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Coexpan lifts global thermoforming capacity

Coexpan, a Spanish rigid packaging specialist, has expanded its presence in Latin America by acquiring extra thermoforming capacity in Chile.

Through its existing Chilean subsidiary, it has acquired the thermoforming unit of BO Packaging Chile - which will continue its current flexible packaging and other operations in Brazil and Peru.

The takeover means that Coexpan now has PS, PP, PET and PLA thermoforming and extrusion capacities at three production plants in Latin America - in Chile, Brazil and Mexico.

The Coexpan's existing plant in Chile plant, near Santiago, has a wide portfolio of products, aimed mainly at fresh food packaging, dairy products and ready-prepared foods.

"This acquisition forms part of our global thermoforming strategic plan and it



Coexpan has further expanded global production of thermoformed packaging

will enable us to reinforce our presence in a strategic area and broaden our portfolio of rigid packaging products in other countries in the short term," said Dinis Mota, CEO of Coexpan.

Separate to this, the company has expanded its Coexpan FSP plant in Roye, France - with a new extrusion line. The new machine manufactures PS, PP and PLA sheets for range of medium- and high-barrier

packaging solutions.

The project includes extending production and storage facilities, doubling the surface area of the plant, with a new 3,700 sq m production area, four new silos, a new 2,700 sq m warehouse and a new office area.

The expansion will increase the plant's production capacity by an extra 7,000 tonnes/year.

> www.coexpan.com

Macchi adds Asia distributor

Macchi of Italy has signed a distribution agreement with Rieckermann - which will now be its representative in China and six other Asian countries: Thailand, Vietnam, Indonesia, Malaysia, Singapore and the Philippines.

The agreement aims to strengthen Macchi's presence in the region. It says that Rieckermann is an ideal partner to help achieve this goal - as it has long experience in the Asian market, specifically in the flexible packaging industry.

"We are confident that this alliance will further boost our international development," said Paolo Perazzi, managing director of Macchi.

Kristian Rieck, director of plastics and converting at Rieckermann, added: "We see great potential in our new partnership."

> www.macchi.it

Constantia expands its presence in Russia

Constantia Flexibles has acquired a majority stake in TT Print, a Russian packaging producer with whom it has been working for more than 10 years.

The deal is expected to be closed in the first quarter of 2019.

At its production site in Voskresensk, Russia, TT Print makes pharmaceutical and food packaging. The company was established in 1999 and has around 100 employees. Its core products include printed aluminium blister foil and coldform, and its main focus is the pharmaceutical industry.

"With this acquisition we will take a leading position in the Russian pharma packaging industry," said Alexander Baumgartner, CEO of Constantia Flexibles. "It requires local presence to serve the rapidly growing Russian packaging market."

The new site is Constantia's second plant in Russia, after Constantia Kuban in Timashevsk.

> www.cflex.com

Right: Baumgartner: "A local presence is required to serve the Russian packaging market"



Industry leaders to debate the future of extrusion at US event

Influential industry representatives will take part in four focused debates in the Film and Sheet Extrusion theatre at the first Plastics Extrusion World Expo. This will be held at the Huntington Convention Center in Cleveland, Ohio, USA on May 8-9, 2019. Admission to the tradeshow and its conference theatre will be free-of-charge to visitors who register in advance [here](#).

The four debates will cover the future for plastics packaging, agricultural films, stretch and shrink films, and women in plastics. They will feature senior executives from significant players in these fields. The discussions will be chaired by Andrew Reynolds, Director of Advance Bidco, and Charmaine Russell, Business Manager - Conferences at AMI.

The future for plastic packaging will be explored by senior market players, including: Salvatore Pellingra, Vice President Global Application and Innovation Development at flexible packaging converter **ProAmpac**; Rodney Weaver, Market Development Manager at global packaging provider **Sealed Air** and Steve Sargeant, General Manager of Technology at **Flex Films**.

The debate looking at the future of agricultural film will involve panellists from across the Americas to give their views on the latest trends and innovations. They include: Ralf Dujardin, Vice President Marketing & Innovation at US-based **Imaflex**, Roger Tambay, Director of **FilmOrganic** based in Canada and Ramon Parellada, Director at **Polimeros Y Tecnologia** in Guatemala.

Women in plastics: empowering industry change is a special panel featuring high-achieving women in the world of plastics sharing their perspec-



Participants in the industry debates include (left to right): Salvatore Pellingra, VP of global application and innovation development at ProAmpac; Ramon Parellada, director at Polimeros Y Tecnologia; Charmaine Russell, business manager for conferences at AMI; and Ralf Dujardin, VP of marketing and innovation at Imaflex

tive on breaking through in this traditionally male-dominated industry. The line-up includes Lauren Hickey, Director of Marketing and Product Management at masterbatch manufacturer **Americhem** and Jennifer Profit, Plant Manager at **Associated Materials**, a leading profile and sidings producer.

Market trends and developments in stretch and shrink films will be under the spotlight in a panel including Sunil Daga, President at **Wraptite**, a producer of stretch film, and Luke Venechuk, Senior Packaging Engineer, at packaging systems supplier **Highlight Industries**.

If you are a senior manager at a packaging, agricultural film or stretch & shrink producer or a senior female executive in the plastics industry and would like to join the panel for one of these debates, then please contact Charmaine Russell for details at charmaine.russell@ami.international.

Organised by AMI, the Plastics Extrusion World Expo will take place alongside the Compounding World Expo and the Plastics Recycling World Expo. By registering in advance, visitors will receive free admission to all three exhibitions, featuring more than 200 suppliers, plus free entry to five conference theatres hosting

technical presentations, educational seminars and business debates. Attendees and exhibitors will also have the option to buy tickets (just \$20 each) for a networking party at Cleveland's Rock and Roll Hall of Fame on the evening of May 8.

Rita Andrews, head of exhibitions at AMI said: "Our debut expos in Essen, Germany attracted 4,024 visitors, and we are confident that our first Cleveland shows will build on this success and be the biggest plastics industry gathering in the USA in 2019".

The three expos will feature leading suppliers of extrusion, compounding, recycling equipment, polymers, additives and related services.

The exhibitor line-up already includes companies such as Advanced Blending Solutions, Azo, BASF, Bausano, Cabot, Chemours, Clariant, Davis-Standard, Dr Collin, Doteco, Farrel Pomini, FB Balzanelli, Ferro, Greiner Extrusion, KraussMaffei Berstorff, Labtech, Maag, Maguire, NFM, Nordson, Parkinson Technologies, Reifenhauer, Sikora, Struktol, Zeppelin, and over 180 additional leading suppliers.

To book your free ticket, which is valid for both days of the event, visit: [ami.ltd/register-ami-expos](https://www.ami.ltd/register-ami-expos)

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KP to expand US medical packaging film capacity

Klöckner Pentaplast of Germany is investing US\$25 million to expand production capacity for pharmaceutical and medical device packaging films at its Gordonsville facility in Louisa County, Virginia, USA.

The expansion is expected to create 34 new jobs, said the company - which established its first North American production facility in 1979 in Gordonsville.

Tracey Peacock, president of Klöckner Pentaplast's pharma and medical device

division, said: "We are excited with the capacity expansion and technology improvements at Gordonsville. Our technology provides safety and protection for pharmaceuticals and medical devices."

"For 40 years Klöckner Pentaplast has played a significant role in the success of [our] advanced materials industry," said Brian Ball, secretary of commerce and trade for the state. "The investment is a strong testament to Central

Virginia's strategic location and business-friendly environment."

The US investment was the third expansion of KP's pharma and medical device division in 2018: in May, it invested €5m in order to expand production of high barrier products at its Cotia plant in Brazil - which is expected to open this summer; and in April, an investment in a slitting line at its Suzhou facility in China became fully operational.

› www.kpfilms.com

TI takeover in Latin America

BOPP film producer Taghleef Industries (TI) has acquired Biofilm - a Colombia-based producer of similar products for flexible packaging, labels and industrial applications.

Biofilm has production plants in Colombia and Mexico, and its products include clear barrier, ultra-high barrier and metallised films.

It claims to be the largest supplier of metallised BOPP films in Latin America, and one of the largest suppliers of packaging-grade BOPP films on the continent.

"Since its inception, Biofilm has created a high-performing business focused on exceptional quality, innovation and growth," said Detlef Schuhmann, CEO of TI.

› www.ti-films.com

Treofan to close BOPP line

BOPP film maker Treofan is to close its site in Battipaglia, Italy due to "unfavourable general conditions which minimise the chance of operating the site profitably even in the medium- and long-term".

With one production line and 67 employees, it is a relatively small plant that makes

standard films - a segment under tight price and margin pressure in Europe recently, it said.

Treofan and its owner, Jindal, operate another two sites in Italy and a total of six in Europe.

› www.treofan.com

Compatibilising multi-layer plastic films



Kay: "Complexity of multi-layer packaging makes separation for recycling extremely difficult"

Interface Polymers of the UK has been awarded a £0.6m (US\$0.8m) research grant to reduce mixed plastic waste by recycling multi-layer flexible plastic packaging back into high value uses. The company will use its Polarfin additive technology to develop new polymer alloys.

Christopher Kay, chief scientific officer at Interface Polymers, said: "The complexity of multi-layer packaging makes separation for recycling extremely difficult. When the packaging is remelted with virgin polymers for potential reuse, the different plastics are repelled from each other. This creates voids in the mixture which makes the recycled plastic very weak."

He says the company's Polarfin additive can be fine-tuned to make polar and polyolefin block chains of any size - enabling currently incompatible mixtures of thermoplastics to be combined.

› www.interfacepolymers.com

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The Cleveland event will build on the success of AMI's first free-to-attend exhibitions held in Essen, Germany last year

Over 200 exhibitors book space at free US plastics shows

Over 200 companies have booked space at three exhibitions focused on plastics extrusion, recycling and compounding. The free events and associated conferences take place at the Huntington Convention Center in Cleveland, Ohio, USA on 8-9 May.

Organised by AMI, the Plastics Extrusion World, Plastics Recycling World, and Compounding World Expos will feature a wide range of processing machinery, auxiliary equipment, polymer materials, additives and related services.

"Visitors to the focused shows will be able to compare a huge range of suppliers and new technologies in one convenient location," said Andy Beevers, AMI's events and magazines director. "In addition, they'll be able to learn from expert speakers in the five free-to-attend conference theatres and network at the after-party at Cleveland's Rock and Roll Hall of Fame," he added.

The 200+ companies that have already booked booths include: Alpha Marathon, Addex, Advanced Blending Solutions, BASF, Brabender, Buhler, Buss, BYK, Cabot, Chemours, Clariant, Cloeren, Colines, Coperion, Cumberland, Davis-Standard, Dover

Chemicals, Dr Collin, Entek, Erema, Exxel Polymers, Farrel Pomini, Ferro, Gneuss, Greiner Extrusion, Heritage Plastics, JSW, Konica Minolta, Krauss-Maffei Berstorf, Kuhne, Leistriz, Lubrizol, Maag, Maguire, Matsui, Milliken, NFM, Nordson, Oden Technologies, Omya, Pall, Parkinson Technologies, PSI-Polymer Systems, Reifenhauer, SI Group, Starlinger, Struktol, Vecoplan, Wacker, Zoltek, and over 150 more.

The limited number of remaining booths are being filled on a daily basis. Prices start at \$3,400 for a 100 sq ft booth. To find out more about exhibiting at any of the expos, visit <https://www.ami.international/exhibitions>.

