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Compounding WORLD

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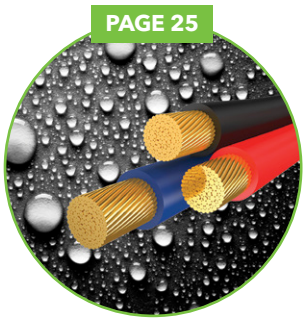

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CONTACT US

AMI

Third Floor, One Brunswick Square,
Bristol, BS2 8PE, United Kingdom
Tel:+44 (0)117 924 9442
Fax:+44 (0)117 311 1534
www.amiplastics.com
www.twitter.com/plasticsworld
Registered in England No: 2140318

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EDITORIAL

Editor-in-Chief: Chris Smith
cs@amiplastics.com

Technology Editor: Peter Mapleston
editorial@compoundingworld.com

Contributing Editor (USA): Jennifer Markarian
editorial@compoundingworld.com

Contributing Editor (UK): Mark Holmes
editorial@compoundingworld.com

Events and Magazines Director: Andy Beevers
abe@amiplastics.com

ADVERTISING

Advertisement Manager: Claire Bishop
cb@amiplastics.com T/ +44 (0)7905 848744

Head of Business Development: Paul Beckley
pb@amiplastics.com T/ +44 (0) 117 311 1529

Advertising Sales (China/Hong Kong): Maggie Liu
maggieliu@ringiertrade.com T/ +86 13602785446

Advertising Sales (Taiwan): Ms Sydney Lai
sydneylai@ringier.com.hk T/ +886-913625628

Advertising and Expo Sales (India): Yogesh Vyas
yogesh@dexspo.com T/ +91 9920735930

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Other speaking companies include: Innventik, Yordas Group, Evonik Operations, Coperion and more.

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Avient acquires Dyneema; plans to exit distribution

Avient is to buy the DSM Protective Materials business, which includes the Dyneema performance fibre brand, for $1.49bn and plans the sale of its own $1.63bn distribution operation.

The Dyneema deal, which is subject to customary closing adjustments, is expected to close before the end of 2022. The business's projected 2022 sales and EBITDA are around $415m and $130m. It includes six production facilities, four R&D centres and some 1,000 employees.

Dyneema is an ultra-lightweight high molecular weight polyethylene (HMWPE) fibre used in demanding applications such as ballistic personal protection, as well as composites for marine and sustainable infrastructure, renewable energy, industrial protection and sporting goods.

IMAGE: AVIENT

Above: Avient Chairman, President and CEO Robert M Patterson

The acquisition will mean Avient's composites product lines will represent more than 50% of its Speciality Engineered Materials segment sales, which last year amounted to $918m. Avient's total sales for 2021 were $4.8bn.

"For 10 years, we have been building our advanced composites platform by focusing on high-performance materials for applications where failure is not an option," said Chairman, President and CEO Robert M Patterson. "The addition of the Dyneema portfolio will raise Avient's material offerings to the highest levels on the performance spectrum of composites and engineered fibres."

Alongside the Dyneema purchase, Avient said it will explore the sale of its distribution operation, which is focused on North America, Central America and Asia and generated sales of $1.63bn in 2021. Patterson said a sale "would allow Avient to remain modestly levered at 2.9 times adjusted EBITDA while also expanding adjusted EBITDA margins from 12% to 18%, the highest amongst our formulator peers."

› **www.avient.com**

Medical recycling for PSU

Solvay and Mitsubishi Chemical Advanced Materials (MCAM) have announced a new collaboration aimed at end-of-life recycling of medical equipment parts made from Solvay's Udel polysulphone.

The two firms said they are currently investigating the logistics for implementing recovery, recycling and reprocessing of such parts. They aim to combine MCAM's technologies for washing and mechanically purifying the material with Solvay's ability to develop a robust recycling strategy that will provide customers with materials that meet all specifications.

MCAM has previously partnered with Solvay in polymer recycling.

› **www.mcam.com/en**
› **www.solvay.com**

USP takes a sustainable approach to TPEs

IMAGE: UNITED SOFT PLASTICS

US-based United Soft Plastics has launched a series of TPEs produced from renewable, post-consumer, post-industrial, and bio-based sources.

