

# Injection WORLD



**ENERGY DRIVE: COST SAVINGS MAKE SENSE**

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**AIMING FOR NEW HEIGHTS IN BIO-BASED PLASTICS**

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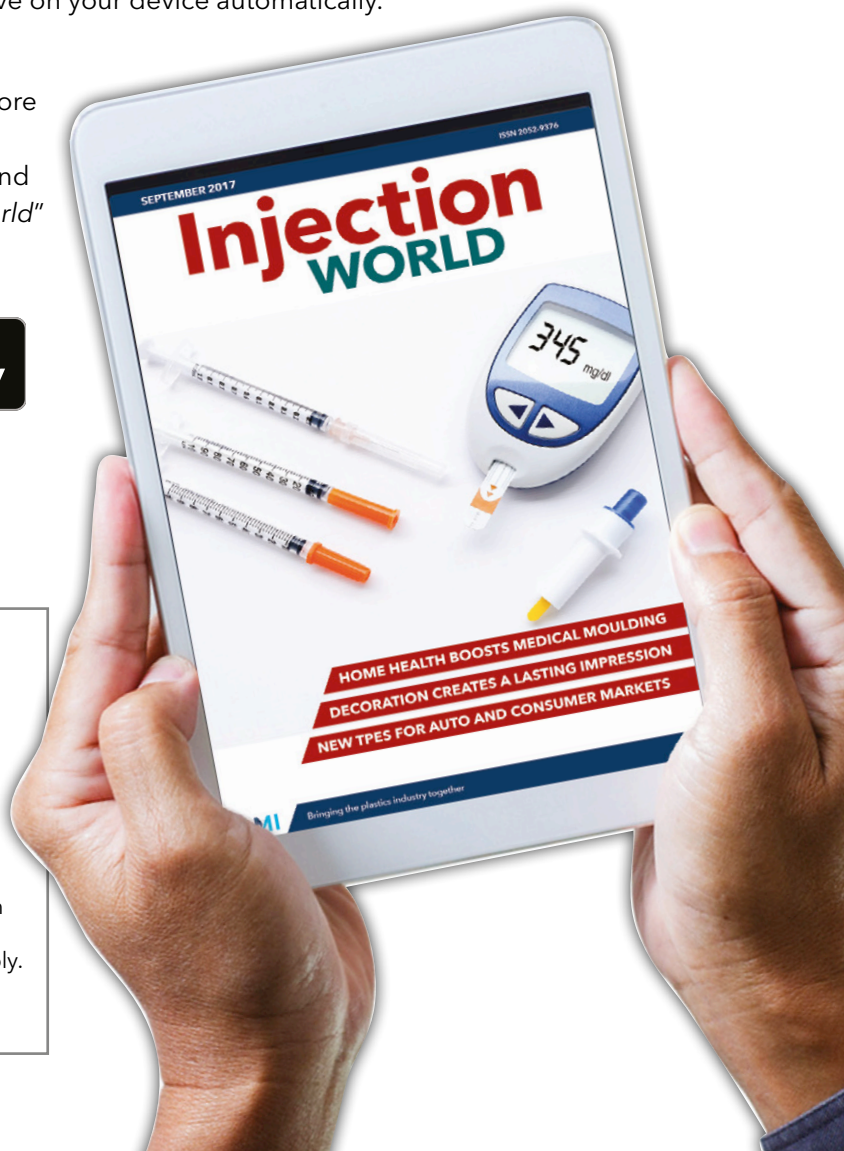
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# Injection WORLD

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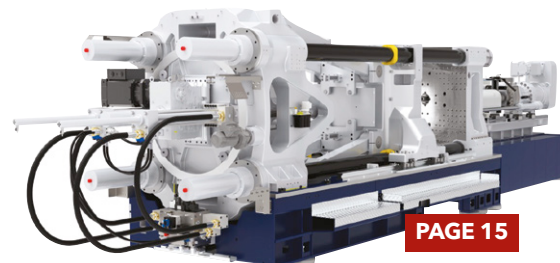
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# PlasticsEurope: Covid-19 impacted 2020 demand

First estimates by PlasticsEurope suggest that production and demand for plastics were stable globally but fell in Europe in 2020, which, the trade body said, was a "particularly challenging and atypical year". This was a direct result of the Covid-19 pandemic.

Worldwide, plastics production reached about 367m tonnes, 0.3% down on the 2019 total, according to PlasticsEurope. China's share of global output increased from 31% to 32%, in line with the growth of its customer industries, while North America's share remained stable at around 19%.

Europe's production, however, fell by more than 5% from around 58m tonnes in 2019 to 55m tonnes, taking its share of global production down from 16% to 15%. Similarly, demand from European plastic

IMAGE: SHUTTERSTOCK



**Shutdowns in car production hit European plastics demand**

converters was about 5% lower at 48m tonnes, the lowest figure since 2014.

The decrease in Europe, PlasticsEurope said, "was strongly driven by a decline in production in two main application sectors". Packaging demand fell by about 500,000 tonnes (a 2.5% fall), mainly due to the knock-on effect of falling production of industrial and commercial goods hitting demand for commercial and

industrial packaging.

European automotive plastic demand, meanwhile, was badly hit by multiple production shutdowns in the first half of 2020 that a recovery in the second half could not make up for. Overall vehicle production numbers were around 23% down in 2020. First estimates of plastic demand in construction suggest that it remained stable in 2020.

> [www.plasticseurope.org](http://www.plasticseurope.org)

## Fanuc medical order

UK-based medical device manufacturer Boddingtons has revealed that it received four Fanuc injection moulding machines during February, which are now fully commissioned in its Class 7 cleanroom. A fifth is due to arrive in June.

The order was made to meet demand from a new pharmaceutical OEM client, as demand from this sector has grown strongly during the Covid-19 pandemic. It involves a combination of tool transfer and new tooling, the firm said. Most of the moulding work will be to produce components for pharmaceutical devices that are used in the testing of bacteriological, viral and cell cultures.

> [www.boddingtons.co.uk](http://www.boddingtons.co.uk)

> [www.fanuc.eu](http://www.fanuc.eu)

## US training recognised

The US ANSI National Accreditation Board (ANAB) has extended its ANSI/ASTM E2569-18 accreditation to include all three of the American Injection Molding Institute's Molding Series training programs. The institute is a subsidiary of injection moulding training and consultancy company Beaumont.

> [www.beaumontinc.com](http://www.beaumontinc.com)



IMAGE: LITTLE YOU

**Above: Little You figures 3D printed by Rize using Rizium composite materials**

## Partners 3D print little characters

Rize, a Massachusetts-based specialist in industrial 3D printing, has joined forces with Little You, a personalised toy design platform in Toronto, to enable full-colour, functional 3D anime toys to be made using Rize's Rizium composite materials.

The two said that the materials make more durable toys, which were only available in relatively fragile 3D colour sandstone until now. In addition, Little You will be able to scale its operations up more efficiently.

> [www.rize3d.com](http://www.rize3d.com)

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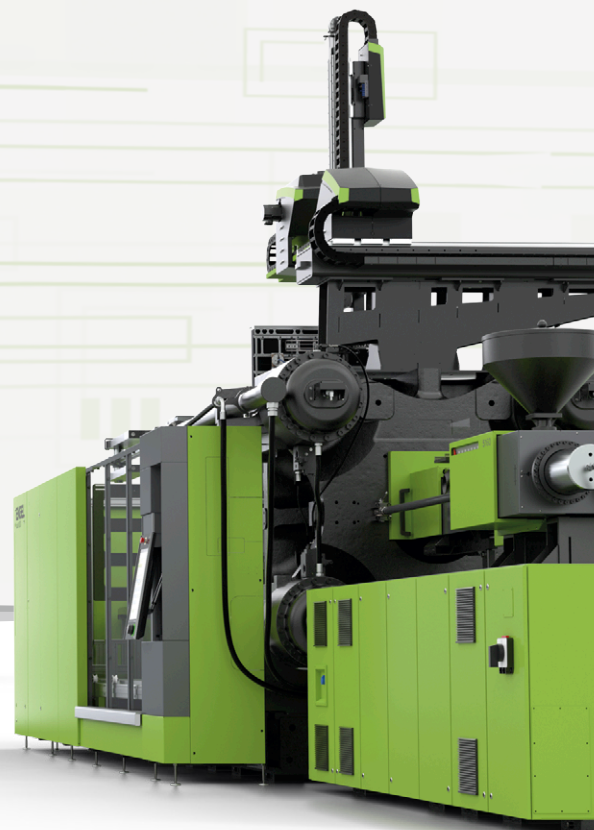
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# Techniplas buys Nanogate core

US-based plastic components giant Techniplas Group has signed an agreement to acquire the holding company and other "major parts" of Germany's Nanogate, which has been in self-administration since June 2020. The price is said to be in the "mid-double-digit million range", all of which will be paid to creditors.

Nanogate produces multi-functional components and surfaces primarily for automotive and general industrial applications. The finishing technologies it offers include radar-transparency, translucency, anti-corrosion, scratch-

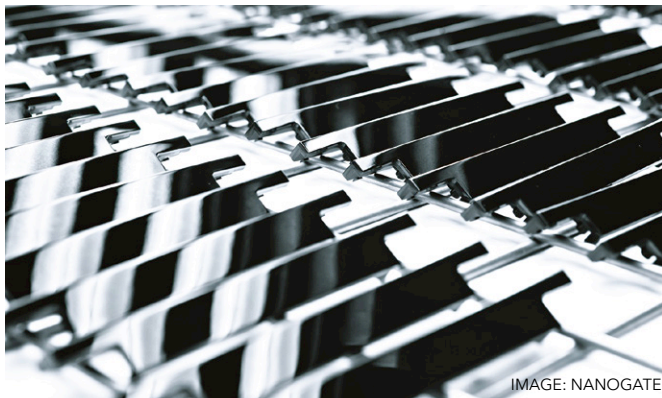


IMAGE: NANOGATE

**Above: Nanogate is a specialist in finishing technologies for injection moulded parts**

proof, non-stick and easy-clean properties.

Techniplas CEO Ali El-Haj said: "The addition of Nanogate's unique and proprietary finishing

capabilities will strategically complement Techniplas' core expertise in injection moulding to create one of a few companies of scale with a full suite of moulding and

finishing capabilities."

Techniplas is acquiring much of the insolvent subsidiaries Nanogate Management Services, Nanogate NRW, Nanogate PD Systems and Nanogate Neunkirchen, plus the solvent Nanogate North America, Nanogate HET Engineering, Nanogate Netherlands, Nanogate Schwäbisch Gmünd and Nanogate Slovakia.

Nanogate Textile & Care Systems and Nanogate Electronic Systems were not part of the Techniplas acquisition and were sold in a management buy-out deal.

➤ [www.techniplas.com](http://www.techniplas.com)

## Husky's new colour change feature

Husky Injection Molding Systems is working with Chem-Trend on a system to create repeatability during the critical colour change process.

The system is based on the process for using Chem-Trend's Ultra Purge compounds, which is itself designed specifically to reduce colour-change

time and carbon formation in hot runner systems. It is integrated as a guided procedure within the Husky Altanium mould controller operator interface.

The two companies said that they "aim to significantly enhance their customers' operational margins by

increasing equipment and labour uptime." In trials, up to 85% reduction in scrap and 80% increase in mould cleaning efficiency have been achieved when following the recommended process.

➤ [www.husky.ca](http://www.husky.ca)

➤ <https://chemtrend.com>

## New plant in Mexico

Toyoda Gosei has established a new plant at its Tapex Mexicana site in Monterrey, Mexico producing automotive airbags on behalf of multiple Japanese OEMs. Overall, the company plans to increase total airbag capacity about 1.6-fold, to 100 million units by 2023.

➤ [www.toyoda-gosei.com](http://www.toyoda-gosei.com)

## Aptar develops mono-material pump

Aptar has launched Future, its first fully recyclable mono-material pump for packaging in the beauty and personal care industries. This is made using PE only, aligning it with the commonest materials in use in the bottles and thus making the full package more readily recyclable, the company said.

Key features of the pump include an incorporated on/off locking system and a 360° actuator. This makes it compliant with ISTA 6-Amazon protocol, subject to final tests by a brand's bottle choice.

The Future pump is certified by Cyclos-HTP, the institute for recyclability and product responsibility, and marked as 'A' by RecyClass, which works to establish a harmonised recycling approach and traceability in Europe. It is also available using post-consumer recycled plastics, and Aptar has obtained International Sustainability & Carbon Certification for its European production.