"The exhibitions will build on the success of AMI's first tradeshow for the plastics compounding and recycling sectors, which took place in Essen, Germany last year and attracted more than 4,000 visitors," said Rita Andrews, AMI's head of exhibitions, adding: "We are confident it will be the biggest plastics industry gathering in the USA this year."

To book your free ticket, which is valid for both days of the event, visit: ami.ltd/register-ami-expos

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Italian figures show decline in foreign plastic machinery sales

Italian exports of plastics machinery declined slightly in the first nine months of 2018 - though imports again saw healthy growth.

Overall, exports for the period fell by 0.6%. While the trend is positive for extrusion lines, and both injection and blow moulding machinery, it fell away for ancillary equipment and moulds.

Exports to the Far East grew by almost 10%, thanks mainly to India and South Korea, while those to the Middle East fell by around one-third.

There was also a 6.5% growth in exports to North America, but a decline of nearly 13% to South

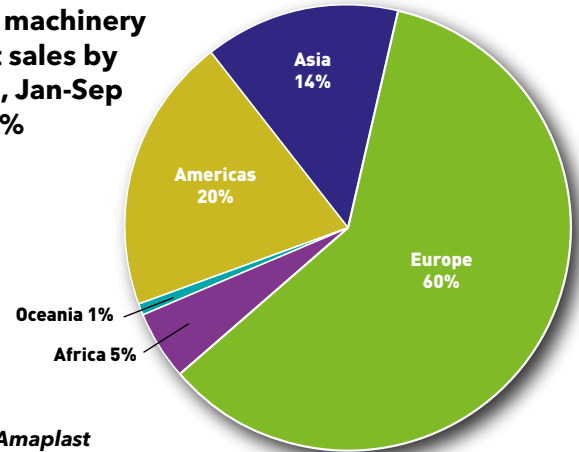


Grassi: "Sales in 2018 will be in line with those of 2017"

America. Sales to North Africa also saw a healthy 13% growth.

And, while sales within the EU were flat, those to the rest of Europe were up by 12%, but those to Russia declined.

Italian machinery export sales by region, Jan-Sep 2018, %



Source: Amaplast

Amaplast's most recent mid-year survey of its members reveals slightly that fewer than half expect stable turnover at the end of the current half-year - while one-third expect continuing growth.

"We expect year-end production and foreign trade to be roughly in line with 2017," said Alessandro Grassi, Amaplast president.

Amaplast says it has a cautious outlook for 2019.

► www.amaplast.org

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Mixed fortunes for exports to Russia

Germany and Italy saw mixed fortunes in their exports of plastics machinery to Russia last year.

While Germany raised its sales by around 3%, Italy's sales fell by nearly 20%.

Both sets of figures - which represent the first three quarters of 2018 - were produced ahead of the countries exhibiting at the Russian Interplastica show.

The increase in German exports comes on the back of a huge 34% rise in sales to Russia in 2017. This, in turn, followed three years of shrinking sales to the region.

Full-year exports to

Russia are expected to be around €117m, said VDMA.

Italy also enjoyed strong sales in 2017 - but these are likely to decline to around €64m for 2018. Extruders were identified as one of the main "victims" of the sales slump, said trade association Amaplast.

"In spite of persistent uncertainties in the Russian market, Italian manufacturers consider [Interplastica] to be of strategic importance in presenting their technological innovations," said Amaplast.

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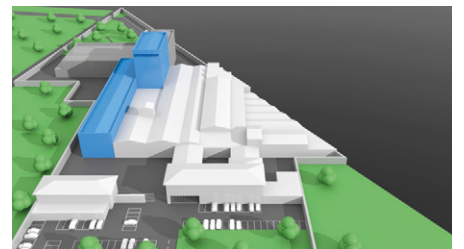
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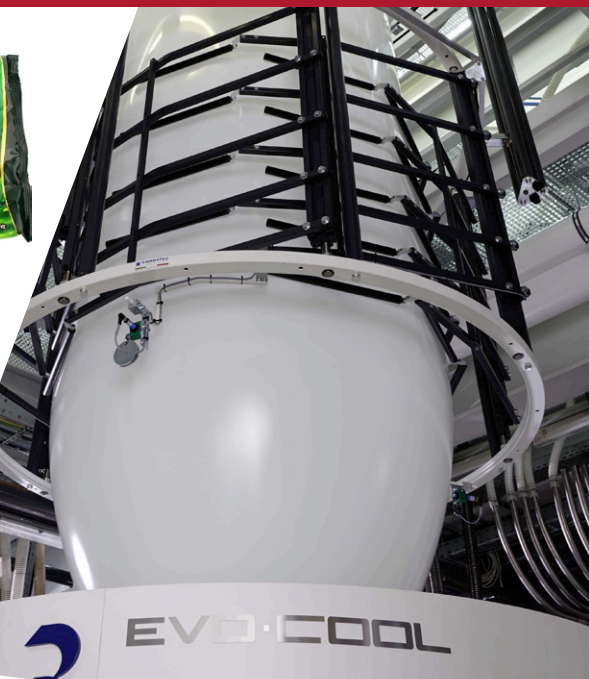
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Researchers are widening their search for bioplastics monomers - with food waste, carbon dioxide and cutting-edge biotechnology all part of the mix. Lou Reade reports



New directions in bioplastics

Competition in the bioplastics market is hotting up, with researchers searching for more and more sources in which to find precursors for new polymeric materials.

A Canadian start-up company, **Genecis**, aims to make bioplastics from food waste. The company uses recent advances in biotechnology, microbial engineering and machine learning to take food destined for landfill and convert it into biodegradable plastics.

The company is led by Luna Yu, a recent graduate from the University of Toronto Scarborough

"Using synthetic biology to create high quality products from this organic waste in a cost-effective way - while mitigating the effects of plastic pollution - is the way of the future," she said.

The company first looked at making bio-rubbers or bio-chemicals from the food waste before settling on PHA plastics.

"We felt this had the biggest market potential," she said.

While PHAs have been in the market for around two decades, most come directly from corn and sugarcane crops. Yu explains that the Genecis

process creates PHA more cheaply because the feedstock is free.

The PHA is made in a three-step process: first, a mixture of anaerobic bacteria breaks down the food waste into volatile fatty acids; next, these fatty acids are added to a mixed culture of aerobic bacteria that are specially selected to produce PHAs; finally, an extraction process is used to break open the cells, and collect and purify the plastic.

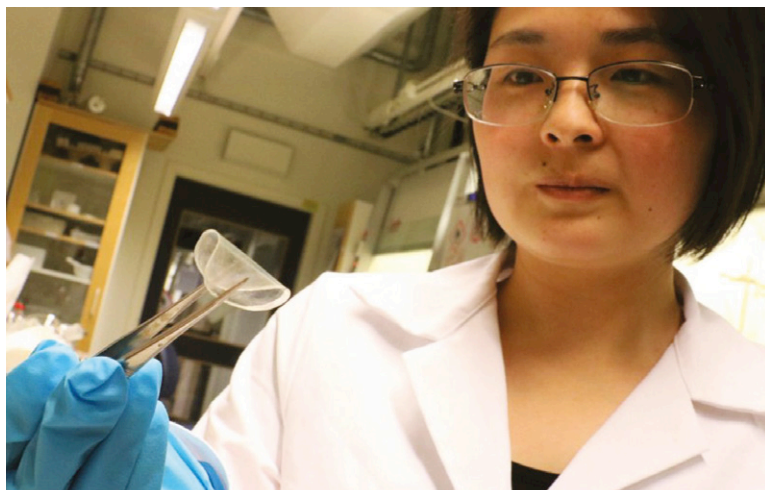
The process takes less than seven days from getting the food waste to having the purified plastic - while biogas takes an average of 21 days. When the company opens its demonstration plant later this year, it will be able to convert three tonnes of organic waste into PHAs every week.

Materials from waste

Another kind of waste - human faeces - might also provide a useful starting material for a new type of polymer. That's because indole, a chemical found in faeces as well as some plants, is showing promise as a precursor for bioplastics, according to research from **Lund University** in Sweden.

Researchers there have created a new family of

Main image:
Luna Yu heads Canadian start-up **Genecis**, which uses synthetic biology to make bioplastics from food waste



Above: Ping Wang of Lund University has prepared polymers based in indole

polymers called indole polyesters, which could be more durable and temperature resistant than conventional polyesters. For instance, a regular PET bottle's glass-liquid transition temperature - when the material softens and deforms - is 70°C. Another bio-derived polyester called polyethylene furanoate (PEF) withstands about 86°C - but an indole plastic created by chemical engineering doctoral student Ping Wang was stable up to 99°C.

The research grew out of the success of PEF, which is based on the hydrocarbon furan - which is derived from maize, wood and certain types of grain. Its main use is packaging, and experiments have shown that PEF is superior to standard PET in protecting against oxygen, carbon dioxide and water.

However, plastics based on indole - which is similar in structure to furan - could have superior properties to PEF, say the Lund researchers.

The research was published in *Polymer Chemistry*.

Plastic from CO₂

An increasingly popular starting material for bioplastics is carbon dioxide.

Bio-on of Italy, for instance, has established a new company that will produce PHA bioplastic from carbon dioxide.

The new company, called Lux-on, is 10% owned by Gruppo Hera (which may later expand its stake to 49.9%). Bio-on already makes bioplastics from materials including sugar beet, fruit and potato waste, and waste frying oil.

The laboratories and first plant of the new Lux-on project will be built by the end of this year close to the Bio-on's industrial facility at Castel San Pietro Terme (Bologna) in Italy. The plant will occupy an area of 1,500 sq m and have "a flexible production capacity that is rapidly expandable".

The electrical energy used in the production process will be produced by photovoltaic systems.

Marco Astorri, chairman and CEO of Bio-on, said: "The technological innovation used at Lux-on enables us to increase the industrial sustainability of a new production concept to capture CO₂ from the atmosphere and produce innovative materials like our PHA biopolymer."

At the same time, scientists at **Rutgers University** in the USA have developed catalysts that can convert CO₂ into plastics and other products.

Other than enzymes, these electrocatalysts are the first materials that can turn CO₂ and water into carbon building blocks containing one, two, three or four carbon atoms with more than 99% efficiency, say the researchers.

Two of the products created - methylglyoxal (C3) and 2,3-furandiol (C4) - can be used as precursors for plastics, adhesives and pharmaceuticals. Toxic formaldehyde could be replaced by methylglyoxal, which is safer. The precursors could be an alternative to using petroleum for making plastics.

The research is published in the journal *Energy & Environmental Science*.

"Our breakthrough could lead to the conversion of carbon dioxide into valuable products and raw materials," said the study's senior author Charles Dismukes of Rutgers University - New Brunswick.

Based on their research, the Rutgers scientists have earned patents for the electrocatalysts and formed a start-up company called RenewCO₂. The next step is to learn more about the underlying chemical reaction, so it can be used to produce other valuable products such as diols, which are widely used in the polymer industry.

Cutting waste

UK-based **Biome Technologies** has received £0.8m (US\$1m) in government funding as part of a larger programme to use industrial biotechnology to produce sustainable polymers.

The two-year project, in collaboration with the **Nottingham University**, will use organisms to produce bioplastic 'building blocks' (specifically PDCA or 2,5-pyridinedicarboxylic acid) at pilot scale. These bio-based building blocks, or monomers, will be used to make compostable and recyclable polymers for flexible packaging applications such as pouches - which are currently not recyclable. The resulting products will then be tested by a leading UK brand.