The first commercially available grades are SEBS-based and include recycled post-consumer and post-industrial content up to 100%. The injection moulding grades provide typical soft touch, anti-slip properties and are available in 45-65 Shore A hardness for a range of consumer applications including personal care.

Left: Wood-flour filled SEBS TPEs are under development at USP

Three further series are under commercial development. These will include cost-effective SEBS grades containing up to 70% wood flour, rice hull, and/or hemp. USP said they will offer a limited performance threshold, so will not be suitable for highly engineered applications, but will be available at volume.

The company said it is also developing fully bio-based and bio-hybrid TPEs, the latter combining renewable, post-consumer, post-industrial, and bio-based content.

› **www.unitedsoftplastics.com**

BASF to expand HALS capacity

BASF is to increase production capacity for production of its hindered amine light stabilisers (HALS) at its sites at Pontecchio Marconi in Italy and Lampertheim in Germany.

The expansion is said to be part of a multi-stage investment to support growing demand and enhance supply security. BASF has not disclosed the scale or value of the programme but a spokesperson said the additional capacities will become available "in the course of the next one to three years."

The sites at Pontecchio Marconi and Lampertheim are described by BASF as world-scale, strategic production locations for HALS and NOR HALS stabiliser production. They service the company's customers around the world.

Left: BASF's plastics additives site at Pontecchio Marconi in Italy

"We see a growing demand for sustainable materials used in applications like automobiles, construction materials and greenhouses, to tackle the global challenges of today and the future," said Dr Achim Sties, Senior Vice President, Performance Chemicals Europe, BASF. "The complementing infrastructure investment will also help to increase the resilience and efficiency of our operations."

BASF said its Tinuvin, Chimassorb and Uvinul HALS products play a key role in protecting polymers from UV radiation and are effective inhibitors of free-radical induced degradation.

The company claims that improved stabilisation of plastics contributes to customers' sustainability efforts by extending product lifetimes, which, in turn, reduces waste.

› **www.performancechemicals.basf.com**

IN BRIEF...

Spanish recycler **Sintac**, which was acquired by compounding giant **GCR** last year, said it saw "unstoppable" growth last year, with sales exceeding €35m and volumes reaching 60,000 tonnes. The company said its goal for 2022 is to consolidate its position.
https://sintac.es/en/
www.gcrgroup.es

Plastics distribution giant **Nexeo Plastics** has established a new warehouse and delivery facility near San José in Costa Rica to serve the Central American market. It is expected to be operational this month and will distribute the company's full range of resins and compounds.
www.nexeoplastics.com

New R&D centre for Erema

Erema has broken ground for a new R&D centre for plastics recycling systems at Ansfelden, Austria. Construction is now underway and should be completed by February 2023.

The centre will comprise two halls with a combined area of 1,550m² and an office building with 50 workplaces. It will offer cross-departmental and cross-company test machines and a fully equipped laboratory for R&D into plastics recycling technologies.

The company said an expanded machine park will be available following the completion of the centre, which will allow it to carry out all of the material tests necessary for effective R&D.

It said that, in addition to improving current recycling technologies, a key focus of the new facility will be to develop systems to recycle material waste that cannot currently be handled effectively.

› **www.erema.com**

Toyoda Gosei develops CNF plastic

Japanese automotive components group Toyoda Gosei has developed a 20% cellulose nanofibre (CNF)-reinforced PP it claims is suitable for use in automotive interior and exterior parts such as glove boxes and pillar trims.

The company said CNF is five times lighter and five times stronger than steel. When used as a polymer reinforcing material, it claims it allows parts to be made thinner and lighter while foam moulding becomes easier. The company said it can also be reused with little loss of strength.

Toyoda Gosei said it has used its expertise in material mixing and kneading to overcome the lower impact resistance that can often result when using CNF reinforcement. It said it has achieved impact resistance levels suitable for automotive components and is now working with CNF material producers to reduce cost.

The work is part of a Japanese government-funded project.

› **www.toyoda-gosei.com**

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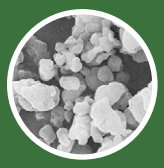

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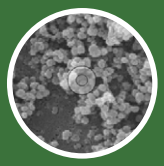

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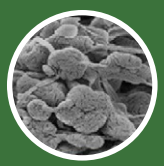

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Julong opts for Coperion

Coperion has installed three pre-configured turnkey systems for production of PP and PA compounds at Nanjing Julong Science & Technology's site in China.

