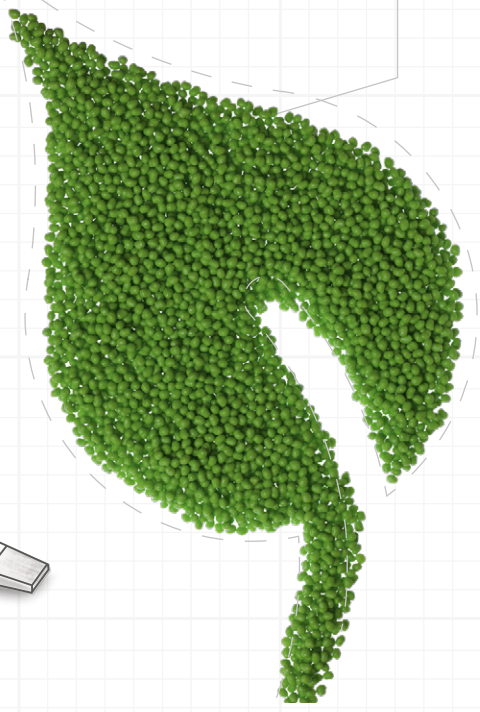

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Expo panel shines spotlight on role of women in plastics sector

A panel discussion at the upcoming Plastics Extrusion World Expo will debate a number of key issues surrounding the professional development of women in the plastics industry.

'Women in Plastics: Empowering Industry Change' is a special panel featuring high-achieving women from across the world of plastics sharing their perspectives on breaking through in this traditionally male-dominated industry.

Among the topics being explored, the 45-minute panel will look at the different paths these leaders have made into the plastics industry, how the modern workplace is changing to become more inclusive, and future challenges and opportunities for the next generation of women entering into plastics or other manufacturing professions.

Panellists in the Women in Plastics include (left to right): Lauren Hickey, Jennifer Profitt, Meli Laurance, Candace Sanders and Molly Bridger

The panellists include:

- Lauren Hickey, director of marketing and product management at masterbatch manufacturer Americhem;
- Jennifer Profitt, plant manager at profile and sidings producer Associated Materials;
- Meli Laurance, regional commercial industry manager for plastics at global pigment specialist BASF Colors and Effects;
- Candace Sanders, assistant plant manager at PVC product supplier Genova Products; and,
- Molly Bridger, group director of marketing at thermoplastic materials manufacturer Simona America.

Organised by AMI, the Plastics Extrusion World Expo will take place at the Huntington Convention Center in Cleveland, Ohio, USA on May 8-9, 2019. It is being held alongside the Compounding World Expo and the Plastics Recycling World Expo. By registering in advance, visitors will receive free admission to all three exhibitions, featuring more than 230 suppliers, plus free entry to five conference theatres hosting technical presentations, educational seminars and business debates. Attendees also have the option to buy tickets for a networking party at Cleveland's Rock and Roll Hall of Fame on the evening of May 8.

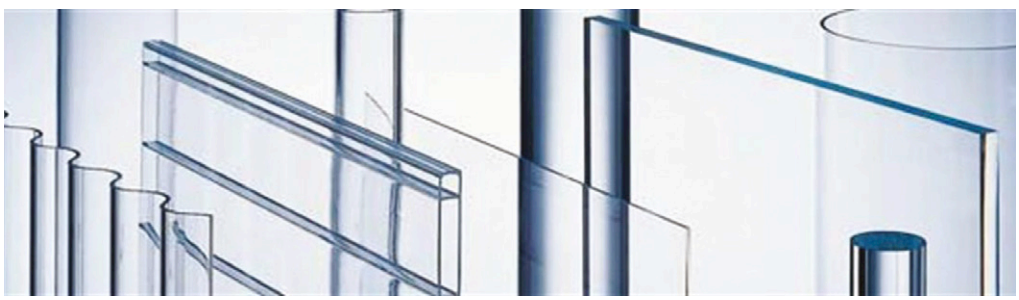
Admission to the tradeshow and its conference theatre will be free-of-charge to visitors who register in advance **here**.

To book a free ticket, which is valid for both days of the event, visit: **ami.ltd/Register-AMI-Expos**

Evonik divests acrylics to Advent

Evonik has agreed to sell its Methacrylates business to private equity firm Advent International for €3bn, or about 8.5x EBITDA. This divestment is part of the company's focus on speciality chemicals and was done with a view to funding other investments in this area, including building a PA 12 site at its Marl site in Germany. The deal should close in Q3, subject to approval by the authorities in several countries, said Evonik.

The business being sold has 18 production sites and 3,900 employees worldwide, generating sales of about €1.8bn/year from 2016 to 2018. It comprises the Methacrylates, Acrylic Products and CyPlus business lines, plus some of the methacrylate resins activities. Advent is one of the world's largest financial investors in the chemical industry, carrying out over 30 transactions over the past three decades.



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New MD takes over at Wittmann Battenfeld

Georg Tinschert, the long-standing Managing Director and CEO of Wittmann Battenfeld, is retiring and Wittmann Group has announced his successor. Rainer Weingraber has been appointed as the new head of the injection moulding machine maker.

When Wittmann Group bought Battenfeld in 2007, Tinschert made the transition to become MD and CEO. The group praised his work in the past 11 years: "Under Georg Tinschert, Wittmann Battenfeld has experienced an impressive development both technologically and economically and is one of the internationally renowned players in the plastics industry today."

Left to right: Rainer Weingraber, Werner Wittmann and Georg Tinschert, who is retiring this month

Managing Partner Werner Wittmann said he was confident that Rainer Weingraber will continue and further strengthen the company's positive development. Weingraber's management experience in international companies has included periods at DaimlerChrysler, Siemens, Magna and, most recently, the Haas Group, where he worked as a Managing Director for several years in Austria.

› **www.wittmann-group.com**

Aptar and Ecover launch PCR dispensing closure

Aptar Beauty + Home has launched a flip-top dispensing closure made from 50% post-consumer recycled resin (PCR). This was developed on behalf of Ecover, a maker of household cleaning products based on renewable raw materials. Ecover will use the closure in its washing-up liquid products, which are sold in 100% PCR and recyclable plastics. The closure also allows users to stand the bottle upside-down so that the maximum amount of liquid can be extracted. The two firms are now looking at other potential uses for PCR in Ecover's portfolio.

› **www.aptar.com**

US machine shipments up in Q4

US shipments of plastics machinery in Q4 2018 rose by 8% to $377m, matching the result for Q4 2017, according to the Committee on Equipment Statistics at the Plastics Industry Association.

Injection machinery shipments were up by 8.8% in value terms, with single and twin screw extruder shipments up by 4.6% and 1.5% respectively.

"We projected higher shipments for the fourth quarter and that's exactly what transpired," said Perc Pineda, Chief Economist at the Plastics association. "The increase is not due to inflationary pressures of the economy, which one tends to think about when dollar value increases, but purely an increase in the quantity of shipments."

The CES also conducts a quarterly survey of market conditions and outlook. It said 75% of respondents expected conditons to hold steady or improve for Q1 2019.

› **www.plasticsindustry.org**

Arkal adds to space at Auburn site

Arkal Automotive USA, a subsidiary of an Israeli injection moulding firm that specialises in black plastic products for structural parts, is investing $2.3 million to expand its operations at the Auburn Technology Park West in Alabama over the next two years. This will add 25 jobs to the 150 employees already working at the plant.

Rami Bitensky, general manager of the Arkal Automotive Plastic division, commented: "The expansion is the result of our successful innovations for weight-saving solutions for the automotive industry. This project represents the additional business that we won from Daimler. Our growing operation in Auburn will handle the additional business for our important customer, MBUSI, in Alabama."

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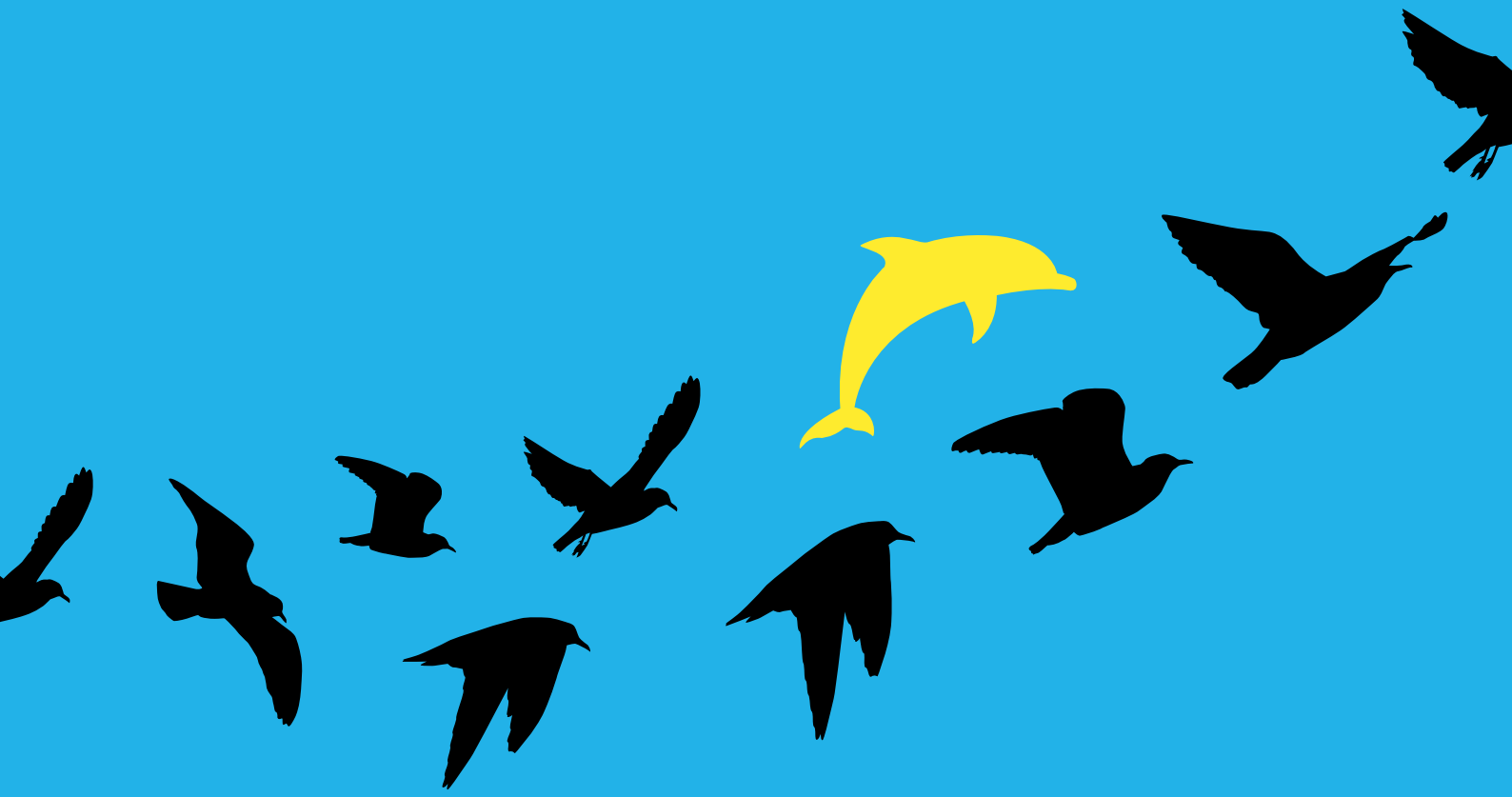

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New fibre calculation method

The Fraunhofer Institute for Structural Durability & System Reliability LBF has developed a new calculation method to take into account the fibre orientation of short fibre-reinforced injection moulded parts, even when no prototypes or other components are to hand. The method uses a newly developed, two-cavity injection moulding tool.

"This phenomenological calculation concept is expected to close a significant gap in the design cycle of these moulded parts," the institute said.

The new method is also said to reduce costly iteration cycles and thus shorten the entire development and manufacturing process.

› **www.lbf.fraunhofer.de**

GW Plastics invests in Irish medical business

GW Plastics is to invest to €5.7m to expand its product development, thermoplastic and silicone injection moulding, and contract assembly capabilities for surgical components, diagnostic devices and drug delivery systems at the Avenue Mould Solutions site in County Sligo, Ireland. This comes in response to increased customer demand, the US-based company said. Over 200 new jobs will be created in production, quality, regulatory and engineering.

GW acquired Avenue Mould Solutions site in County Sligo, Ireland, in 2017

The Irish government has supported the project through IDA Ireland, which owns the Business & Technology Park in Finisklin, where the 2,100 m² site is located. Because of this, the Irish Taoiseach, Leo Varadkar made the official announcement about the investment. County Sligo, he said, is "recognised as a major regional centre and a driver of economic development" within the government's national development plan, Project Ireland 2040

GW acquired Avenue Mould Solutions in 2017. Bringing this firm into the company portfolio, it said at the time, gave it "a unique industry position with precision mould-building facilities in North America, Asia and now Europe". This also brought in expertise in building ultra-high-cavitation tooling, complementing existing advanced injection moulding and contract manufacturing capabilities, and made GW one of the largest manufacturers of precision moulds.

› **www.gwplastics.com**

Sumitomo (SHI) Demag sees results boost

Sumitomo (SHI) Demag Group has reported a 13% increase in sales to €294.9m in 2018, while incoming orders rose by 6% to €314.2m. This was mainly down to rising demand for IntElect all-electric injection moulding machines and El-Exis packaging machines, the company stated.

The company is investing at its site in Wiehe, Germany

In addition, Sumitomo (SHI) Demag has recently modernised its production processes and replaced half of its machining systems. "Our platen machining capacities were stepped up by almost 50% and our production processes have become more efficient. In 2019, we are aiming for a 10% increase of our production output," said CEO Gerd Liebig.

In 2019, the company expects to invest more at the site at Wiehe in order to maximise the efficiency of cyclic operation. This site, one of two in Germany, is dedicated almost totally to the IntElect series. Sumitomo (SHI) Demag also manufactures in Japan and China, employing about 3,000 people.

› **www.sumitomo-shi-demag.eu**

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Join the party at the Rock and Roll Hall of Fame in Cleveland

Cleveland's iconic Rock and Roll Hall of Fame will be the venue for a major networking party for the plastics industry on the evening of May 8, 2019. The event will be open to visitors and exhibitors from the plastics extrusion, recycling and compounding tradeshows, which are being held at the nearby Huntington Convention Center on May 8-9.

Admission to the Plastics Recycling World Expo, Plastics Extrusion World Expo and the Compounding World Expo plus their associated conferences is free-of-charge if you **register in advance**. Advance tickets for the networking party cost just $20 (less than a standard ticket), and they include exclusive access to all of the Rock and Roll Hall of Fame exhibits, plus a drink and some nibbles – **details here**. The party will run from 7:00PM to 11:00PM.

"This fantastic venue will provide a great place for attendees to relax and network after a busy first day at the exhibitions, which will feature more than 230 exhibitors and over 120 speakers across five free-to-attend conference theatres," said Rita Andrews, head of exhibitions at AMI, the organiser of the events.

Located on the shore of Lake Erie in downtown Cleveland, the Rock and Roll Hall of Fame is a short walk from the Huntington Convention Center and neighbouring hotels. Housed in an eye-catching structure designed by I. M. Pei, it boasts an extensive collection of popular music artefacts spread over six floors. Multi-media exhibits map out the history of rock music and the people who created it.

The breadth and depth of the display is hugely impressive, covering everything from the birth of rock and roll through to current pop stars and everything in between. Fans of rock, pop, blues, country, folk, gospel, soul, funk, R&B, heavy metal, punk, new wave or hip hop will all find plenty to enjoy among the thousands of objects on display.

For example, the attractions include Jimi Hendrix's Stratocaster guitar, David Bowie's iconic outfits, Keith Moon's platform shoes, John Lennon's Sgt Pepper suit, Run DMC's Adidas sneakers, and the awning from legendary New York venue CBGB.

The Hall of Fame also features exhibits on cities that have had a major impact on the development of rock and roll, including Memphis, Detroit, London, Liverpool, San Francisco, Los Angeles, New York, and Seattle. There are also displays focusing on the influential local music scenes in Cleveland, Akron and beyond.

For those who have been lucky enough to visit the attraction before, there is always something new to see including recent acquisitions and constantly evolving temporary exhibits. This year there are displays honouring the 2019 inductees to the Hall of Fame, which are The Cure, Def Leppard, Janet Jackson, Stevie Nicks, Radiohead, Roxy Music and The Zombies. Another new addition will be an interactive display featuring rock-themed pinball machines to play on.

The party is being sponsored by Technical Process & Engineering (TPEI) and Entek, and is supported by AMI's magazines – *Plastics Recycling World*, *Compounding World*, *Film and Sheet Extrusion* and *Pipe and Profile Extrusion*.

For more information on the Rock and Roll Hall of Fame party and to register for the three industry tradeshows and their five focused conference theatres for free, please visit: **www.plasticsrecyclingworldexpo.com/na/**

Husky unveils digitalised execution process

Husky Injection Molding Systems has officially unveiled its digital next-generation operating model (NGOM) during a special event at its Europe, Middle East & Africa region headquarters in Dudelange, Luxembourg. This was developed in partnership with Siemens and the Luxembourg Departments of Economy and Labour.

The NGOM process, Husky says, has reduced the time needed for ordering and manufacturing hardware from weeks to hours. Via this process, "customised stack components can be configured through a web interface and are then manufactured in a state-of-the-art laboratory through a completely automated process". The physical and virtual environments "work together within a closed loop" connected to the Canada and Luxembourg sites, so that the system can continuously improve and feed information back.

John Galt: Leveraging Husky's global presence

Husky president and CEO John Galt added that having "an end-to-end fully digitalised architecture" enables the company to use its global presence and scale up operations when demand increases.

› **www.husky.ca**

New hall for BMB

Italian injection moulding machine maker BMB has started the construction of a new production hall at its Brescia facility. The hall will be BMB's fourth production area at its HQ facility. It will have 6,400 m² floor space and will produce the company's machines above 1,000 tonnes. The company will start production in the new hall in H2 2019. BMB says two 4,500 tonne dual platen KX series machines are already scheduled for assembly there this year.