Over the last five years, Biome has led a £6m (US\$7.7m) development programme to bring new bio-based and biodegradable polymers to market using industrial biotechnology. The programme currently involves seven universities and around 25 scientists, engineers and other industrial partners. ➤



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Paul Mines, CEO of Biome Technologies, said: "The UK government has set a target of eliminating all avoidable plastic waste by 2042. Bioplastics will play a crucial role in achieving this target by reducing waste. While current bioplastic technology is limited by price and performance in some applications, our development programme intends to change that by preparing new polymers with improved functionality."

Edible packaging

Nottingham University researchers have also developed edible, biodegradable food packaging film from a variety of plants.

The project, led by Saffa Riffat of the Faculty of Engineering, is working on plastic films derived from konjac flour and starch, cellulose or proteins that are fully edible and harmless if accidentally eaten by people or animals

The researchers have found that plant carbohydrate and protein macromolecules bond together into a special network structure during the film-forming process. The network structure gives the film the necessary mechanical strength and transparency to be used as packaging materials.



"The EU plans to make all plastic packaging recyclable or reusable by 2030," said Riffat. "We need to find degradable solutions to tackle plastic pollution, and this is what we are working on now."

As well as being edible, degradable, strong and transparent, the materials have low gas permeability - making them more air tight - which cuts moisture loss, slows down spoilage, and seals in the flavour, added Riffat. The research team is also looking to advance the technology for general packaging in areas such as construction.

Above: Biome Technologies is using industrial biotechnology to produce sustainable polymers



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Left: Saffa Riffat and Fatang Jiang of Nottingham University have developed edible, biodegradable food packaging film

Repellent effect

US researchers have investigated how extruded PLA - in this case, fibres - can be imbued with insecticide in order to ward off insects.

Cindu Annand, a graduate research assistant at **Ohio State University** in the USA, told delegates at Antec last year about a project to add either pyrethrum or DEET (both insecticides) to PLA fibres, either by extrusion or spraying. The fibres could be used to create protective garments - a

practical suggestion as PLA is a polyester.

Two different grades of PLA were compounded with insecticide and extruded into fibres - then woven into small pieces of fabric. Separate to this, pieces of fabric were created from pure PLA fibre - then sprayed with an equivalent amount of the insecticide.

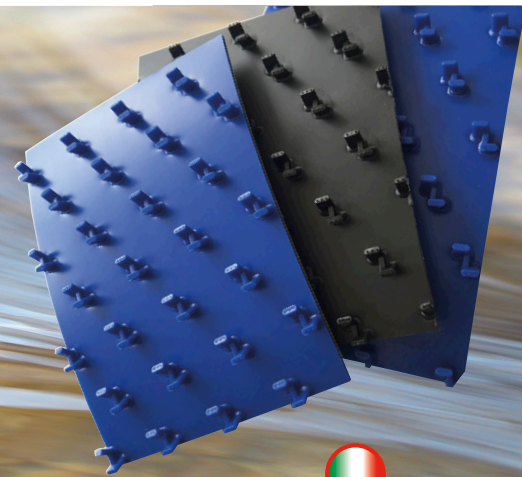
The effectiveness of each was tested by exposing mosquitos to the sample, and checking how many were repelled by it. The amount of 'escape' of the insecticide - that is, the release of insecticide from the fabric, which would have an effect on the insects, was also measured in each case: for DEET, this was $33.3 \pm 3.3\%$; for extruded pyrethrum it was $80 \pm 6.3\%$; and for sprayed pyrethrum it was $98.3 \pm 1.7\%$.

The researchers found that all the treated fabrics had some kind of repellent effect compared to the untreated control PLA fabric. PLA sprayed with pyrethrum was the most effective, followed by PLA extruded with pyrethrum.

"The sprayed natural pyrethrum-treated fabric is more repellent than the extruded natural pyrethrum-treated fabric, which may be due to a loss of active natural pyrethrum in the extrusion process," said Annand. ➤

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Bio-based TPEs

At Fakuma last year, **FKuR** presenting a range of bio-based thermoplastics for applications including thermoforming and extrusion.

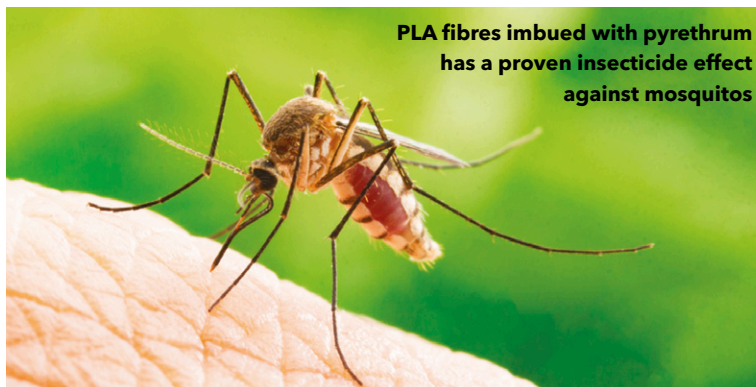
Terraprene, a bio-based TPE compounds for extrusion and injection moulding, has a bio-based content of 40-90%. They offer the same mechanical properties as their hydrocarbon-derived counterparts and can be processed on existing production equipment and tools.

Terralene PP is a PP compound with a bio-based carbon content of approximately 35% (ASTM D 6866). In profile extrusion, it is a drop-in solution because its performance and processability are comparable to those of conventional PP grades.

And France-based **Lactips** - which makes water-soluble, biodegradable plastic from milk proteins - has signed a deal to supply its packaging film for dishwasher tablets from Ulrich-Natürlich of Germany.

The company previously used PVA to package the tablets. The first batch of orders has already been delivered to a number of European countries.

"The first order, with a manufacturer committed to offering environmentally-friendly solutions,



PLA fibres imbued with pyrethrum has a proven insecticide effect against mosquitos

recognises all the work accomplished by Lactips," said Marie-Hélène Gramatikoff, CEO at Lactips.

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Whether for development or quality purposes, reliable polymer characterisation is essential in modern production plant. Jennifer Markarian explores the latest developments and learns more about the impact of Big Data



PHOTO: SHUTTERSTOCK

Polymer analysis moves from lab to production

The ability to analyse the rheology and other properties of polymers and the components of polymer compounds is vital for product and process development and quality control purposes. Tools range from the simple but useful melt flow indexer to more complex instruments such as dynamic-mechanical analysis (DMA). And it is not just about laboratory-based testing – line-side and on-line instruments are growing in importance as testing and integration technology advances and process control systems become more sophisticated. And the ability to collect, store, and analyse ever greater volumes of data is making new ways of thinking about polymer analysis possible.

Sensor and polymer testing equipment group **Dynisco** has expanded its polymer evaluation products for laboratory testing with the release of the LMI5500 Series Melt Flow Indexer for

thermoplastics. A unified software platform between laboratory and online production equipment in this latest model is said to enable processors to more easily obtain detailed analytics globally on a single dashboard. Other features for improved ease of use include an easy-to-clean and remove inspection plate; improved access for sample cutting; and a revamped and more intuitive touchscreen. In addition, the new instrument's gravitational correction feature (for which a provisional patent has been obtained) takes into account gravity based on geographical location in relation to the equator, which is said to improve accuracy.

While instruments such as melt flow indexers or capillary rheometers (utilised for measuring apparent viscosity) are used offline in the lab, online rheometers are increasingly being used to provide a continuous data stream of rheological

Main image:
The ability to measure polymer properties such as rheology is vital for development and QC purposes, with many now doing that in the lab and on the production line

Right: Dynisco's LMI5500 Series melt flow indexer uses a unified software platform to simplify handling and analysis of lab and production data

properties at different process conditions, according to Johannes Lorenz, Sales Manager at Dynisco Europe, in a presentation given at AMI's Polymer Testing & Analysis Europe conference in September last year. "These data can be used in many ways," says Lorenz. "Data could provide viscosity as a parameter to be used in the extruder control system – for example to control the dosage of additives or raw materials. They can also be used for in-process quality control instead of, or in addition to, lab tests."

To correlate process and lab data, Dynisco's Internet-of-Things-based platform collects, stores, and visualises data from on-line as well as lab instruments. "Field tests and case studies show that – next to the classical process parameters such as pressure, temperature or motor torque – viscosity or MFR [melt flow rate] can provide a much more sensitive and accurate insight into the process," Lorenz says. He explains that such measurements have been standard in polymer manufacturing but their use has more recently been increasing in compounding and recycling, especially of polyolefins and polyesters.

Dynisco's ViscoIndicator Online Rheometer, for example, can be set to calculate either apparent viscosity or MFR. One of the challenges in correlating online and offline measurements is the difference in temperatures of the tests, says Lorenz. However, he says the company's scientists have been able to calculate an appropriate temperature correlation that gives good agreement between online and offline MFR measurements.

In-line options

First introduced in 2017, **Leistritz's** Elongational Rheometer can be used as a standalone instrument or linked to an extruder for on-line or in-line measurement of shear and elongational viscosities along the entire viscosity curve. Developed by Leistritz and the Institute for Polymer Extrusion and Compounding at the Johannes Kepler University in Linz, Austria, the instrument uses a



PHOTO: DYNISCO

patented slit die approach that is claimed to allow it to provide a more complete picture of melt quality than existing on-line technology using fixed-geometry capillary rheometers.

The rheometer works by diverting a small amount of melt via a bypass into the slot die, which features a hyperbolic narrowing designed to generate constant elongational flow (said to be a first for an online elongational rheometer). Delivery of the melt to the die is controlled by an internal gear pump, providing full independence from the compounding extruder. After the

measurement has been made the molten material is transferred back into the process, avoiding any waste.

The device can be used with materials ranging from high viscosity pipe grades to low viscosity fibre or injection moulding grades. It provides online measurement of shear viscosity with shear rates in the range 10 to 10,000 s⁻¹ and elongational viscosity with elongation rates in the range 5 to 75 s⁻¹. During the continuous measuring process, the operator can query two measured values of shear viscosity and one value of extensional viscosity.

Leistritz says the unit can be used to obtain viscosity curves in a very short time through targeted variation of shear and elongational rates. It can also indicate the melt flow index, IV value and melt density and can be used to monitor reactive compounding processes.

Goettfert's on-line rheometer product line ranges from bypass and side stream instruments to the Dynamic Online Rheometer (DOR), which attaches to the extruder and, because it also connects to a data collection system, can be considered to be "big data friendly," according to Tim Haake, General Manager of Goettfert. Speaking at AMI's Polymer Testing and Analysis North America conference in 2018, he said: "Connecting instruments via the Internet of Things and starting to collect data now is crucial."

Keeping data relevant by linking rheology data with the lot number and procedure is important for statistical analysis. Haake says that artificial intelligence (AI) can analyse unstructured data but, for now at least, keeping lab and process data in sync and understanding where the data comes from is necessary. Big data techniques can be used to recognise patterns, which can then be

Below: Leistritz claims the patented slit die geometry of its Elongation Rheometer delivers benefits over capillary types in in-line applications



PHOTO: LEISTRITZ

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Right: Leistriz's Elongation Rheometer can be used in standalone and in-line applications

used to optimise manufacturing. Big data can also be used to predict material properties and aid development of new materials and compounds. The widespread use of advanced analytics and even AI is not far off, predicts Haake, but for now the task is to collect relevant data that can later be used to feed mathematical models.