➤ [www.aptar.com](http://www.aptar.com)



IMAGE: APTAR

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# Canadian plastics firms to fight 'toxic' listing

A coalition of Canadian plastics companies is to challenge its government's decision in May to add "all plastics manufactured items" to the toxic substances (Schedule 1) list in the Canadian Environmental Protection Act (CEPA), the country's main piece of legislation covering human health and environmental protection.

The newly-formed Responsible Plastic Use Coalition (RPUC) has filed a notice of application in the Federal Court of Canada challenging the decision. It argues it is scientifically unjustifiable and points out that plastics comply with

federal regulations in place to ensure safe use.

Substances can be added to the CEPA Schedule 1 list if they are considered to be harmful to environment and biodiversity and/or human



health. Legal experts say that inclusion of "all plastics manufactured items" on the list may simplify the process of implementing bans on single-use products such as plastic drinking straws and

can collation rings.

However, "all plastics manufactured items" is the only non-specific class of substances to be added to the Schedule 1 list. The RPUC described the inclusion as "a significant over-reach by the federal government" and said the move presents an obstacle to creation of a circular economy.

"The challenge we face is not that plastic is toxic, but rather the challenge of post-consumer plastic in the environment resulting from human behaviour and systemic waste management and recycling shortfalls," the coalition says.

➤ <https://rpuc.ca/>

## US moulder adds largest Engel yet

Custom moulder i2-tech of West Des Moines, Iowa, has revealed that it will take delivery in June of the largest machine it has bought from Engel in their five-year relationship. Originally ordered in October 2020, this has 4,400 US tons of clamping force and an integrated Viper 120 linear robot.

"For a long time, many of our customers had been asking us to quote business in the 4,400-plus press range. And we've had to no-quote those opportunities," said Darin Endecott, president of i2-tech. "In addition, we needed redundancy for our 3,300-ton press for disaster recovery purposes."

The new machine will

enable i2-tech to add parts such as sun tops on recreational vehicles, and fuel and hydraulic tanks. This is all part of a larger expansion that includes four more Engel machines in the 310-1,725 tonne range. It is also increasing its production and warehousing space.

➤ [www.engelglobal.com](http://www.engelglobal.com)

➤ <https://i2-tech.com>

## Jokey invests in France

Jokey France has revealed that it completed construction of a fully automated high-bay warehouse at Labourse, northern France, in 2020, after two years of work. This has also cleared space to enable new production lines to be set up in the future, the company said.

Within the new warehouse, which operates around the clock, 7,500 pallet spaces are stored in ten levels over an area of 2,000 m<sup>2</sup>. Three cranes move autonomously between the 25m high racks to store and retrieve pallets. In all 80 pallets can be stored each hour.

In addition, Jokey is investing in a 1,800 m<sup>2</sup> photovoltaic system to generate electricity to power the plant, which should be completed by summer. In all, the company is investing €5.2m in energy-efficient and energy-saving technologies as part of a commitment to carbon-neutrality by 2030.

➤ [www.jokey.com](http://www.jokey.com)

## SABIC advances EV battery packs concept

SABIC's automotive business in the Netherlands has developed a plastic-intensive electric vehicle (EV) battery pack concept, using a systems-engineering approach. This is said to offer 30-50% weight savings per component, improve energy density, simplify

assembly, reduce costs, improve thermal control and safety, and enhance crash-worthiness.

The company expects several large battery enclosures moulded with its thermoplastics to be used in production EVs by 2024. One plug-in hybrid

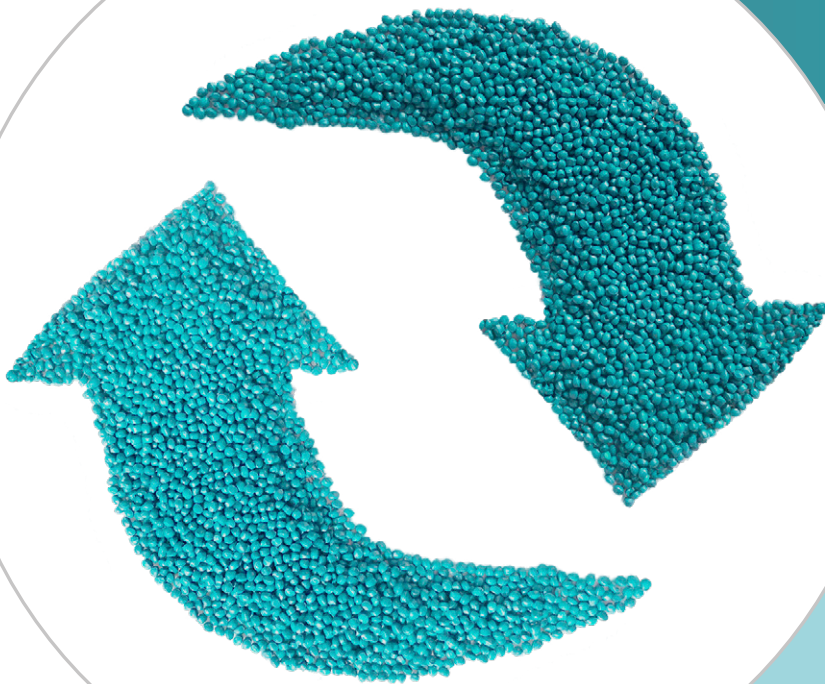
EV model in China is already using a SABIC PP compound instead of aluminium for its battery pack cover, while others are using its materials for cell carriers and housings, battery modules and battery enclosures.

➤ [www.sabic.com](http://www.sabic.com)

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US-based plastic packaging firm Berry Global has announced plans to invest further into 'circular polyolefins' by sourcing PP from Borealis that has been made through chemical recycling. This will be used in food packaging at one of the company's European manufacturing facilities from Q3. Berry already has access to about 275,000 tpa of post-consumer recycled content and had announced plans to source a further 135,000 of chemically recycled material in April.

[www.berryglobal.com](http://www.berryglobal.com)

Plastic closures giant Bericap has expanded its portfolio to include aluminium closures by acquiring the German, family-owned firm Mala Verschluss-Systeme. The company said that this will give it the opportunity to open up new market segments and to develop innovative closure technologies combining plastic and aluminium. Mala employs 200 at two sites in Germany.

[www.bericap.com](http://www.bericap.com)

# Conair's new platform for common controls

US machinery supplier Conair is implementing a common control platform for all its auxiliary equipment to deliver a consistent user experience. Sam Rajkovich, Vice President, Sales & Marketing, said the common platform "will give a leg up to processors".

Unveiling the initiative at an online media event in May, Conair executives said the new platform and HMI have already been implemented in the company's new SmartFLX material handling control, truck-fill line-proofing system, blenders and temperature-control units. It is scheduled to be released on dryers in the third quarter - chillers and other equipment will follow later. Other systems, such as Wave Conveying and Conair's new RFID-proofed resin-selection system are controlled through the SmartFLX Platform.

The development took two years to complete, said Matt Shope, Director of

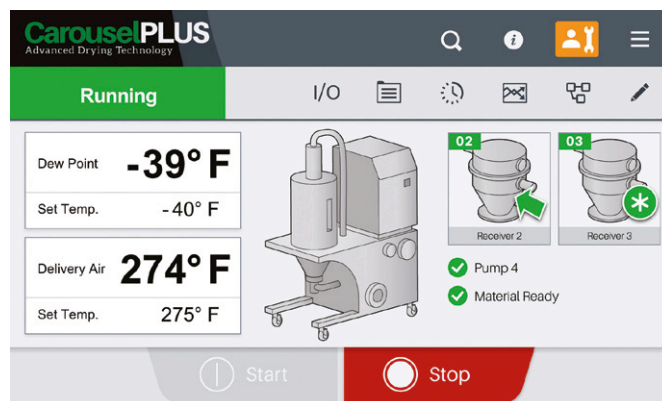


IMAGE: CONAIR

**Dryer example of Conair's new unified interface**

Engineering. Conair wanted a common control platform to reduce training time for its customers, he said, and it worked with a design firm on the HMI.

The controls are compatible with SmartServices, Conair's cloud-based Industry 4.0 solution for machine monitoring and data collection. The Machine Control portion of SmartServices mirrors the same control screen that an on-the-floor operator would see, said the company.

The latest version of SmartServices gives users expanded naming, group-

ing, and sub-grouping features, an increase from three to ten customisable KPIs for each machine type, and new resin usage features.

Other new products discussed at Conair's online event included: AutoWave, a new automated feature of its multi-phase, variable-speed Wave Conveying system for materials handling; new temperature control units in its TW Series; and PipeMaster downstream processing equipment and tooling for pipe extruders.

➤ [www.conairgroup.com](http://www.conairgroup.com)

## Thin-wall packaging application centre opens

SABIC and KraussMaffei HighPerformance have officially opened their Thin-Wall Packaging Application Centre at the site of KraussMaffei's Netstal subsidiary in Näfels, Switzerland. The stated aim is to facilitate "innovative application, material and processing solutions in the thin-wall packaging industry through closer collaboration across the segment's entire value chain".

SABIC added that it will use the centre in collaboration with others to develop added-value materials in terms of enhanced mechanical performance, more efficient processability and greater sustainability value. The learnings will also be used to further improve the Netstal injection moulding portfolio for packaging applications.

Additional capabilities there include

in-mould labelling and part handling capabilities, advanced tooling and testing equipment. The first new systems installed by SABIC will include moulding equipment designed to investigate injection compression moulding options and test the mechanical properties of thin-wall packaging applications.

➤ [www.sabic.com](http://www.sabic.com)

➤ [www.kraussmaffei.com](http://www.kraussmaffei.com)

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# Wittmann says supply shortages cause concern

First-quarter 2021 order intake at injection moulding and ancillary equipment maker Wittmann Group hit an all-time record, according to company President Michael Wittmann. However, he warned shortages of raw materials are impacting heavily on component supply, which means uncertainty in predicting full year results.

"We are on track right now to reach €400m or higher, that means an increase of more than 30%. However, if material shortages continue then certainly there might be some slowdown and, in the worst case, that could result in revenues of €350m for this year. That's still a very nice increase but definitely not what is possible," he said at a virtual meeting held in May to mark the introduction of its Wittmann Interactive remote training platform.

While the first part of 2020 was certainly hit hard by the onset of the Covid-19 pandemic, Wittmann said the company had seen investment pick up from the beginning of the second half of the year and that improvement is evident across the board. "Every sector has been doing well with the only exception automotive, which is average," he said.

Markets proving the most buoyant are those directly linked to the home, such as garden products, electronics and white goods. And while automotive has not recovered in terms of the number of cars sold, Wittman said model programme delays caused by the pandemic and the shift to EVs have now eased. "The automotive industry is now stable," he said.

Wittmann warns, however, that the combination of high investment and material and component shortages



**Above: Raw materials and electronic components are in short supply, says Michael Wittmann**

means delivery times are inevitably extending. "Everything electronic is in short supply but not only electronics. There is also a shortage of steel. We are still able to get steel and sheet metal but the prices are going up and not just by percent but by factors," he said.

"The situation is quite critical - now and for the months to come. We think it will remain critical to the fall and we are not seeing any kind of improvement [in material and component availability]," Wittmann said.

While plastics industry investment is recovering rapidly from its Covid lows, it is likely that the pandemic will continue to shape the way business will operate.

In particular, Wittmann sees digital communication tools becoming a core part of its sales and support strategy for the future, hence the investment in its Wittmann Interactive technology. This uses multiple media tools to allow virtual demos as well as to support customers in fault-finding or to run remote acceptance trials on new production.

➤ [www.wittmann-group.com](http://www.wittmann-group.com)

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*Good energy management is now an essential aspect of an effective injection moulding operation. Machinery manufacturers are now meeting this challenge with new technologies and features to achieve energy-saving goals, writes Mark Holmes*

# Energy drive: making savings makes sense

Twenty to thirty years ago energy saving and good energy management practice in injection moulding was certainly not as high up the agenda as it is now. Rising energy costs and the need to meet sustainability targets mean that current injection moulders need to look at all aspects of their operations to keep energy usage in check. Injection moulding machinery manufacturers are introducing an array of features and new technologies on modern equipment that can greatly assist with this endeavour. However, some sensible and practical tips can be also employed to keep energy costs down in an injection moulding facility (see article on page 25).