The project – which included engineering, design, installation supervision and commissioning of all three lines – was carried out by Coperion's teams based in Shanghai and Nanjing.

The systems are built around three ZSK 70 Mc18 twin-screw extruders assembled at Coperion's Nanjing plant. Each line also includes raw material handling, SP 320 Treasure strand pelletisers from Coperion Pelletising Technology, and silo washing system.

The pelletisers, developed between Coperion's sites at Offenbach in Germany and Nanjing, are said to be optimised for processing abrasive reinforced products. Each offers a working width of 320mm and can process up to 88 strands at throughputs up to 2,500 kg/h.

Coperion also designed and supplied the distributed control system, which interfaces with Julong's MES to support automated processes from order handling to manufacturing.

› **www.coperion.com**

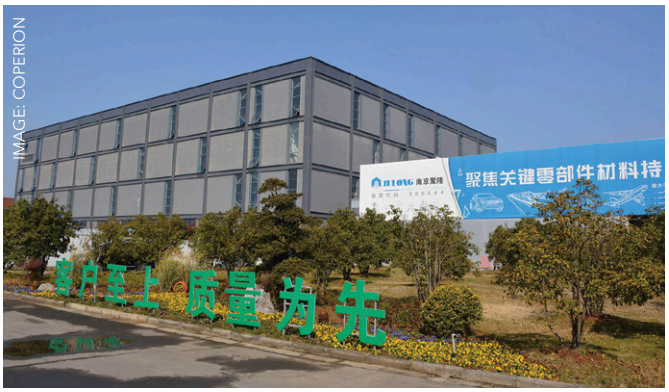

IMAGE: COPERION

Above: The Julong Science & Technology plant at Nanjing in China

MOL buys recycler ReMat

Hungarian petrochemical firm MOL has acquired ReMat, a recycler with plants located at Tiszaújváros and Rakamaz in Hungary and a logistics hub at Bratislava in Slovakia. It has a total recycling capacity of 25,000 tonnes/year of PE and PP.

MOL said the acquisition is part of its 'Shape Tomorrow 2030+' strategy, which was launched in February 2021 with the aim of spending $1bn over the next five years on circular economy and green projects.

In 2019, MOL acquired Aurora Kunststoffe, a recycled plastic compounder in Germany with capacity of 15,000 tonnes/year. It also has partnerships with APK, a German firm that has developed a solvent-based process to recycle high-quality polymer from complex plastic waste, and with Swiss polyolefins recycler Meraxis.

› **www.mol.hu**

Mitel selects BioCote additive

Telecoms equipment maker Mitel said its latest 612dt, 622dt and 632dt digital enhanced cordless technology (DECT) handsets are using silver ion-based antimicrobial technology from UK-based BioCote.

The company said the additives used are US EPA-registered and independently laboratory tested according to ISO 22196-2011 and ISO 21702-2019. It claims they inhibit growth of certain viruses and bacteria by up to 99.9%.

Mitel first introduced antimicrobial additive protection on its IP business phones last year. It said the handsets are designed "to deliver the functionality and ruggedness required in industries like hospitals, hospitality, manufacturing and other tough working environments".

› **www.mitel.com**

› **www.biocote.com**

RecyClass issues polystyrene protocol

IMAGE: SHUTTERSTOCK

The latest RecyClass protocol covers post-consumer polystyrene pots used for yoghurt

The RecyClass initiative in Europe has published its Recyclability Evaluation Protocol for Polystyrene Containers, covering post-consumer polystyrene pots used for yoghurt and other food and beverage products.

The protocol aims to guarantee the mechanical recyclability of polystyrene packaging, while maintaining protection properties, ensuring polystyrene recycling process efficiency and encouraging innovation, according to RecyClass.

RecyClass said the document details laboratory testing methodology and represents – as accurately as possible – how the polystyrene mechanical recycling process should work at an industrial scale, allowing polystyrene containers to be recycled into applications with a higher value.

› **https://recyclass.eu**

IMAGE: PERSTORP

Above: Perstorp's plant at Stenungsund in Sweden

Perstorp adds more capacity

Sweden's Perstorp has announced plans to add around 70,000 tonnes/year of new capacity for carboxylic acid – a key feedstock for its Pevalen and Pevalen Pro phthalate-free plasticisers – by 2024.