Goettfert has also recently introduced the off-line Melt Index Machine mi-Robo 89.16. This is a fully automated melt indexer that can run pellets, powders, or be fed directly with material from the process itself. Automation improves accuracy by eliminating the "human factor" that can create variability. The instrument's electric drive technology is also significantly quieter than the previous version's pneumatic motor.

Austria's iVON offers an online rheometer designed to measure the intrinsic viscosity (iV) of PET. A key benefit of the system is the ability to optimise input material mix and pre-drying times using a feedback control loop based on iV measurement. In addition, the system provides full traceability for documenting quality parameters. The "plug & play" system can be operated as an independent unit or connected with the extruder control system.

DMA for the lab

Anton Paar's new MCR 702 MultiDrive for dynamic mechanical analysis (DMA) combines a new linear motor with the EC drive technology from its MCR rheometers, enabling users to perform DMA in tension, bending, compression, and torsion, as well as thermomechanical analysis (TMA) and rheological characterisation, in one instrument. The motor

design, unique to the MCR 702 MultiDrive, has low magnetic hysteresis that enables precise measurements over a broad force range up to 40N. This range enables characteri-



PHOTO: LEISTRIZ

sation of all types of materials ranging from soft to stiff. The large displacement range of the linear motor from 10nm up to 9.4mm is suitable for all kinds of DMA in tension, bending and compression; thermomechanical analysis; and static procedures such as tensile testing.

The MultiDrive can also be used for DMA in torsion or as a research-grade rheometer to characterise polymer melts or polymer solutions by using the top EC motor and keeping the bottom linear motor fixed. As an extra feature for rheological measurement, the two drives can work in counter-movement mode and also in separate motor-transducer mode when combined with an additional EC motor instead of the linear motor. In this configuration, the device enables

combined characterisation methods (for example, rheology and microstructural analysis with a microscope), rheological tests at high rotational speed, steady and transient rotational tests, and oscillatory tests.

The instrument provides automatic recognition of measuring systems using an RFID chip in each accessory, which reduces operator error. The system's temperature-controlled chamber (offering a temperature range from -160 to +600°C) has been optimised using computational fluid dynamics to avoid internal temperature gradients, ensuring a uniform temperature across the sample. The measuring system also includes an integrated temperature sensor, which increases the reproducibility of the measurement of the sample temperature.

An existing Anton Paar MCR 702 TwinDrive rheometer can be upgraded to a MultiDrive DMA system by substituting the lower rotational motor with the new Linear Drive and installing a new computer processing unit and firmware. "A user's current setup can easily be adapted to this functionality. This set-up saves space in the lab as well as the cost of two different instruments," says Anton Paar USA Sales Manager, Norbert Ponweiser.

Multivariate analysis

Polymer scientists have developed considerable understanding of how molecular structure and morphology, combined with processing variables, affect the properties of polymers and their end-use performance. Univariate (one variable) analysis is of some use, but since the relationships between

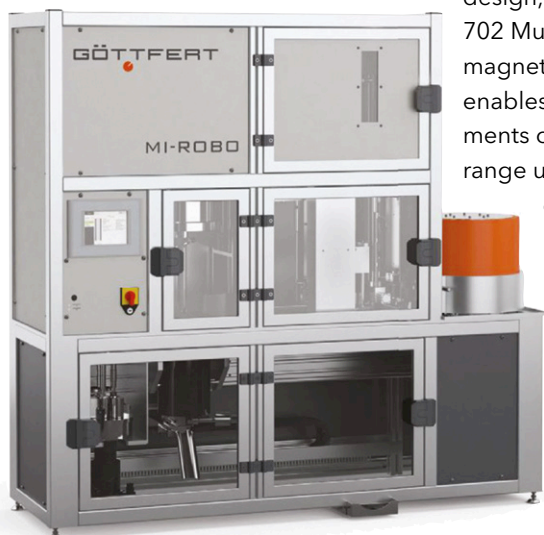


PHOTO: GOETTERT

Left: The Goettfert mi-Robo 89.16 is a fully automated melt indexer

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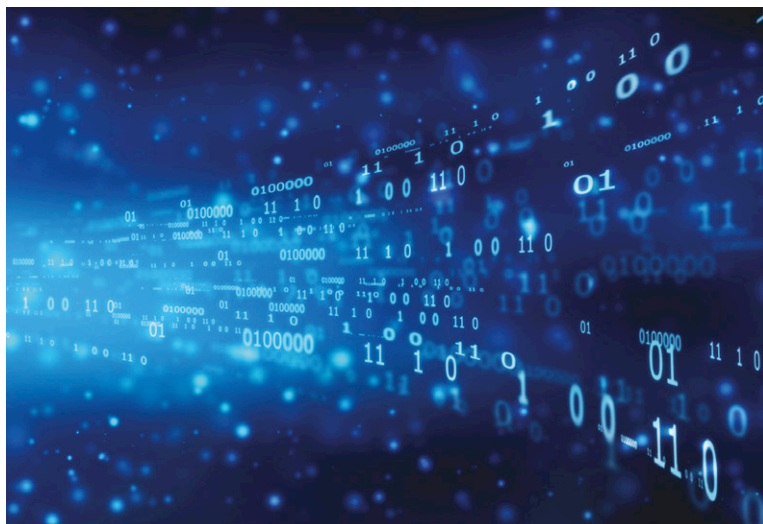
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PHOTO: SHUTTERSTOCK



Above: Big Data is opening up new opportunities for process analysis but will require new data analysis tools

the variables are actually complex and interrelated (correlated), multivariate data analysis (MVDA) methods are more appropriate in providing greater accuracy and a more thorough explanation of the variables' relationships.

At the Polymer Testing & Analysis North America conference in September last year David Fiscus, Senior Chemist at **ExxonMobil**, shared an example of how MVDA was used to develop structure-process-property relationships for polyethylene blown films. A big dataset was developed and analysed using multivariate linear regression methods to solve the multitude of simultaneous equations relating the variables.

The method of analysis was explained based on traditional chemometric approaches. Statistical analysis removed differences in the measurement scales of the variables, which enables comparing variable effects on an equal basis. Principal component analysis (PCA) independently relates the variables composing the input space (for example, molecular structure, morphology, and

processing variables) with those of the performance space. The data can be visualized in various ways (Figure 1). Principle component regression analysis and partial least squares (PLS) regression analysis relate the variables of the input and output spaces, with both types of analysis mapping the input variables onto the output variables. The results of these forward regression analyses can be inverted, which enables prediction of the input variables needed to obtain any specific balance of performance variables.

MVDA is ideal for analysing big data sets generated during routine operations involving many correlated variables, including correlated data from steps along the value chain (such as the resin manufacturer, compounder, fabricator and end user), says Fiscus. He notes that MVDA can be used to improve compound formulations and optimise compounding and processing operations. It can also be used to establish multivariate statistical process control protocols for those processes, and it can be used to analyse data sets generated using design-of-experiments methods.

Various commercial multivariate software packages are available. Now that large amounts of data can be easily collected and stored, and the computing power to analyse big data sets is available, MVDA is likely to be increasingly used.

Pellet analysis

A new system from **Sikora** automates visual inspection and analysis of plastic materials in the lab. The Purity Concept V is an optical offline inspection and analysis system. As material on a tray moves through the inspection area, a colour camera records images for analysis. Contamination, such as black specks inside transparent pellets as well as on the surface of opaque and colored

Figure 1: Principal component analysis (PCA) of machine and transverse direction ultimate properties of blown PE film

Source: ExxonMobil

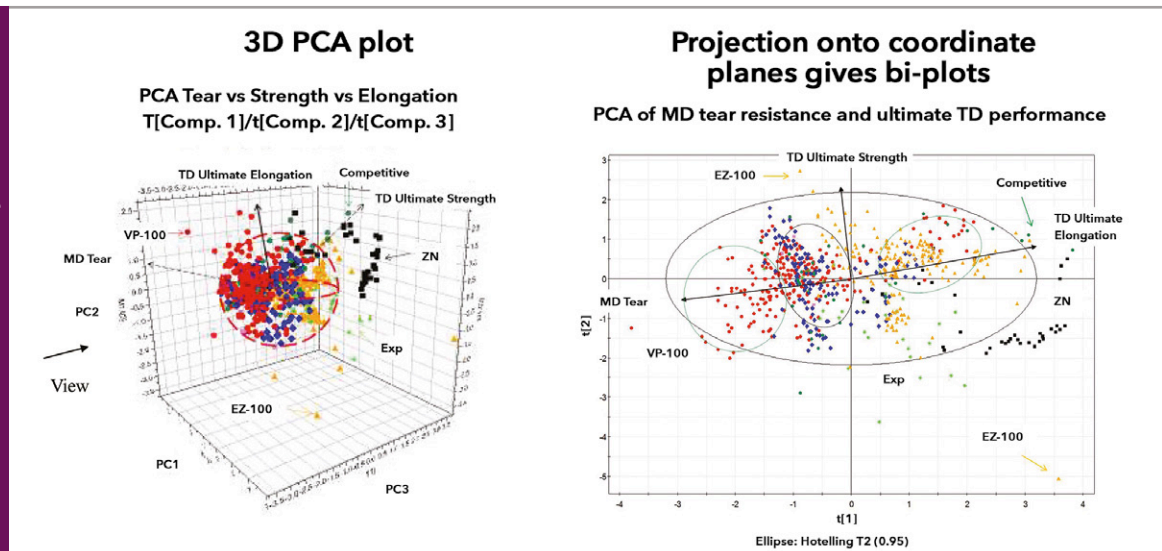


PHOTO: SIKORA



(including fluoropolymers, PEEK, PA, PE, and PP) at its site at Appenzell in Switzerland. The company uses the inspection system to ensure high material purity. Black spots, foreign particles, and metal particles are eliminated by the automated system.

The scanner, combined with a processor to analyse and visualise the sorting, provides statistical evaluation of detected contamination sorted by number, size and frequency as well as an image gallery of contaminated granulates. This information is saved, and data such as the duration of the order, material type, throughput and rejection rate are also recorded, allowing full traceability after a project has been completed. "We use the production data as reference for future orders. Furthermore, we forward the information as a final report to our customer, who receives absolute technical transparency about his product and the production process," says Minger CEO Bruno Ofner.

Left: The Purity Concept V system from Sikora fully automates lab-based pellet inspection

material, is automatically detected, visualised, and evaluated. The automated offline system is more accurate and more reproducible than an operator using a manual light table, says Sikora. The system determines the size of contamination, which is useful for quality control and process optimisation.

For online inspection and sorting of plastic material, Sikora recommends its Purity Scanner Advanced, which combines X-ray with optical technology to detect contamination inside plastic pellets as well as on their surface. The system uses an adaptive camera concept, with up to three optical cameras depending on the expected contamination and application. For example, an X-ray camera detects metallic contamination inside pellets; optical cameras identify yellow discolorations or black specks inside transparent and on opaque pellets; and colour deviations are detected by colour cameras. Contaminated pellets are sorted out automatically. The combination of online and offline inspection, sorting and analysis benefits quality control, and the data can be used to improve processes and to avoid future contamination, noted the company.