**Netstal** is observing increasing demand for all electric injection moulding machines, even for higher clamping forces, with energy efficiency being a major reason. "This trend is being driven by a number of factors," says Marcel Christen, Product Manager Packaging and Medical Systems for KraussMaffei's Netstal brand. "These include

reduced emissions and an increase in precision and controllability, as well as energy efficiency optimisation."

Nevertheless, improvements are still being developed. "For all rotational movement, the electric drive concept provides an ideal solution," adds Christen. "However, translational movement is more challenging with small strokes and high loads, for example, the movement and contact of the injection unit. Although various solutions are available for this on the market, hydromechanical solutions are still commonly used. Another current challenging topic is the cost of direct driven electrical solutions."

He says: "One other interesting area of development is electric mould auxiliaries, such as core pullers and hot runner shut off systems. It would be beneficial if electric cylinders were available that could easily replace hydromechanical cylinders. We are also looking to define standards for clear and functional interfaces between the machine and

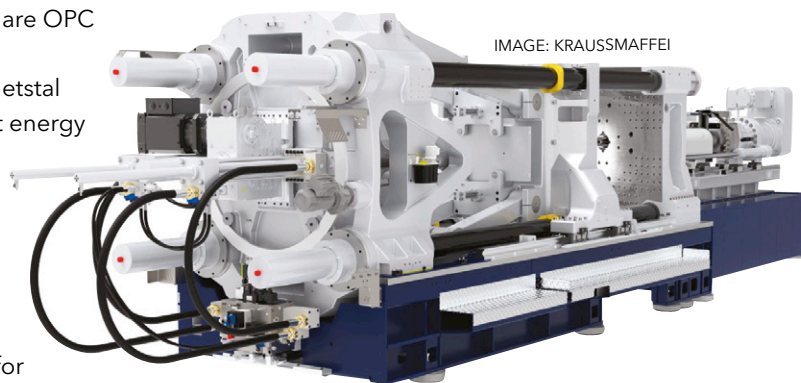
**Main image:**  
**Injection moulders can reduce energy costs and become more sustainable**

**Right: The new Netstal Elios 10000**

external peripheral controllers that are OPC UA-based."

Two of the latest products that Netstal has developed that offer significant energy savings have a combined electric and hydromechanical drive system to provide bigger clamping units. Netstal first presented the Elios hybrid range at K2016 with models from 450-750 tonne. The machines offer high performance, for example, the Elios 7500 has a dry cycle time of 1.9s. However, there is an increased demand for models with an even higher clamping force. With higher-cavity moulds that require a higher clamping force and larger clamping surface, the output volume and productivity of thin-wall packaging can be further increased. The recently released Elios models with 880- and 1,000-tonne clamping force cover these requirements.

Netstal says that the two new models - Elios 8800 and Elios 10000 - provide performance combined with optimum efficiency that is ideal for demanding thin-wall applications. The machines are designed for fast, precise and long-term continuous operation. According to the company, the performance and efficiency of the Elios clamping unit is due to the actuation concept for the toggle lever. In the Elios series, the crosshead moves the lever mechanism of the clamping unit and is actuated by a combination of a servo-electrically driven rack-and-pinion gear and two hydro-mechanical synchronised cylinders. The actual travel movement is fully electric, while the two cylinders run synchronously. In the clamping force build-up phase, which in the case of toggle-lever machines takes place automatically due to the toggle lever geometry, the two cylinders support the locking process. The advantage of this solution is that energy can be recuperated during travel movement via the servo-electric drive. Due to the additional cylinders, the driveline can also be kept slim, which improves the dynamics and



acceleration capability. The drive concept and robust design of the machine results in fast motion cycles. The Elios 10000 has a dry cycle time of 2.2s, as per Euromap specification.

The modular design means that the high-performance injection units are also used in the new Elios models. With screw diameters of 80-100 mm, two different injection units are available as standard. If other dimensions are required, additional combinations can be realised on request. The twin valve technology achieves good injection performance, both in terms of the maximum achievable injection speed but also in dynamics. At pressures of up to 2,400 bar, injection times of a few tenths of a second can be achieved. This allows wall thicknesses to be minimised and material savings achieved. A large power reserve is also an advantage in the processing of recycled raw material.

The company adds that the dual drive of the clamping unit integrates well into the overall adaptive drive system. All electrically driven axes are combined through the connection between the power converters to form an electrical DC link in which energy can circulate virtually unhindered. The servo-electric motor of the main drive is also integrated into this intermediate circuit, therefore the energy generated during braking processes of the clamping unit can be used directly and transferred to the hydraulic accumulator by means of an energy conversion.

Netstal says that the system provides good energy efficiency. In addition, there is great power potential available, especially for the highly dynamic actuation axes such as the injection process. The user benefits from an efficient machine that also offers sufficient power reserves for future applications.

**Sumitomo (SHI) Demag** uses high torque direct drives in its injection moulding machines which, it says, can achieve lower energy consumption and better performance than a traditional belt driven electrical axis. The company says that the highly dynamic direct drives provide more power and

**Below: The Netstal Elios 7500 injection unit and the main hybrid drive with adaptive drive control and energy recuperation from the clamping unit**



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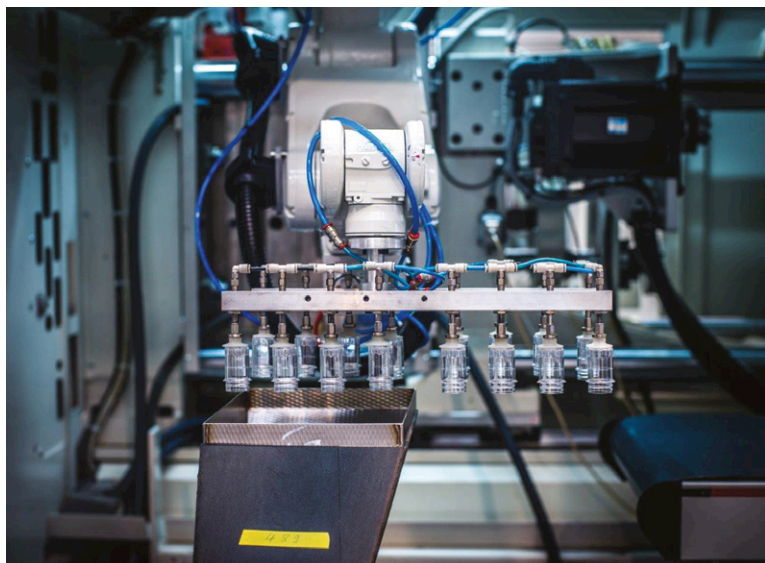
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IMAGE: SUMITOMO (SHI) DEMAG



**Above:**  
**Sumitomo (SHI) Demag**  
**develops,**  
**designs and**  
**builds all of its**  
**direct drives**  
**in-house**

precision. Increasing moulding reliability and repeatability, while simultaneously reducing energy consumption when compared to belt drives, the technology also reduces maintenance and unscheduled downtime costs. Tailored to the exact requirements of injection moulding machines, the company adds that it designs and builds its own drive motors in-house and has an R&D centre entirely dedicated to drive development.

Drawing power only when it is needed, a direct drive delivers higher injection power and a more dynamic response, the company says. Direct drive technology is also more energy-efficient than conventional belt drive solutions and when compared to hydraulic drives. In many instances energy savings exceeding 70% can be achieved and even faster cycle times. Kinetic energy can also be recovered and reused. For example, while the clamping unit is braking, energy generated can be used for plasticisation.

Sumitomo (SHI) Demag reports that many of its customers are keen to opt for more energy-efficient systems. But until recently, machinery suppliers have struggled to quantify and compare performance data in relation to energy consumption, investment and planned maintenance costs, mould wear and output quality. To help with these, the company has launched a new testing service. More than 300 performance measurements were already being undertaken for customers annually. However, due to its popularity, an investment was made in three new Fluke energy monitoring devices to extend this service. Plugging the tool into existing machines, including legacy and competitor moulding systems, the company conducts the energy tests on-site using a real production scenario. Calculating the energy used in kilowatts for each kilogramme of raw material converted, the

**Right:**  
**Sumitomo (SHI)**  
**Demag says its**  
**IntElect**  
**machines**  
**reduce process**  
**downtime and**  
**part scrap rates**

team then provides the customer with a credible comparison if they were to purchase a newer Sumitomo (SHI) Demag machine.

In order to get a like-for-like comparison, engineers run the same product before and after new kit is installed, with all ancillary equipment plugged in. As well as looking at energy performance, the tests also examine other factors including the parallel movements and the impact of drive cycle times on output. The results are compiled into a report that presents companies with robust data that can be included in annual CSR reports.

Sumitomo (SHI) Demag illustrates the service with two customer case studies. UK-based **McLaren Plastics** used the new test service to measure the energy savings realised after replacing two legacy hydraulic machines with two all-electric IntElect machines. One of the performance benchmarks was for a packaging black end cap. The investment resulted in the business saving 60% of its energy bill – in excess of £7,000 per year (US\$9,900/€8,100).

Significant energy savings were also one of the benefits demonstrated by a series of hydraulic versus all-electric like-for-like tests undertaken by Sumitomo (SHI) Demag for **Essentra Components**, a UK injection moulder with 14 facilities worldwide. The tests also showed consistency of process, large cycle time savings, reduced scrap rates and enhanced workforce health and safety.

As Essentra Components' first all-electric moulding machine installation, the company tested the IntElect 50-tonne machine, trialling over 50 different applications and tools. Performing tests against the same tonnage hydraulic machine of similar specification, Divisional Process Development Manager Chris Butler disclosed that both the all-electric cycle times and energy savings surpassed his expectations. ➤



IMAGE: ESSENTRA COMPONENTS

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Butler has carried out a project to analyse the age, condition and sustainability of the company's combined fleet of 419 moulding machines spread across 13 countries. Specifically, he was interested in strategically proving that the improvements that could be realised by taking the all-electric route would enable Essentra Components to maintain its capacity, while also shrinking its machine count and lowering the company's overall carbon footprint without compromising output, cycle speed or moulding quality. Through a series of trials, Essentra Components has collated all the raw data it needs to push forward with its investment strategy of replacing legacy hydraulic with all-electric machines.

As a result of the improved process control and the IntElect's quicker clamp unit/linear movements, the trials showed an average 24% cycle time saving. Across the company, this means that it could potentially install, run and maintain 100 fewer injection moulding machines if replacing hydraulic with a like-for-like all-electric precision machine. "The capacity gains in one test for a particular job where we make 1.6 million parts annually, equated to saving 248 hours production hours annually. That is an exceptional saving," says Butler.

In a separate trial, Sumitomo (SHI) Demag's Technical Manager Nick Stockton replicated the exact product processing, shot weight, cycle time and machine tonnage to document energy improvements. Previously consuming 6.31 kWh at an average cost of £0.78 per hour (US\$1.1/€0.9), on the new IntElect this dropped to 4.3 kWh. This instant 32% energy saving was gained without adjusting any of the process steps.

The company adds that even when slightly optimising the process and reducing the cycle time by 1.1s, all the test data and energy savings remained consistent. Yet, by cycling quicker, the component yield went up. "With the optimised cycle time, the volume of material we processed per hour increased by nearly a third compared to the hydraulic machine. So, we are essentially making more mouldings at virtually the same energy cost," says Butler.

**Engel** has developed the servo hydraulic Ecodrive, which is now standard equipment on its hydraulic injection moulding machines from the Victory and Duo ranges, for example. Depending on the machine type and the application, the energy-saving option reduces the energy consumption of hydraulic

injection moulding machines by up to 70%. The Ecodrive is energy-optimised servo-hydraulic drive technology, with the drive speed resulting from the required speed of the injection moulding machine axles. When the machine is not moving – during the cooling phase, for example – the drives are at a stand-still as well and do not consume energy. Energy losses are reduced to such an extent, particularly with small machines, that the hydraulic oil is heated only minimally. The temperature of the hydraulic oil is an indication of how energy efficient the injection moulding machine is.

The company adds that the energy efficiency of these hydraulic machines can only be improved by using all-electric equipment. Engel first introduced the E-motion electric machine in 2002, with the latest all-electric machine, the E-mac 130, offering a clamping force of 130 tonnes. For example, an Engel E-mac 465/130 is producing actuators for Han-Quick Lock brand connector systems for German company **Harting** using a 16-cavity mould. Depending on the connector type, up to almost one hundred actuators are fitted in a single connector housing. They enable particularly fast and easy connection of stranded conductors. The requirements for the small precision components, which weigh little and have a strong wall thickness variance, are high. High rigidity is required to ensure reliable functioning; this is achieved with a polycarbonate containing glass fibres.