The company said it will build a new plant on the site of its existing carboxylic acid operation at Stenungsund in Sweden, which produces acids with C_3 to C_9 chemistry. Both plants will be fully integrated into the site's oxo production platform.

Perstorp, which is a fully upstream-integrated producer of carboxylic acids, said that the decision to go ahead with the expansion comes during a period of high demand growth. It said the new capacity will support increased demand for its Pevalen polyolester plasticisers as well as bolstering its presence in other non-plastics markets.

› **www.perstorp.com**

Gabriel-Chemie ups medical competence

Gabriel-Chemie Deutschland has opened an EN 13485 certified medical masterbatch competence centre at Weitnau, Germany.

Key features include wall-isolated machinery to eliminate external risks, plus isolated raw material and finished goods storage facilities.

"We have been European pioneers of masterbatch for medical applications and we have differentiated ourselves for more than a decade through the EN ISO 13485 certification of our Austrian site. By adding a new EN ISO 13485 certified site, we are providing an additional, geographically close support to our customers," said Diego Karpeles, Corporate Business Development Manager, Gabriel-Chemie Group.

› **https://gabriel-chemie.com/en**

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Milliken expands German facility

IMAGE: MILLIKEN

Above: Milliken employees at the former Zebra-Chem site at Bad Bentheim in Germany

Milliken is expanding the Zebra-Chem site at Bad Bentheim in Germany that it acquired in March 2021, when it bought the specialty compounder and chemicals producer.

The company said it is responding to growing demand for the site's products in the EMEA region. It said it will add 60% more capacity by the end of 2022 through the installation of new manufacturing equipment and addition of more staff. It has also built a new warehouse nearby.

Milliken produces viscosity modifiers and performance modifiers at Bad Bentheim that are said to increase the melt flow of recycled PP resins with little to no loss of physical properties.

The site also produces solid concentrate chemical blowing agents for the production of foamed thermoplastics. These allow for lightweighting and improved thermal and sound insulation without compromising mechanical properties in PVC, PE, PP and PS, Milliken said.

› **www.milliken.com**

Röchling/Polysecure security partnership

German marker material specialist Polysecure and plastics processor Röchling Industrial are launching a cooperation covering the use of marker technology in plastic products. PolySecure's SmartMarker technology is said to provide new options in areas such as counterfeit protection, development of digital material passports, and recycling. It can support product authentication, product identification, and can be used as part of a tracer-based sorting system.

› **www.roechling.com/smartmarker**

› **https://www.polysecure.eu/en/**

IN BRIEF...

Americhem has created a new Healthcare division. Based on its clean compounding expansion at Morrisville, PA, US, it will support customers in the healthcare and medical device sectors via material selection, product development and cross-collaboration between teams.
www.americhem.com

Avantium has signed a conditional offtake agreement for PEF from its FDCA flagship plant with **Sukano**, a Swiss producer of additive and colour masterbatches and compounds for polyester and speciality resins. Sukano aims to develop masterbatches for use with PEF resins.
www.avantium.com
www.sukano.com

Distrupol, a UK-based pan-European distributor of thermoplastics and elastomers, has acquired Baritec. Based at Espoo near Helsinki, Baritec has a network of warehouses in Finland and the Baltic States.
www.distrupol.com
www.baritec.fi

PSC Group acquires TSI

PSC Group, a specialist in product handling, site logistics, and railcar repair for the petrochemical, refining and marine industries based in Pasadena, TX, US, has acquired Thermoplastics Services (TSI), a custom compounding and pelletising business located at Dequincy, LA.

The move is PCS Group's second plastics compounding acquisition. Last December the company – which is owned by private equity firm Aurora Capital Partners – bought Akrotex Extrusion & Recycling, a custom compounding and pelletising business based in Orange, TX.

"In the last 12 months, PSC has made strategic investments in human capital, equipment and M&A to establish a leading plastic resin sustainability offering," said CEO said Joel Dickerson.

"The TSI acquisition reinforces PSC's focus on providing ESG [Environmental, Social and Governance] solutions to our customers and supporting our customers' Operation Clean Sweep initiatives while reprocessing and repurposing scrap plastic into products used every day," he said.

PSC is an Operation Clean Sweep member.