› **www.bmb-spa.com**

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PHOTO: SABIC

***Peter Mapleston** looks at developments from materials producers working to meet the medical sector's tough demands*

Suppliers help moulders in regulation and performance

There is probably no industry of importance to the plastics injection moulding community that is more regulated than medical and healthcare. And it is just about to get more regulated. The European Union Medical Device Regulation will be fully implemented in May next year after coming into force in 2017. It will replace two existing directives on medical devices, the Medical Devices Directive from 1993 and 1990's Active Implantable Medical Device Directive [90/385/EEC].

The European Commission expects the Medical Device Regulation (MDR) to improve the quality, safety and reliability of medical devices, while also strengthening the transparency of information for consumers, and enhancing vigilance and market surveillance. The MDR fundamentally changes the way medical devices will be regulated in the future. The changes to legislation it involves could impact the entire supply chain.

Under the MDR, all of the actors in the supply chain will, for the first time, have potential responsibility for defects in devices – previously the regulations focused solely on manufacturers. In addition, manufacturers outside the EU will need EU-based authorised representatives.

Materials companies try to keep in tune with changes in regulations like the MDR, of course. A typical example is **Borealis** and its joint venture Borouge (which handles business in Middle East, Asia Pacific, the Indian sub-continent and Africa), which recently introduced Bormed BJ868MO, a high flow, heterophasic polypropylene copolymer intended for production of medical and diagnostic devices. Borealis says the new product is "an important extension of the dedicated Borealis Bormed portfolio of polyethylene and polypropylene products."

Validation of Bormed BJ868MO was carried out in co-operation with **Premix**, a leading producer of electrically conductive plastics, some of which are used in healthcare applications, and a leading medical diagnostics company. Borealis says that Premix compounds have been used in automated liquid handling applications since the early 1990s. ❯

Main image: Thermoplastics with very good friction properties are critical for such products as insulin pens

The compounds enable extremely accurate liquid level detection, and are now widely used in in vitro diagnostics to ensure precise measurement.

"Longer life expectancies and ageing populations have increased the importance of early diagnostics for disease prevention," Borealis says. "Technological innovation is driving development of novel devices that are portable, smaller, and in some cases operated by patients themselves."

At the same time, says the company, regulation of medical and diagnostic devices is becoming more stringent, particularly in Europe. It points not only to the MDR but also the In-Vitro Diagnostics Regulation (IVDR), which will be fully implemented in 2022. "Both aim to improve patient safety by introducing stricter procedures for conformity assessment of such devices."

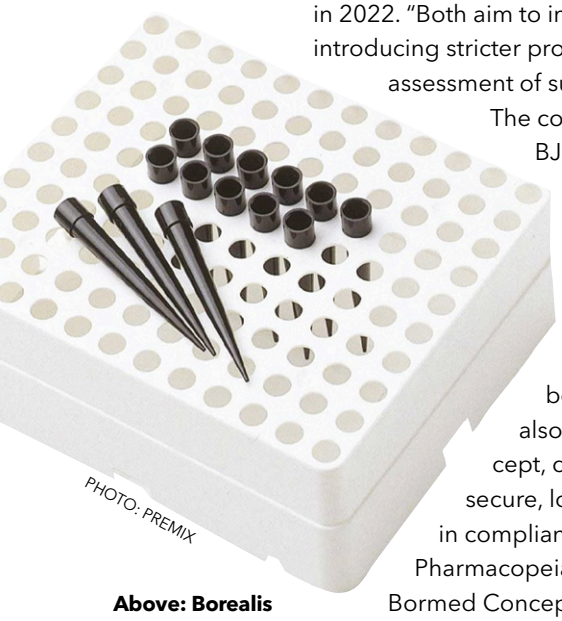

PHOTO: PREMIX

Above: Borealis Bormed BJ868MO was utilised as a base for a new electrically conductive compound from Premix, used in the production of high precision pipettes

The company says Bormed BJ868MO should enable its healthcare customers to achieve full regulatory compliance in the production of medical and diagnostic devices such as pipettes. "Moreover, because Bormed BJ868MO is also part of the Bormed Concept, customers can rely on a secure, long-term supply of materials in compliance with European, US Pharmacopeia, and ISO standards." The Bormed Concept provides for a two-year pre-notification period informing customers of any changes to the product. It also guarantees product quality and consistency, as well as long-term product traceability thanks to retention of quality control data and samples.

Borealis Bormed BJ868MO was utilised as a base for a new electrically conductive compound from Premix, used in the production of high precision pipettes. In addition to being covered by the Bormed Concept, says Borealis, this new material solution offers several other important benefits, including high impact resistance to reduce risk of breakage during handling at low temperatures and at the end user; high flow for fast and easy mould filling, with flow length: wall thickness ratios of up to 300; and the ability to use lower holding pressures and processing temperatures during moulding, with attendant energy savings.

The MDR contains cross-EU, minimum, legal and binding regulations. "We have moved from a situation where some countries had higher standards than others in Europe due to their higher national requirements, to one where everyone must do the same, regardless of EU location," says Dr. James Stern, Global Business Development Manager – Healthcare, at **Albis Plastics**. "This is good for patient safety, as it requires players in the healthcare market to have more controls on their medical device materials of construction."

Albis is a member of MedPharm Plast Europe (MPPE), a sector group of the EuPC (European Plastic Converters) created in 2014 by and for companies involved across the complete value chain for plastic medical devices and pharmaceutical packaging in Europe. MPPE represents the interests of these different industry groups and, as such, interacts directly with the European Institutions such as the Parliament and Commission to support the delivery of final regulations (such as the MDR) in a way that means they are workable for the industry, whilst not compromising patient safety.

"There is no such thing as 'medical plastics'," says Mike Freudenstein, Marketing Director for Healthcare at Albis, writing in a recent blog. "In the first instance, plastics in the medical and pharmaceutical sectors are selected for their technical properties. There are some manufacturers that offer "medical types" but this term is not protected or even clearly defined. And as so often in life, there are goodies and baddies. There are polymer producers that are very familiar with the strict requirements of the healthcare industry and that try to address them with the products they offer. But then there are others that see the "medical" label from a marketing perspective and use it as such.

"In short, for customers, whether processors or OEMs, sourcing plastics for the healthcare sector is like battling through impenetrable undergrowth. Material selection often results in uncertainty and doubt."

But the VDI guideline "2017 Medical Grade Plastics" has changed that, he says. Specialists from the medical and pharmaceutical sectors and large plastics producers have helped significantly to shape the VDI guideline, all with a common objective to provide clarity on what constitutes a true "medical grade plastic" and what service qualities can logically be expected when choosing such materials.

Albis Plastics says that with Alcom Med, which it introduced last year, it has expanded its product portfolio to include tailor-made compounds for medical products, pharmaceutical packaging, and diagnostic applications. Grades are based on a variety of different polymers and include colouring as well as a variety of fillers. Albis backs up the products with recipe uniformity, dedicated change management, and regulatory support.

Mike Freudenstein, director of Marketing

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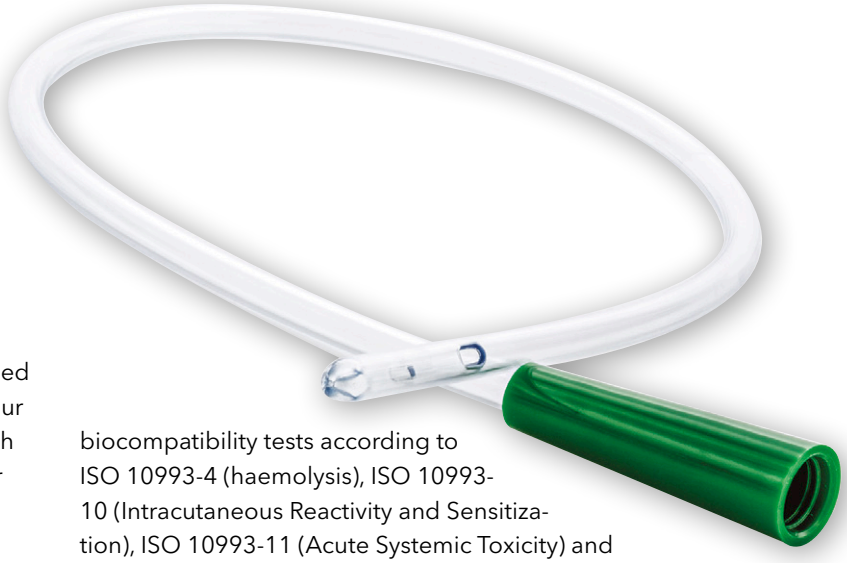
Healthcare at Albis, says: "We are seeing a continuously growing demand from the processing industry for compounds that both comply with the regulatory requirements and offer customer specific material solutions. Alcom Med means we can guarantee our customers' production with strict quality criteria and offer close project support through our experienced healthcare specialists."

Albis has installed an entirely self-contained production line for the manufacture of Alcom Med compounds at its site in Hamburg, Germany. "Our investment will enable us to be flexible even with small quantities whilst also being able to deliver worldwide," Freudenstein says.

The latest developments in **Hexpol TPE's** Mediprene family of TPEs for medical applications include several grades for solvent bonding applications. "Many customers are today joining tubes with injection moulded components, such as connectors, by solvent bonding," says Niklas Ottosson, Technical Manager – Medical. "Traditional TPS based formulations do not bond well with solvent – cyanoacrylate glue with or without primer is an alternative to achieve high bond strength in these situations.

"With the new Mediprene TPE materials, we have achieved high bond strength when applying solvents such as cyclohexanone." Initially the solvent bondable materials for injection moulding will range from 70 Shore A to 45 Shore D in hardness and then be further expanded based on customer demand, Ottosson says.

Representative Mediprene grades have passed cytotoxicity tests according to ISO 10993-5 and biocompatibility tests according to ISO 10993-4 (haemolysis), ISO 10993-10 (Intracutaneous Reactivity and Sensitization), ISO 10993-11 (Acute Systemic Toxicity) and USP Class VI.



Above: Hexpol Mediprene TPEs for solvent bonding can be used for catheter connectors

"The medical device industry continues to be an interesting market for TPE compounds, Ottosson says. "We see an ongoing trend of customers exploring TPE as alternatives to rubber, silicone and PVC in applications requiring soft touch aesthetics or sealing functionality. Growing markets for our Mediprene TPE compounds include urology and continence care, airway management, IV set components and plunger seals in single-use syringes."

Trinseo emphasises the growing importance of two-component moulding with thermoplastics and TPEs in medical devices. "The reasons for over-moulding include a need to differentiate products, support an ergonomic design, or make a product safer," it says.

The company points to several trends that are driving the demand for the over-moulding process.

Over-moulding demand drivers

Trinseo explains the four factors behind the trend for TPE over-moulding in medical devices.

Home healthcare

As healthcare services move from traditional settings such as hospitals, clinics, and physician's offices to non-clinical and personal living spaces, people want medical equipment that blends in with their surroundings. The use of TPEs provides aesthetically pleasing, soft-touch surfaces to help devices look more attractive and less institutional. They also offer benefits such as reduced vibration and noise as well as soft-touch, easy-to-grip knobs and handles that can improve functionality for professionals familiar with medical equipment and those who are not.

Self-administered care

Patients want convenient, effective treatment that can be administered "on the go." This has created a need for drug delivery devices such as auto injectors, asthma inhalers, and portable respiratory equipment. Along with the actual device, is a need for easy administration and error-free performance. Part design and/or textured surfaces can help guide proper handling. Coloured inserts or moulded-in labels can provide instruction and non-slip grips can help ensure accurate administration.

Aging and special needs

As population ages, medical device OEMs need to adjust to this growth by developing devices that take a variety of factors into consideration. Not only is patient age important, but physical dexterity, flexibility, and coordination are all key as manufacturers work to create ergonomic designs for patients of all types and abilities.

PHOTO: LED SpA

The Surgeon Pencil S for high-frequency surgery uses Kraiburg's Thermolast M soft-touch TPE

Below: Gerresheimer has developed an integrated adapter solution for the needles of prefilled syringes

PHOTO: GERRESHEIMER BÜNDE

These include a move toward home healthcare, growth in self-administered treatments, special needs patients, and an overall aging population (see box).

"The FDA may have also contributed to the interest in over-moulding," Trinseo says. It recently issued a guidance document called "Applying Human Factors and Usability Engineering to Medical Devices" intended to encourage manufacturers to make sure their devices can be used safely, without causing immediate or long-term injury or harm, or lessening the effectiveness of treatment.

Trinseo says that with its acquisition of Italian compounder API in 2017, it began to offer soft touch plastics to complement its rigid plastics portfolio. "This allowed the company to better support its customers by being a single source for rigid and soft touch materials and most importantly having control over the chemistries of both the overlay and the rigid substrate to provide optimal adhesion," says a representative. "The demand for this combination of materials is evident in the medical devices marketplace."

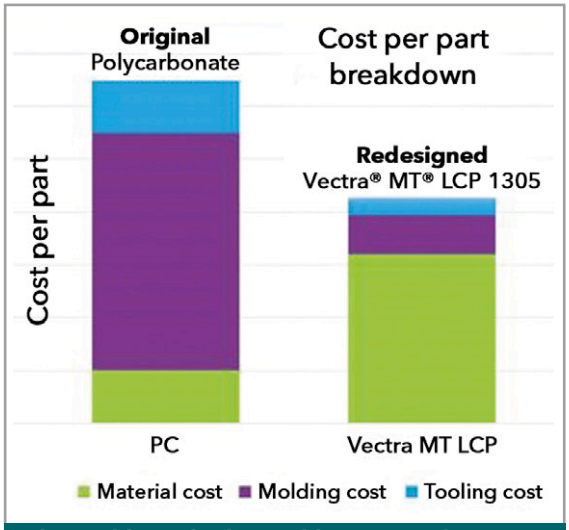
The Surgeon Pencil S for high-frequency surgery from Italian company LED benefits from the medical conformity, design freedom and aesthetics of **Kraiburg TPE's** Thermolast M thermoplastic elastomer compounds. The pencil, which weighs just 30 g, comprises a central handpiece with a screw-on electrode holder, two different-coloured button rings and a cable end. The body parts of the tool are two-component moldings with a solid polypropylene core and a Thermolast M soft-touch skin, which ensures the secure non-slip grip of the tapered instrument for fatigue-free surgery and comfort even in wet conditions. The Surgeon Pencil S can be autoclaved up to 100 times at 134°C.

The market for prefilled syringes is currently experiencing strong growth – for example, in systems for the treatment of chronic diseases such as rheumatism. The design of such injection systems is primarily concerned with ease of use to ensure that the patient is reliably supplied with the intended dose of the active substance. The adapter for screwing in the needle and the syringe cap plays a key role. Medical technology specialist **Gerresheimer** developed an integrated solution for its Gx TELC (Tamper Evident Luerlock Closure) that combines both functions in a single component and also enables tamper-evident protection of the active ingredient.

The adapter is made by over-moulding Apec 1745, a high-heat resistant polycarbonate copolymer from Covestro, with a TPE. Apec can be sterilised using conventional methods such as gamma rays or ethylene oxide. "In addition, it is dimensionally stable and dimensionally accurate at high temperatures, so that the entire component does not warp after hot steam sterilisation at 143 °C, for example," says Dr. Wenzel Novak, global senior director business development at Gerresheimer. Turning the cap to open the syringe releases tabs that spread and prevent the cap from closing again. This means that the syringe cannot be opened and closed unnoticed, preventing misuse.

Comfort and reliability of injection devices have become crucial as the possibility to receive home-treatments is increasing rapidly. "The constant development of new drugs is multiplying the kinds of devices available in the market," says **Celanese**, which is a major player in medical with its numerous ranges of engineering thermoplastics, including PBTs, polyoxymethylenes (POM, or acetal), and liquid crystal plastics (LCP). In some applications, its Vectra LCPs come into direct competition with polycarbonate.

Celanese says Vectra MT (Medical Technology) glass-reinforced, high flow grades of LCP are the material of choice for medical devices that require thinner walls and reduced weight that improves end-user experience. "The technology behind the



A disposable medical wearable injection device made in PC was redesigned for manufacture with Celanese's Vectra MT LCP, reducing system cost

PHOTO: GETTY IMAGES COURTESY OF CELANESE

Left: Wearable pumps call for materials that can be moulded into very thin sections

Vectra grades can provide extraordinarily easy flow and low warpage," it says – ideal properties for highly complex designs.

Celanese cites the case study of a disposable medical wearable injection device, where the high flow of its LCP, together with its CAE insights, enabled thinner wall design for improved end-user experience and reduced system cost (see bar chart). The customer, which was already making a device using components in polycarbonate, wanted higher mechanical performance, including dimensional stability, high stiffness and tight part tolerances for the internal chassis. It also wanted to use moulds with more cavities, and to cut cycle times.

Vectra MT LCP delivered up to 50% per part cost savings, Celanese says. It could also be processed with shorter cycle times and allowed the moulder to build a tool with an increased number of cavities. Finally, it provided the required stiffness with very thin walls, which freed up space in the device, enabling overall size reduction and creating more space for other components.

The Vectra MT LCP range includes glass reinforced, mineral-filled, higher-flow, tribologically modified and appearance grades, suitable for a variety of uses in medical device applications, particularly in wearable injection devices, Celanese says. It complies with regulatory requirements, including FDA – it is listed in Drug Master File DMF 8464, and Device Master File MAF 315 – and meets the requirements of US Pharmacopeia Class VI and ISO-10993 covering biocompatibility, as well as corresponding European Union and national regulatory registry requirements.