Engel adds that all-electric injection moulding machines are preferred for the production of connector components in order to ensure maximum dimensional accuracy and repeatability of the filigree component structures. The cost-effectiveness of the machines plays an important role, especially in high-volume production. For precision applications with cycle times of more than 4s, the

E-mac is an economical solution, it says. It combines high output with flexibility, efficiency and a compact machine design. With the smallest available injection unit, the new E-mac 130 measures only 4,400 mm in length. The clear tie-bar width is 530×530 mm. This



**Left: Engel has introduced the E-mac 130 all-electric injection moulding machine**

IMAGE: ENGEL

means that the E-mac 130 offers the largest tie-bar spacing among all-electric injection moulding machines with a comparable clamping force, according to Engel.

All movements of the Engel E-mac – including the nozzle movement and ejection – are performed by servo-electric drives. This means that the machine achieves high overall efficiency. If required, a servo-hydraulic unit can be integrated into the machine frame without requiring additional space. The E-mac machine is designed to be particularly maintenance-friendly. Ergonomics were the focus of attention in the positioning of interfaces and the barrel design. The new size enables Engel to adapt the machine even more specifically to the requirements of the application in order to leverage efficiency potentials in an even better way.

Apart from the drive technology, which is adjusted for every application, numerous other factors contribute to energy efficiency in injection moulding, says Engel. Among them are the insulation of the barrel, the efficient design of machine components and the choice of clamping force. The smaller the machine, the lower its energy consumption. Due to the tie-bar-less design, Engel



**Left: The requirements for small actuators for connector systems are high. All-electric injection moulding machines are preferred for this application**

Victory technology enables the use of large and bulky moulds on relatively small injection moulding machines, which leads to a constructive use of energy-saving potential.

Injection moulding machines from **Boy** are designed to be energy-efficient, reports the company. The servo-motor pump drive saves 50% on energy compared to other drive technologies and more than that for some applications. Due to the low current consumption and the effectively

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**Right: The BOY 35E injection moulding machine is particularly energy efficient, says the company**



IMAGE: BOY

designed hydraulics system, the cooling requirement is low.

The latest addition to the company's E series is the Boy 35 E injection moulding machine. The four-tie bar machine offers a clamping force of 350 kN and a universal injection unit with screw diameters from 14-32 mm. With a footprint of only 1.96 m², the Boy 35 E is particularly suitable for the production of precision parts within narrow tolerance ranges with a part weight of up to 69.5g (PS). A wide variety of thermoplastics, elastomers and silicones, as well as thermosets, metals and ceramics can be processed with the Boy 35 E.

The company claims that the fully hydraulic reciprocating-screw injection moulding machine with two-platen clamping unit, swivel-out injection unit and energy-efficient servo drive has been proven to achieve the lowest possible machine-hour rates. Equipped with the optionally available EconPlast plasticising unit, the energy consumption of a Boy 35 E is significantly reduced. Awarded with the efficiency classification 7+ according to Euromap 60.1, the energy consumption is 0.49 kWh/kg of material throughput.

With a horizontal clamping unit and a vertically arranged injection unit, the materials are injected into the parting line of the mould. This means that injection points on decor surfaces are avoidable. Expensive and complex hot runner techniques are not necessary. Sprues can also be avoided by injection into the parting line. The Boy 35 E is available in four different machine types, where the clamping unit and the injection unit are each arranged horizontally or vertically.

The latest development from **Wittmann Battenfeld** that can provide significant energy savings in injection moulding is the MacroPower large machine series with a 400-2,000 tonne

clamping force range and servo drive technology in combination with constant displacement pumps. "This not only results in energy savings of up to 15% compared to conventional drive technology, but also reduces noise levels by up to 7%," say Bernhard Zöhling, Team Leader System Development and Patrick Chromy, Team Leader Application Development.

"Furthermore, less heat is introduced into the hydraulic system, which means less cooling power for the drive system and a further contribution to energy savings. This is all part of our programme to help protect the climate, use resources economically and sustainably, and promote the circular economy."

Solutions for improved use of regrind are also being developed. "A long-practised approach in the injection moulding industry is the addition of regrind to virgin material," say Zöhling and Chromy. "In the past, economic advantages have certainly been a greater driver than ecological considerations. However, the higher the proportion of regrind, the larger the window of material and processing properties. The goal is to produce a qualitatively consistent end-product. Material and energy savings through physical foaming of the plastic melt is also a viable option. In this case, the challenges are process consistency, reproducible foam quality and the extended complexity of the process."

Wittmann Battenfeld adds that changes in material viscosity – resulting from different regrind proportions or batch fluctuations – can not only be detected but also be actively compensated. The HiQ Flow and HiQ Melt application software packages have been developed for this purpose. While HiQ Melt detects the change in viscosity during metering, HiQ Flow actively intervenes in the control during injection and holding pressure. The next development steps for these packages have already been initiated and are being carried out based on customer feedback.

Wittmann Battenfeld says that future developments will continue to focus on energy savings, as well as possibilities to integrate energy generating systems that operate without almost any energy loss.

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# How to stop granulators chewing through energy use

*Energy-efficiency expert Dr Robin Kent of Tangram Technology says there is an unseen energy drain in injection moulding - granulators. He discusses solutions with Mark Holmes*

Effective and efficient handling of reground material is particularly important in any injection moulding facility. Used inefficiently, granulators can be a financial drain on an operation. However, by taking a few key steps, this can be greatly minimised, according to Dr Robin Kent, Managing Director of UK-based Tangram Technology, consulting engineers for energy management in plastics processing.

"Granulators for injection moulding do not use large amounts of energy but the good thing is that much of [the energy they do use] is discretionary and can be saved by simple actions," says Kent. "However efficient the site, there will be a need for some type of regranulation to allow the re-use of waste produced by the process, even if it is only the start-up scrap - either for re-use in the process or for size reduction before disposal. Most sites have no control over the use of granulators and this costs significant amounts of money - granulators running in the background are common at plastics processing sites and, like compressed air leaks, are taken to be part of the environment. The energy cost of even a small granulator can be around £10,000 per year (US\$14,200/€11,600). Failure to control granulators will use large amounts of energy and controlling granulators can be a rewarding exercise."

Kent's first recommendation is to stop granulators idling. The power trace of a 30 kW central granulator is shown in Figure 1 (on next page) and for most of

the 20 minutes of monitoring the granulator was idling and doing no effective work. The full load power was around 23 kW - it was not really working hard, but this was only for about 25% of the time. The idling load was around 17 kW, and this was drawn even when the machine was idling and doing no productive work. At an energy cost of £0.1/kWh, this is £11,000 (US\$15,600/€12,800) of wasted energy. It is possible to fit most types of granulators with controls to turn them off automatically when they are not needed. This can be by simple current detection and turning off the granulator when the current indicates that it is idling.

Kent offers some further tips when operating granulators. These include:

- Do not turn the granulator off immediately but pause to allow the throat of the granulator to clear. If this is not done, then it is possible that it will stall when restarted.
- Consider a control which uses vibration detection as a signal to turn off the granulator. Start-up is controlled by a photocell which detects feeding of the granulator. This is simple, effective and available as a retrofit kit (120V) for around £800 (US\$1,140/€930).
- Train staff to recognise that granulator use is not 'free' and provide them with the techniques and tools to minimise energy use.

Another suggestion is to make sure that you have

**Main image:  
Production  
scrap needs to  
be granulated  
efficiently**

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the right sized granulator. Kent says that the granulator shown in the example was 30 kW but the actual reggranulation process required a maximum of 6 kW and the rest of the energy was wasted. He adds that similar waste is seen in machine-side granulators which are poorly sized for the application. At one site, two moulding machines were producing exactly the same products, but were fitted with different granulators:

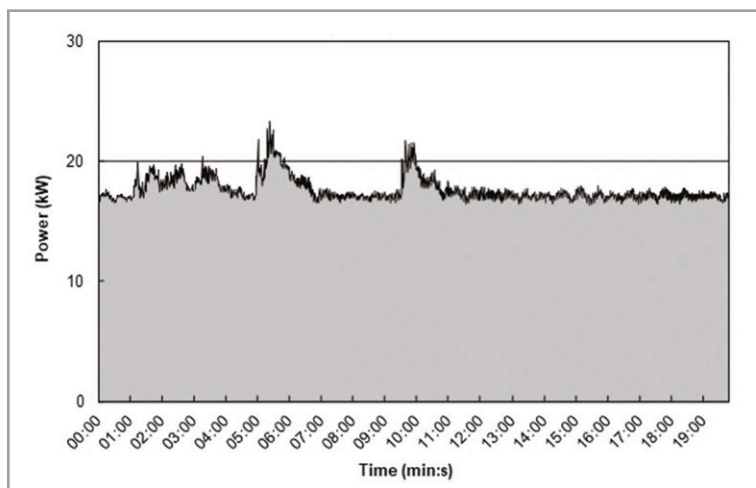
- Machine 1: 5.5 kW granulator with 0.55 kW blower to the blender. Running cost was around £6,235 per year (US\$8,850/€7,230).
- Machine 2: 7.5 kW granulator with 2.5 kW blower to the blender. Running cost was around £10,306 per year (US\$14,600/€12,000), which is £4,071 per year (US\$5,780/€4,720) higher.

"There was no difference in the requirements, but the site had the 7.5kW granulator with the 2.5kW blower available and simply used it without thinking about the energy cost of the larger motors," says Kent. "The savings from using the correct size granulator and blower were more than enough to pay for new, and correctly sized, equipment, with a payback of less than six months. This site had 25 granulators so the total savings were over £100,000 per year (US\$142,000/€116,000). Always make sure that the granulator is the smallest size possible for the job. Never use the largest granulator, just because it is there."

Another energy-saving technique he recommends is to make the granulator responsive to moulding activity. Granulators should be linked to the injection moulding machine motions so that when the machine stops operating, the granulator runs on for a small time to clear the throat and then switches off. In addition, the granulator can be set to only start when the machine motions start - it will be up to full speed before the first material enters the throat and the risk of jamming due to high start-up torque is low.

Kent says that granulators are designed to be sturdy workhorses but he nonetheless makes a number of usage and maintenance suggestions:

- Use soft-start and other motor controllers to prevent high starting currents.
- Sharp blades are needed for efficient operation and good reggranulation. Sharpen them regularly to reduce energy, noise and fines.
- Always check and maintain the gap between the rotating and fixed knives - it should be around 0.2-0.3 mm.
- Do not overfeed granulators. Overfeeding will increase current spikes and can causing jamming.
- Check the drive mechanism. If it uses V-belts, then consider replacing these with cogged belts.



**Figure 1: Granulator power trace**

Source: Tangram Technology

- Make sure the motor is a high-efficiency motor and possibly replace it if it is not.
- Granulation is a dusty process and bearings are subject to dirt and dust collection. Clean and lubricate bearings regularly.
- If the granulator is not automatically emptied, then always make sure that the collection bin is regularly emptied. Full collection bins will back up and the granulator will eventually fail.
- Granulation of purgings has always been a problem. However, there are solutions such as the Purgings Recovery System from Maguire, for example, which shaves purgings down to a size where they can be reggranulated.

A sound management approach is called for. "The cost of closed loop reggranulation for injection moulding should be critically examined," Kent says. "The cost of running a granulator is largely fixed and reducing the amount of sprues and runners can make closed loop recycling expensive. In one case, the cost of the closed loop recycling was £0.80/kg (US\$1.14/€0.93) and this excluded the investment and operational cost of the sprue picker/robot. The continuous operation of machine-side granulators for small numbers of sprues and runners, often as low as 1 kg/hour, can make it more economic to turn the granulator off and collect the sprues and runners until an economic amount is collected. The granulator can then be run for a short time to clear the backlog."

He concludes: "A final tip is to calculate the cost of closed loop recycling, especially when the sprues and runners are small and the granulator is large and compare this to the cost of the material being recycled. It may well be more economic in energy and cost terms to centrally granulate at night when energy costs are lower."