› **www.pscgroup.com**
› **https://thermoplasticservices.com/**

ESU backs Polykemi LCA tool

Swedish compounder Polykemi Group said it has gained new third-party certification for the methodology behind its web-based materialsmart carbon footprint reduction tool, which it launched last year.

The certification was carried out by ESU Services, the Switzerland-based competence centre for Sima Pro LCA software. Its analysis concluded that the Polykemi methodology was appropriately defined and the methods used in its implementation are scientifically and technically valid.


IMAGE: POLYKEMI GROUP

Henrik Palokangas, Sustainability Specialist at Polykemi

"The process of conducting a life cycle analysis (LCA) is complex and the results are based on the assumptions that were made. The third-party certification proves that our assumptions were correct," according to Henrik Palokangas, Sustainability Specialist responsible for polymer materials at Polykemi Group.

The materialsmart tool aims to provide customers with accurate information to calculate the climate impact of their material choice and is said to allow the selection of the optimal solution for both sustainability and cost efficiency.

› **www.polykemi.com**
› **https://materialsmart.info/**

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Renewing interest in natural composites

IMAGE: FORD MOTOR COMPANY

Plant-based natural fibres and fillers are finding renewed appeal as users demand more sustainable – and often lighter – plastics compounds. Jennifer Markarian reports

Natural or renewable plant-based fibres and fillers have been an option for polymer compounds almost from the dawn of the plastics industry, but the recent focus on reducing carbon footprint is drawing new attention to them. And while, in some cases, the plant-based materials available to date have lacked the mechanical properties to directly replace glass fibre reinforcement, formulators have found many ways to compensate, whether that be by using them in combination with glass or by employing new methods to improve the basic properties of the plant-based material.

The automotive sector has for many years been at the forefront of work to incorporate natural materials and continues to push for increasing use of sustainable content while maintaining performance. Alper Kiziltas, Technical Expert at Ford, says that several market, policy, and technical factors are coming together to make natural fibres a more attractive option for automotive applications. These include changes in consumer behaviour, current policy frameworks, increasing use of plastics in automobiles, supply-chain concerns for glass fibre, and R&D innovations coming from natural fibre suppliers.

"It is becoming a core business strategy for the automotive industry to deal with a future of constrained resources," says Kiziltas. "The use of natural fibres improves the environmental sustainability of our company. Based on our internal studies and third-party data, there are definitely LCA [life-cycle assessment] benefits versus inorganic fillers and fibres. Use of these materials is becoming more widespread."

Kiziltas points out that the Sustainability and Emerging Materials Group at Ford has performed sustainable composites research since 2000, resulting in use of a wide range of renewable materials, including kenaf, rice hulls, and cellulose. Some are more 'obvious' candidates than others; recent Ford experiments have shown that coffee chaff, after a biocarbonisation process, can replace talc in PP compounds.

The coffee chaff experiment was undertaken as a way to use agricultural waste to create a sustainable

Main image: Ford is a leader in the development of natural materials for production of automotive parts, trialling the use of coffee chaff to reinforce headlamp housings for the Lincoln Continental

IMAGE: FORD MOTOR COMPANY

Above: Ford replaced a 40% talc filled PP with a 20% coffee chaff filled PP alternative in this headlamp housing for its Lincoln Continental, estimating a 5% cost saving, 17% weight saving and 25% reduction in process energy

product. While initial trials had problems such as odour and water absorption, carbonisation of the coffee chaff solved these concerns and resulted in better compatibility with the PP matrix, says Kiziltas. Improved compatibility, along with the reduced hydrophilicity of the carbonised filler, results in less moisture absorption by the composite part.

The Ford team developed a PP formulation using 20% coffee chaff biocarbon to replace 40% talc for an injection-moulded headlamp housing in the 2020 Lincoln Continental. "Using the coffee chaff biocarbon, we reduced weight by 17% and cost by 5%, with no sacrifice to processing or part performance," says Kiziltas.

Ford was also able to use lower processing temperatures for moulding the biocomposite part, which resulted in shorter cooling cycles and energy savings. "There is an additional saving of around 15% in the energy consumed when extruding biocarbon filled materials due to the inherent lubricity of organic materials compared with the rheology of inorganic materials. Overall, we estimate this innovative composite material results in a total energy saving of 25%," says Kiziltas.