At the beginning of the year, **Polyplastics**, which is a joint venture between Celanese (45%) and Daicel, introduced Duracon PM09S01N, its first acetal for drug contact and delivery applications for the medical and healthcare market. Eventually

Table 1: Physical properties of Polyplastics' Duracon PM09S01N acetal polymer

Item	Test Method	Unit	Grade PM09S01N
MFR (190, 2.16kg)	ISO 1133	g/10min	**9**
Density	ISO 1183	g/cm^3	**1.41**
Tensile Strength	ISO 527-1,2	MPa	**66**
Strain at break	ISO 527-1,2	%	**35**
Flexural Strength	ISO 178	MPa	**88**
Flexural Modulus	ISO 178	MPa	**2500**
Charpy Notched Impact Strength (23℃)	ISO 179/1eA	KJ/m^2	**9**

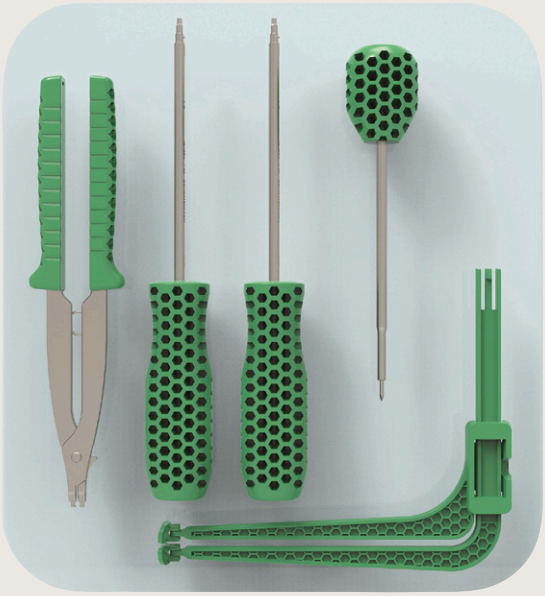
there is likely to be a series of grades in the Duracon PM family. Polyplastics says they will complement its Topas cyclic olefin copolymer (COC), a high-purity, high-clarity material already well established in numerous medical applications.

Polyplastics says the new grade complies with global medical and food regulations. These include ISO10993 and USP Class VI covering biocompatibility/cytotoxicity, FDA Drug Master File (DMF) and Device Master File (MAF), as well as European and US food contact regulations (EU 10/2011 and CFR Title 21).

"The material also adheres to strict quality management systems, including conformity to the German VDI 2017 Medical Grade Plastics Guideline," the company says, adding that it "provides full traceability of processes and products, and production management based on GMP principle. Polyplastics also provides uniform quality and global supply."

Medical device manufacturers can access extensive data on the long-term reliability of Polyplastics' materials. Customised data on extraction, mouldability, durability, slip and wear, and other key attributes are also available.

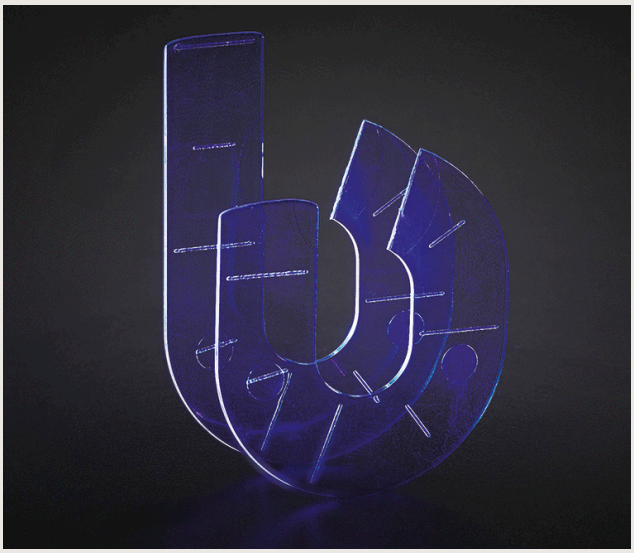
SABIC is another company offering wear and



Above: Solvay's Ixef GS-1022 PARA forms the awl and pin-screwdriver handles, measuring calliper, and locking plier handles in Intelligent Implant Systems' kit. The polymer's high impact resistance also eliminated the need for a metal strike plate that had been part of the awl's early designs. This reduced cost and simplified manufacturing.

The growing trend of miniaturisation in healthcare devices is impacting how products are designed. On-body drug delivery or monitoring applications call for lightweight designs to improve patient comfort and overall compliance; small devices are also often used in surgery to advance patient recovery times. These require materials with flow properties suitable for thin-wall applications. Makrolon Rx2235 polycarbonate from Covestro is one of the latest materials to fulfil these needs.

Pierre Moulinié, Global Healthcare Technology Lead, Polycarbonates, at Covestro says Makrolon Rx2235 polycarbonate "sets a new benchmark for flow length." The material is biocompatible according to ISO 10993-1 test requirements and designed to be sterilised using gamma or e-beam methods. Covestro says the spiral flow testing shown in the picture demonstrates the increased flow length that can be achieved using Makrolon Rx2235 polycarbonate.



friction solutions for medical devices, this time from its LNP product line. It notes that for a medical device, whether it be a drug delivery pen or a laparoscopic surgical tool, repeatable and efficient motion is critical to performance. The friction between moving parts plays a large role in how a device is perceived and accepted by both consumers and healthcare professionals. "Lubricomp and Lubriloy compounds can help deliver the performance required," the company says.

Demands on wear and friction materials for medical devices are growing as sterilisation and cleaning techniques evolve, parts get smaller and thinner, and market trends move towards more consumer-friendly styling and colours, says SABIC. "Add the heightened emphasis on system cost optimisation and the need for innovative internally lubricated thermoplastic solutions expands."

The addition of an internal lubricant to a thermoplastic material can reduce the coefficient of friction between two plastic parts, allowing them to slide past each other smoothly with minimal wear. Traditional lubricants like medical grade silicone and PTFE can be combined with advanced PC copolymer technology to deliver the required performance in thin wall parts.

Typical applications include surgical stapler internals, laparoscopic surgical tool internals, trocar latches, insulin pen dials, screw, and sleeve, inhaler dose counter buttons, and fluid coupling quick disconnects

Solvay recently announced that the high stiffness, strength, gamma sterilisation resistance and biocompatibility of its Ixef polyarylamide (PARA) resin helped enable a new single-use instrument kit for anterior cervical fusion procedures. Developed by Intelligent Implant Systems, a medical device company specialising in solutions for spinal surgery, the Mediant Anterior Cervical Plating System leverages Solvay's advanced polymer to help boost operating room efficiency, eliminate onsite sterile processing and reduce infection risk.

"The primary benefit of Solvay's Ixef PARA in this application is its metal-like strength, which gives our single-use surgical instruments a very high level of performance without incurring the costs associated with machining metal and repeated steam sterilisation," says Marc Richelsoph, president and CEO of Intelligent Implant Systems. "Although PEI also offered viable options for our surgical tool kit, we specified Ixef GS-1022 PARA because its superior stiffness and mouldability was essential for the kit's instruments."

Ixef GS-1022 PARA also provides an attractive surface finish. The material is available in a range of gamma-stabilisable colours. The polymer has been evaluated for ISO 10993 limited duration biocompatibility and is supported by an FDA Master Access File.

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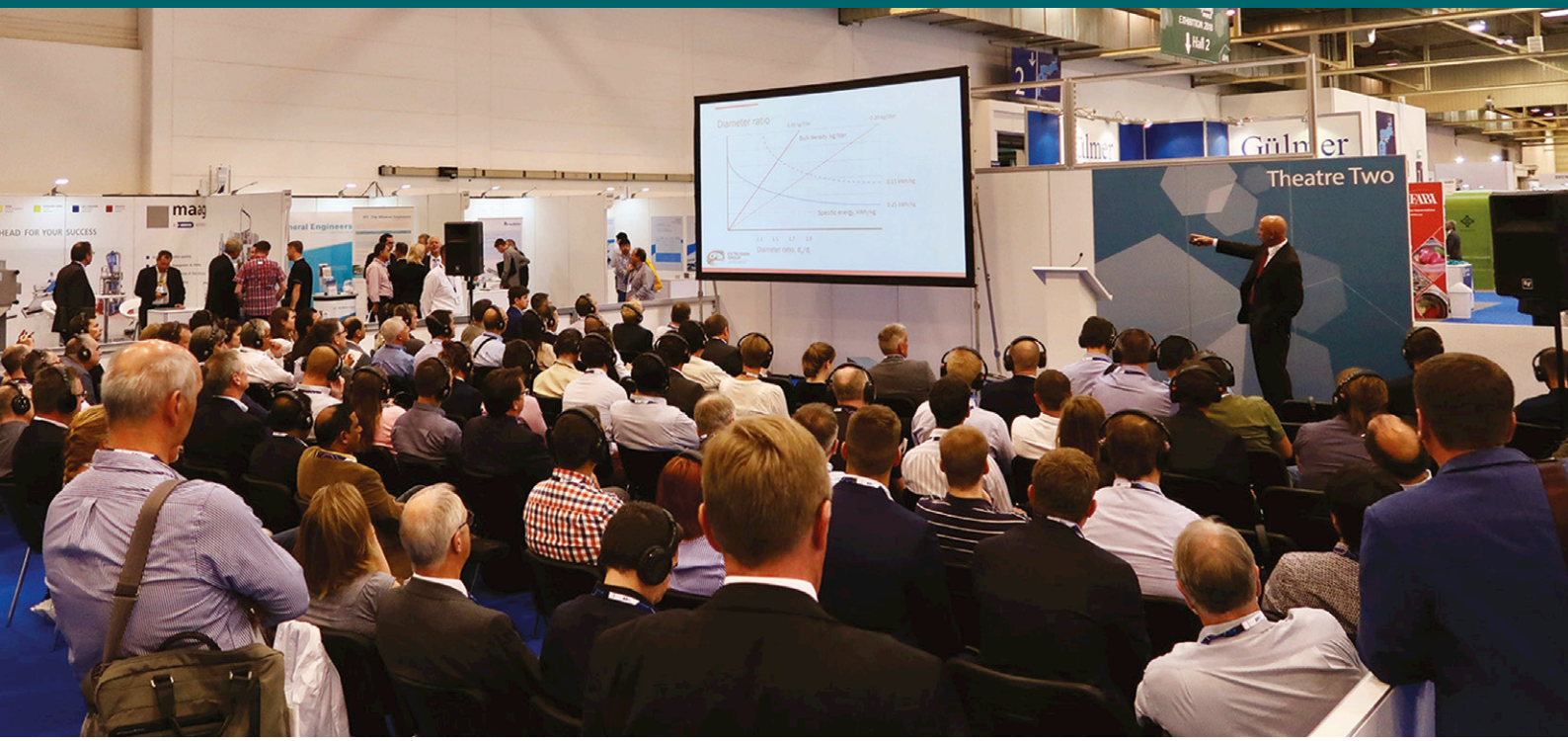

Free conferences to cover compounds and recycling

AMI is hosting a series of free-to-attend conference sessions at its plastics compounding, recycling and extrusion exhibitions in Cleveland, Ohio in May. We preview the programmes

Main image: A busy conference theatre at AMI's first Compounding World Expo in Essen, Germany last year

The speaker line-ups have been revealed for the five free-to-attend conference theatres at the Compounding World, Plastics Recycling World and Plastics Extrusion World Expos which AMI is holding at the Huntington Convention Center in Cleveland, Ohio, US on 8-9 May 2019.

The five theatres will host more than 130 speakers over the two days and will feature a series of technical presentations, market forecasts, business debates and training seminars. Here we highlight some of the talks that will be of interest to the injection moulding market.

Across the two days of the conference there will be 15 separate panel discussions featuring industry leaders debating topics such as: global plastics recycling trends; how to increase recycling rates; women in the plastics industry; and the future for plastics packaging, technical compounds, masterbatch and PVC. These debates will feature influential representatives from A Schulman, Amcor, Americhem, BASF, Chroma Color, Clariant, Foodservice Packaging Institute, Genova Products, Mexichem, Phoenix Technologies, Primex Plastics, ProAmpac, Prysmian, Raumedic, Ravago, RTP, Sealed Air, Simona, Sustainable Packaging Coalition, Techmer PM, Terracycle, Westlake Compounds and many more.

In addition, there will be a total of 10 training seminars and workshops covering topics such as polymer stabilisation, product stewardship, food contact regulations, plus colour measurement and control. One of the highlights will be a workshop hosted by **John Standish**, technical director at the **Association of Plastics Recyclers**, which will focus on designing plastic products with improved recyclability.

Market trends will be covered in six focused presentations. For example, **Andrew Reynolds**, Director of **Advance Bidco**, the owner of AMI, will give a paper analysing global trends in plastics compounding markets. More specifically, the opportunities for PP compounds will be covered in a talk by **Sylvia Tabero**, Senior Project Consultant at **AMI**. In the plastics recycling theatre, there will be a keynote presentation looking at five global recycling trends to watch, which will be given by **Lizzy Carroll**, Senior Research Analyst at **AMI**.

In between the various business debates and training seminars, there will be more than 60 presentations covering the latest technology developments. A number of these technical presentations will be focused on adding functionality to plastics. For example, **Dr Hyun Seog Kim**, R&D Manager at **Shamrock Technologies**, will discuss improving the wear-resistance of plastics, while **Piergiovanni Ercoli Malacari**, Product and Application Development at **IMI FABI** in Italy, will detail lightweighting strategies using talc in automotive TPOs. And **Alexander Kulichenko**, Technical Director at **Europiren** in the Netherlands, will speak about optimised magnesium hydroxide as a flame retardant for building and construction compounds.

The role of silicones as high-performance additives will be explored by **Dr Daniel Calimente**, Technical Manager at **Wacker Chemical Corporation** in the US. **Dr Rob Lorenzini**, Technology Manager at **Maroon Group** in the US, will speak about innovations in high-performance thermal stabilisation and VOC-scavenging solutions for polyolefins and engineering resins. In addition, innovations in anitimicrobial and odour control solutions for plastics will be discussed by **Ivan Ong**, VP Innovations & Research at **Microban**.

Ardy Doelen, Sales and Business Development Manager at **Polyscope Polymers** in the Netherlands, will explore progress in optimisation of engineering plastics blends. And **Dr Nima Moghimian**, Product Development Manager at **NanoXplore** in Canada, will assess process-induced properties of graphene-polyethylene nanocomposites.

Another important technology topic to be covered will be electrically and thermally conductive compounds. **Rijo Jacob Robin**, Technical Product Manager at **Superior Graphite** in the US, will discuss developments in resilient carbon fillers for improving wear resistance and thermal conductivity. Advances in metal fibres for enhancing the conductivity of plastic compounds will be explored by **Tom Daniëls**, Global Market Manager Conductive Plastics at **Bekaert Fiber Technologies** in Belgium. And **Jakub Olšan**, Researcher at **Unipetrol RPA Polymer Institute Brno** in the Czech Republic, will speak about tailoring of electrical conductivity of thermoplastics using carbon black masterbatches.

Alex Walk, Product and Technology Development Manager at **SGL Carbon** in the US, will discuss current and future use of carbon-fibre-reinforced plastics in automotive applications. And **Dr Ashok Adur**, Global Commercial Development Director Plastics at **Vertellus** in the US, will cover surface chemistry modification as a means to improve the performance of polyamide compounds reinforced with glass fibres.

With sustainability becoming such an important issue, several presentations will focus on technical innovations in the use and development of recycled plastics and sustainable materials. **Emily Blai**r, Business Development Manager at **Milliken** in the US, will detail compounding options to enhance properties of recycled PP resins. **Duan Hao**, R&D Market Development Manager at **Fine-Blend Compatibilizer** in China, will detail the use of chain extender to improve performance of recycled PET. Innovative additive solutions for adding value to recycled compounds will be the subject of a paper by **Tom Inch**, market manager for thermoplastic additives at **BYK USA**.

There is also an interesting case study on closed-loop recycling, highlighting the importance of collaborative partnerships. This is going to be given by **Dean Miller**, Program Manager for Recycling Innovation at IT group **HP,** together with **Jean Luc Lavergne**, CEO & Maestro Group Leader at the Canadian-headquartered plastics recycler **Lavergne Groupe.**

The conference sessions will also cover the important area of testing and analysis. **Dr Yanxi Zhang**, Technical Sales Support at **Netzsch Instruments North America**, will explain how thermal analysis can be used to characterise recycled polymer compounds. And **Brian Birmingham**, Business Development Engineer at **Sikora** in the US, will detail how optical inspection and

Expert speakers include, (top row from left to right), John Standish from APR, Dean Miller from HP, Jean Luc Lavergne from Lavergne Group, Tom Inch from BYK USA, (bottom row from left to right), Piergiovanni Ercoli Malacari from IMI FABI, Dr Daniel Calimente from Wacker Chemical Corporation, Ardy Doelen from Polyscope Polymers and Emily Blair from Millken

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Plastics Extrusion World Expo

Your **free ticket** for the Cleveland event covers entry to all three of these tradeshows plus their five conference theatres. The three Expos will feature more than 230 exhibitors from around the world including a wide range of suppliers of processing machinery, auxiliary equipment, raw materials, additives, and related products and services.

Exhibitors include Addivant/SI Group, Aditya Birla, Advanced Blending Solutions, Alok Masterbatches, Azo, BASF, Bekaert, Brenntag, Budenheim, BYK, Cabot, Cardinal Recycling, Chemours, Clariant, Cumberland, Dover Chemicals, Erema, Exxel Polymers, Ferro, Herbold USA, Heritage Plastics, IMI Fabi, JSW, Kaneka, Kisuma, Konica Minolta, KraussMaffei, Lanier Color, Lubrizol, Maag, Maguire, Maroon, Matsui, Milliken, Mitsui Chemicals, Modern Dispersions, Netzsch, Nordson, Omya, Opticolor, Orion, Paramount Colors, Plastics Systems, Polymer Technology Center, PolyOne, Polyscope, QLab, Sekisui Chemical, SGL Carbon, Shamrock, Sikora, Struktol, Thermo Fisher, Toyota Tsusho America, Una-Dyn, Unipetrol, Vertellus, Wacker, Zeppelin, Zerma, Zoltek and many more.

Rita Andrews, Head of Exhibitions at AMI, said: "The Cleveland exhibitions will provide visitors with a great opportunity to learn about the latest products, find new suppliers, and negotiate deals. In addition, the conference sessions will provide the perfect place to discover innovative technologies and industry best practices".

The very limited number of remaining booths are being filled on a daily basis. To find out more about exhibiting at any of the expos, visit **https://www.ami.international/exhibitions**.