In 2018, recycler and compounder Minger Kunststofftechnik added Sikora's online Purity Scanner Advanced system to its lines for recycling technical and high-performance polymers

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Below: Sikora's automated pellet analysis is said to be more accurate and repeatable than manual light table techniques

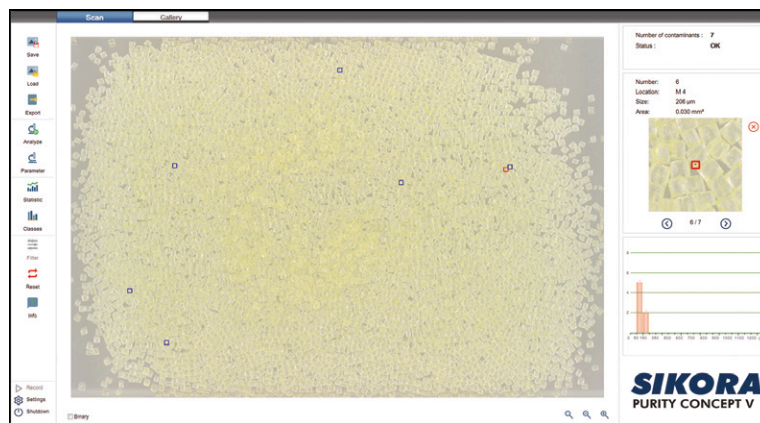


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New polyolefin grades and formulations are finding use in a multitude of applications - from film tie-layers to mulch film. Lou Reade reports

PHOTO: SHUTTERSTOCK

Multiple uses for polyolefins

Polyolefins are the most widely used polymers, with applications across the spectrum - ranging from packaging to agriculture, in foam, film and sheet.

For instance, while they are commonly used in multi-layer films, their role in tie-layers is less well known - although they are often a vital component. At AMI's Multilayer Flexible Packaging conference last year, Norman Aubee, technical service specialist at **Nova Chemicals**, said that selecting the correct tie-layer formulation is vital in these applications.

C4-LLDPE can be used in tie layers to cut costs, but the saving may be offset by higher tie concentrate requirements to achieve similar adhesion strength, he told delegates.

He said there was a long-term trend towards multiple layers in food packaging. Typical applications are meat, cheese and liquid packaging, and pointed to a typical commercial example of a frozen pizza, protected by a seven-layer film with a total thickness of 170 microns, including a total of 94 microns in tie-layers - more than 55% of the structure.

"Optimising the tie-layer formulation would present significant opportunity here," he said.

He added that most film manufacturers blend

10-20% tie concentrate with 80-90% LLDPE as the base resin - so the base resin is often the highest volume percentage of the total barrier structure.

As well as giving package integrity, the tie-layer should maintain film optics and appearance and give barrier protection, he said.

"The opportunity is to develop a test protocol to optimise tie-layer formulations for individual film formulation," said Aubee. "After this, use the protocol to generate recommendations for tie-layer design."

Nova did this on a five-layer co-extruded film, 125 microns thick. Adhesion strength was tested straight off the line, and at 72 hours. Several formulations used a resin with a tie concentrate - rising from 5 to 20% - which all saw increased peel strength after 72 hours.

Overall, Nova found that tie concentrates offered an effective alternative to tie resins.

"Processors were able to select blend resins to optimise end use performance or economics," said Aubee.

Pore formation

Researchers at **Dow** say that resin selection is a crucial factor behind pore formation in PE film.

Main image:
Nova says that optimising the tie-layer formulation in a seven-layer film for frozen pizza would reduce packaging thickness significantly

In a paper presented at last year's Antec conference, Wenyi Huang, a research scientist at the company, told delegates: "There is a growing interest in polyethylene porous films, because of their low cost and breathability.

However, he noted that some methods to create porous film have drawbacks: using calcium carbonate as a filler can irritate the skin, while low molecular weight species and incompatible polymers often create inferior pore structure and reduce mechanical performance.

To try and overcome this, Dow tested five different PE resins - of varying crystallinity and molecular weight - using multiple methods, including DSC, GPC, light-scattering GPC, and X-ray techniques. Mercury porosimetry was used to characterise the pore structure of PE porous films, and water vapour transmission rate (WVTR) was used to determine their breathability. The semi-crystalline homopolymer PE films were created by cold stretching at room temperature and subsequent hot stretching at an elevated temperature.

The results showed that high crystallinity (> 0.96 g/cm³), high molecular weight distribution (Mw/Mn > 6) and high z-average molecular weight Mz (> 500,000) of PE resins were critical for the pore formation in these films.

Coffee boost

In agriculture, **Braskem** has developed a mulch film to improve crop yields on coffee farms. In collaboration with the Federal University of Uberlandia, and a local farm in Monte Carmelo, it developed a series of three-layer polyethylene mulch films. These were 40 microns thick, 1.6m wide and intended for use over 24 to 30 months. The project evaluated two double-sided films: both had black internal layers, but one had a silver external layer, the other a white external layer.

One formulation used 55% Flexus 9211 (a metallocene LLDPE), as well as an LLDPE butane grade and a masterbatch to incorporate pigments and additives.

Some of the advantages were: a 30% reduction in weed killer costs; a similar reduction in water consumption; and improved yields on the first commercial harvest.

Balance of properties

Braskem has also developed a new polypropylene (PP) grade - called

Prisma 6810 - that offers a balance of transparency, stiffness and impact toughness for thermoforming applications.

Braskem says the material combines characteristics not typically seen in single resin solutions - including the toughness of an impact copolymer, but stiffness and haze values close to that of a clarified homopolymer. These properties offer new options in packaging applications such as refrigerated deli containers, cold blended drink cups, and meat or seafood trays.

The company says that - as well as preferring more transparent containers - its clients were looking for new single-pellet resin solutions that do not require the addition of an elastomer to achieve the necessary performance characteristics. Prisma 6810 also maintains its ductile characteristics at temperatures as low as -10°C.

Isla Regenye, Braskem America market segment leader, said: "We believe Prisma 6810 meets the market's growing preference for clearer containers and that its performance properties make it an ideal new candidate for material replacement opportunities."

Clear choice

Oman Oil Refineries and Petroleum Industries Company (**Orpic**) has also developed a new PP thermoforming grade, which it says will increase the productivity and overall performance of transparent thermoformed cups, trays and containers.

The material, called Luban HP1151K, uses Hyperform HPN-600ei nucleation technology from **Milliken**. It combines high clarity and aesthetics with a new level of superior dimensional stability for thermoformed products, says Orpic - offering the food packaging and household storage solutions industries a new standard in PP.

As well as being able to increase the number of articles that can be produced, finished products provide good stacking performance. The material also offers a broad processing window that allows product quality and consistency advantages, as well as productivity benefits for converters.

Additionally, the grade delivers optimal environmental and handling-related advantages associated with using lightweight PP compared to other materials, says Orpic.

"Luban HP1151K reduces haze in the product and increases clarity and gloss," said Gilles Rochas, general manager for polymers at Orpic. "We are confident that it will help international packaging customers reduce their cycle times and achieve

Right and below: Orpic says its new PP thermoforming grade will increase the productivity and performance of transparent thermoformed cups



High barrier flexible films for food packaging

The global market 2018

From
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This specialist market report will provide you with insightful and actionable information on the trends and material choices for high barrier films.

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- Key end use segments
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Plus an extended section on sustainability and recycling and the implications for high barrier films.



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High barrier BOPP films

Innovia Films has developed a range of Biaxially Oriented Polypropylene (BOPP) products with optimum barrier performance - including a high barrier metallised film, an AIOx clear high barrier film and co-extruded oxygen barrier film.

Innovia will also develop mono layer materials for different applications, which can be recycled more easily.

Stephen Langstaff, global business manager for packaging, said: "We have been working hard to develop new films that will extend the shelf life of a range of products, to reduce food waste. We will develop options that allow pack simplification, by removing or replacing layers within lamination materials that restrict recycling."

> www.innoviafilms.com



better results through less wastage - while offering all-round productivity improvements."

Hyperform HPN-600ei also offers good organoleptics with no contamination risk - making Luban HP1151K suitable for food applications.

Beta nucleation

At last year's Antec conference, consultant **Philip Jacoby** explained some novel applications of beta nucleated PP in applications including film and thermoforming.

He told delegates that PP exists in three crystalline forms - and that the beta form can reduce the cost and weight of PP parts. He also presented details of a beta nucleant from **Mayzo**, available in masterbatch form, that can be added to PP to achieve beta nucleation.

He said that beta nucleation could create a number of benefits in film - such as mono-oriented PP film with low density, uniform colour and good printability, and breathable BOPP film with low levels of filler (and can be used for applications including car covers, roofing membranes and battery separator film).

Separate to this, beta nucleated PP can be thermoformed into opaque cups that are nearly 15% lighter than when made from non-nucleated PP. Tests showed that sidewall distribution was also more uniform for the beta nucleated version, he said.

Strong performer

Polyolefin films also play an important role in pallet stabilisation - as long as they have high cling performance and are strong enough to withstand tearing. At last year's Stretch & Shrink Film conference, **SABIC** said that some of its grades can boost pallet stability.

Bart Van Hoof, global marketing manager for flexible packaging at the company, said that

adhesion performance of its Cohere grades have helped to boost cling performance when incorporated into the cling layer. In a project run with Polish stretch film manufacturer Efekt Plus, it changed the formulation of the outer LLDPE cling layer of a five-layer film, replacing 32% VLDPE with 10% Cohere. This led to a cling layer with similar cling force - despite the lower percentage - as well as a cost advantage, he said.

And, in a project with packaging specialist Maillis, Sabic helped create a thin, stiff stretch film using Supeer 8315. The films were 10 microns thick and used Supeer to replace LLDPE. The resultant films had higher stretch force, reduced stretching and a constant steep tensile curve.

And, in a project with ForumPlast and DuoPlast, it combined Supeer and Cohere to replace EVA in stretch hoods, while improving properties at a competitive price. In the original structure, a middle EVA layer, sandwiched between two mLLDPE layers, was replaced by a new structure: two outer layers of Supeer/LDPE, sandwiching a middle layer of Cohere, Supeer and LDPE.

Some of the advantages of the new design included: higher, more consistent holding force; more stable COF; better protrusion resistance; and higher transparency.

Van Hoof added that Sabic is adding m-C6 LLDPE grades to the Supeer portfolio.

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AMI is pleased to announce the timely return of the Polymers in Photovoltaics conference, taking place Hamburg Marriott Hotel, Hamburg, Germany.

The recent sign off on new rules in the Clean Energy for All Europeans package will help the EU embrace the clean energy transition. This is anticipated to help reinvigorate the European photovoltaics sector and provide support to manufacturing equipment of renewable energy technologies, as well as to material producers.

The conference brings solar module manufacturing professionals together with polymer experts to get up-to-date with the latest industry requirements.

The event will also feature a table-top exhibition and provide plenty of networking opportunities.

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Testing times for medical plastics

Delegates at two recent medical plastics conferences heard the latest on testing leachables and extractables - as well as the importance of scale-up to medical bags. Lou Reade reports

Medical fluid bags are a critical part of patient care - providing everything from saline to blood products. Although they are often life-saving products, they are still rigorously assessed for safety - such as whether foreign substances can leach into the liquid they contain.

Attendees at AMI's two Medical Fluid Bags conferences held in 2018 learnt a great deal about how manufacturers are balancing bag performance with issues like migration - while also finding out more about processes to improve efficient production.