The Ford R&D team is also considering biocarbon fillers, made using pyrolysis of biomass to yield a porous substance, as a solution to improve thermal stability of natural materials. "Natural fibres have lower thermal stability than many synthetic fibre alternatives, limiting their application to low-processing temperature polymers, less than 200°C, and low-temperature automotive environments. Our recent studies proved that we can use biocarbon [as a filler in] engineering thermoplastics composites such as PA6 and PA66."

Nano cellulose

Canada's **Performance Biofilaments**, which is backed by Mercer International and Resolute Forest Products, says that its proprietary process technology takes wood fibres and converts them to nanofibrillated cellulose (NFC) with high strength and purity. NFC materials are being evaluated in thermoplastics for a range of applications, according to Geoff Fisher, Director of Business Development at the company.

Performance Biofilaments recently completed a test series with a third-party automotive materials R&D centre in Canada. "We compounded our NFC material in a hybrid system with glass fibre in polypropylene compounds and obtained promising

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www.byk.com

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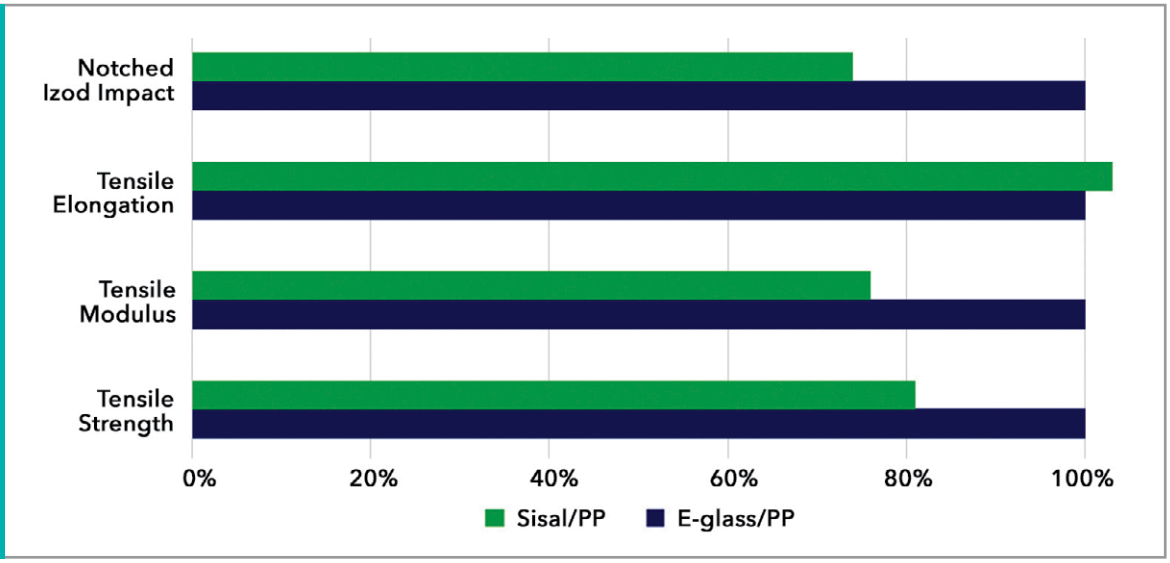

Figure 1: Comparison of key mechanical properties of a 20% sisal fibre reinforced PP compound compared with a 20% glass fibre reinforced alternative

Source: Green Dot Bioplastics

results. The goal of this test series was to demonstrate that we could increase the sustainability content (i.e., increase the natural fibre content and decrease the glass fibre content) within a PP compound and maintain a high level of performance," says Fisher. The company is building a commercial plant for NFC production that is expected to start production towards the end of 2022.

US-based **Green Dot Bioplastics** manufactures biobased and compostable polymers and commercialised its Terratek Natural Fiber Reinforced Plastic (NFRP) product line in 2020. These biocomposite materials use fibres such as sisal, American Bamboo, and reclaimed jute fibres to replace glass fibre in PP, PE, or PA. While natural fibres are not a 1:1 replacement for glass fibres, they provide a sustainable option in many applications where reinforcement and stiffness are required beyond unfilled materials, says the company, which supplies both compounds and natural fibre masterbatches.

"Performance and supply are the two key drivers in natural fibre selection. We have to be able to ensure a repeatable product and performance for our customers," says Mark Remmert, CEO at Green Dot Bioplastics. "American Bamboo is a native grass with excellent physical properties and sustainable growing practices."