To book your free visitor ticket, which is valid for both days of the event and includes access to all three exhibitions and their respective conference theatres, visit: **ami.ltd/Register-AMI-Expos**

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PHOTO: ARBURG

Technology suppliers are presenting injection moulders with new foaming systems which add to the processes already in the market. David Eldridge reports on the latest developments

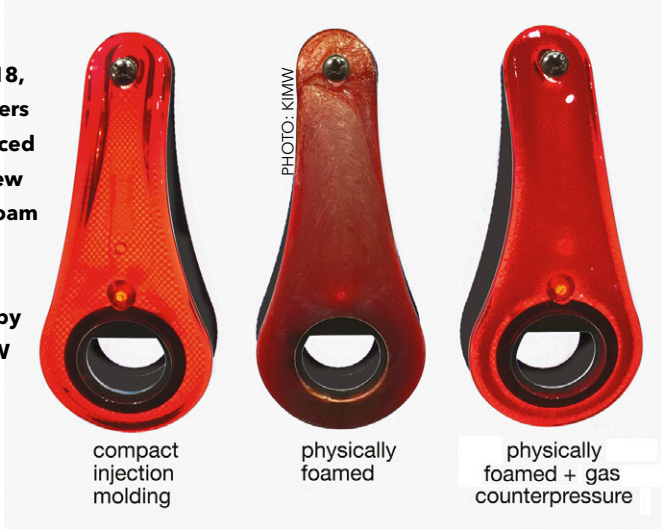
Expanding options in foam moulding

Foam injection moulding is a technology that automotive, packaging and technical moulders can use to provide significant value in their customer offering. Foamed mouldings have lower density than unfoamed parts and are therefore attractive in the lightweighting trend seen in automotive and packaging markets. Foaming can be used for thin wall parts and also for thick wall parts, meaning that applications as diverse as margarine tubs and car parcel shelves are suitable for the technology. As well as the lightweighting of finished parts, there are other benefits, such as lower material costs, and processing advantages, including reduced cycle time and the possibility of downsizing the machine's clamp force.

Trexel's MuCell process is perhaps the best known foam injection moulding technology, but in addition some injection moulding machine companies have produced their own foaming options, plus independent groups have developed expertise and new foam technologies too. Each of these technologies has differences which their backers claim makes them stand out, but the essential difference is between technologies using chemical foaming and ones using physical foaming. In chemical foaming, the agent used for foam expansion is added into the polymer granules and is activated once processing starts inside the machine barrel. In physical foaming, the gas is introduced into the barrel from an external unit and then mixed with the polymer melt to create the foam expansion.

A new foam injection moulding technology combines the best of physical and chemical foaming, according to industrial gas producer **Linde**. The Plastinum foam moulding process was launched by Linde and its development partners **Kunststoff-Institut Lüdenscheid (KIMW)** and **ProTec Polymer Processing** at the Fakuma

Main image: Foam moulding is an attractive technology to meet the need for lightweighting automotive parts



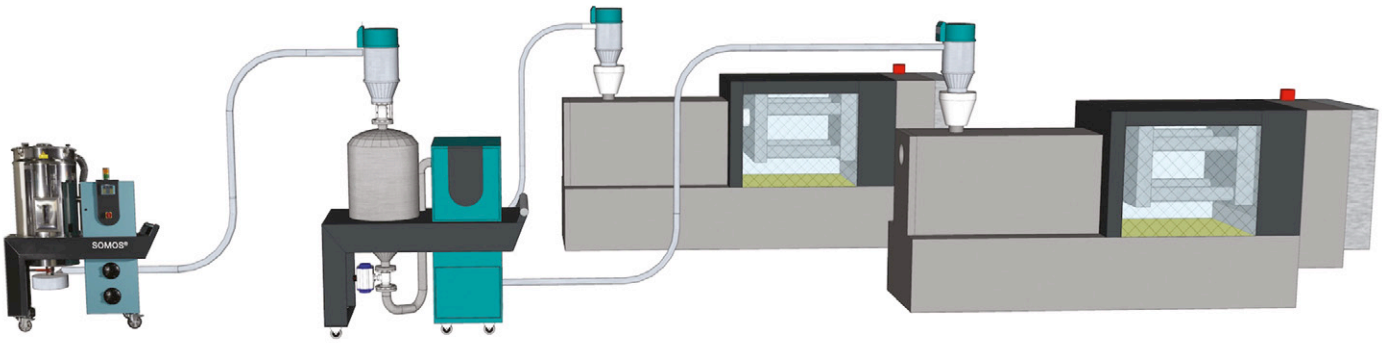
Right: At Fakuma 2018, bottle openers were produced using the new Plastinum foam moulding process developed by Linde, KIMW and ProTec

exhibition in Germany in October last year. ProTec demonstrated the process using its Somos Perfoamer system and an Engel E-Victory 310/80 injection moulding machine. In the process, polymer granules are first dried in a conditioner unit, and are then impregnated with the carbon dioxide foaming agent in a pressure vessel (autoclave) upstream of the injection moulding machine. The amount absorbed by the granulate depends on the plastic material, pressure, temperature and impregnation time. The CO2 typically remains in the granulate for a period of more than two hours after it has been loaded and the pressure released.

"Plastinum is as flexible as chemical foaming, because it is used with any tool without need for modification, and is as precise and reproducible as physical foaming," said Pavel Szych, Plastics Applications Expert at Linde, who was speaking at AMI's Polymer Foam conference in Hamburg, Germany in November. Other injection moulding technologies that are part of Linde's Plastinum product family are gas injection moulding, mould hotspot cooling, and dry ice blasting to clean moulds. The development project for Plastinum foam injection moulding started from scratch in 2015, said Szych. Process development was jointly conducted with KIMW, while ProTec built the hardware to enable the Plastinum process. The Perfoamer equipment comprises a conditioner with control unit and an autoclave with buffer tank. A conditioner is necessary because it is important that gas impregnation is not done at too high a temperature as it affects the level of absorption, said Szych. The Plastinum process uses CO_2 because it is a commonly available gas and it provided the best absorption compared with nitrogen and other gases when tested during development, he said.

Linde says the benefits of Plastinum foam injection moulding include: weight savings of up to 60%; cycle time reductions of up to 50%; clamping force reductions of up to 60%; the production of thin walled parts of less than 2mm; and the ability to use engineering plastics. In the development project, more than 60 polymers were tested, including polycarbonate, ABS and glass-reinforced polyamide. Testing was carried out for two hours at 35 bar, using small injection moulded test plates with 4mm wall thickness. The tests were designed to study gas absorption and weight reduction using different polymers, and Szych said the process and equipment were set up to maximise foaming in the testing, not to achieve certain properties in the moulded part.

Customer trials using Plastinum can be done at KIMW's facility, where there are injection moulding machines from a variety of manufacturers. Multiple injection moulding machines can be supplied from one gas supply scheme, said Linde. Depending on volume requirements, the CO_2 gas can be supplied from cylinder bundles or a bulk tank. Linde and ProTec designed and developed a special manifold to ensure optimum foaming performance and security of supply by automatically switching from an empty to a full cylinder bundle. If a bulk tank is preferred, Linde said the Presus C is an energy-efficient pressure-boosting unit designed for CO_2-based moulding processes. "The entire gas supply, boosting and injection package has been



Above: Image shows the Somos Perfoamer units from ProTec for drying and temperature adjusting polymer pellets, loading them with CO_2 under pressure and then feeding them to the injection moulding machine. Photo: ProTec Polymer Processing

specially engineered to maximise the physical properties of CO_2 as a foaming agent for stable, predictable outcomes in foam injection moulding," said Linde.

UK technology start-up firm **Bockatech** has developed EcoCore foam moulding, which it says can be carried out on standard injection moulding machines with minimal extra investment. It is targeting insulated food packaging applications, where moulding of smooth-walled foam containers using EcoCore technology can match cycle times for standard single wall injection moulded containers, the company says. Bockatech is also promoting the green credentials of EcoCore: the first commercial product made with the technology is Corretto, a PP cup for on-the-go use, such as in coffee shops, which can be reused many times and is then recyclable in established PP packaging waste streams.

Left: Corretto is a reuseable on-the-go coffee cup, foam injection moulded in PP using Bockatech's EcoCore technology

In September 2018, Borealis announced it was partnering Bockatech in the development of EcoCore using two of its PP materials suited to the foaming process. Andreas Leitner, Borealis Head of New Business Development, said: "As strong advocates for the circular economy within our industry, we at Borealis are eager to partner with pioneering firms like Bockatech to develop polyolefins-based solutions that are reusable and recyclable."

Peter Clarke, Co-Founder of Bockatech, said **Borealis** is the exclusive materials development partner for EcoCore. Injection moulders are not restricted to using the Borealis materials for EcoCore, however, they have outperformed all other materials tested. But moulders must take a technology licence from Bockatech which applies to a particular product group in a particular territory.

Clarke has developed other patented packaging moulding technologies, including Coralfoam core-back expansion moulding. With EcoCore, the mould is also opened to allow expansion after injection, but it is a more controlled foaming process than Coralfoam where fast expansion leads to an open cell structure. "EcoCore is a controlled expansion, with very, very fine cell structure," Clarke said to *Injection World*. The benefit of the fine, closed cell structure is improved thermal insulation in the cup.

Achieving the fine cell structure comes from a combination of the blowing agent and the materials. The Borealis PP grade BH381MO is used in EcoCore containers for its high stiffness and high impact strength, and a percentage of Daploy WB140HMS is added, as this high melt strength PP material improves the cell structure.

Clarke said the cup's exterior is designed with a waveform, creating thick and thin sections around the cup. The surface expands during foaming in a controlled way that determines how thick the wall section is (typically 2-3mm). The skin does retain a remnant of the original waveform, said Clarke, but it has a very good surface that enables good printing quality. Bockatech has also created a new waveform designed specifically for IML containers.

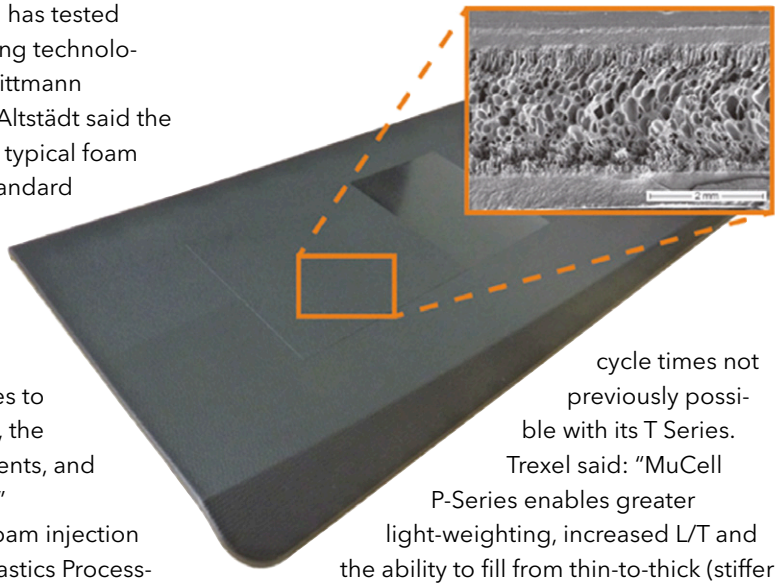
As well as cups, EcoCore can be used for other packaging that needs thermal insulation, such as noodle pots, freezer tubs for ice cream and microwavable trays. The company sees good potential in a variety of other applications too, such as industrial packaging and medical sharp-safe containers, said Clarke.

Injection moulders do not need much additional equipment to run the EcoCore process. Clarke said a mould heater is required to control the surface temperature in the cavity. Chemical blowing agents are widely available in masterbatch form which can be added in a standard blender.

Above: Bockatech has created a new waveform designed specifically for IML containers made with the EcoCore foam technology

AMI's Polymer Foam conference in November showed that R&D organisations are active in foam injection moulding. **Neue Materialien Bayreuth** in Germany offers a number of foam-related services to injection moulders: material and process development for the production of injection moulded integral foams; foam structure analysis and mechanical characterisation; matching of foam injection moulds; and optimisation of foam injection moulding processes with regard to surface quality and lightweight construction potential through special process technologies. Volker Altstädt, CEO of NMB, said at the conference: "If you are interested to compare the foamability of your materials on different machines independently, we can do that."

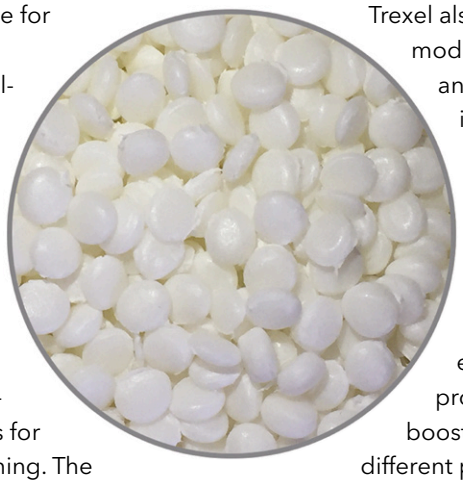
NMB is involved in a comparative analysis



Right: Neue Materialien Bayreuth in Germany offers a number of foam-related services to injection moulders

project, called FIM Compare, which has tested different polymers with three foaming technologies: MuCell (Trexel), CellMould (Wittmann Battenfeld) and ProFoam (Arburg). Altstädt said the project is "an independent study of typical foam injection moulding materials like standard PP, PP with long fibres and PC, and in this study we used only nitrogen. The idea is to compare semi-crystalline materials, amorphous materials, fibre-reinforced materials in all these three processes to identify possible weight reductions, the morphology of the mould components, and also the profitability of the process."

Another organisation studying foam injection moulding is **IKV** – the Institute of Plastics Processing at RWTH Aachen University in Germany. At the Polymer Foam conference, Yuxiao Zhang, Research Associate at IKV, discussed work she is doing to investigate the influence of processing parameters (including mould temperature, the delay time before mould opening and the opening speed) on the mechanical properties of physically foamed TPE materials. The studies have covered various elastomeric material types, including TPVs and TPUs.



Right: Trexel has launched its new TecoCell chemical foaming system

US-based **Trexel** made a name for itself in the world of injection moulding with its MuCell technology, a physical foaming process. So it was surprising when last year it unveiled its new TecoCell chemical foaming system. Executives at Trexel told *Injection World* the reason for adding a chemical foaming technology to its portfolio was because customers had requested that Trexel gave them options for both physical and chemical foaming. The TecoCell system uses $CaCO_3$ nanoparticles measuring less than 0.08 microns to create a highly uniform and evenly distributed cell structure. The result is said to be injection moulded components with impressive weight savings, good mechanical characteristics and high quality surfaces.

Trexel has further broadened the MuCell physical foaming suite of products with the new MuCell P-Series. MuCell is well established in automotive and technical moulding markets, and the P-Series is Trexel's adaptation of the gas dosing process for fast cycling, thin-wall packaging applications. The company says the P-Series is able to precisely dose N2 as a super critical fluid at fast cycle times not previously possible with its T Series. Trexel said: "MuCell P-Series enables greater light-weighting, increased L/T and the ability to fill from thin-to-thick (stiffer rim for sealing). It has been demonstrated that the use of MuCell P-Series on existing packaging products provides 30% reduced clamp tonnage, 12% lower injection pressure, 6% weight reduction and 7% cycle reduction."

At the NPE2018 exhibition in Orlando, US, in May last year, Trexel demonstrated the MuCell P-Series moulding a 6 oz (200 ml) yogurt cup with in-mould label. The P-Series made its European debut at Fakuma 2018 in October. At Fakuma, Trexel also showed the T Series satellite model, which it said offers "an easy and cost-competitive entry route into MuCell microcellular foaming", which can be easily expanded for further machines. The satellite development enables several injection moulding machines to be equipped for MuCell, especially for interconnected production cells. Trexel also offers booster stations in two sizes with different performance ranges to supply the different satellites with the physical blowing agent.

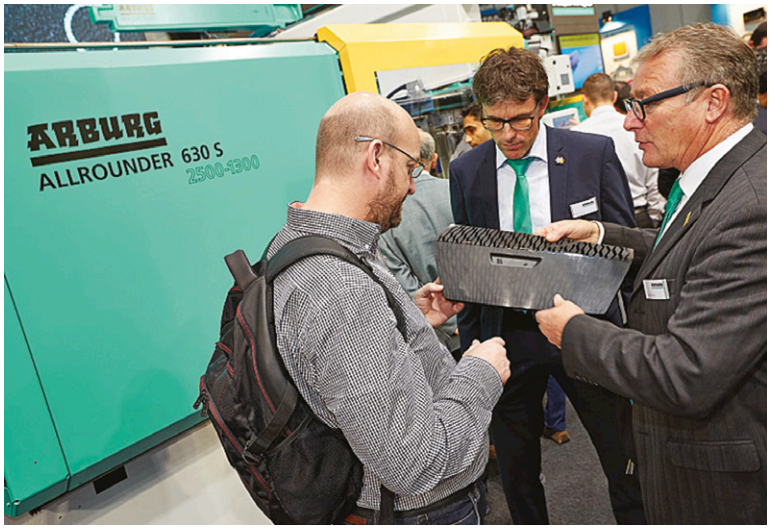
MuCell is a technology offered as an option by many injection moulding machine manufacturers. This could be seen at NPE2018: Engel demonstrated its DecoJect in-mould graining technology on an automotive part moulded using MuCell; and Milacron used MuCell in conjunction with its "Core Back/Reverse Coining" technology package on a Maxima Performance machine moulding an automotive door panel with map pocket.

Arburg, at its Technology Days 2018 event in Lossburg, Germany, presented its Profoam physical foaming process as an option for moulders

involved in a lightweighting project. It said in its presentation that the earlier the decision is made in the project regarding the technology, then the more efficient the process will be. For example, component design and mould design can be adapted to the chosen process. Arburg also recommends qualifying processes with pre-trials and test moulds.

At the Technology Days event, the company demonstrated Profoam on a hybrid Allrounder 630H machine producing a backup battery cover weighing 80 g on a two-cavity mould in a 30% glass reinforced PP on a 28 s cycle. A weight saving of nearly 10% was achieved. Arburg also offers customers Trexel's Mucell physical foaming technology. The Profoam system differs from the Mucell technique in that gas is introduced into a special pressurised hopper before it enters the screw, where it is dissolved into the polymer during plasticising. This means that a relatively standard – and therefore lower cost – plasticising system can be used. Arburg says that Profoam plasticising is also more gentle than the Mucell system (which introduces gas into a modified plasticising unit) so it is highly effective with materials such as LFTs that are susceptible to shear damage. Mucell technology does allow higher levels of gas to be introduced, however.