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# Material majors dive deep into additive manufacturing

*Polymer producers and compounders are enhancing materials for additive manufacturing to satisfy companies wanting to 3D print functional parts, jigs, fixtures and mould cavities.*  
By Peter Mapleston



IMAGE: COVESTRO

It's a sure sign that additive manufacturing (AM) or 3D printing (3DP) has hit the mainstream when major polymer producers and compounders more used to selling high volumes into injection moulding take big stakes in the business. That is what is happening now, with the likes of Covestro, Evonik, LehVoss, and others, all putting significant resources into AM, whether it's for product development, collaborations with smaller but more established players, or business acquisitions.

It's not just the materials companies that are making moves though. Technology companies are also advancing with equipment more suited than ever to production of commercial parts. But AM does not forget its origins in rapid prototyping either: many things are going on there too. Far too many to cover in a single article, so what follows are highlights that have the most interest for injection moulders.

At compounding major **LehVoss Group**, Thomas Collet, Director 3D Printing Materials & Marketing in the company's Customised Polymer Materials BU, says many injection moulders are now carrying out 3DP (mostly fused filament fabrication, FFF) themselves or buying parts for internal use, in applications spanning prototypes, functional parts, jigs, fixtures and mould cavities. "More and more companies are starting small series production (end use parts) or considering it," he says.

Parallel to the development and launch of new materials for different AM technologies, LehVoss is working on the industrialisation of 3DP, says Collet. Certification body TÜV Süd has certified a 3DP process using the combination of one of its Luvocom 3F filaments, with an Ultimaker printer. This comprised the material properties, production of the test specimen, including the dimensional tolerances, the manufacture of the filament and the printing process. Emissions were also measured during the printing process.

"The printing process meets the requirements drawn up by TÜV Süd in all aspects," says Collet. "The filament under test, Luvocom 3F Filament PAHT 9825 NT (an unreinforced high-performance polyamide), and the Ultimaker S5 Pro Bundle are the world's first system certified by TÜV Süd in the field of fused filament fabrication."

"This is an important step for the industrialisation and scalability of FFF," says Thiago Medeiros Araujo, Business Development Luvocom 3F. "The certified system increases reliability in parts production and is intended to accelerate the use of 3D printing to put it on a par with already established production processes such as injection moulding." He says LehVoss is the world's first supplier of filaments with this certification.

The biopolymer PLA played a big part in getting FFF going. For some time, PLA was a clear favourite

**Main image:**  
**Polymaker PC-r polycarbonate filament for 3D printing is made from a Covestro plastic recycle produced from used water bottles from Chinese water bottle manufacturer Nongfu Spring**

**Right: Spool and parts made of the Lehvoss filament certified by TÜV Süd**

in filaments (along with ABS), especially among hobbyists, owing to its good processing characteristics and its green credentials. The material continues to grow in the sector, in industrial as well as consumer applications. **NatureWorks** for example recently added to its portfolio of Ingeo grades for AM with the introduction of Ingeo 3D700 for use in large-format 3D printing.

"In large-format printing, the higher rate and volume of polymer deposition can quickly result in excessive warpage with certain materials, like ABS, or significant shrinkage as with some polyolefins or even some general-purpose PLA grades," says NatureWorks. "This can result in failed prints as warping pulls the part away from the print bed or causes layer separation."

NatureWorks says that by controlling the polymer microstructure, it has created an amorphous PLA, which has a low shrink rate critical for reducing warpage, improving gap fill and adhesion.

"As the 3D printing space expands into larger, more complex applications, we are seeing an increased need for printing materials that are tailored for a specific application or process," says Dan Sawyer, Business Development Leader for NatureWorks. "With significant growth in large-format additive manufacturing for industrial applications, we saw the opportunity to develop a new Ingeo biopolymer grade specifically designed to minimize the loss of time and material due to failures in large format prints."

If a specialty print requires additional reinforcement, cellulose-based additives are easily compounded with Ingeo 3D700, "creating a biobased compound alternative to high-cost petrochemical-based compounds such as carbon-fibre ABS," says NatureWorks. The company adds that various partners have evaluated Ingeo 3D700 for use in large-format FFF and also direct resin-to-print processes, with positive results. For example, Xiaofan Luo, President at Polymaker, a leading manufacturer of 3D printing material and filaments, says that in addition to lower shrinkage, the com-



IMAGE: LEHVOSS

pany also measured improved z-layer adhesion.

Filament manufacturer **MCPP** (Mitsubishi Chemical Performance Polymers, owned by, but operated independently of, Mitsubishi Chemical) demonstrated a 11-13% increase in flow rate due to the optimised melt viscosity, compared to a general-purpose PLA. "This resulted in improved gap fill and adhesion between perimeter layers," it says. "Therefore, it is also expected to be suitable for FGF (fused granulate fabrication) 3D printing."

Another NatureWorks partner, compounder/processor Nexx in Vancouver, supports its manufacturing efforts by rapidly prototyping new product designs via 3DP. "Off-the-shelf 3D printers can be used to quickly bring Nexx's designs to life," says Zac Hudson, Chief Scientific Officer at the company. "With 3D printing, minor modifications can be made to an earlier prototype, and a finished part can be ready for testing in the span of an hour."

Czech 3D printing filament producer **Fillamentum** has launched its first 100% biodegradable filament for 3DP, NonOilen. This contains PLA and also PHB (polyhydroxybutyrate). Sustainability is one of the main principles of Fillamentum, says Josef Doleček, CEO of the company. However, "sustainability cannot be the only consideration when 3D printing. In this case, the filament offers high strength, toughness, hardness, and long-term durability. Just like PLA, NonOilen is easy to print with parts featuring a smooth finish with a natural silk look. NonOilen as well as PLA is safe for food contact applications and can be washed in the dishwasher. In contrast with PLA, NonOilen resists temperatures up to 110°C."

Fillamentum says parts made in NonOilen can either be composted after use or sent back to the company for reprocessing into a new filament.

Among major polymer makers, **Evonik** says it has a strategic focus on new high-performance materials for all major polymer-based 3DP tech-

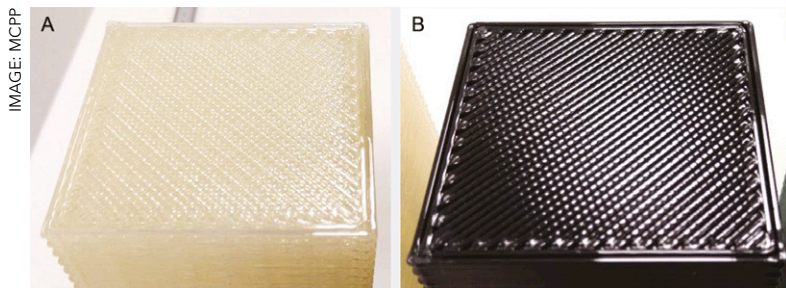


IMAGE: MCPP

**Above: The part (A) printed with clear Ingeo 3D700 shows fewer gaps on the top solidfill layers and between perimeters in comparison to the general-purpose PLA grade part (B) in black**



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**Right: Fillamentum has launched its first 100% biodegradable filament for 3DP, called NonOilen**

nologies. Infinam is the new brand name for all of its 3DP materials. The company has made several AM-connected announcements in recent months, the most recent one on the strengthened collaboration with **Farsoon**, China's largest SLS (selective laser sintering) 3D printer manufacturer, on powder-based materials with high temperature resistance, with their eyes on large-scale industrial applications.

Evonik says it has already successfully tested its Infinam PA 6005 P, a polyamide 613 with a 213°C melting point, on Farsoon's ST252P and HT403P series machines. "We used our synergies to develop a market-ready system solution," says Wolfgang

Diekmann, Director Research, Development & Innovation Additive Manufacturing at Evonik. "The development of new formulations is underway."

Infinam PA 6005 P is strong and has high chemical resistance; plus it has low water absorption for a polyamide, below 3%. This has a positive effect on processability as well as on part dimensional stability.

Farsoon's machines can reach process chamber temperatures of up to 280°C (220°C on HT units). They have high-speed scanners and powerful lasers. "The high productivity of component production increasingly enables series applications," says Evonik.

Earlier, Evonik announced a new 3DP filament based on PEEK (polyether ether ketone), Infinam PEEK 9359 F, for industrial applications (it already offers PEEK filaments for medical components). Apart from very high temperature resistance (it resists heat peaks of over 300°C), it also has high mechanical strength, hydrolysis resistance, or inherent flame retardancy. Evonik is aiming at applications in aerospace, automotive, and oil & gas, especially for parts in place of metal. Apart from advantages in weight and toughness, Infinam

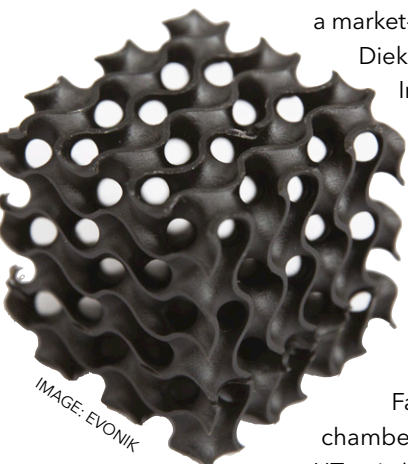


IMAGE: EVONIK

**Above: Infinam TI 3100 L is an ultra-strong and tough light-curing resin**

**Below: Evonik has a new product line of photopolymers for 3D printing**



IMAGE: FILLAMENTUM

PEEK 9359 F also has very high wear resistance and low sliding friction.

A third announcement related to two photopolymers for industrial applications, Infinam TI 3100 L and Infinam ST 6100 L. These are the first in a new line of materials for processing using vat polymerisation technologies such as SLA (stereolithography) or DLP (direct light processing). Evonik says Infinam TI 3100L can be used to make "ultra-strong" and tough parts, while Infinam ST 6100 L is for applications which need high temperature resistance combined with high flexural strength.

**DSM** was one of the pioneers in AM, beginning with its Somos SLA resins. In fact, Somos resin was in the first stereolithography printer sold. Last June, DSM took over parts of Clariant's 3DP business portfolio. It said the integration of the Clariant assets enabled it to strengthen its engineering grade filament, pellet and powder portfolio. Three months later, it sold its Resins & Functional Materials and associated businesses - which include DSM Additive Manufacturing - to Covestro.

With the dust still settling around that deal, **Covestro**, which has taken a strong line in sustainability in all of its businesses (principally polycarbonate and polyurethanes), has launched a 3DP material in a glass-reinforced post-consumer recycled PET. Arnite AM2001 GF (G), which was developed by DSM prior to the acquisition, is for FGF. Covestro says it fits perfectly into its vision for a Circular Economy and "illustrates how complementary the two organisations are in their approach to adding more value to additive manufacturing and industrial production overall." FGF allows for fast and economically viable additive manufacturing of large parts, Covestro says.

"Arnite AM2001 GF (G) rPET's mechanical properties and broad processing window make it ideally suited for structural applications across a variety of industries, including pedestrian bridges,



IMAGE: EVONIK



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**Right: 3DP chair designed by Michiel van der Kley in glass reinforced recycled PET**

tiles for cyclist or pedestrian tunnels, architectural applications like cladding or partition walls, in- and outdoor furniture, small boats, packaging crates or tooling," the company claims.

Recycled polycarbonate is also being used in 3DP. Covestro says **Polymaker**, a leading manufacturer of 3D printing materials, uses a recycled polycarbonate coming from used large water bottles to produce Polymaker PC-r filament. The bottles are made in China by Nongfu Spring, and are recovered and recycled (following multiple trips) through a partnership with recycling company Ausell after use in offices, homes, and public spaces. Covestro blends the waste with virgin material and Polymaker extrudes the filaments.

"The fact that the waste comes from one single source is an advantage," notes Covestro. "This means that no prior sorting and identification of the plastics is necessary. The plastic waste is quite pure and can be recycled in a cost-effective manner. In addition, it is available in sufficient quantities."

Shanghai-headquartered Intamsys, which makes 3DP equipment (and also provides a printing service), has tested Polymaker PC-r on its Funmat Pro 410 printer, which can achieve a dual jet temperature of up to 500°C and a platform temperature of up to 160°C. Covestro says the tests demonstrated that Polymaker PC-r is "extremely easy to process. The test scores show good values for tensile strength, Young's modulus, flexural strength and flexural modulus, which were slightly higher than standard polycarbonate."