Last year, Green Dot Bioplastics partnered with Tier 1 automotive supplier Mayco International to take trim waste and scrap jute fibers from Mayco's process to create a new NFRP material. "Rather than the scrap and trim being landfilled, we take it and incorporate that into a biocomposite pellet for use in other applications," says Sarah Harbaugh, Sales and Marketing Director at the company.

Spanish research organisation **Aimplas** has investigated many natural fibres for use as reinforcing additives in biobased plastics composites over the years, including hemp, kenaf, sisal, flax, jute, cotton, and others, according to Luis Roca Blay, Leader of Compounding. When developing a compound from bio-based plastic, he suggests it is more desirable to use natural fibres so that as many components as possible are renewable, and in some cases also compostable.

Composting concern

Compostability is an attribute that is attracting growing attention in Europe, particularly for packaging. However, packaging items made using a compostable plastic reinforced with plant-based fibres might have difficulty achieving the EN 13432 standard for industrial compostability, depending on the percentage of fibre used and the thickness of the part, says Roca. Grinding the package before composting may provide a solution to this problem, he says.

Composite strength and weight are key factors in many end-uses. Roca also says natural fibres are not a direct replacement for glass fibre in their reinforcing properties, but adds that they can replace mineral reinforcing fillers and reduce weight. Other additives (such as impact modifiers) might also be used to create the necessary property balance.

Aimplas recently studied the flame retardancy of formulations containing natural fibres. Roca reports that in a flame-retarded formulation, natural fibres were not found to have a negative effect on flame retardancy; replacing plastic with a percentage of natural fibre caused a decrease in heat release. The study also examined formulations containing natural fibres and phosphorous-based flame retardants and confirmed that they did not interact in a detrimental manner.

Norwegian research association **RISE PFI** says it

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Right: A natural fibre reinforced 3D print filament produced at Norwegian research organisation RISE PFI

continues to make advances in development of biocomposites produced using biobased polymers with, for example, biobased fibres, nanocellulose or lignin. These are being developed and evaluated for a range of applications including infrastructure, automotive, food and beverage packaging, healthcare, and additive manufacturing (3D printing), says Gary Chinga Carrasco, Lead Scientist in the Biopolymers and Biocomposite area at the association. It has a fully equipped lab for 3D printing to support increasing demand from industrial partners looking for biobased and sustainable material solutions for 3D printing as well as injection moulding.

"3D printing provides a nice possibility to manufacture complex structures that are not easy to produce with conventional processes. 3D printing is not only used for prototyping but also for fabricating fully functional devices for very specific applications. In addition, material consumption is reduced, which is a major advantage from an economical and environmental point of view," says Chinga Carrasco.

"Biocomposites are biobased, renewable and if necessary can be biodegradable; this is beneficial compared to other types of filled fossil-based polymers," he adds. "This is a growing area of development of sustainable materials which is also in line with the current bio and circular economy."

Moulding gains

Beyond 3D printing, RISE PFI's BioComp project is developing novel and sustainable biocomposite materials to replace fossil-based plastics in the injection moulding sector. This project, which is partly funded by the Research Council of Norway, is a collaboration between RISE PFI and Norwegian companies Alloc (a building products company), **Norske Skog Saugbrugs** (a biocomposite producer) and Plasto (an injection moulder). The project started in 2021 and the partners says they have made significant progress.

Norske Skog Saugbrugs has finished building the new biocomposite demonstration plant, which has an output of 120 kg/h at maximum speed (around one tonne on a normal working day), says Dag Molteberg, Senior Development Manager at Norske Skog Saugbrugs. The company has a large thermo mechanical pulp (TMP) facility for production of paper and will supply the biocomposite plant with TMP fibres from spruce wood.

One part of the demonstration plant is used for drying, preparation and pelletising of wood fibres; the second part houses the compounding system where the fibre pellets are combined with plastics and additives to produce biocomposite pellets (brand-named Cebico). The compounding system includes degassing zones for moisture removal and features fine-tuned temperature control. The line is capable of both air-dried pelletising and underwater pelletising; typical compound pellets are 3-5mm in diameter and 4-7mm in length, says Molteberg.

Saugbrugs has produced several tonnes of material since test production started in December last year. "The material tests show well-dispersed fibres in the matrix, giving good tensile strength and high flexural stiffness," Molteberg says. "Thermal dimension stability is better than unfilled PP and PE and the results also show quite low moisture uptake, even in boiling water. Melt flow parameters are also acceptable for injection moulding."