Wittmann Battenfeld's proprietary CellMould physical foaming process was one of the exhibits at the event held in its facility in Kottingbrunn, Austria, in June last year, to mark the tenth anniversary of Wittmann Group's acquisition of Battenfeld. The CellMould technology was demonstrated on a MacroPower 1100 machine, making a side part for a drum cable. In the CellMould process, pressurised nitrogen gas in supercritical liquid form is injected into the polymer melt inside the barrel during the metering process, where it dissolves and is finely distributed in the melt. Following injection into the mould cavity, the pressure drops and the nitrogen fluid returns to its gaseous state and separates from the polymer again, forming a compact outer layer and foamed core. The demonstration was one part of an "Expert Corner" at the event, with Battenfeld also demonstrating its AirMould gas-assisted moulding process on an EcoPower 160 machine making a coat hanger.



Above: Arburg's Profoam process can be used for automotive parts, such as the one pictured which the company moulded at K 2016

Lehmann & Voss makes blowing agents in masterbatch form for foam injection moulding under the Luvobatch brand name. At Fakuma 2018, the company launched the Luvobatch PA BA 1001/1002 blowing agent system for foam moulding with reinforced polyamides. The new product enables weight reductions of up to 30% for glass or carbon fibre-filled PA materials. "As an example, foamed components produced with this system exhibited a performance factor for bending stress in the range from 1 to 1.3. Consequently, the change in flexural strength is smaller than the reduction in weight," said Lehmann & Voss.

Above and left: At NPE 2018, Trexel demonstrated its new MuCell P-Series system moulding a yogurt cup with in-mould label

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Injection moulding cooling time: a breakdown

*In this guide by injection moulding training group RJG, **Jeremy Williams** outlines how to approach part cooling*

If you have attended one of RJG's training events, there is a value that probably sticks out in your mind: 80%. That is how much of the moulding cycle is spent cooling the plastic part to a temperature that it is rigid enough to withstand the forces of ejection.

As engineers (part, mould, or process), we need to understand which factors influence cooling and how that ultimately determines the cycle time. So where does that 80% number come from? In Figure 1 is an equation used to estimate cooling time.

In this article, we will review four areas and their impact on cooling: part design, material selection, mould design, and processing.

The basis for cycle time is rooted in the decision made by the product design engineer. The thicker the product must be to meet its working conditions, the longer the cycle will be to produce the product.

In the formula in Figure 1, h^2 represents part thickness. Since the thickness is squared in the equation, it has the most influence over cooling time. For this analysis, we utilised a American Society of Testing and Material (ASTM) Tensile Test Bar. The dimensions are an overall length of 63.25mm, a width of 10.41mm, and a thickness of 3.3mm.

Considering material selection, it should be noted that by nature, plastic is an insulator. In a melted or molten state, plastic transfers heat slightly better. As it gives up heat, however, its insulation properties increase. The material properties that are used in the equation are:

1. Melt Temperature – Temperature at which material transitions from solid to liquid
2. Mould Temperature – Temperature range to best achieve surface finish replication of the cavity surface
3. Heat Deflection/Distortion Temperature (HDT) – Temperature at which a material will deflect under load.

Typically, the eject temperature in the equation uses the HDT, or a temperature slightly below HDT. The ASTM test for HDT closely represents what a part endures during ejection with an ejector pin pushing on a single side, while the opposite side is unsupported. The alpha symbol in the equation in Figure 1 is an important factor in determining cooling time. But what does it mean? Figure 2 shows how to find alpha.

The variables in the thermal diffusivity equation include:

1. Thermal Diffusivity – Rate at which a thermal disturbance (a rise in temperature) will be transmitted through a substance
2. Density – The quantity of a substance per volume (g/cm³ for plastics)
3. Specific Heat – Heat in calories required to raise the temperature of one gram of substance one degree Celsius

For this test, we utilised a Toyolac 100 ABS material from Toray Plastics with a melt temperature range of 230 to 250°C, mould temperature of 40 to 80°C, and HDT of 83°C. Density can typically be found on a material data sheet, but for thermal conductivity or specific heat, it's best to contact the material supplier directly or utilise the data within the simulation software.

Based on the part geometry and material selection, the estimated cooling time is 18.00 seconds in simulation.

Given all the energy required to melt a material, it's impractical to remove all of it while the part is still in the mould. Only 40% of the energy must be removed so the part is rigid enough for ejection.

Figure 1: Cooling equation

$$t_{COOLING} = \frac{h^2}{2\pi \times \alpha} \times ln\left[\frac{4}{\pi} \times \left(\frac{T_{MELT} - T_{MOLD}}{T_{EJECT} - T_{MOLD}}\right)\right]$$

Figure 2: Thermal diffusivity equation

$$Thermal\ Diffusivity\ (\alpha) = \frac{Thermal\ Conductivity\ (\lambda)}{Density\ (\rho) \times Specific\ Heat\ (C_p)}$$

Generally, we do not recommend selecting a cooling timer that only meets the HDT – a buffer should be allowed as a safety factor. A good rule of thumb is adding 20% to the cooling timer to account for variation on incoming material and slight shifts in machine performance. For tighter tolerance parts, the safety factor will likely need to increase.

For the mould design, an 8-cavity mould with an "H" pattern runner and a lapped edge gate is used. Cooling lines have been placed in the cavity, core, and runner block following established guidelines for diameter/depth/pitch. By using proven methods for cooling line design, warp and cooling time are minimised. The mould is also fully instrumented with cavity pressure sensors at post-gate and end-of-fill in conjunction with in-cavity temperature sensors.

So where does that 80% number come from? Let's look at the data we collected. The process segments we looked at were: fill, pack/hold, cooling, mould open/eject/mould close. For this experiment, we developed a robust Decoupled II process, resulting in the following process parameters:

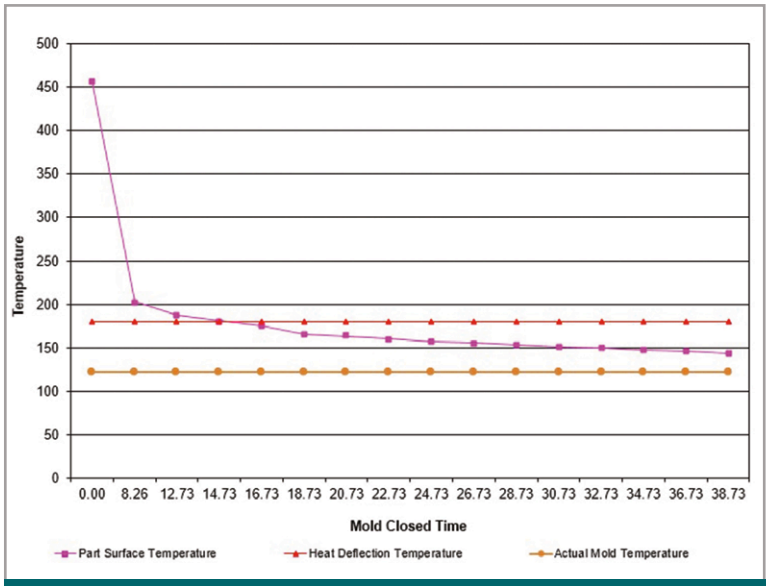
1. Actual Melt Temperature: 236°C
2. Actual Mould Temperature: 50°C with a flow rate of 11 lpm per cooling circuit
3. Fill Time: 0.26 seconds with a transfer pressure of 576 bar plastic pressure
4. Pack/Hold Time: 8.0 seconds at 286 bar
5. Cooling Time: 10.0 seconds
6. Overall Cycle Time: 21.43 seconds

If we add the process times together and divide by the overall cycle time, we reach a value of 0.85. That means that 85% of the cycle is spent cooling the part so that it can withstand the forces of ejection.

The chart shows the actual part temperatures measured with a surface probe at different time increments during process development. In our experiment, the tensile test bar cooled from 228°C to 103°C in 8.26 seconds (fill and pack/hold time). For the part to get below the HDT of 83°C, it took an additional 8.47 seconds. The temperature only dropped 20°C (to 80°C) in just under 9 seconds, which means that there was a lot of heat transfer efficiency lost.

The chart also indicates that at some point, leaving the part in the mould is of little to no added value. Based on geometry, material, mould, and processing, leaving the mould closed for longer than 24.73 seconds really is not cooling the part down much more.

We must consider that using thermal imaging technology or a surface probe are not perfect representations of the actual part. The surface temperature of the part was measured several times over a 2-hour run at 74°C.



Part surface temperature

Thermal imaging showed the part to be roughly 87°C, while software predicted 83°C at the same time in the cycle. The image also indicates that the thermal signature across all eight cavities is nearly identical. By utilising two different methods, we can feel confident that the part temperature is at about 80°C (3°C under HDT).

In conclusion, part cooling is always a function of wall thickness and the material that the design engineer selects. It's up to the mould design engineer to place the cooling channels in the proper location to allow for a minimum cooling time. As a process engineer, the old adage of "fill as fast as possible consistent with quality" still holds true. If the volumetric flow rate is very low, the chances of packing out a part are slim to none because the material will likely be frozen.

For this geometry and material, most of the heat (125°C) is removed during the filling and pack/hold phases. However, to remove the last 20°C to be below the HDT, it takes longer than it did to fill and pack/hold the part. Cooling is a waiting game, but with better engineering (part design, mould design, and process), the time required to cool the material goes down.

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About the author

Jeremy Williams is based at RJG in Michigan, US and has over 17 years of experience in the plastics industry. Currently he is a Consultant/Trainer with TZERO®.

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A cost-effective injection moulding operation relies on an efficient and highly accurate pre-drying procedure to guarantee quality and minimal waste. Mark Holmes finds out more

Controlling the drying process for cost and quality

Preparing materials for the injection moulding process requires precision drying to ensure maximum moulding efficiency, while minimising waste. However, the drying operation can be a costly one, so there is a constant need to find ways to minimise energy usage for a cost-efficient injection moulding operation.

Injection moulders, like all processors, are continuing to streamline and automate. "Time is money and time spent down due to changeovers, diagnosing issues, or waiting for support is time wasted," says A.J. Zambanini, Dryers Product Manager at **Conair**. "Our goal is to make robust equipment that lasts. Our drying equipment is designed for simple operation and maintenance. At the same time the controls are easy to use, providing advanced features and help menus. The dryer is no longer a black box, it is a data wiz that allows you to know in real time what is going on in all facets of your drying system. By the same token, our new air-cooled mobile drying/conveying units – the dX Series – which do not require a water connection, allow processors to pre-dry resins off-line, anywhere there is a power outlet, so they are ready for a quick material change.

"As shops that may have resisted drying in the past begin using more hygroscopic resins, those new dryers put a load on an already taxed conveying and water infrastructure. This is another reason Conair has developed a totally air-cooled option for our mobile dryers. These air-cooled units are very efficient and do not require water. They can also be provided with on-board loading capabilities so they can fill the hopper independent of a central vacuum system. This eliminates the need to run additional chilled water, vacuum, and material lines, which can be a huge saving when looking into adding a dryer to your system.

"In addition, custom-blended resins, including post-industrial and post-consumer materials, are being used more often to gain a competitive material advantage or to save on lower-cost material streams. All of these can have an adverse effect on drying equipment if not handled properly. Conair has filtration equipment for dust, fines, and volatiles that help keep the dryer running like new, even when these alternative materials are being processed." ›

Main image: Conair's new Carousel Plus D Series portable dryer (left) and dX Series mobile drying/conveying system offer advanced features, easy-to-use controls, and a new air-to-air intercooling option that eliminates the need for a cooling water supply

Above: Piovan's Modula automatic multi-hopper drying system can adapt itself to variable working conditions

In order to meet these challenges Conair says that, although not new, it has demisters and volatile traps available to condense, trap, and filter the air stream on all its dryers – in sizes from 6.8-2,273 kg/h (15-5,000 lb/h). This helps to keep the dryer clean and desiccant working like new. Wheel drying technology is also efficient and consistent. It has a very long life cycle and can last up to five times longer than traditional beads with no degradation, break down, or maintenance required. In order to enjoy these benefits, it is necessary to keep the air clean.

Conair recently marked the re-design of the Carousel Plus with the launch of new small- and mid-sized desiccant dryers. The company says that the D Series portable dryers and dX Series mobile drying/conveying systems offer good resin-drying performance together with advanced yet easy-to-use controls, high reliability and energy efficiency, and a new air-to-air after-cooling option.

Conair adds that the new dryers are the product of a re-design of its Carousel Plus desiccant dryer architecture affecting portable dryers and mobile drying/conveying systems – the former W Series and MDCW Series – sized from 6.8-181 kg/h (15-400 lbs/h) throughput. The D and dX Series dryers now combine a new and feature-packed control interface with high-reliability components that maximise performance, uptime and energy efficiency. These are housed in a new, space-efficient chassis that not only preserves floor space but offers easier, more direct access to key components and to user-serviceable items like filters.

The new D and dX Series dryers also utilise new air-to-air after-cooling. After-cooling is required to reduce the temperature of the return air from the drying hopper, which improves the moisture-absorption efficiency of the desiccant. Now, processors may specify dryers equipped with either an optional air-to-water after-cooler or the new air-to-air after-cooler. The air-to-air unit can sustain drying efficiency while handling return-air temperatures of up to 190.5°C (375°F) and dew points of -40°C (-40°F). At the same time, it saves water, maximises dryer portability, and makes installation and set-up faster and easier.

The company adds that the dryers have a new DC-C programmable logic controller, which was developed specifically for drying applications. The control uses software developed by Conair to maximise flexibility in adapting to current and future customer application needs. It is available on both the D and dX Series dryers in two configurations: the DC-C Plus package features a 4-inch touchscreen user interface, while the DC-C Premium offers a 7-inch screen.

Both configurations share a common interface layout, making them easy for processors to learn, regardless of dryer size. Both offer dew-point monitoring and control, energy-use reporting, heater on-time trending and predictive maintenance as standard features. As standard, Premium units add more energy-saving features, including Temperature Setback, which automatically adjusts drying air input temperatures to avoid overheating, and an optional Drying Monitor, which utilises RTD sensors in the hopper to confirm that proper drying conditions are maintained. These are options on the Plus. Premium units also offer remote access and control capabilities and enhanced monitoring and alarm functions.

Both control configurations offer built-in loader options as well. The Plus configuration includes options for one loader, the Premium for two, typically with the first loader option used for the processing machine and the second serving the dryer hopper. Dryers supplied as part of dX Series mobile drying/conveying systems include a stainless-steel hopper, conveying blower, dust collector and direct-feed vacuum receiver – all assembled on a safe, convenient wheeled cart. Loaders can be supplied with a sensor to confirm resin fill levels, a ratio valve for loading two materials (typically a regrind and a virgin) into the dryer, and a choice of long- or short-distance conveying blowers.

Italian ancillary equipment manufacturer **Piovan** sees the priorities of the latest developments in drying technology as being a need to increase the energy efficiency of systems and make them fully automatic in order to be able to respond to changing working conditions over time. "Reducing operator intervention, maintaining a stable process under control even with variable running conditions, as well as tracking raw material flow along the process, are now the common requirements from

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customers," says Peter Dal Bo, Group Chief Commercial Officer. "Other trends driving new developments in drying include the need for high flexibility, reduced productions runs, rapid injection moulding machine set-up and avoiding mistakes in quick changeovers of materials and moulds. The principles of Industry 4.0 are also the basis for the design of new drying systems and resin handling, meaning the compilation of raw data received from the machines and the interconnection of all devices.

"In this scenario, it is necessary to provide drying systems that can automatically adjust the drying parameters to meet variable conditions in terms of the material to be dried and throughput. It is also critical to have instruments for material traceability and to avoid mistakes in raw material distribution. In automotive factories, for example, the request is not for more simple dryers, but complete systems that can be integrated with a customer's ERP or MES, providing aggregated data for analysis, quality checks and actions for efficiency improvement."

In order to meet these requirements, Piovan has developed the Modula, a fully automatic multi-hopper drying system that can adapt itself to variable working conditions. Each drying hopper is equipped with load cells or with a continuous level sensor in order to detect the real throughput requirement to the drying system. The system can adjust all drying parameters, including air flow due to a frequency converter on the process blower and automatic modulating valves on each hopper, combined with a proprietary air flowmeter. In addition, the temperature and dew point of the process air is controlled through the DewPoint stabiliser. Residence time is controlled by adjusting the level in the hopper to meet the real production target.

The system can be complemented with Easylink+, the automatic coupling station that ensures that all hoppers are fed with the correct material, and with the Material Tracking System (MTS) – the new feature of Winfactory (WF) 4.0. The MTS tracks each resin batch along the production line from storage silo to the injection moulding machine and reports show when a batch of raw material is received by a specific destination, for example an injection moulding machine. The data can be filtered by destination, date or material or production batch, and exported for further customer analysis.

"Future developments will be an even higher level of integration between drying and automatic feeding systems in order to have error-proof systems," Dal Bo adds. "Drying systems will be required to be automatically adaptive to variable working conditions, maintaining a high level of efficiency. There will also be an increased need for machines and supervising systems that can record, manage and make data available for advance analysis about energy and material consumption, machine performance and traceability of raw materials."

According to the UK supplier and distributor of plastics ancillary equipment **Summit Systems**, the majority of the plastics industry remains extremely conscious about energy consumption when it comes to drying. "Historically, it has been an expensive process," says Jason Culleton, Technical Sales Engineer. "The biggest influences are energy and time, and everyone is working hard to miminise them. This is where we have found that one product that we distribute in the United Kingdom – the **Maguire** Vacuum Batch Dryer (VBD) – comes into its own. It dries plastic material six times faster than conventional dryers, at 85% less energy use. For example, polycarbonate would take four hours to dry. With the same material going through a VBD at the same throughput, there are significant benefits in terms of running costs, better quality mouldings and cost per kilo."