Pilot licence

At the most recent event, held in Boston, USA in October, Franz Wenzl, sales and marketing director for medical pharma at **Dr Collin**, told delegates that using pilot plants to test multi-layer film formulations - for later scale-up to full production - are vital to the overall efficiency and cost-effectiveness of the process.

Pilot production allows manufacturers to test key characteristics such as barrier properties and mechanical strength, as well as parameters such as

process temperature and rheological properties - while controlling costs.

"The general aim is to get optimal results for minimum effort," he said. "We want to determine how small a pilot line can be - and how the knowledge can be transferred to a large line."

In flat film manufacture, for instance - such as could be used to produce medical bags - there are three processing steps after the melt exits the die: formation of a melt bank prior to the calender gap; cooling the melt by surface contact with the roll; and subsequent air-cooling.

Comparing roll diameters of 72, 168 and 350mm (an approximate ratio of 1:2.4), he said that a scale-up of 1:2.5 is quite reasonable. A similar ratio is applicable to haul-off speed (such as going from 120m/min to 300m/min). Similar criteria can be tested for blown film production, he said.

Pilot production was vital in estimating cost for full production - and was more effective than using a full-scale machine to perform test runs, he added. For instance, running smaller amounts of an expensive material kept costs down. The more expensive a material, the greater its overall

Main image: Eastman has tested blood bags - for red blood cell storage - that were plasticised by its DEHT, an alternative to DEHP

Right: Dynasol has developed new grades of its Calprene SEBS block copolymer for medical applications, including film

contribution to final cost – and the more effective a pilot system was for doing this.

Some other disadvantages of using full-sized machines for development included: production downtime of the machine; having only a short time (such as one day) in which to perform trials; and taking longer to reach stable production conditions.

“Developing on a pilot line gives more flexibility and shorter development time – and so a higher market presence with new products,” he said.

Material developments

At the same event, several speakers presented a range of new material developments – encompassing block copolymers, PVC and alternative plasticisers.

Dynasol has developed a range of its Calprene SEBS block copolymer for use in medical applications including film.

The grades, which have a high vinyl content (62%), can produce products with better transparency, high flexibility and good impact and scratch resistance when combined with PP, said Sergio Corona, advanced materials manager at Dynasol in Spain.

He said that using SEBS in medical applications had several advantages, including: regulatory compliance; phthalate-free formulation; high resistance to acids and bases; and recyclability. The three grades also showed high optical and mechanical properties.

The company prepared and tested a number of elastic non-wovens from the grades – showing much lower set and higher recovered energy than existing materials, he added.

At the same time, Cristian Barcan, vice president of sustainability and industry Affairs at the **Vinyl Institute** in the USA, said that PVC is making a comeback in the medical sector – following the



failure of some materials that had begun to replace it.

“The use of PVC in single-use medical devices – including fluid bags – is expected to increase in the coming years,” he said.

He also said that, due to concerns over plasticisers – a vital ingredient in flexible PVC products such as medical bags – scientific research was continuing. He said that, while DEHP in particular was a concern, current studies are “inconclusive or inconsistent” regarding its effects.

“DEHP for PVC in medical applications is justified because of the medical benefits,” he said.

Despite these reassurances, **Eastman** has developed an alternative to DEHP – called DEHT – which it says offers several advantages.

Scott Boito, who deals with product stewardship and advocacy at the company, told delegates that Eastman had evaluated DEHT-plasticised blood bags for red blood cell storage, comparing it to those stored in standard DEHP-plasticised containers.

The researchers also assessed the performance for fresh frozen plasma (FFP).

Red blood cell parameters – including complete

Applying supplier selection criteria

When making medical fluid bags, it is critical to choose the correct supplier – whether it is of materials, machinery or services, according to Renolit.

Because medical fluid bags are not simple products – combining several components made by variable methods, in several steps – it is vital to get all these elements right, said Peter Robben, global product manager at Renolit Medical.

“There’s a lot more than material performance and pricing,” he said.

For instance, there is cleanliness to think of – with ISO Class 7 cleanrooms preferred – and the existence of medical-oriented Quality Management Systems. In addition, a supplier should be able to offer both regulatory and technical support.

On the materials supply, security of supply is vital – meaning that a supplier should have multiple production sites.

In summary, Robben said:

■ Medical fluid bags are not simple

– so carry out a broad overview of material and supplier requirements;

■ Many material options are available – so engage with suppliers early in the product development process;

■ It’s more than a piece of plastic: suppliers with strong medical experience and medical industry business orientation are ideal; and,

■ Changes can be long and complex – so design products with supply security embedded from the beginning.

➤ www.renolit.com



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Housewrap 2019 covers the latest technical developments and market trends in this dynamic sector and focuses on the most commonly used types of housewrap. The program looks at developments in raw material characteristics, machinery, testing techniques, material formulation, extrusion & processing technologies continuing to facilitate cost reduction without compromising performance and safety criteria.

The conference sessions are complemented by a focused table-top exhibition and plenty of networking opportunities, including an evening drinks reception.

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Right: Fluid bags - made from a range of materials - are vital to medical treatment



blood count, ATP and haemolysis (%) - were measured after 0, 35 and 42 days. A range of plasma factors was measured at 0 and 30 days, and 1 year. In both bases, plasticiser concentrations in the fluids were also measured, using liquid chromatography-mass spectrometry.

After 42 days, haemolysis of the red blood cells was well below 1% - a key criterion set by the FDA. There was also a 72% lower migration from DEHT bags than from DEHP bags.

Results for plasma parameters showed no statistical difference between DEHT and DEHP bags, said the researchers. In these bags, DEHT migration was 90% lower than for DEHP.

"Based on this data, Eastman's DEHT is a potential replacement for DEHP in FFP storage bags," said Boito.

Finding DEHP

The whole debate over plasticisers - especially DEHP - means that producers of medical fluid bags must be able to demonstrate accurate knowledge of its level in their products.

Roger Pearson, president of analytical services at **Aspen Research**, said that tests on medical fluid bags could throw up positive results, even if the bag was 'DEHP-free'.

"In one test, DEHP was detected at about 2,000 microgrammes per bag," he said. "The source was tracked to the laboratory water used. It was an intermittent problem - and at low level."

While the level found was of no toxicological

concern, he says it is a problem of perception to detect DEHP in a material that is not meant to contain any.

Low extractables

The subject of leachables and extractables was also a major theme at the earlier Medical Fluid Bags conference held in Cologne, Germany in June 2018.

Robin Van Landeghem, director of technology for the global films division of **Tekni-Plex**, told delegates of the importance of designing medical products for low extractables.

Due to an ongoing trend towards care at home - rather than in hospital - there is a greater need for reliable medical packaging. Multi-layer films will play an important role - but must be assessed extensively for leaching and extractables.

For this reason, polyolefins are likely to be the most suitable product contact material, he said - with barrier layers being added via coextrusion. As well as PE and PP, other suitable materials include cyclic olefin copolymers (COCs) and PCTFE.

He cited the example of a MiniBag, which holds volumes of 1-3ml of liquid, or a larger version with 3-30ml. It would form part of a device that dispenses medicine for a variety of conditions.

One pharmaceutical company has carried out multiple stability studies on the bags - which incorporate both COC and PCTFE - for different types of insulin.

Migration testing

In a session devoted to extractables and leachables, Karen Pieters of **Nelson Labs** highlighted some of the challenges of testing for migration from a bag system into a parental solution (the liquid contained within the bag).

There is a difference between the two: extractables are everything that can come out of packaging (which is usually achieved using solvents), while leachables are what comes out under normal conditions.

These could come from several sources in a medical bag, including the bag itself or other parts such as the tube or stopper - and some other surprising sources.

"Due to the semi-permeable nature of the primary film, compounds from printed labels can easily migrate," she said.

The migrating species might include curing agents or residues from solvent, adhesive or paper.

In similar fashion, compounds from overwraps or pouches - such as bislactone from PU adhesives - may also migrate.

Steam sterilisation of the final system can also

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Right: Fraunhofer IST is an expert in surface treatment of medical products

affect migration – as was found in one study that an aluminium overpouch was the main contributor to leachables into a 0.9% solution of sodium chloride in 100ml PP bags.

Plasma treatment

Researchers at the **Fraunhofer Institute for Surface Engineering and Thin Films (IST)** have developed an atmospheric plasma treatment to reduce the migration of PVC plasticisers from blood bags.

Thomas Neubert, a scientist in the research team, told delegates that the method was an alternative way of solving the problem. Typical solutions that are currently used include: using alternative plasticisers – which can be expensive, and still require regulatory approval; and barrier coatings, which require high elasticity and adhesion, while also being expensive.

Fraunhofer’s method is a low-cost technique that does not affect layer adhesion or elasticity, and uses no new materials, he said.

In tests, Fraunhofer assessed the migration of DEHP and DINCH plasticisers across a known area of PVC film, over a period of two hours. It found that DEHP was almost completely blocked using this surface treatment method, while DINCH migration was cut by 20-50%.

Separate to modifying a plastic’s barrier properties, plasma treatment can make a surface more ‘biocompatible’ with the liquid it contains: Fraunhofer IST has previously worked on developing processes for surface functionalisation or coating using atmospheric pressure dielectric barrier discharge. In this way, a cold physical plasma is used to treat the surfaces of many materials – which may be temperature sensitive. With suitable process control, it is possible to improve the wettability with polar media such as water, as well as in capillary or porous structures.

Accredited production

Extrusion companies are used to having quality systems in place – but the standards required for making medical products go much further.

Here, a faulty product can have major ramifications, such as hefty fines from the US Food and Drug Administration (FDA).

For this reason, a different type of accreditation is needed, said Justin McCabe, **MedAccred** program lead at the Performance Review Institute in the USA.

He explained that the MedAccred programme is an industry-managed supply chain oversight scheme for critical manufacturing processes – such



as film extrusion for making medical fluid bags.

He said that the programme reduces risk to patient safety, assures quality products and verifies compliance with requirements.

MedAccred will carry out audits in order to verify the accredited suppliers meet a number of standards in areas such as process capability, equipment, qualified staff and process validation.

It carries out audits of many plastics processes, including extrusion of both film and sheet – as well as associated processes like plastics welding and sealing.

Some common audit findings within plastics extrusion include:

- Inaccurate measuring of components for mixtures;
- Inadequate use of extrusion process parameters (such as temperature, pressure and speed);
- Not addressing all process steps in sequence within procedures; and,
- Lack of a comprehensive Master Validation Plan.

Accreditation under the programme raises product quality, reduces scrap and re-work, and improves process control and capability, said McCabe.

“It also gives the potential to expand business within the growing medical device industry,” he said.

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AMI's second Single-Serve Capsules conference in North America takes place in Atlanta in March. We take a look at the programme and speakers

Serving a growth market

Single-Serve Capsules, Atlanta 2019 brings together industry-elite speakers from the entire supply chain with the aim of identifying opportunities and overcoming obstacles in the North American single-serve capsules industry. The conference provides a unique forum to debate and evaluate the global trends, innovations, challenges and opportunities facing the industry through the entire value chain of plastic and metal capsules. This includes capsule fillers, coffee roasters, capsule moulders, material suppliers, technology and machinery suppliers as well as companies expanding the scope of applications for single-serve capsules.

From a niche market, single-serve beverage capsules have grown to be one of the most important sub-applications of the ambient thin wall packaging segment in the past five years. Following the disruptive changes to the supply chain in 2012, new opportunities have been created for both end-users and converters to tap into this growing market segment through compatible products. New to this year's conference, AMI introduces a more upstream market focus on product innovation including cold beverage, nutritional supplements and even food applications.