Compounding company **Mocom** points to a strong demand for technical semi-crystalline plastics for AM, which it says is currently extending beyond additive prototyping for smaller series. But prototypes made of semi-crystalline plastics are difficult to produce with low distortion in non-SLS-based processes, it says. It has developed Alcom 3D, a combination of PA6 and aromatic compo-



IMAGE: COVESTRO

nents. It is characterised by a high semi-crystalline content as well as processability in additive manufacturing and injection moulding.

The technical profile of Alcom 3D "is closest possible reflection of the properties of PA6," says Mocom. It was designed for **Arburg**, which produces not only injection moulding machines but also the Freeformer 3DP equipment series. On the Freeformer, the material can be used for the production of technical components, including those subject to alternating bending loads, such as snap hooks.

"To produce parts with complex geometries, the Alcom 3D can be processed on the Freeformer together with a water-soluble support material from Arburg," Mocom says. "During the mechanical testing of the Alcom 3D it became clear that even relatively strong mechanical impact did not lead to the defect or warpage of the component, which had previously been a problem for the customer. It enables the production of components with near-series properties."

The advantages of Arburg Plastic Freeforming (APF) in the AM world are many, including the robustness of the process and its ability to use materials identical to those used in injection moulding. Arburg recently added another machine, the Freeformer 300-3X which can combine two materials in a single resilient component.

"Injection moulded two-component parts are generally in great demand for the large-scale production of items such as razors, toothbrushes and tools that are pleasing to the touch," says Arburg. "The Freeformer 300-3X with three discharge units enables the industrial additive production of complex functional components from original material in a resilient hard/soft combination with support structure. This is of

**Below: Arburg's Freeformer 300-3X making two-component grippers for robotic systems**

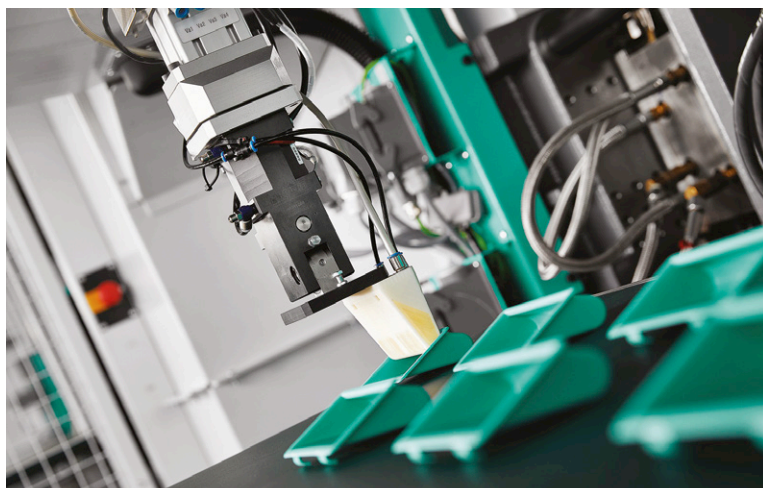


IMAGE: ARBURG



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IMAGE: ARBURG

**Above:**  
Arburg's Freeformer 300-3X has produced a finger whose individual PC/ABS phalanges are moved by joints made of soft TPE

particular interest to users who want to produce and test functional prototypes made from exactly the same material as that used in large-scale production of the end product."

Another field of application for components in hard/soft combinations are automation solutions and production equipment, the company says. It cites a two-component gripper it has designed itself for a particularly tricky removal task in its own injection moulding production facility. The gripper's hard housing is made of PC/ABS, while a soft TPU membrane expands positively in the mould using compressed air. A moulded part can be reliably removed at an angle of 15°, despite its awkward position. Another example of a component is a finger whose individual PC/ABS phalanges are moved by joints made of soft TPE.

A potential rival to Arburg's Freeformer is AddiFab's Freeform Injection Molding (FIM) technology, but while both companies have injection moulding companies very much in their sites, the technologies they use are quite different. The Freeformer uses regular injection moulding pellets to produce parts free of the constraints of injection moulding, in a way not all that different from equipment using filaments. FIM involves production of injection moulding cavities using a UV-hardening liquid acrylic resin (called AddLine), virtually without limits on design, just as long as they can be filled; the cavities are put in moulds on standard injection moulding machines processing standard injection moulding materials. The cavity is removed from the mould with the part, and then dissolved.

AddiFab says it saw FIM spread across the globe last year. "Mitsubishi Chemical Advanced Materials has begun offering FIM-as-a-service in Belgium, Japan, and the United States to provide customers with faster and more advanced injection mould prototyping," it says. "In parallel, AddiFab has brought FIM into the micro injection moulding

domain, with the introduction of AddLine Micro. This printer add-on allows the printing of moulds with features smaller than a white blood cell."

The company has moved its headquarters to a new facility in Copenhagen, Denmark. "The move allows the young scale-up much greater capacity for feasibility studies, showcasing, research and development, and much more," it says.

**Mitsubishi Chemical Advanced Materials** says FIM, in conjunction with its Sprint (Soluble Printed Injection Tooling) rapid prototyping service, provides a unique alternative to the status quo in part development. It says: "Tooling has always been a major hurdle for injection moulding high strength parts. A design can't be validated until a tool is made and the part is moulded. If the design fails or is modified, the process must start all over, which can set a project back by months and cost several thousands of dollars. Manufacturers need to find ways to validate part performance while reducing risk, cost, and lead time. FIM enables the user to print a single-use, soluble mould for validation of injection moulded parts."

The Sprint rapid tooling solution is used to validate the performance of prototype parts before investing in production tooling. "This solution can provide tremendous value early in the design cycle because it enables engineers to work together on design and manufacturability without excessive cost or lead time. A typical part moulded using the Sprint process will take days (versus weeks)."

Among major producers of 3DP equipment, **3D Systems** earlier this year introduced the High Speed Fusion industrial 3D printer platform and material portfolio, developed in a collaboration with major AM manufacturer Jabil. Products include the Roadrunner 3D printer, which 3D Systems says "is expected to provide the best economics of any high throughput industrial fused-filament offering in the market today." It says the Roadrunner system is designed to address the most demanding

**Right: Parts made using AddiFab's FIM technology**



IMAGE: ADDIFAB

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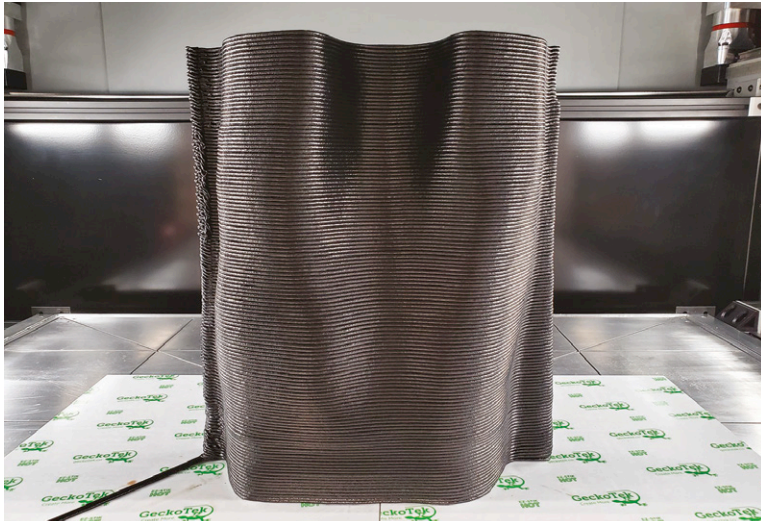
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IMAGE: JUGGERBOT



**Above: FGF printed part made on Juggernaut's Tradesman Series P3-44 using EcoPaXX PA410**

aerospace and advanced automotive applications.

Target applications include: aerospace interiors and ducting; automotive under-dash and under-hood; general industrial applications; various types of tooling and fixtures, including moulds and sacrificial tools; and prototyping parts across industries.

Roadrunner is said to provide the highest deposition rates and best dimensional precision of any standard industrial class of fused filament platform. It can work with all thermoplastics. Application engineering and materials development on the new platform is continuing, with shipments of the Roadrunner system to begin in 2022.

At the end of last year, **Stratasys** acquired Californian company Origin, saying: "Origin's software-centric additive manufacturing solution offers best-in-class printing technology based on digital light processing for production-oriented polymer applications."

According to Stratasys, "Origin is pioneering a new approach to additive manufacturing of end-use parts. Origin One, the company's manufacturing-grade 3D printer, uses Programmable Photo Polymerisation to precisely control light, heat, and force, among other variables, to produce parts with exceptional accuracy and consistency. [Origin has developed] some of the toughest and most resilient materials in additive manufacturing."

Back in 2014, Cincinnati Incorporated and the US Department of Energy's Oak Ridge National Laboratory (ORNL) developed a large-scale additive manufacturing system capable of printing polymer components up to 10 times larger than was producible at the time, and at speeds 200 to 500 times faster than existing additive machines. That was BAAM, Big Area Advanced Manufacturing. It used regular plastics granules, which it extruded onto the print bed, and it could print parts up to almost 2.5 x 6.1 x 2 m. It was very niche. But it was the beginning of yet another branch of AM technology, called fused granulate fabrication (FGF), or pellet printing.

Fast-forward to today, and **Juggernaut 3D** in Youngstown, Ohio, which has been offering FFF equipment for some time, is now also a leading proponent of FGF. It offers equipment that can be considered a scaled-down version of BAAM: build volume of its Tradesman Series P3-44 unit is 0.9 x 1.2 x 1.2 m, which means you can actually fit it in your factory. But it is still fast: it has a maximum traverse speed of 1m/s, and maximum material throughput (depending on the extruder size) of 9kg/h. That's a lot, lot faster than FFF.

Dan Fernback, one of the company's founders, says it is addressing barriers to industrial manufac-

## Elix Polymers gives ABS a work-out

ABS producer **Elix Polymers** recently participated in a six-year EU-sponsored research project, RIS3CAT Transport, which had the goal of developing ABS products for AM with a special focus on the transportation industry. The company offers a general-purpose grade (Elix ABS-3D GP), a high impact grade (ABS-3D HI) and an ABS/PC blend (Elix ABS/PC-3D) for FFF. "The products can be used for prototypes, spare parts, and also serial, functional parts," it says. During the project, the Alstom Transport logo was printed via FFF using Elix ABS-3D GP. The part was then chemically polished and chrome plated with the Covertron process from Atotech, a fully Cr6-free process.

Elix Polymers has also developed a grade that fulfils EU regulation 10/2011 covering plastics intended for food contact, as well as biocompatibility standards ISO 10993-1 and USP class VI for medical applications: Elix ABS-3D FC. The company donated some of this material in response to the high demand of hospitals for the production of medical masks, valves for ventilators and other medical devices to support the fight against Covid-19.



**The 3D printed Alstom Transport logo**

turing with AM, and while FGF is not intended to take on injection moulding head-to-head, it will serve as a very good complement, with its ability to process, at relatively high speed, a wide range of materials in regular pellet format, and hence at very reasonable cost.

JuggerBot will still offer FFF equipment, Fernback says, because even though it is much slower than FGF, it can produce finer details, smoother surfaces, and thinner walls. But for larger parts that are less complex, FGF is the way to go, he says.

FGF will work with regular granules, but as is the case in all plastics processing technologies, it's better if materials are developed for the purpose. JuggerBot has been working with DSM Advanced Manufacturing for some five years, initially on grades for FFF, but now also for FGF. Several grades were developed by DSM AM - now part of Covestro - specifically for FGF, including ones based on polypropylene, PET, and PA410.

Fernback says he believes FGF could evolve to become a highly prominent AM technology, but appreciates that it will take time. To date, the number of Tradesman machines it has shipped can be counted on the fingers of two hands. But

business is now "going gangbusters" he says, with a virtual seminar jointly held with Covestro recently attracting several hundred attendees. One project currently underway is with Goodyear, to produce non-pneumatic tyres in a thermoplastic elastomer. Another involves medical equipment.