Above: The Maguire Vacuum Batch Dryer (VBD)

Controlling moisture is increasingly important. "Aesthetic and technical engineering products have to be tightly controlled in moisture terms with very tight parameters," Culleton adds. "You have to ensure everything follows a set procedure to keep consistency, otherwise you get huge amounts of scrap. The plastics sector is becoming more demanding, in particular with more material blends being created.

"We are getting great results with vacuum drying because it creates fewer issues with the polymer. This results in better quality components. With material under much less intense heat, there is less stress on the material which minimises scrap. The VBD is extremely fast drying technology, which uses a vacuum and no desiccant. It is ideal for optical, medical and technical applications."

Left: The Plug & Dry from Eisbär is an all-in-one material drying system for low material throughputs

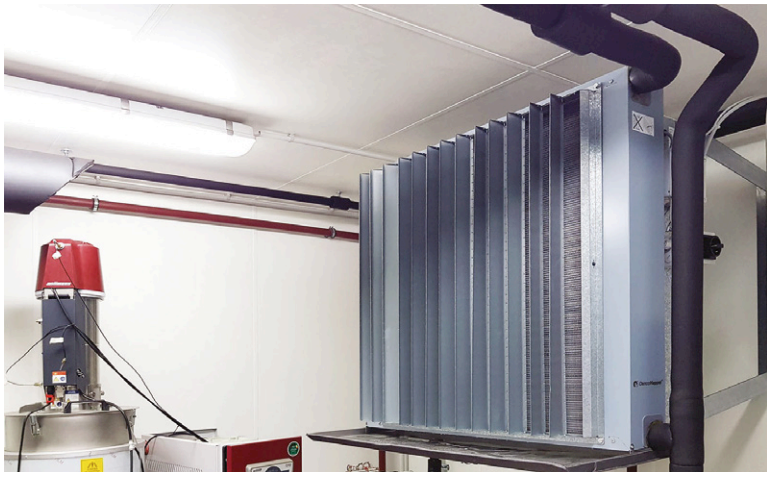
Summit Systems adds that R&D Leverage in the UK has been trialling a Maguire LPD200 for the application of PET in injection stretch blow moulding and the company reports

Table 1: Examples of test conditions created inside the climate chamber at Wittmann's plant

	Temperature [°C]	Relative Humidity [%]	Dew point [°C dp]	Water load [g/m³]
Test climate I	35	50	23	19.8
Test climate II	37	50	25	22.1
Test climate II	37	57	27	24.9
Test climate IV	35	67	28	26.6

that the results are very promising – resin dry and ready to use in 1 hour and 10 minutes, giving moisture readings of 30-40ppm.

Eisbär has developed an all-in-one material drying system for low material throughputs. The Plug & Dry is claimed to offer a number of advantages, while requiring less space than conventional drying systems. The company says that space for positioning and installing a material drying system, including drying hopper, material conveying system as well as pipework, is expensive and often limited. The energy-efficient compact Plug & Dry module for drying PET granulate and flakes consists of a material dryer, drying hopper and material conveying system. The company says that it offers high efficiency with low material throughputs (50-200 kg/h) in a small footprint, as well as low maintenance and user-friendly design. Due to the closed process air circuit for the material drying, there are no restrictions in relation to ambient conditions. The continuous drying process, low energy consumption and long service life are further key advantages of the system.



Above and right: Inside views of the climate chamber at the Wolkersdorf production plant of the Wittmann Group

Wittmann has established a climate chamber at its materials handling technology plant in Wolkersdorf, Lower Austria to undertake development work on dryers in extreme conditions to ensure that appliances can function in any part of the world with the local ambient temperature and air humidity.

The company says that the climate chamber offers a room completely insulated from the outside and equipped with an ultra-modern air conditioning system, which is able to simulate a wide range of ambient climatic conditions. The chamber can accommodate not only mobile and battery dryers for test purposes, but also entire drying systems. This makes it possible to specify, at an early stage, necessary adaptations to specific requirements for local markets. The test results are recorded using the OPC protocol and included in relevant documentation, from which locally required adaptations can be derived. For example, if a dryer operating in Europe or North America is able to reach an excellent dew point value with standard equipment and in standard operation, specific adaptations still need to be made to reach a comparable result under tropical conditions.

Wittmann says that the recently developed Aton segmented wheel dryer was optimised in terms of drying performance and energy efficiency with the help of tests carried out in the climate chamber. The company says that its dryers have the option to have the actual dew point displayed, rather than the set target value.

Moretto has recently installed its Moisture Meter technology for a smart drying system for technical polymer production at injection moulder **Marca Group** – a specialist in automotive, electronics and household appliances with factories in Italy and Romania. The Moisture Meter provides in-line measurement in a few seconds of the real residual moisture content present in granules after drying immediately before processing and is Industry 4.0 compliant.

Marca Group has a staff of 60 in Italy and 300 in Romania, with 38 injection moulding machines installed in the Italian plant and 60 in the Romanian one. These range from 10-400 tonnes, capable of processing around 1,200 tonnes of thermoplastics

Left: The Moisture Meter Manager from Moretto

Far left: Moretto has installed its Moisture Meter system at Marca Group in Italy

per year, such as PA, PE, PP, PC, ABS, PS, PMMA or PET, as well as epoxy, phenolic and polyester thermosets, through a special department equipped with different injection moulding machines (from 50 to 150 tonnes) and compression.

Moisture Meter is ideally suited to meeting the drying requirements of such an injection moulding operation, says Moretto. It is able to measure the real residual moisture content of granules (in ppm) in-line and checks that the polymer is properly dried before the production process. Power-Peak technology analyses the dielectric characteristics of a granule and detects the exact content of water present in the polymer, without any further off-line analysis. The device has a high precision moisture measurement capability of 3,000 down to a minimum of 15 ppm, with an accuracy of ±3 ppm and within a temperature range of 20-180°C. Moisture Meter guarantees the production of plastic material products with qualitative and certifiable characteristics that pass qualitative audits. It serves to eliminate offline analysis, which is expensive in terms of process efficiency, time and equipment.

In 2017 Moretto also introduced the Moisture Meter Manager, a device able to integrate the dryer into an adaptive system for Industry 4.0. The Moisture Meter Manager is made up of two sensors - MM Crown and MM Box. The MM Crown is installed at the hopper inlet, detecting the initial moisture level of the granule. This allows the system to predict the drying process accurately and manage all the parameters to obtain the exact final humidity of the polymer at the MM Box at the hopper outlet. Measuring the difference between the initial and final granule moisture level, Moisture Meter Manager is able to manage the dryer's working conditions autonomously, maximising process performance and using only the energy needed.

The Moisture Meter Manager is equipped with a 10-inch HD colour touch-screen operator interface, and is easy to program and object-oriented, capable of handling up to 12 hoppers, each equipped with Crown and Box sensors. It can be interconnected with Ethernet, Serial RS 485, USB and Mowis Supervisor systems, providing reports which can be stored for 30 days and printed. This device creates an 'on-demand drying process', based on the polymer's real drying needs and capable of managing internal and environmental variables that affect the level of polymer humidity. Moisture Meter is integrated with the process management software, based on the OPC-UA universal communication protocol.

According to Massimo Parini, Production Manager at Marca Group, the Moisture Meter has been able to keep the process under control, reducing waste to zero, with all information available in real time for analysis and management requirements. The next step is to anticipate problems, trying to predict the relationship trends in the variables that will lead to a certain type of result. The relationship undertaken with Moretto

Left: The Moretto Moisture Meter Manager in place at the Marca Group

Above: Motan-Colortronic's installation at Mitschke included two interconnected dry air generators equipped with ETA Plus air volume controls, a dew point control unit and a water cooler for the return air

started with the centralised drying system, then introduced transport and drying at the machines.

Motan-Colortronic has also installed new comprehensive drying facilities as part of a materials conveying system for the production division of German company **Mitschke**. Following recent expansion, Mitschke now has an annual material throughput of around 4,000 tonnes of different engineering plastics. These plastics include many speciality products comprising up to 30% talc, glass beads, short and long glass fibres with a fibre content of up to 50%. The company operates 17 injection moulding machines with clamping forces of 450-32,000 kN in two production halls. Its product range comprises technical parts for agricultural machinery and automotive manufacturers, for both exteriors and interiors, enclosures, panels and large fans. The weights of the injection-moulded parts range from 25-30,000 g and are produced at cycle times of 25-240 seconds. Moulded part dimensions of up to 1,800 × 1,800 mm are possible.

As a result of the expansion, Mitschke decided to revamp its material conveying system, including material loaders, decentralised and central drying systems, as well as the conveying system used to supply the machine park with material. In addition, Mitschke decided that the dust created by the highly filled materials needed to be contained and that the system should be more energy efficient. The machines are supplied by 12 external silos as well as a twin-design big bag station specially designed by Motan-Colortronic.

In collaboration the companies designed a central drying system with two Luxor A900 dry air generators, as well as six Luxorbin drying hoppers with a capacity of 1,800 litres each, installed on a specially designed platform. The new system also included an ETA Plus air volume control, a dew point control unit and a water cooler for the regeneration air. One of the two dry air generators comprised an existing one rather than new one. This generator was connected to a new controlled drying unit, with an air performance of 30-100%, depending on the current throughput or demand rate which supplies the drying hoppers with dry air. Connecting this unit required a number of changes to be made to the control technology and the associated piping. The overall design is such that it can be expanded by additional dry air generators and drying hoppers. The system is located centrally between the two halls, allowing material to be fed into the system on a demand basis. The drying system's control system has been integrated into the company's network and can be centrally monitored by the production management.

The process air is controlled by the ETA Plus system, which analyses and controls both the individual process air requirements of the individual drying hoppers, as well as that of the entire system. This means that each drying hopper is only supplied with the amount of dry air needed to achieve and maintain the required material conditions. If the control system detects that the material in the hopper has been fully dried, it will reduce the flow rate, heat output and the total air output. This ensures that the system will always operate at its optimum performance level. The integrated Drying Organizer automatically detects drops in the material throughput rate and gradually reduces the drying temperature to the optimum stand-by parameters. This again saves energy and protects the material from thermal damage.

ProTec Polymer Processing has developed the Somos Perfoamer equipment for the Plastinum foam moulding process (see page 31 for more information). ProTec's innovation includes all the components for drying and temperature adjusting polymer pellets, loading them with carbon dioxide under pressure and then feeding them to the injection moulding machine, which generally requires no modification.

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Speakers at the Polymer Foam conference in Pittsburgh in June will cover advances in processing, technologies and applications

Growing the potential for polymer foams

The use of foam technology is increasing rapidly across all fields of plastics processing. Applications have been expanding across many markets, including construction, infrastructure, packaging, transportation and energy generation.

The 7th edition of AMI's Polymer Foam US conference explores advances in a wide range of polymer foam materials, processes and applications. Presentation topics cover foam technology and applications in thermoplastics and elastomers, future trends in applications and markets, innovation in the foam industry, optimisation of foam processing, interplay between chemical and physical blowing agents, regulatory status and new developments in additives and sustainable solutions.

This two-day event takes place on 18-19 June 2019 in Pittsburgh, PA, US, and brings together expert industry speakers from the entire supply chain to evaluate and discuss the trends, challenges and opportunities facing the polymer foam industry across multiple end-use applications.

In this article we preview the event, with a closer look at the line-up of expert speakers.

Speakers in the opening session of Polymer Foam 2019 explore future trends in a variety of markets and applications. **Klaus Brenner,** Head of Global Engineering and Design at **Greiner Aerospace** in Austria, gives the audience an overview of design and production trends and innovation in aircraft interiors and seating. Increased use of polymer foams in structural sandwich core materials is discussed by **Russell Elkin**, Product Development Manager USA at **3A Composites**, who highlights future trends in applications for these materials and discusses future market potential. This is followed by **Steven Sopher**, Technical Director at **JSP** in the US, talking about particle foam properties for the growing sporting goods and impact protection markets.

After the networking break, the session continues with a paper from **Rob Dernovsek,** Manufacturing Area Manager at **Polycon Industries** – a division of Magna Exteriors – in Canada, who will discuss the company's work with foams. Next, **Rohit Ghosh**, Head of Marketing at **BASF Corp** in the US, shares with the audience how BASF is encouraging innovative practices that are tailored towards their customers' needs and how the foam industry can adapt some simple steps to drive innovation. The final talk in this session is given by **Andrew B Cole**, Executive Director at the **Canadian Urethane Foam Contractors Association (CUFCA),** who

reviews the success of the field quality assurance program in the Canadian spray foam industry.

Blowing agents

The second session explores the changing regulatory landscape for blowing agents and also highlights some technical advances. **Margaret Sheppard**, Lead Environmental Protection Specialist at the **Environmental Protection Agency** in the US, updates the audience about regulatory changes in blowing agents and shares an overview of classification of new blowing agents. International regulations regarding employees coming into contact with the powdered ADCA blowing agent and performance of the masterbatch ADCA blowing agent as an alternative are subjects discussed by **Benjamin J Reisman**, Head of Materials Development at **Palziv** in Israel. **Peter Schroeck**, President & CEO at **Reedy Chemical Foam** in the US, explores chemical blowing agents for thermoplastic elastomers in the final part of this session.

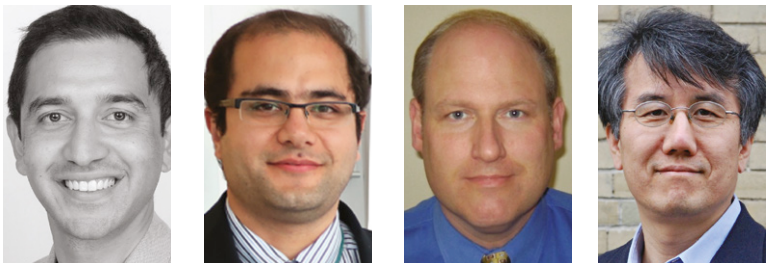
Fire resistance

Shari Kram, Senior Research Scientist at **Dow** in the US, shares her experience in the transition to a polymeric flame retardant for PS foam across China, Europe and the US. Developments in fire performance in PU and PET foams are highlighted by **Margaret Baumann**, Business Manager, Americas at **FRX Polymers** in the US.

To round off the first day's proceedings, a networking drinks reception is being held in the exhibition room, where delegates and speakers can network with industry peers.

Sustainable foam

Day two of Polymer Foam 2019 is opened by **Mario Grenier,** VP & General Manager at **Dyne-A-Pak** in Canada, who delivers an overview of developments in recycling and sustainability of polymer foams including trends in bio-based materials and packaging. The session continues with a panel discussion focussing on sustainability in the foam industry. Led by **Steven Sopher**, Technical Director at **JSP** in the US, the discussion will explore tangible sustainable solutions and focus on how the industry can apply sustainable practices moving forward. Panellists include **Prof Chul B Park**, Professor at the **University of Toronto** in Canada, and **Denisa George**, Marketing Manager Polyolefin Foams, at **Borealis** in the UK. More panellists will be confirmed closer to the event.



Speakers at Polymer Foam in Pittsburg in June include (from left to right) Rohit Ghosh from BASF, Alireza Tabatabei from Woodbridge Foam Corp, Steve Sopher from JSP, Professor Chul Park from the University of Toronto

Improving processing

The final session of the conference is opened by **Prof Chul B Park** and **Dr Vahid Shaayegan**, Research Director and Postdoctoral Fellow, both from the **University of Toronto** in Canada, who look at foaming mechanisms of pure and reinforced polypropylene in foam injection moulding. Low density polypropylene extrusion foaming with decreased cell size in the presence of crystals and additives is the presentation subject from **Dr Alireza Tabatabaei**, Senior Development Engineer at **Woodbridge Foam Corporation** in Canada. Next, **Dr Denis Rodrigue**, Professor at the **Department of Chemical Engineering, Laval University** in Canada, discusses piezoelectric properties of polyethylene foams with a focus on optimisation of the processing and post-processing conditions.

Closing the conference is **Samuel Dix,** R&D Director at **Trexel** in the US, who compares foaming level, structure and operating cost of two different foaming techniques in injection moulding.

Polymer Foam US conference

The 7th edition of AMI's Polymer Foam US conference will take place on 18-19 June 2019 in Pittsburgh, PA. The event provides an international forum for all companies involved in the manufacture, supply and use of polymer foam, from end users and manufacturers to converters and suppliers.

In addition to the formal conference sessions, the event provides extensive networking opportunities throughout the informal breaks, including access to the table top exhibition area and complementary cocktail reception at the end of the first day. To find out more about attending the conference, taking a table-top exhibition space, or becoming a conference sponsor, visit the **conference website** or contact Conference Coordinator Christa Beveridge Tel: +1 610 478 0800, **christa.beveridge@ami.international**.