With the growing number of capsules in

landfills, the industry is under pressure - there is an urgent need to review the materials used for capsules conversion in search of more sustainable options, as well as to explore end-of-life solutions. In addition to the busy two-day program, *Single-Serve Capsules 2019* offers high-level networking opportunities in a focused exhibition area featuring displays from a range of suppliers.

Here we preview the conference, with a closer look at the line-up of expert speakers.

Market outlook

The opening session of the conference kicks off with **Martyna Fong**, Unit Manager - Packaging at **AMI** in the UK, who gives a global single-serve capsules market overview.

The second session of the conference features a host of innovators who are pushing the boundaries of applications for single-serve capsules. The session opens with **Bryan Fedorak**, Co-founder of **Bartesian** in the US, focussing on cold beverage applications of single-serve capsules and the unique challenges and opportunities they bring. Next **Andrew Cousins**, Technical Key Account Manager at **Alupak** in Switzerland, looks at their success in creating a dynamic single-serve beverage

age system from scratch.

After a networking and refreshment break, **Gian-Carlo Ochoa**, Founder & Executive Chairman from **Güdpod** in the US, discusses how blender pods could be the next generation of single-serve applications. **Carlos Ruiz**, Founder, CEO and Chairman of **Flatev** in Switzerland, presents his vision beyond beverages for the future of single-serve capsules. The final paper of this dynamic session is presented by **Charll van Veen**, Unit Manager Single Serve Brewing Systems from **Frieslandcampina Kievit** in The Netherlands, who looks at a winning combination of dairy with coffee for single-serve capsules.

Capsule advances

The third session starts with **Marius Olszewski**, President and CEO of **Rychiger** in the US, who discusses innovations in the assembly of single-serve capsules. **Pat Seitz**, Vice President Packaging Division at **Hermann Ultrasonics** in the US, then focuses on preserving the aroma with ultrasonic sealing with a closer look at technology advances for the capsule market.

The fourth and final session of Day 1 is a panel discussion featuring **Stephen Schulman**, Senior Vice President Sales / Head of Specialty Coffee from **Lacas Coffee Company** in the US, **Michael Szyliowicz**, Founder of **SolaBev** in the US, **Martin Bussman**, Team Leader Segment Biodegradable Packaging and Technical Marketing from **BASF** in Germany, and **Latisha Tillie**, Senior Brand Manager for TheraFlu at **GSK** in the US. The panel focusses on market trends, innovations and vision for single-serve capsules and will be moderated by **Martyna Fong** from **AMI**.

To round off the day's proceedings, a networking drinks reception is held in the exhibition room, where delegates and speakers debate the conference so far and attendees have the opportunity to network with industry peers.



Speakers at the conference include (from left to right): Bryan Fedorak from Bartsian, Gian-Carlo Ochoa from Güdpod, Charll van Veen from Frieslandcampina Kievit and Gianmaria Pavan from Ahlstrom-Munksjö

Innovations and materials

Day 2 of *Single-Serve Capsules* is opened by **Dave Morton**, Vice President, Multi-Layer Technology Solutions at **Husky Injection Molding Systems** in the US, who looks at unlocking sustainable packaging possibilities for single-serve capsules through multi-layer technology. This is followed by an introduction to certified home compostable beverage capsules given by **Benjamin Haas**, R&D Engineer at **Alpla Werke Alwin Lehner** in Austria.

The final session of the conference begins with a look at an environmentally sustainable solution for single serve coffee through a K-cup compatible alternative from **Gianmaria Pavan**, Head of Beverage at **Ahlstrom-Munksjö** in France, and **Cesare Rapparini**, Owner of **ICA** in Italy.

After the networking and refreshment break, **Steve Davies**, Vice President - Performance Packaging from **Natureworks** in the US, continues the session with his paper on compostable capsules developments. **Shigeaki Yamane**, Global Director of Marketing, Global Business Office, Performance Polymers Division at **Mitsubishi Chemical Corporation** in Japan, then explores a home compostable multilayer barrier packaging solution for single-serve capsules. Closing the conference is **John Moore**, Senior Vice President of Business Development at **Danimer Scientific** in the US, who presents a new generation bioplastic to create home compostable coffee pods.

About Single-Serve Capsules 2019

The second edition of AMI's international *Single-Serve Capsules* conference in North America will take place on March 5-6, 2019 at The Westin Buckhead, Atlanta, Georgia, USA. The event provides an international forum for all companies, through the entire value chain of plastic and metal capsules in the US, to come together and engage with each other over two days - be they end users, capsule fillers, coffee roasters, capsule moulders, material suppliers, technology and machinery suppliers or converters. In addition to the formal conference sessions, the event provides extensive networking opportunities throughout the informal breaks, including access to the table top exhibition area and complementary cocktail reception at the end of the first day. To find out more about attending the conference, taking a table-top exhibition space, or becoming a conference sponsor, visit the [conference website](#) or contact Conference Organiser Agata Swietek: agata.swietek@ami.international Tel: +44 (0) 117 314 8111.



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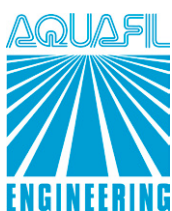
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FOAMING TECHNOLOGY

MuCell adds packaging performance

Plastilene, a Colombia-based specialist in high density foam technology (HDFT), is using MuCell to manufacture a range of foamed films.

It has applied HDFT in coextrusion processes for polyolefin blown film, and for PET calendaring coextrusion sheeting.

Plastilene has developed foamed materials - using nitrogen as the foaming medium - for a number of flexible packaging applications, including: secondary packaging for hygiene markets; liners for large bags; pouches for fresh milk; vertical closures for greenhouses; heat sealing films for laminated structures; light weight films for retail pouches; and, rigid sheets for thermoforming applications.

Plastilene is also using HDFT to make barrier materials for both flexible and rigid packaging uses.

➤ www.mucellextrusion.com

ACRYLICS

Tough roofing film also offers high light diffusion

At the recent IPM horticultural exhibition in Essen, Germany, Evonik highlighted its Plexiglas Resist multi-skin sheets with hail-resistant finish. The product also high light transmission - which is vital for plant production.

"The new version, Plexiglas Resist AAA 16-64 SDP in D-Structure, offers

high light diffusion," said Bernd Petri, head of the roofing business in the acrylic products division at Evonik.

With a high chamber spacing of 64mm, the multi-skin sheeting is almost as transparent as glass but also dimensionally stable and tough. The high light diffusion and transmission provide optimal growth

conditions for plants, says Evonik.

Also on display was Plexiglas Alltop multi-skin sheeting, with high transparency. The no drop coating allows rain and condensed water to flow away rapidly and prevents drop formation. This allows a light transmittance of about 91%.

➤ www.evonik.com

POLYURETHANE

Wrapping film with flexible use



Avery Dennison has developed a polyurethane wrapping film for a wide variety of applications.

Its MPI 1405 Easy Apply RS film can be used everywhere from vehicle wraps to challenging textured building surfaces such as brick and concrete blocks.

Oliver Guenther, senior director of marketing and channel strategy for Avery Dennison, said that a single film for so many applications makes installers' lives easier: "The print performance and stretchability of this PVC-free material makes it a straightforward choice for applications where looks really matter - and where there are challenges arising from irregular curves.

➤ www.averydennison.com

POLYCARBONATE

Honeycomb panels with superior fire resistance

Covestro and EconCore are combining their technologies to produce honeycomb panels for mass transport.

A key performance aspect is to comply with Fire, Smoke, Toxicity (FST) requirements for applications including railway and aerospace.

Covestro has developed and tested polycarbonates and blends that meet the FST performance - and is develop-

ing lightweight thermoplastic composites under the brand name Maezio - while EconCore is the developer of a process to make light honeycomb structures in an economic way.

The companies intend to optimise the FST performance of honeycomb panels in order to meet different application requirements, by combining the appropriate polycarbonate

grade with EconCore's technology.

At this early stage of development, sandwich panels with different material and technology combinations have been produced and evaluated. The results of preliminary FST tests are being verified for different material combinations, said the partners.

➤ www.covestro.com

➤ www.econcore.com

LABORATORY EXTRUDERS

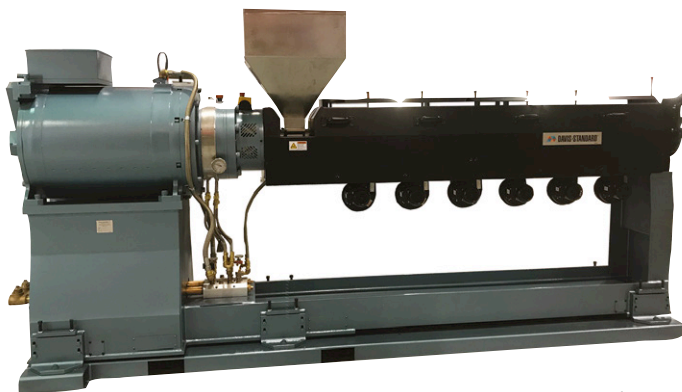
Extended capability for groove feed extruder

Davis-Standard has extended the lab capabilities at its technical centre in Pawcatuck, USA - offering trials for its Helibar groove feed extruder and DS Activ-Check control system for continuous extruder monitoring.

"These technologies are proven in the field and we're pleased to offer experimentation in our technical centre," said John Christiano, vice president of extrusion technology at Davis-Standard.

Helibar is suitable for use with profile and sheet extrusion processes, while Activ-Check is suitable for the majority of the company's extruders, it says.

Davis-Standard says the Helibar is a "next generation" groove feed extruder. Helical grooves inside the barrel run along the entire barrel bore. This can increase extruder output



rates while improving energy efficiency and reducing barrel and screw wear. Other advantages include: lower start-up costs; shorter residence time; and the ability to process higher levels of regrind. This is especially beneficial for high-profile applications where speed, melt quality and efficiency are paramount, said Christiano.

The new extruder in the lab will be 65mm, with a 36:1 L/D.

The DS Activ-Check system will be mounted on

a 4.5in (114mm) extruder. Using a continuous monitoring platform, it boosts preventative and predictive maintenance. Operators can monitor key mechanical and electrical components of the extruder and gearbox and receive early notification of potential component failure.

John Clemens, director of extrusion controls, said: "The capability to monitor extrusion line variables such as mechanical and electrical system conditions is essential in order to bring products to market faster."

> www.davis-standard.com

CAST FILM

Cast film line for JV in Thailand

SML of Austria is to supply a cast stretch film production line to a joint venture company in Thailand.

The customer, Sigma Stretch Film of Asia, is a tie-up between US-based Sigma Plastics Group and King Pac Industrial of Thailand. It will combine Sigma's experience in the US market with King Pac's local manufacturing and distribution networks.

The SML line will be delivered to Thailand towards the end of this year and go onstream shortly after. SML's technology will allow the company to make supply premium-quality stretch films.

The line will be installed in a new, custom-built 300,000 sq ft facility and will produce around 20,000 tonnes/year of stretch film.

> www.sml.at

SPARE PARTS

Express delivery for extrusion spares



Windmüller & Hölscher can now manufacture and deliver some rare consumables or old machine parts now stored in stock in 24 hours.

It says that simple to medium complex machine components that have been manufactured to customer specifications can be rebuilt and delivered within this timeframe.