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- March 2021: The world of injection moulding
- April 2021: Capex and opex
- May 2021: The world of injection moulding
- June 2021: The world of injection moulding
- July/August 2021: Packaging
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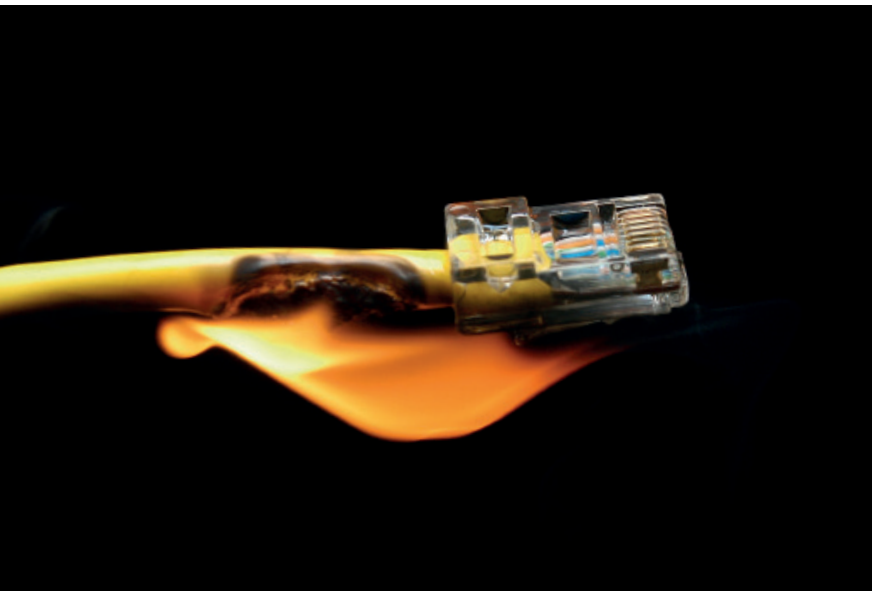
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# Aiming for new heights in bio-based materials

*Development of bio-based polymers with properties that come close to fossil-based plastics is allowing their use in more demanding applications. Peter Mapleston writes about new materials from producers*

Polymer producers, compounders and processors around the world are having notable successes in obtaining increasingly impressive properties from thermoplastics made from renewable resources, referred to as bio-based plastics or bioplastics. Sometimes, the polymers used are just about identical to polymers made from fossil-based feedstocks – think polycarbonate for example. Sometimes they are extensions to existing polymer families, most notably polyamides. And sometimes they are polymers that never existed before – PLA and PHAs are the most notable examples, polymers that some people would have you believe are not plastics at all. But in all cases, suppliers and processors are pitching them at applications that require performance, not just that “green” tag.

**Arctic Biomaterials** in Tampere, Finland, produces high-performance bio-based and biodegradable compounds and composites. One unique feature of its ABMcomposite technology is proprietary high-strength degradable glass fibres (see *Injection World* March 2019).

Ari Rosling, the company's R&D director, says: “These glass fibres start to slowly dissolve and degrade under moist conditions. The technology is well-known in the medical implant sector. The main ingredients are the same as in conventional window glass – only the proportions are different, which enables fibre production and the unique dissolution chemistry.” Arctic Biomaterials brought a new commercial-scale glass production facility



IMAGE: ARCTIC BIOMATERIALS

online in 2019 to meet needs in technical materials. The company is currently validating its degradable glass fibre-reinforced grades, which Rosling says have shown excellent cycle times combined with high strength, heat resistance and compostability.

Arctic Biomaterials has already launched a new product family, ArcBiox MFA-series, which consists of bio-based compounds using blends of various biopolymers filled with inorganic minerals. It says their environmental footprint is up to 80% lower than fossil-based ABS. According to R&D project manager Esa Hallinen, the MFA-series provides an excellent alternative for ABS and PP in such applications as cosmetics and personal care, kitchenware or industrial applications, such as semi-durable machine parts.

**Main image:**  
**The Belightful**  
**Butterfly**  
**Feeder,**  
**injection**  
**moulded in**  
**ArcBiox A1008**  
**from Arctic**  
**Biomaterials**

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Key technical benefits of the MFA-series include what Hallinen says is a rather uncommon combination of fast injection moulding cycle times and good thermal resistance: "Customers who have been working with fossil plastics have been positively surprised by the processability of our products. We also offer on-site injection moulding assistance for those who want to optimise their production with bio-based ArcBiox materials."

A new development grade from the MFA-series has given results that the company describes as "revolutionary." Hallinen says the material can be processed with cycle times with a cold mould, and its impact properties are comparable to those of polycarbonate. Flexural modulus is 1.8 GPa and the heat deflection temperature (HDTb) is 80°C without post-crystallisation. "There is still more development to be done, but we consider this mix of properties completely unforeseen in bio-based and compostable materials," he says.

One recent application for Arctic Biomaterials is the Belightful Butterfly Feeder, injection moulded in ArcBiox A1008. This is a durable, weather-resistant compound made using an extremely high impact PLA (grades in the ArcBiox A-series have Izod unnotched strengths ranging from over 100 kJ/m<sup>2</sup> up to no-break). Parts can be made using a cold



IMAGE: ARCTIC BIOMATERIALS

mould with short cycles, unlike many other high-impact PLA compounds that require an additional annealing step or long moulding cycles with a hot mould to obtain the necessary level of crystallinity.

**Bio-Fed**, a branch of compounder Akro-Plastic, says its M-Vera portfolio of biodegradable and/or bio-based compounds continues to grow. It already supplies a wide range of injection moulding compounds with renewable content ranging from 50% to almost 100%. They are PLA-, PBAT- or PHA-based.

One new grade derived almost entirely from renewables, M-Vera GP1045, is home compostable. Bio-Fed says it is particularly suitable for applications requiring high stiffness (tensile modulus is 2 GPa), including a wide range of household articles, toys, packaging, coffee capsules, and so on. Stanislaw Haftka, Sales Director at Bio-Fed, says it has food safety approval in the EU. A bioplastic with a comparably comprehensive properties profile is currently difficult to find on the market, he reckons.

For rigid applications, various materials are available depending on the specifications and customer requirements. M-Vera GP1015 and M-Vera GP1018 are certified OK Compost Industrial and cover a wide range of mechanical properties.

"Bio-Fed is happy to support its customers from the first trials on, and also offers its services as a cooperation partner for the development of new

**Above:**  
**Products made**  
**from Arctic**  
**Biomaterials'**  
**ArcBiox**  
**MFA-series**

**Left:**  
**Application**  
**for M-Vera**  
**portfolio of**  
**biodegradable**  
**and/or**  
**bio-based**  
**compounds**  
**from Bio-Fed**



IMAGE: BIO-FED

## Eurotec bio-based materials comparison

Property	Tecobio PL30 WR30 NL	Competitor Grade	Tecotek PY30 WR30 NL	Competitor Grade
	PLA, 30% wood fibre reinforced, natural	PLA, 30% wood fibre reinforced, natural	PBS, 30% wood fibre reinforced, natural	PBS, 30% wood fibre reinforced, natural
Stress at Break	65 MPa	62 MPa	35 MPa	35 MPa
Tensile Modulus	6000 MPa	5750 MPa	3500 MPa	2000 MPa
Izod Impact, notched (+ 23°C)	4.5 kJ/m <sup>2</sup>	2.4 kJ/m <sup>2</sup>	5.5 kJ/m <sup>2</sup>	3.5 kJ/m <sup>2</sup>
HDT (1.80 MPa)	55 °C	53 °C	85 °C	85 °C

**Source: Eurotec**

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**Above: Eurotec's PLA and PBS materials are available with various natural additives, including (left to right): beech powder, nutshell powder, corn cob powder, walnut shell powder and wood shavings**

products," says Haftka.

**Eurotec** is another compounder that has created its own green product portfolio. Its 100% biodegradable polymer product line consists of PLA, PBS and natural additives (including wood flour, walnut shell powder, beech powder, apricot kernel powder, nutshell powder and corn cob powder) reinforced with blends of these polymers.

The company also offers compounds containing the same natural additives, but using a polypropylene matrix.

**MAIP Compounding** in Italy is continuing with development of compounds based on various types of polymers in the PHA family, for injection moulding and also extrusion, in its lamNature range. One grade, lamNature B6 G713, based on PHBH, has obtained TUV Austria certification for composting, even at a thickness of 2.17 mm. Another grade, lamNature B6 E13 516 E21M, obtained TUV Austria's top four-star rating for bio-based content.

Similar grades have been used by Prodir, a leading Swiss producer of promotional products, for a special pen, the QS40 True Biotic. Prodir is promoting the pen as "created by nature for the nature," claiming the PHA it is made from is a "plastic-free biopolymer". Another grade, lamNature B6 E13/429 G1, was chosen by the bio-cosmetics manufacturer Eywa to underline the green character of all its production, which is based on natural components.

**Nexe Innovations** in Vancouver, Canada, is a processor working with Ingeo PLA from **NatureWorks**. Zac Hudson, Chief Scientific Officer at the company, says its aim is to replace traditional single-use plastics with sustainable, fully compostable alternatives. Compounds of Ingeo and plant fibre are used to produce fully compostable coffee pods

compatible with Keurig single-serve brewing systems. The pods composted in as little as 35 days during field trials conducted at a biofuels facility.

The company has spent five years in research and development of the pod, which it commercialised this April via its subsidiary Xoma Superfoods. Xoma produces such beverages for the health and wellness market as "keto" coffee, mushroom coffee and a coffee with medium-chain triglycerides from coconut oil. A second product line for Nespresso pods is set to launch later this year. Hudson says Nexe aims to partner with large coffee brands to offer a sustainable single-serve option for consumers.

Nexe recently expanded its production facilities to bring manufacturing of the pods in-house. It is installing industrial-scale compounding and injection moulding equipment. Pods will then be dosed with coffee and packaged. "This technology platform can be readily applied to other products calling out for a sustainable solution, such as meat and fish trays, eyeglass frames, disposable facemasks, or cosmetics packaging," says Hudson. He says the company does not intend to sell compound to other processors at this time.

Manufacturing efforts at Nexe are supported by rapid prototyping new product designs via 3D printing with PLA filament (also see the feature on Additive Manufacturing on page 29). And the company continues to innovate: part of its facility expansion will be dedicated to R&D on new compostable formulations, in an effort to extend product shelf-life and accelerate composting.

"As consumers and businesses make the shift away from conventional plastics, Nexe hopes to see improved guidance from local and regional governments on



**Left: Prodir has designed pens that are made with PHA from MAIP Compounding's lamNature range**

how compostable materials should be handled,” says Hudson. “Improved labelling, waste collection, and municipal composting facilities are all needed to support a transition to compostable materials, creating the same level of awareness that the public has towards recycling.”

PLA producer **Total Corbion PLA** has begun front-end engineering design for a 100,000 tpa plant in Grandpuits, France. The plant, due to be operational in 2024, will be the first of its kind in Europe and, added to its existing 75,000 tpa capacity in Thailand, would take Total Corbion PLA's global capacity to 175,000 tpa. In comparison, NatureWorks produces PLA at a 150,000 tpa plant in Nebraska, USA.

Total Corbion PLA was at the Chinaplas exhibition in Shenzhen in April, showing partner applications based on its Luminy PLA. The portfolio includes both high heat and standard PLA grades and is used in a wide range of markets, from packaging to durable consumer goods and electronics. One interesting product was a water bottle that has been launched with a take-back scheme and is currently undergoing trials to be chemically recycled by Total Corbion PLA. The

company says it intends to launch Luminy PLA made from post-consumer and post-industrial PLA recycle shortly.

In April, **SABIC** launched the first bio-based compound in its LNP Thermocomp range, for demanding applications in electrical/electronics, healthcare and elsewhere. The flame-retardant, carbon fibre-reinforced polycarbonate, LNP Thermocomp DC0041PE-7M1D145W, has a carbon footprint potentially 17% smaller than an existing grade with the same properties, DC0041PE-7M1D145. It can therefore be used as a drop-in alternative.

Says Joshua Chiaw, Director, Business Management, LNP Compounds & Noryl Resins, at SABIC: “All aspects of the value chain, from raw materials to finished goods, are certified through ISCC and compliant with regional and global regulations.”

SABIC says that, by weight, 21% of fossil-based materials used for the compound have been replaced with bio-based materials derived from waste or residue, such as crude tall oil and hydrotreated vegetable oils (based on a mass balance approach). It also contains over 50% post-consumer recycled resin and post-industrial recycled carbon

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fibre from the original production.

LNP Thermocomp DC0041PE-7M1D145W is produced in Asia Pacific, with plans to expand local production to other geographies, as needed, says SABIC.

Durabio, developed by **Mitsubishi Chemical Corporation** (MCC), is a partially bio-based polycarbonate made from plant-derived isosorbide. The supplier says it features excellent performance, offering higher resistance to impact, heat and weather than conventional polycarbonate. Additional benefits include: ease of colouring, to create glossy, highly reflective, and rich-hue surfaces; and hardness, enhancing durability and scratch resistance. These advantages eliminate the need for painting or coating, thus cutting costs and VOCs.