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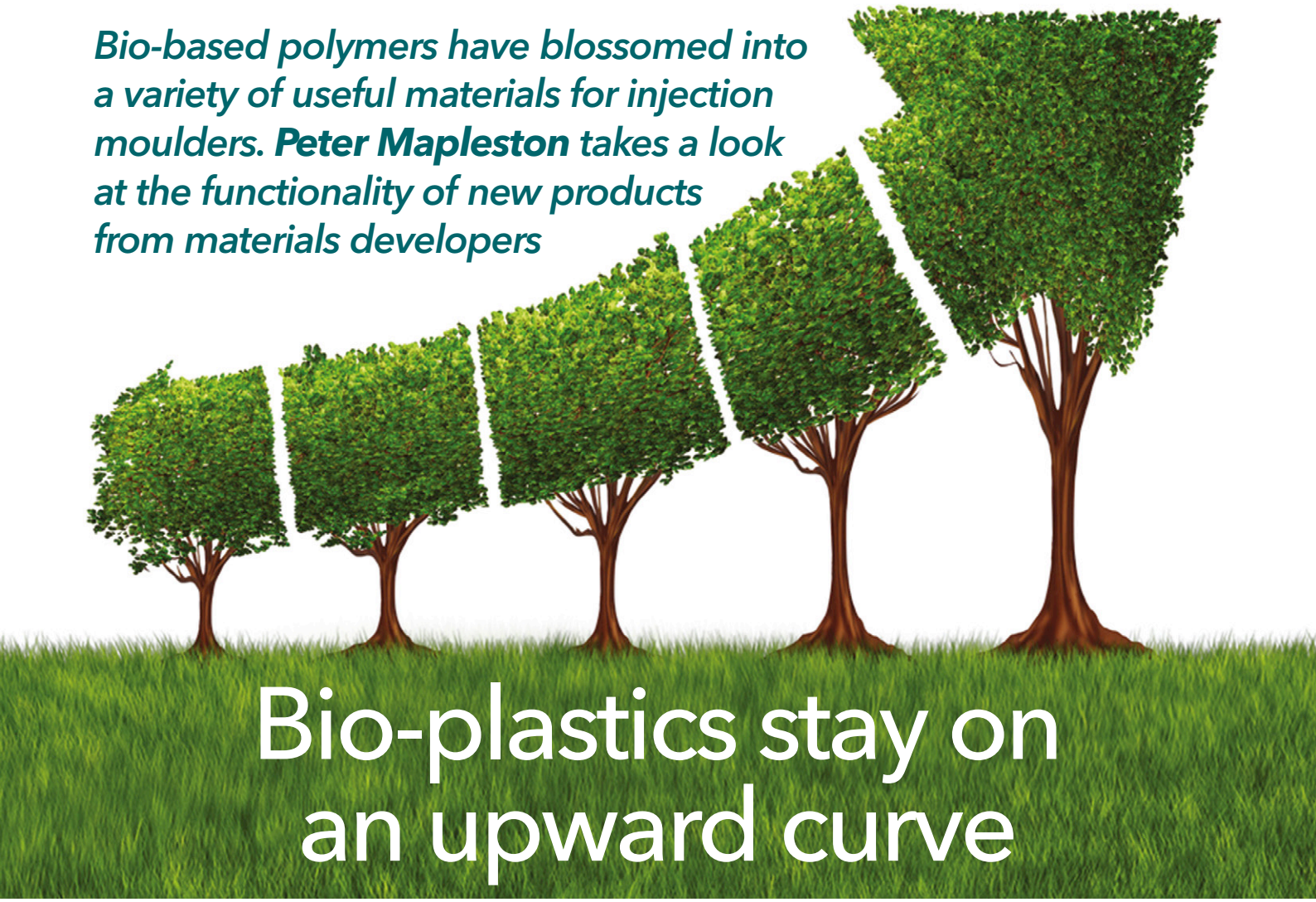
Bio-based polymers have blossomed into a variety of useful materials for injection moulders. ***Peter Mapleston*** *takes a look at the functionality of new products from materials developers*



Bio-plastics stay on an upward curve

Plastics derived from bio-based, renewable resources are continuing to expand in terms of both production and their applications. Last year, according to the German Nova-Institute, global production volumes reached 7.5 million tonnes, around 2% of the production volume of petro-chemical polymers. The potential is much higher, says the institute, but is currently hampered by low oil prices and a lack of political support. Nevertheless, start-ups and established manufacturers are putting a lot of effort into developing new biopolymers and improving existing ones, and there is a sense that in markets of all types around the world, there is increasing enthusiasm for these materials.

Many consumer brand owners now want to offer their customers environmentally friendly solutions. But we are now also seeing bio-based materials selling simply because they make the most sense in terms of bang for your buck: they perform as well as, or better than, traditional materials, at the same, or occasionally lower, price.

"The production of bio-based polymers has become much more professional and differentiated in recent years," says the Nova-Institute. "By now, there is a bio-based alternative for practically every application."

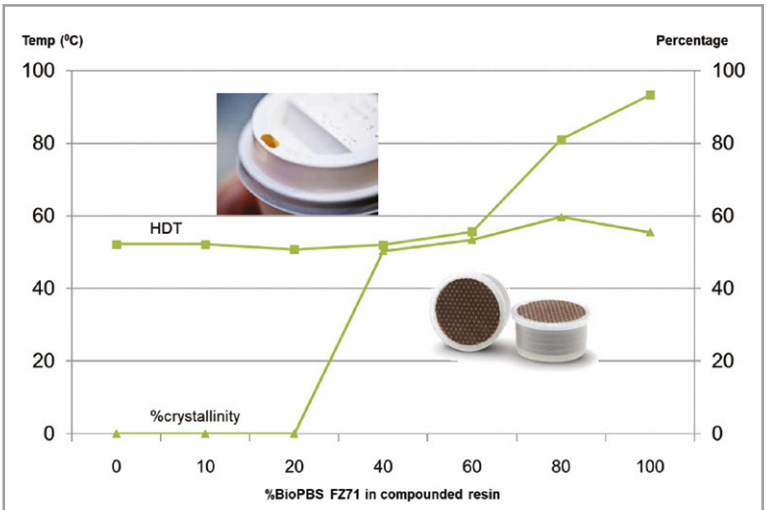
Bio-based polyesters

PTT MCC Biochem Company in Thailand, which is partly owned by Mitsubishi Chemical, says it is the only manufacturer of bio-based polybutylene succinate – which it calls, unsurprisingly, BioPBS. The company says a key differentiation is its good biodegradability. It sees applications in single-use products, stationery, toys, and other products. BioPBS can also be used in compounding with other bioplastics to improve biodegradability, as well as flow, flexibility and impact strength, heat stability and cycle time.

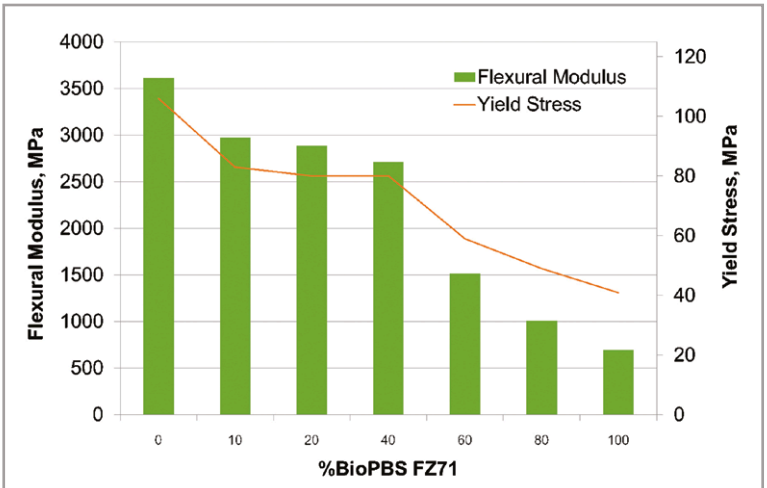
The supplier envisages the use of BioPBS for such applications as housewares, automotive, electronics and healthcare. It is already used in unreinforced form in coffee capsules and disposable tableware. PTT MCC Biochem has also been working with **Arctic Biomaterials** on development of long-

Main image: Global bioplastics production is growing, says Nova-Institute

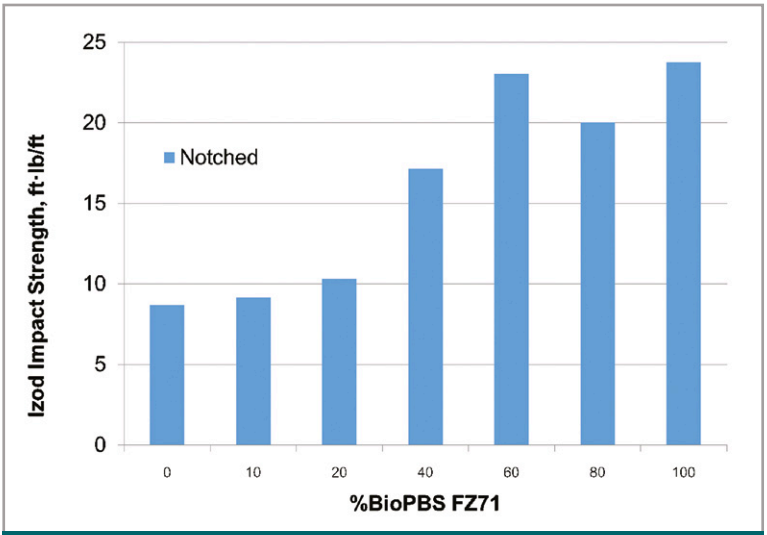
Below: Sample bottle openers made in various bio-compounds from Arctic Biomaterials



With increasing BioPBS content in a blend with PLA, the level of crystallinity increases rapidly after the addition rate rises above 20%, hitting 50%, before it virtually plateaus, hitting a maximum at an addition rate of 80%. Additionally, when using 60% of BioPBS and more, heat deflection temperature, HDT, sharply increases to almost 100°C



Adding 40-60% BioPBS improves flexibility in PLA blends



Effect on impact strength of addition of BioPBS to PLA

and short-fibre reinforced compounds incorporating the Finnish company's ABMcomposite technology, based on bioresorbable glass fibres. The fibres were originally developed for medical applications, but Arctic Biomaterials has since moved into technical applications as well.

Tomi Kangas, Sales and Marketing Director at Arctic Biomaterials, says ABMcomposite technology brings added-value properties to bio-based and/or biodegradable polymers. In PBS compounds, mechanical properties such as impact resistance are comparable with PC or PC/ABS, while flexural strength is similar to glass reinforced polyamide. An HDT A of around 110°C is obtainable.

Depending on fibre content (from 20% up to 40%), compounds can achieve a flexural modulus of 3,845–7,250 MPa, notched and unnotched (Izod) impact strengths of 30–37 kJ/m^2 and 66–74 kJ/m^2 respectively.

PLA development

Arctic Biomaterials' first venture into bio-based compounds involved the use of PLA. It has succeeded in creating compounds with HDTs of around 155°C and modulus of well over 10,000 MPa. Kangas says the company is involved in some 50 customer projects, some of them with major global brands. It now also makes compounds based on a range of different biopolymers, reinforced and also unreinforced, and also containing other bio-based additives.

Kangas says that, using its own chemical expertise, the company has been able to develop a PLA-based blend with a bio-content of over 80% that has hinge properties better than any other biopolymer currently on the market. Its most recent success is the development of PLA-based compounds (also containing PBS) that can resist temperatures of around 100°C but which do not require parts to be crystallised by annealing either in the mould or afterwards to achieve this performance, enabling injection moulding with reduced cycle times.

The Finnish company is on a steep expansion path. In Finland, it already has small-scale equipment for production of glass and compounds, including LFTs, as well as small polymer reactors. At the end of last year, it started up a large glass manufacturing plant in China, and in the third quarter of this year, it should also have a 30,000 tpa compounding line installed in the country.

"We are still a small company, but our plan is to be one of the biggest suppliers of bio-based plastics solutions in the world," says Kangas.

Trinseo says that, as a result of its acquisition of Italian compounder API in 2017, it is solidifying

Left: Typical applications of FKuR's Bio-Flex S 7514 PLA compound, which has been optimised for flowability and heat resistance, include catering items such as cutlery

its position as a provider of sustainable solutions for injection moulding to include bio-based and biodegradable plastics.

One of the most ubiquitous application areas where Trinseo biodegradable materials can be found is in single-serve coffee capsules. The company offers Apinat Bio products, which are biodegradable and compostable. It says that for this particular application, they offer exceptional mechanical and thermal characteristics, including high oxygen barrier properties. They are based on between 60% and more than 90% renewable resources.

Trinseo says it sees an important need for biodegradables in this application. "In 2016 alone, the industry still produced more than 35 billion non-recyclable plastic coffee capsules worldwide with experts expecting an increase of 17 billion plastic capsules by the end of 2020," it says. "Non-recyclable capsules end up as landfill waste. This reality combined with growing global coffee consumption creates the need for more sustainable solutions."

Bio-Fed, a branch of compounder Akro-Plastic, offers M·Vera GP1012 for coffee capsules. This bio-polyester-based compound – the company does not specify which polyester – was recently tested by inspection, control and certification corporation TÜV Austria and awarded the "OK biodegradable Soil" certificate as per EN 13432. To qualify, at least 90% of the material must degrade into carbon dioxide and water.

The supplier says all elements of the compounds meet FDA requirements for use in products that come into contact with foodstuffs. The requirements for other certificates such as "OK compost Home," as well as approval for products intended to come into contact with food as per EU 10/2011, are expected to be met this year.

Due to its light colour, the material can be coloured with a bio-based masterbatch from another Akro-Plastic branch, AF-Color.

At the Fakuma exhibition in Friedrichshafen, Germany last October, compounder FKuR presented various bio-based thermoplastic compounds, including an advanced injection moulding grade Bio-Flex S 7514, as well as bio-based TPEs. It says the PLA-based Bio-Flex S 7514 has been optimised by the company to improve processability. With an MFR of 27 g/10 min, it can be used in multi-cavity moulds and the production of parts with longer flow paths. FKuR also says that the high heat resistance (Vicat A 110°C), which is achieved without annealing to increase crystallinity, allows for shorter cycle times. Typical examples of use are catering applications such as cutlery. Bio-Flex S 7514 has a bio-based content of 75% and is available in both natural and white, which can be coloured if required.

PHB primer

Polyhydroxyalkanoates, PHAs, have been around for a long time. It is now over 35 years since ICI introduced Biopol, a polyhydroxybutyrate, or PHB. But it has taken until quite recently for the bandwagon to start rolling. Today, PHAs are offered by numerous suppliers, many of them start-ups, and volumes are on the rise. One major innovator in the field, **Bio-on**, has in recent months announced a series of initiatives involving its technology that will take its Minerv PHAs into areas well beyond injection moulding, including slow-release capsules for fertilisers, micro-powders for cosmetics, fashion products, and even electronics. It is also developing new ways to make PHAs, not only from biomass, but also frying oil and carbon dioxide.

But the learning curve to get the most out of these polymers is quite steep. "At least once a week I receive a mail asking for our PHB," Urs Hänggi, the head of supplier **Biomer** told a recent conference on PHAs. "I have to explain that it's not true what is said in the introduction of nearly all papers on PHB, that native PHB is a thermoplastic with properties like PP. This is wrong. PHB is a polymer having thermoplastic properties pretty much like DNA also has thermoplastics properties. However, in contrast to PHB, nobody labels DNA a thermoplastic.

"A PHB bottle breaks when you squeeze it, it cracks when one tries to bend it, and its properties change over time. All essential properties, except the melting points, are different in PHB and far from being useful as a replacement of PP. PHB becomes a fantastic thermoplastic by focusing on its unique (hidden) properties; and by knowing

Below: Coffee capsules – a possible application for M·Vera GP1012 from Bio-Fed

PHOTO: BIO-FED

how to compound and process it."

Hänggi says that the PHB chain is absolutely regular, with only C4 sub-units, and absolutely isotactic. Both facilitate crystallisation. The chains are also absolutely linear, without any branches, so they cannot entangle. The glass transition temperature of PHB is at 0°C or below. "This means that polymer chains keep on moving and crystallising even at room temperature. Such a combination of properties is unknown in any synthetic thermoplastic."

The absolute regularity yields hard, creep resistant parts, the linearity of the polymer chains allows adjustment of melt viscosity right in the machine, and finally, the glass temperature results in stable parts.

"The hard, creep-resistant parts are due to the fact that PHB does not stop crystallising until the thermodynamic optimum is reached, that is, until all polymer molecules are fixed in crystals. There they stay forever.

"If you aim at high speed moulding, you simply lower the temperature at the tip of the screw so that crystallisation already starts in the barrel. If you aim at filling the finest cavities in a mould, you increase the temperature at the tip of the screw. I am not aware of any other thermoplastic with which you could adjust the viscosity as easily as PHB right in the machine.

"The reason for the stability is that, after having reached the thermodynamic end point, there is no free amorphous mass left to move. This is also the reason why we can guarantee no changes in properties if the parts are exposed for five years from -40 to +60°C. UV does no harm as there are no double bonds in the chains and no aromatic subunits that might absorb UV light. With respect to mechanical and UV stability over time, PHB beats PP."

Above: The PHA famiy of polymers is very broad and versatile. These products, made by various processing routes, not just injection moulding, are in a copolymer of hydroxybutyrate with hydroxyhexanoate, PHBH, from Kaneka, which recently said it would expand its manufacturing facility in Takasago, Japan, to around 5,000 tonnes/yr. It will begin operating in December

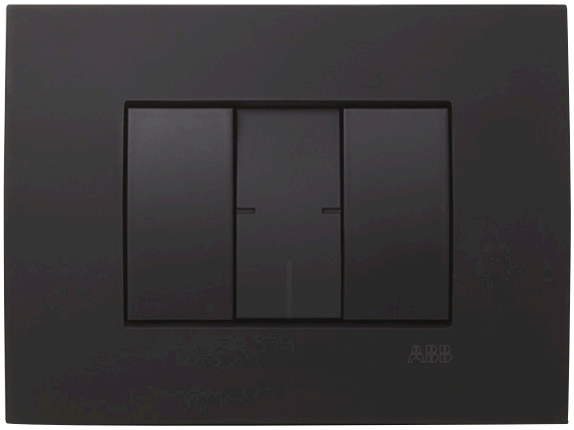


PHOTO: MAIP

Right: ABB switch cover

There are obstacles on the road to PHB reaching its full potential, but they can be overcome, says Hänggi. Problems with degradation in the melt, for example, can be averted by extracting PHB in a solvent rather than in water (the way it is usually done) to avoid the presence of calcium ions that catalyse degradation. Slow crystallisation can be countered in numerous ways, including improved nucleation. Hänggi says Biomer now offers grades with a new nucleant that produces spherulites sizes of below one micron, and has started tests with another that promises to yield even smaller spherulites.

But the most severe impediment to using PHB as thermoplastic is that PHB parts get brittle over time. Hänggi says this is due to voids appearing between spherulites, which act as "cracking gates" through the parts. **"**The best solution is to link the spherulites by molecules that span the voids and interact with the crystals. This type of interaction is very strong and firm. And so you finally end up with hard, creep resistant parts.

"Taken all together and processed the right way PHB becomes an exceptional thermoplastic."

Plastics sell by properties, he concludes. "PHB is no exception. Biodegradation is a property, but as a matter of fact we have no customers who focus on biodegradation. This might change in the future, but only if the parts are of equal or better quality than the original parts. Some of our clients look for 'renewables', but to most of them the term 'bio' is of minor importance and considered a fringe benefit. Almost all of our clients focus on the specific properties."