"Our express service for spare parts works in a similar way to an emergency room," says Jörg Dellbrügge, head of W&H service logistics. "The most

important thing is to stabilise the patient (or the machine)."

The service covers the small proportion (around 10%) of W&H components that are not available from stock. The usual delivery time for such parts is two weeks or more.

Express manufacturing was set up in April 2018, and since then its three full-time employees at W&H in Lengerich have completed more than 200 rush orders.

> www.wuh-group.com

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2019

*The international conference addressing artificial grass/synthetic turf
from raw materials to end-user experience.*

25-27 February 2019

Imperial Riding School Renaissance Vienna Hotel, Vienna, Austria



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Based on a novel polymer/mineral mix, the Scanfill range of packaging resins can minimise environmental impact by reducing polymer consumption, non-renewable energy use and greenhouse gas emissions without sacrificing barrier performance. Find out more in this brochure.

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MACCHI: FILM EXTRUSION



This 28-page brochure from Macchi covers the company's wide range of film extrusion technologies including coextrusion lines, wide webs, die heads, take offs, winders, trim recovery and control systems.

[CLICK HERE TO DOWNLOAD](#)

COLINES: BARRIER FILMS



This new brochure from Colines focuses on extrusion lines for the production of barrier films for vacuum and modified atmosphere packaging to preserve foodstuffs and medical products.

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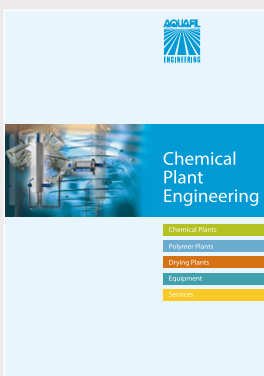
W&H: VAREX II FILM SYSTEMS



Varex II is Windmüller & Hölscher's latest universal system for high output blown film production. This publication details the critical Varex II system features that ensure production of the highest quality films with minimal scrap and highest plant efficiency.

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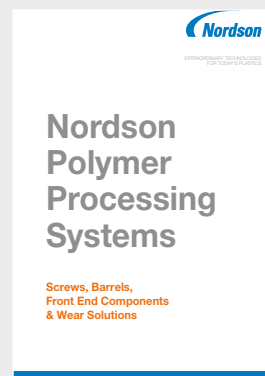
AQUAFIL: PLANT ENGINEERING



This 12-page brochure from Aquafil Engineering details its comprehensive range of chemical plant engineering capabilities, which include polyamide polymerisation, polyester condensation and polymer drying installations.

[CLICK HERE TO DOWNLOAD](#)

NORDSON: SCREWS & BARRELS



In this Nordson Polymer Processing Systems brochure, find out about Xaloy bimetallic extrusion screws and barrels, designed to meet process requirements, help optimisation, combat wear, boost output, and improve and maintain quality.

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If you would like your brochure to be included on this page, please contact Claire Bishop claire.bishop@ami.international. Tel: +44 (0)1732 682948

Learn more about AMI's upcoming conferences

Click on the relevant brochure cover or link to download a PDF of the full conference programme

PVC FORMULATION USA 2019



Taking place in Pittsburgh, PA, USA, on 26-27 February 2019, AMI's second North American PVC Formulation conference looks at the latest PVC market trends, material innovations and mixing technology.

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BREATHABLE FILMS 2019



The second edition of the Breathable Films conference will take place on 27-28 February in Berlin, Germany, and will cover market, materials and technology developments.

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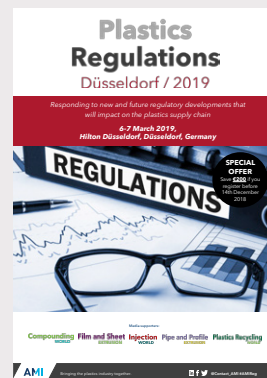
SINGLE-SERVE CAPSULES USA 2019



The second North American Single-Serve Capsules conference will be held in Atlanta, GA, USA, on 5-6 March 2019, providing an opportunity to learn more about this rapid growing thin wall packaging market.

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PLASTICS REGULATIONS 2019



Taking place on 6-7 March 2019 in Düsseldorf, Germany, the third European edition of Plastics Regulations will consider how to respond to new and future regulatory developments that will impact on the plastics supply chain.

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SPECIALTY PACKAGING FILMS ASIA 2019



The key event covering markets and technology or flexible packaging in a fast-growing region, AMI's sixth Specialty Packaging Films Asia conference will take place on 19-20 March 2019 in Bangkok, Thailand.

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PLASTIC POUCHES 2019



AMI holds its fifth Plastic Pouches conference in Vienna in Austria on 2-3 April 2019. The event is the meeting place for all involved in design, specification and production of this innovative packaging format.

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To see our full line-up of more than 50 plastics industry events over the next 12 months, please visit www.ami.international/events

Tech II

Head office: Springfield, Ohio, USA

CEO: Eric Shiffer

Founded: 1969

Ownership: Private

Employees: Around 300

Turnover (2018): US\$40m

Profile: Tech II was founded in 1969 by Jerry Shiffer. Although the company began by making injection moulded lids, it has since moved heavily into thermoforming and in-mould labelling - though still runs a number of injection moulding presses. In 2013, in order to be more competitive, it began extruding its own thermoforming sheet.

Product lines: As well as making injection moulded products, such as packaging containers, the company produces a wide range of extruded, thermoformed and decorated products. It offers a number of in-mould labelling products, for instance: one variant has a high oxygen barrier, thanks to a multi-layer structure incorporating EVOH; another is compatible with high pressure processing (HPP), while many of them exhibit high quality printed graphics.

Factory locations: The company has two production facilities - which are very close together: a large portion of production is still carried out at the Springfield plant where the company has operated since 1974; it also has a second plant in Urbana, just four miles away. Despite this concentrated production in the American Midwest, the company operates on a global basis.

To be considered for 'Extruder of the Month', contact the editor on lou@filmandsheet.com

Film and Sheet FORTHCOMING FEATURES EXTRUSION

The next issues of Film and Sheet Extrusion magazine will have special reports on the following topics:

March 2019

Thermoforming applications
Additives for film
Control & Instrumentation

April 2019

Flat die developments
Agricultural films
Film winders
Plastics Extrusion World Expo preview

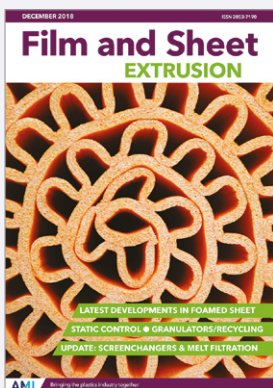
Editorial submissions should be sent to Lou Reade: lou@filmandsheet.com

For information on advertising in these issues, please contact:

Claire Bishop: claire.bishop@ami.international Tel: +44 (0)1732 682948
Levent Tounjer: levent.tounjer@ami.international Tel: +44 (0)117 314 8183

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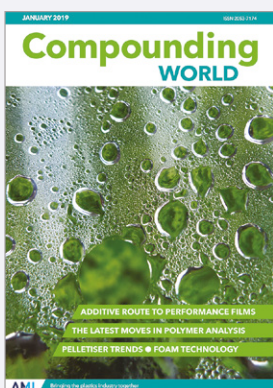
Film and Sheet December 2018
The December edition of Film and Sheet Extrusion magazine reviews the latest developments in foamed sheet technology. It also details innovations in melt filtration, granulation and static management.

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Film and Sheet November 2018
The November edition of Film and Sheet Extrusion has features looking at developments in the sheet sector, construction market, thin wall packaging and active packaging. Plus, AMI analysis of the European distribution market.

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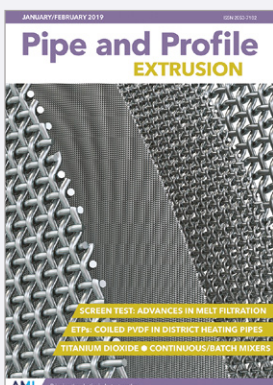
Compounding World January 2019
The January 2019 edition of Compounding World magazine takes a close-up look at additives for film production. It also reviews developments in pelletising technology, polymer analysis and polymer foaming.

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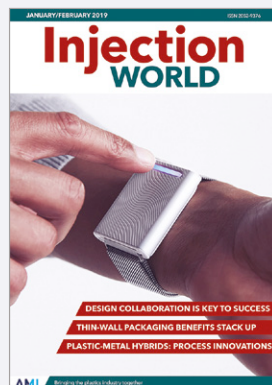
Plastics Recycling World November/December 2018
The November/December 2018 edition of Plastics Recycling World takes a look at the PVC industry's progress in recycling in Europe and Australia. It also reviews the latest developments in process control and plastic granulation.

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Pipe and Profile January/February 2019
The January/February edition of Pipe and Profile Extrusion features a study on the feasibility of using coiled PVDF for slipline rehabilitation of district network heating pipes. Plus features on titanium dioxide, melt filtration and mixer technology.

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Injection World January/February 2019
The January/February edition of Injection World magazine examines the role of designers and material producers in successful product developments. It also reviews innovations in polymer-metal hybrids and thin wall packaging.

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Film and Sheet
EXTRUSION

Pipe and Profile
EXTRUSION

Injection
WORLD

Plastics Recycling
WORLD

GLOBAL EXHIBITION GUIDE

2019	12-15 March	Pro-Pack Africa, Johannesburg, South Africa	www.propakafrica.co.za
	12-16 March	Koplas, Seoul, South Korea	www.koplas.com
	19-21 March	EU Coatings Show, Nuremberg, Germany	www.european-coatings-show.com
	25-29 March	Plástico Brasil, São Paulo, Brazil	www.plasticobrasil.com.br
	8-12 April	Feiplastic, Sao Paulo, Brazil	www.feiplastic.com.br
	8-9 May	Compounding World Expo, Cleveland, USA	www.compoundingworldexpo.com
	8-9 May	Extrusion Expo, Cleveland, USA	www.extrusion-expo.com
	8-9 May	Plastics Recycling World Expo, Cleveland, US	www.plasticsrecyclingworldexpo.com
	21-24 May	Chinaplas, Guangzhou, China	www.chinaplasonline.com
	21-24 May	Moulding Expo, Stuttgart, Germany	www.moulding-expo.com
2020	18-21 September	T-Plas/Tiprex, Bangkok, Thailand	www.tplas.com
	16-23 October	K2019, Dusseldorf, Germany	www.k-online.com
	25-28 November	Plastivision Arabia, Sharjah	www.plastivision.ae
	27-29 November	Plastics & Rubber Vietnam	www.plasticsvietnam.com
	16-20 January	Plastivision India, Mumbai, India	www.plastivision.org
	21-23 January	Swiss Plastics, Lucerne, Switzerland	www.swissplastics-expo.ch
	7-13 May	Interpack, Dusseldorf, Germany	www.interpack.com


AMI CONFERENCES

27-28 February 2019	Breathable Films, Berlin, Germany
5-6 March 2019	Single Serve Capsules, Atlanta, USA
14-15 March 2019	Speciality Packaging Films Asia, Bangkok, Thailand
2-3 April 2019	Plastic Pouches, Vienna, Austria
8-10 April 2019	Stretch & Shrink Film, Barcelona, Spain
25-26 June 2019	Multilayer Flexible Packaging, Chicago, USA
17-18 September 2019	Housewrap, Coral Springs, USA
12-14 November 2019	Polyolefin Additives, Vienna, Austria
18-20 November 2019	Agricultural Film, Barcelona, Spain

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

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