MCC says the results of a recent life cycle assessment for Durabio resin suggest that by using Durabio, Global Warming Potential is reduced by 30% compared with polycarbonate, by 35% compared with PMMA, and by 60% compared with PA6.

MCC launched Durabio in 2013 and says that since then it has been adopted in many Japanese and European cars, for both interior and exterior parts. Keiichi Kanatani, Business Development Manager, America, for Durabio, says: "Recently, Durabio has also been used in the large front grilles. Furthermore, MCC is developing various technologies in cooperation with customers [and] Durabio is beginning to be used for high-value-added decorative parts such as two-colour moulded parts, silver metallic parts, and matte parts."

Kanatani also expects Durabio to be used for sensor covers, owing to its high radar transmittance as well as high weather and scratch resistance. In fact, it has already been adopted for radar covers on three trucks produced by Isuzu. MCC is also



IMAGE: ARKEMA

working with customers on development of transparent exterior panels to replace heavier glass panels.

**Arkema** says that it is on track to begin production of Rilsan PA11 at a new plant in Singapore in the first half of next year. The plant, for which production will be 100%-derived from renewable castor beans, represents a 50% increase in Arkema's global PA11 capacity. "When complete, this will represent the biggest integrated bio-factory in the world dedicated to high performance polymers," says Arkema. End-use sectors for PA11 include EVs, consumer goods, electronics, sports and lifestyle markets.

Arkema has announced plans to buy Agiplast in Italy, a leader in the regeneration of high performance polymers, in particular specialty polyamides and fluoropolymers, and its historical partner in recycling operations. "With this acquisition, Arkema will be the first fully integrated high performance polymer manufacturer offering both bio-based and recycled materials in order to address the challenges of resource scarcity and end-of-life products," says the company. The deal is expected to close in June.

Phone accessory company PopSockets was looking for a way to make its products more sustainable and in April, it launched a new line, PopGrip Plant, made with **DSM's** bio-based Arnitel Eco copolyester TPE and EcoPaXX PA410.

"Arnitel Eco delivers high performance, through a wide portfolio of grades that thrive in extreme conditions, while EcoPaXX delivers performance, aesthetics and sustainability, which are all key features of the PopGrip application," says DSM.

The application is a small retractable grip that fits on the back of a mobile phone. "It seems very simple at first glance, but not just any sustainable material would work," says Geert Vanden Poel, the project's application development engineer. "The grip contains multiple parts that must expand and

**Above: Castor beans are a feedstock for Arkema's PA11**

**Left: PopSockets' PopGrip Plant is made with DSM's bio-based Arnitel Eco copolyester TPE and EcoPaXX PA410**



IMAGE: DSM

contract as the consumer uses it."

Arnitel Eco is made from 50% renewable resources, based on rapeseed oil. It can deliver up to a 40% reduction in carbon footprint compared to traditional co-polyesters. EcoPaXX combines DSM's propriety C4 technology with C10 building blocks derived from castor plants. The combination of the short C4 block and the long C10 block provides high mechanical properties of typical short chain polyamides, combined with lower moisture uptake and higher chemical resistance more typical of long chain polyamides.

Safilo, a leading Italian global eyewear company, is the first to use Trogamid myCX eCO, a bio-based transparent polyamide optimised by producer **Evonik Industries** specifically for lenses. The polymer is produced partly from a bio-based monomer and entirely with renewable energy, says Evonik. Safilo will launch eyeglass lenses made of Trogamid myCX eCO in January 2022 with the BOSS Spring Summer 22 collection and gradually expand its use across its portfolio.

"It was particularly important for us to offer Safilo a sustainable polyamide whose properties differ in no way from those of the Trogamid myCX they already use," says Viviane Papa, responsible for Evonik's high-performance polyamides granules and compounds business. The material offers transparency of more than 90%, excellent mechanical properties, stress crack resistance, and fracture strength.

While there is a strong focus on increased sustainability within injection moulding through routes that include biopolymers, recycled materials, use of renewable energy sources, and lightweighting, minor components such as additives are often overlooked in pursuit of sustainability even though

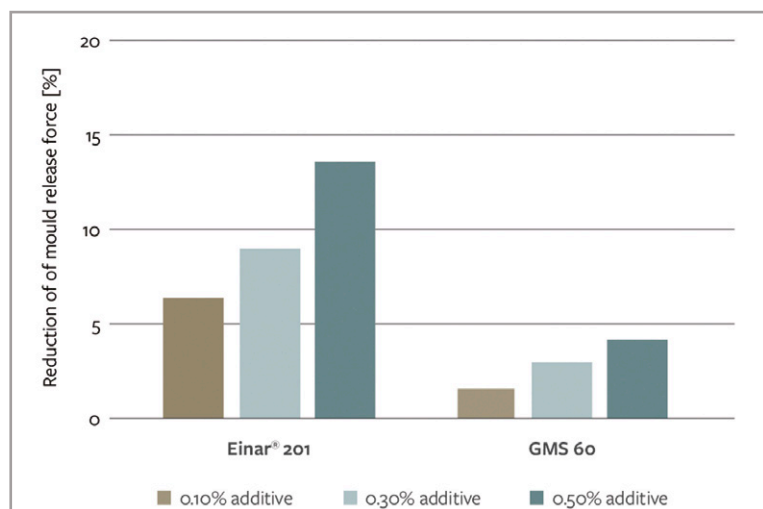


**Safilo's new lenses use a transparent bio-polyamide**

they can contribute significantly. So says **Palsgaard**, a producer of plant-based additives, which it says can help optimise the injection moulding process "and provide high-functional performance in challenging designs without compromising on food safety or end-of life recycling."

Palsgaard's Einar polymer additives are derived from animal-free and edible plant sources. In fact, they are sold as dual use plant-based additives with full FDA and EU food-contact applications. So, for example, its products can be found in ice-cream as well as ice-cream tubs: in the former to ensure heat-shock stability and a creamy texture, and in the latter where it acts as a mould release and anti-static additive.

The company has mould release additives for various polymers, including PP, PE, PVC, and PC, where they provide an alternative to conventional amine and amide products. Einar 601, for example, can be used in a very broad range of PE applications. Palsgaard says it delivers excellent performance when used in the thin walled pieces. It also acts as a processing aid. In tailored formulations for PP compounds, anti-static additives such as Einar 201 and Einar 411 facilitate mould release and denesting, at concentrations as low as 0.1%. "The low dosing concentrations and natural composition of the Einar polymer additives will not interfere with mechanical nor with chemical end-of-life recycling schemes," the company says.



**Palsgaard's Einar mould release performance in homopolymer vs. conventional GMS**

Source Palsgaard

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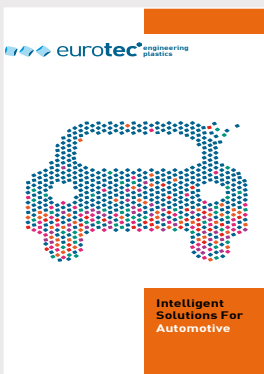
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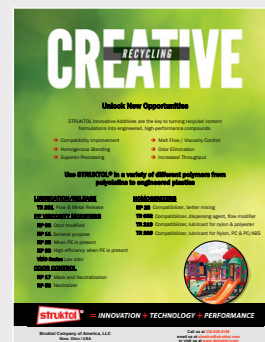
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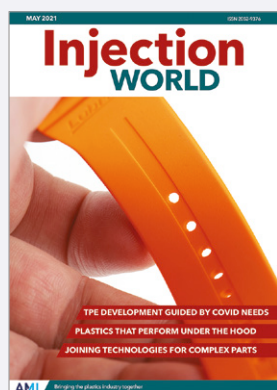


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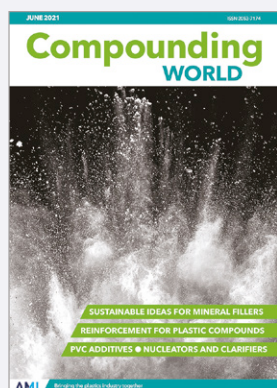
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## Injection World April 2021

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## Compounding World June 2021

The June edition of Compounding World looks at the sustainability aspects of mineral filler products. Other features are on reinforcing options for compounds in addition to glass fibre, developments in PVC additives and the latest in nucleating and clarifying agents

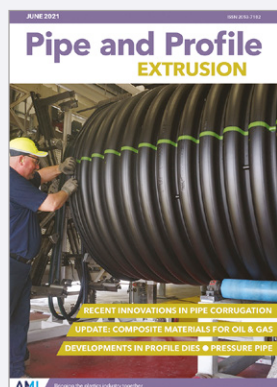
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EXTRUSION

**Injection**  
WORLD

**Plastics Recycling**  
WORLD

## GLOBAL EXHIBITION GUIDE

2021	<b>22-25 June</b>	Plast 2021, Milan, Italy <b>POSTPONED</b>	<a href="http://www.plastonline.org/en">www.plastonline.org/en</a>
	<b>10-12 August</b>	Feiplar, Sao Paulo, Brazil <b>NEW DATE</b>	<a href="http://www.feiplar.com.br">www.feiplar.com.br</a>
	<b>14-18 September</b>	Equiplast, Barcelona, Spain <b>NEW DATE</b>	<a href="http://www.equiplast.com">www.equiplast.com</a>
	<b>29-30 September</b>	Compounding World Expo Europe, Essen, Germany <b>NEW DATE</b>	<a href="http://www.compoundingworldexpo.com/eu/">www.compoundingworldexpo.com/eu/</a>
	<b>12-16 October</b>	Fakuma, Friedrichshafen, Germany	<a href="http://www.fakuma-messe.de">www.fakuma-messe.de</a>
	<b>3-4 November</b>	Compounding World Expo USA, Cleveland, USA <b>NEW DATE</b>	<a href="http://www.compoundingworldexpo.com/na/">www.compoundingworldexpo.com/na/</a>
	<b>8-12 November</b>	Plastico Brasil, Sao Paulo, Brazil <b>NEW DATE</b>	<a href="http://www.plasticobrasil.com.br">www.plasticobrasil.com.br</a>
	<b>15-18 November</b>	Arabplast, Dubai, UAE <b>NEW DATE</b>	<a href="http://www.arabplast.info">www.arabplast.info</a>
2022	<b>25-28 January</b>	Interplastica, Russia, Moscow	<a href="http://www.interplastica.de">www.interplastica.de</a>
	<b>17-21 February</b>	PlastIndia, New Delhi, India <b>NEW DATE</b>	<a href="http://www.plastindia.org">www.plastindia.org</a>
	<b>8-10 March</b>	JEC 2021, Paris France <b>NEW DATE</b>	<a href="http://www.jec-world.events">www.jec-world.events</a>
	<b>8-11 March</b>	Plastimagen, Mexico City	<a href="http://www.plastimagen.com.mx">www.plastimagen.com.mx</a>
	<b>16-17 March</b>	Injection Molding & Design, Detroit, MI, USA	<a href="http://www.injectionmoldingexpo.com">www.injectionmoldingexpo.com</a>
	<b>5-8 April</b>	FIP, Lyon, France <b>NEW DATE</b>	<a href="http://www.f-i-p.com">www.f-i-p.com</a>
	<b>19-26 October</b>	K2022, Dusseldorf, Germany	<a href="http://www.k-online.com">www.k-online.com</a>

## AMI CONFERENCES

<b>22-24 June 2021</b>	Thin Wall Packaging <b>VIRTUAL</b>
<b>27-29 July 2021</b>	Smart Packaging <b>VIRTUAL</b>
<b>21-22 September 2021</b>	Single Serve Capsules, Barcelona, Spain
<b>27-28 September 2021</b>	Chemical Recycling, Dusseldorf, Germany
<b>4-6 October 2021</b>	Polymer Sourcing & Distribution, Hamburg, Germany
<b>20-21 October 2021</b>	Plastics Recycling Technology, Vienna, Austria

For information on all these events and other conferences on film, sheet, pipe and packaging applications, see [www.ami.international](http://www.ami.international)



**29 - 30 September, 2021**  
**ESSEN, GERMANY**



**3 - 4 November, 2021**  
**CLEVELAND, OHIO**

[www.ami.international/exhibitions](http://www.ami.international/exhibitions)