One compounding company having success with PHB (and other biopolymers) is **MAIP** in Italy. One of its more notable successes is the use of one of its IamNature compounds for Etik frames in the Mylos range of wiring accessories produced by ABB. They replace frames made in traditional

thermoplastics (PC/ABS for example). IamNature is said to be strong and durable, resistant to heat and light, and water resistant. MAIP managing director Eligio Martini says that the compound, which was developed specifically for the application, has exceptional scratch resistance.

MAIP uses a full range of biopolymers, including the Bios family, which are biodegradable and made from renewables; Kios, also made from renewables but non-biodegradable; and Orios, which are biodegradable but fossil-sourced. The company's main focus has been on the Bios family (which includes PLA), PHAs and other polymers derived from biomass.

IamNature compounds use one or more polymers from the Bios family (predominantly PHAs), together with vegetable fillers, mineral fillers, and natural colours. MAIP has developed over 100 different formulations, all of them compostable. Some have also been tested to show that they degrade in sea water. "IamNature degrades just like wood," Martini says. "If I leave an ABB cover on the wall, it will last for years and years. But if it ends up in the soil or a stream, it will rot as microorganisms attack it. The great advantage of PHB over PLA and PBS is that it degrades in sea water and also in anaerobic conditions."

Polyamide substitutes

Staying with durables, numerous polyamide producers now have partly or fully bio-based products in their line-ups. These are almost always the ones that have a 10 in them, which means they have the acid component derived from castor oil. Companies include Arkema, BASF, DSM, DowDuPont, EMS-Grivory, Evonik, and Radici. More often than not, grades are intended for extrusion applications, but some have also been developed for injection moulding.

RadiciGroup has been offering Radilon D PA610 for around seven years. PA610 is around 63% bio, says Market & Application Development Director Erico Spini. He says the company developed an interesting number of applications for Radilon D by bringing together the competence in polymerisation of the group's chemicals division with the compounding and marketing know-how of RadiciGroup's newly-named High

PHOTO: MAIP

Above: Pens injection moulded in IamNature


PHOTO: DSM

Right: Expansion tank made by Heyco in DSM's EcoPaXX PA410 has high performance as well as environmental credentials

Performance Polymers business.

Spini points to a growing number of interesting applications that make use of some key characteristics of PA610: higher chemical resistance than PA 6 and 66, better hydrolysis resistance, and improved dimensional stability (due to lower water absorption). Its density, 1.07, is also lower (PA6 weighs in at over 1.1, PA66 at over 1.3). PA610 also scores with its better resistance to cooling liquids, as well as road de-icing chemicals. In fuel lines, it offers the possibility of both tubes and fittings being made in the same material.

RadiciGroup has developed an injection moulding grade of Radilon D PA610 for fuel line connectors, incorporating an impact modifier and 30% glass fibre. This is Radilon D ERV 300 W 333 BK. The company is also developing an unfilled grade, Radilon D HS 3032 BK, which gives improved surface properties, targeted at automotive interior components. Gloss retention after exposure to UV radiation is very good, as is chemical resistance, including resistance to creams and lotions that may transfer from the skin of passengers. Spini also mentions Radilon D RV 600 RKT, which has 60% glass, for sanitary components carrying water at temperatures of up to 60°C. It has approvals from various water authorities.

Despite the clear sustainability benefits, for many years bio-based plastics have struggled to grow beyond a few niche applications in the automotive industry, says **DSM**. However, this is starting to change as automakers discover some of the unique performance characteristics a bio-based resin can provide versus more traditional materials.

With its EcoPaXX, which is a PA410, DSM has succeeded in producing a polyamide that is 70% bio-based and certified 100% carbon neutral from cradle to gate. DSM says that, as the global PA66 shortage continues, EcoPaXX offers a sustainable alternative that doesn't sacrifice performance. Because EcoPaXX maintains its strength during aging, this enables thin-walled parts that reduce weight by 30% over PA66, the company says. EcoPaXX absorbs 30% less moisture than PA66 and 40% less than PA6, offering benefits in terms of dimensional stability and hydrolysis resistance. EcoPaXX can be moulded using the same tooling as PA66.

One target application is coolant expansion tanks, which are made by a combination of injection moulding and welding. The material must withstand under-the-hood temperatures of 105°C to 150°C; exposure to water glycol; internal coolant temperatures of 120°C to 137°C; internal pressure levels of more than 2.3 bar; and vibration from the chassis or engine. It must obviously also demonstrate good welding properties, with high strength at the weld line at under-the-hood temperatures. Under these conditions, DSM says, PA66 is now at the limit of its performance capabilities.

EcoPaXX demonstrates superior chemical stability and weld-line strength after aging, resulting in a part that lasts up to three times longer, with higher safety margins. The ability to use thinner walls and still get a technically superior part means that EcoPaXX turns out cost-competitive with PA66.

Another bio-based polyamide is **Cathay Industrial Biotech's** PA56. Alex Kedo, vice president of the company's international business, says the successful commercialisation of its new bio-based polyamide monomer, 1,5-pentanediamine (PDA), "has significantly increased the functional options for the polymer chemist as well as provided the competitive market advantage by being bio-based." (See also *Injection World* March/April 2017.)

"We supply a broad range of applications within injection moulding and are growing," he says, adding that confidentiality agreements prevent him from naming customers. "Besides performance, the renewable attribute is a key selling feature."

PDA, a five-carbon diamine, is produced from sugar via a fermentation process using Cathay Industrial Biotech's proprietary technology. PA56 has a similar crystalline structure to PA66 and as such has similar stiffness, tensile and flexural modulus

Below: Comparison of various properties of grades of PA56 with PA66

Flame Retardance

	PA56a	PA56a Flame Resistant
Tensile Strength (MPa)	83	83
Tensile Modulus (MPa)	1921	2246
Flexural Strength (MPa)	98	110
Flexural Modulus (MPa)	2255	3028
IZOD (kJ/m²)	3.0	2.9
Flame Retardance (UL-94)	V-2	V-0

Impact Resistance

	PA56b	PA56bGF
Tensile Strength (MPa)	91	182
Tensile Modulus (MPa)	1671	8095
Flexural Strength (MPa)	109	265
Flexural Modulus (MPa)	2611	8330
IZOD (kJ/m²)	2.3	9.5

Heat Ageing

Tensile Strength MPa 120°C	PA56HR	Competitive PA6 Heat Resistant Product
0 Hour	84	83
500 Hour	85	86
1000 Hour	63	63

Dimensional Stability

1000 Hours (room temperature)	PA56DS	Competitive PA66 Dimensionally Stable Product
Transverse Mold Shrinkage (%)	0.88	1.68
Flow Mold Shrinkage (%)	0.89	1.54

and wear resistance. In addition, PA56 has been observed to have inherent flame resistance (limiting oxygen index is 32-34%).

Cathay has formulated various products based upon PA56. The tables show four formulations, suitable for injection moulding, and how they compare with virgin resin or PA66 formulated to have similar properties.

Flame retardance of a UL-94 V-0 for PA56 was achieved without compromise of other key function properties. Impact resistance was obtained by compounding with glass fibre. The tensile strength of PA56b, the virgin resin, is considerably higher than that normally obtained for PA66, and provides an example of the molecular weight achievable for PDA-based polyamide due to the greater flowability at high sheer.

In heat ageing tests, PA56 showed the same reduction of tensile strength as a PA66. Finally, dimensional stability of PA56 in both the flow and transverse axis is superior to that of PA66.

"The polymerisation potential for PDA has only just begun," says Kedo. "In addition to the market benefit of having 100% of its carbons from renewable sources, this unique monomer imparts benefits which provide the compounder and injection moulder a competitive advantage."

Strictly speaking, it is not a biopolymer, but Desmopan 37385A from **Covestro** does have some attractive environmental credentials. It is the first thermoplastic polyurethane (TPU) containing polyether carbonate polyols produced with the aid of CO_2. Covestro says its mechanical properties are at least at the level of conventional TPU grades of

Bioplastics used for youngsters' toys

When it comes to bio-polyolefins, users like the sustainability that they confer. In terms of properties, there is no difference at all between a polyethylene or a polypropylene made using ethylene from sugar cane, and one using ethylene from fossil-based oil.

This likely explains why numerous new users of Braskem's sugar-derived "I'm green" polyethylenes are producing consumer products – and consumer products for kids.

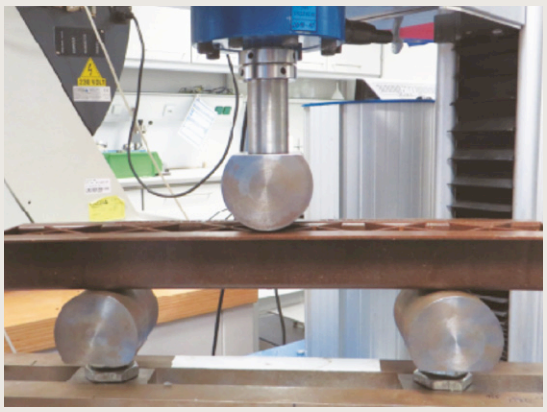
Viking Toys in Sweden uses the material for its Ecoline range, which it says "combines Viking Toys timeless design of durable and non-toxic toys with an oil-free, plant-based material made from sugar canes." Another customer, Dantoy in Denmark, says it is launching a new line of bioplastic products, "thereby enlarging our already eco-friendly selection of plastic toys." These two launches come after Lego also began using the Braskem polymer for some products (see *Injection World* March 2018).

Beyond toys, packaging is another important target market for Braskem. Last year, United Caps, headquartered in Luxembourg and with production units across Europe, said it had collaborated with Braskem to deliver bio-sourced plastic caps and closures as an addition to its portfolio. It has started with two standard closures: the Victoria, a 30/25 screw closure designed for still drinks; and Proflatseal for dairy products and still drinks.

Compounds with natural fibres

PolyOne says its reSound NF, a natural fibre filled portfolio of materials launched in 2015, is making headway these days with a number of appliance manufacturers interested in creating products with a higher sustainability factor. Products have a minimum 30% bio-based fibre content and can be formulated using a number of base resins, including PLA blends but also fossil-based polymers like ABS and PP.

Testing at Fraunhofer ICT Institute in Pfinztal, Germany has shown that a 40% filled reSound NF formulation has equivalent performance to a 30% filled short glass fibre reinforced alternative, at a 7-8% lower density. Several trials have shown that reSound NF can be successfully processed on standard injection moulding machines and dropped into existing tooling with little to no modifications.



similar hardness, and even exceed some of them. For example, it has a tensile strength of 36 MPa. The elongation at break is 660%. It is suitable for extrusion and injection moulding.

Desmopan 37385A has a hardness of 85 Shore A. Covestro plans to expand the series with variants of different hardness. A product with a hardness of 95 Shore A is in advanced development.

Back on more solid bio-ground, **Lubrizol Engineered Polymers** says it is working on a new generation of its aliphatic Bio TPU for injection moulding. "This is the first bio-based TPU that looks, functions and feels even better than conventional TPU," the company says. "The new development is designed to achieve outstanding moulding performance, mechanical strength and chemical resistance." Shore A hardness is 80. The grade can be highly transparent or in light colours, does not yellow, and has high stain and hydrolysis resistance.

Trinseo also offers bio-based non-degradable TPUs, designated Apilon 52 Bio, for footwear and the leather goods sectors. These compounds were also designed to have equivalent physical-mechanical properties and the same processability as traditional fossil-based TPUs.

Below: Lubrizol is aiming at light-coloured auto interior parts, among other things, for its bio-TPU

At another TPE supplier, **Hexpol TPE Group**, Global R&D Manager Klas Dannäs says interest in bio-based materials in the automotive industry has accelerated over the last few years "and it's an upward trend. Our Dryflex Green TPEs are being adopted for several applications previously using conventional TPE compounds, both as a drop-in substitution, without the need for mould or tool modification, and also for new developments."

Dannäs says that, since most bio-based raw materials in the market are quite hard on their own, a major challenge has been to develop compounds with high renewable content at low hardnesses, while at the same time maintaining mechanical properties at acceptable levels. "With grades from 15 Shore A, Dryflex Green TPEs differ from other soft thermoplastic materials on the market, by also including soft materials with high levels of renewable content," he says. Depending on the hardness, compounds with a renewable share of over 90% are possible.

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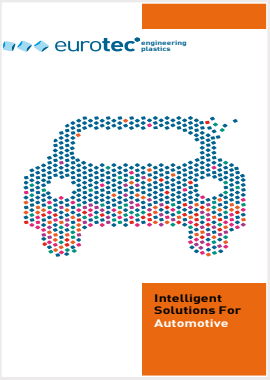

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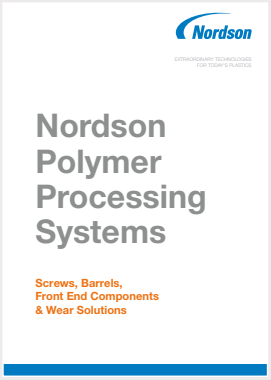

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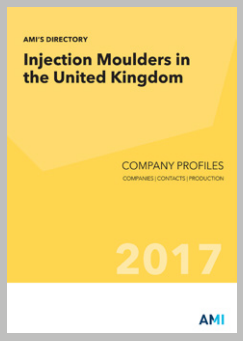

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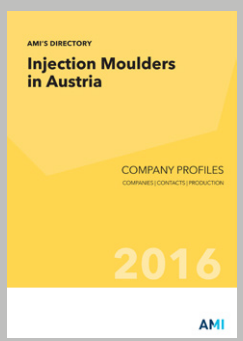

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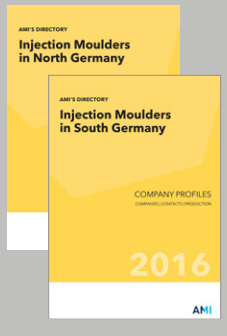

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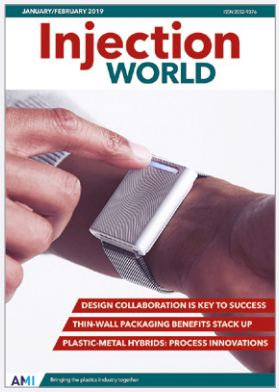

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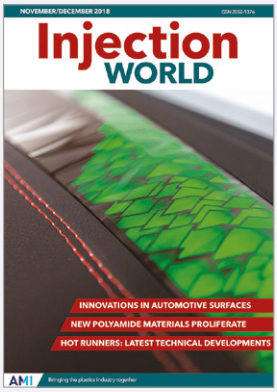

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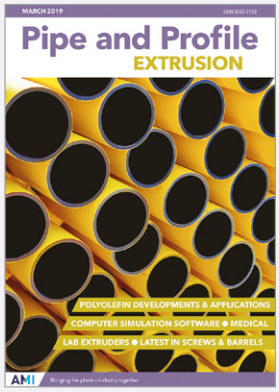

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The March issue of Pipe and Profile Extrusion explores the growing use of PP in the pipe industry. It also takes a look at the latest developments in computer modelling, medical tubing technology, lab extruders and screw design.

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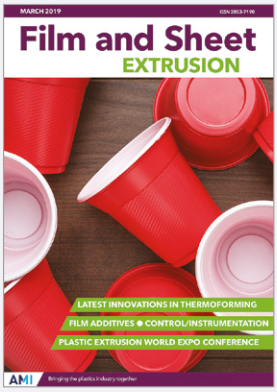

Film and Sheet
March 2019
The March issue of Film and Sheet Extrusion magazine takes a look at the latest in thermoforming, additives for films and innovations in film extrusion technology. Plus regular updates on machinery and materials.

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GLOBAL EXHIBITION GUIDE

2019

19-21 March	EU Coatings Show, Nuremberg, Germany	www.european-coatings-show.com
25-29 March	Plástico Brasil, São Paulo, Brazil	www.plasticobrasil.com.br
26-28 March	PlastPrintPack Nigeria, Lagos	www.ppp-nigeria.com
28-30 March	Mecspe, Parma, Italy	www.mecspe.com
2-5 April	Plastimagen, Mexico City	www.plastimagen.com.mx
8-12 April	Feiplastic, Sao Paulo, Brazil	www.feiplastic.com.br
10-12 April	Utech Las Americas, Mexico City	www.utechlasamericas.com
8-9 May	Compounding World Expo, Cleveland, US	www.compoundingworldexpo.com/na
8-9 May	Plastics Recycling World Expo, Cleveland, US	www.plasticsrecyclingworldexpo.com/na
8-9 May	Plastics Extrusion World Expo	www.extrusion-expo.com/na
8-9 May	Plastteknik Nordic Malmö, Sweden	www.easyfairs.com
21-24 May	Chinaplas 2019, Guangzhou, China	www.chinaplasonline.com
21-24 May	Moulding Expo, Stuttgart, Germany	www.moulding-expo.com
28-31 May	Plastpol 2019, Kielce, Poland	www.targikielce.pl
11-12 June	PDM Event, Telford, UK	www.pdmevent.com
19-22 June	Interplas Thailand, Bangkok	www.interplasthailand.com
5-7 September	Utech Asia, Guangzhou, China	www.puchina.eu
18-21 September	T-Plas / Tiprex, Bangkok, Thailand	www.tplas.com
16-23 October	K 2019, Dusseldorf, Germany	www.k-online.com
25-28 November	Plastivision Arabia, Sharjah	www.plastivision.ae
27-29 November	Plastics & Rubber Vietnam	www.plasticsvietnam.com

AMI CONFERENCES

27-28 March 2019	Polymers for Oil & Gas Engineering, KL, Malaysia
2-3 April 2019	Fire Retardants in Plastics, Pittsburgh, PA, US
14-15 May 2019	Performance Polypropylene, Cologne, Germany
3-5 June 2019	Plastic Closure Innovations, Barcelona, Spain
4-5 June 2019	Oil & Gas Polymer Engineering, Houston, TX, US
4-5 June 2019	Compounding World Congress, Cologne, Germany
18-19 June 2019	Polymer Foam, Pittsburgh, PA, US
18-19 June 2019	Plastics Recycling Technology, Düsseldorf, Germany

For information on all these events and other conferences on film, sheet, pipe and packaging applications, see

www.ami.international

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