Molteberg says the amount of fibre in the composites can vary between 20-60% by weight but is most typically in the region of 30-40%. The thermoplastic component includes both virgin and recycled PE or PP and the project will also investigate the use of biobased and biodegradable thermoplastic matrix materials.

Injection moulder Plasto processes the biocomposite pellets using high-speed automated injection moulding equipment. "The production line is configured for 24/7 unmanned production and will ensure a high and stable output of the produced biocomposite components," says Runar Stenerud, Project Manager at Plasto.

"Collaboration with RISE PFI in the BioComp project gave us valuable insight of the materials' mechanical characteristics and process-related properties and how to design for optimal handling at end-of-life," Stenerud says. "Being involved in early-stage development of new materials also gives us the opportunity to influence the material

IMAGE: RISE PFI

Right: Parts produced using natural fibre filled 3D print materials developed at RISE PFI in Norway

specification to ensure the best possible compatibility with the product under development and our production process."

Building products company Alloc aims to market products from the BioComp project this year. "We are pleased to experience that the R&D conducted by RISE PFI can be transferred to improve our operations and contribute to the production of high-quality and innovative wall panel and flooring products," says Leif Kåre Hindersland, R&D Manager at the company.

Functional lignin

Finnish company UPM Biofore has multiple fibre and biomass businesses and has produced its **UPM Formi** cellulose-fibre reinforced plastic compounds for injection moulding and 3D printing for several years. The company is now developing another filler and is building a biorefinery at Leuna in Germany that takes beech wood and hydrolyses it to sugars – which are used to make bio-monoethylene glycol and bio-monopropylene glycol – and lignin suitable for processing into renewable functional fillers (RFF).

One of the targets for RFF is to replace carbon

IMAGE: AVIENT/GETTY IMAGES

Above: Avient says the renewable filler content in its Nymax Bio PA compounds offers a sustainable option for consumer brands

black or precipitated silica. In thermoplastics and thermoplastic elastomers, RFF may have two different uses, says Christian Hübsch, Director Sales and Marketing, UPM Biochemicals (a UPM group company based in Germany). One application for RFF is as a black pigment to replace pigment carbon blacks. A second is to use high RFF filler loadings to increase renewable content and reduce carbon footprint, while maintaining acceptable mechanical properties. "So far, we have made compounds with up to 30-40% by weight of RFF in PE, PP, PBAT, and others," says Hübsch.

While RFF is frequently used to replace polymer in a compound formulation, it can also be used to substitute traditional fillers to obtain part weight savings. "With a density of only 1.3 g/cm^3, RFF is 50-60% lighter than most white fillers," says Hübsch.

Hübsch says RFF is different from cellulose fibre-based compounds or wood-plastics composites. "Thermoplastic compounds with high loadings of RFF represent a completely new class of material, with enormous future potential. RFF is essentially VOC-free, and we are in the process of collecting all data necessary for certification for food-contact and drinking-water contact," he says.

UPM has opened an Application Development Centre on the site at Leuna and has started product testing and development as well as compounding services. "We see our company as a partner for masterbatchers and compounders," says Hübsch. "Still, we do a lot of compound development activities ourselves. We run both customer-specific compound optimisation programmes and more fundamental studies in parallel, for a broad range of polymers and applications."

The industrial biorefinery is expected to start up in late 2023, and first commercial quantities should be available in early 2024. Currently, material samples of up to a few hundred kilograms are being tested by selected partners for compound development and approval purposes.

UPM says the BioMotion RFF is CO_2-neutral and is expected to be CO_2-negative at industrial scale, based on third-party verified life-cycle analysis, according to Barbara Gall, Manager of Business Development, Renewable Functional Filler, at UPM Biochemicals. The filler will have more than 94% renewable carbon content (certified by DIN CERTCO) and will be high purity (low VOCs and sulphur content).

Nymax Bio is a new line of PA compounds from **Avient** that contain between 16 and 47% filler from renewable plant-based sources, such as corn, straw and wheat. "Sustainability is a high priority for consumer brands. Most have initiatives built around bringing more environmentally friendly products to market," says Matt Mitchell, Director, Global Marketing, Specialty Engineered Materials at the company.

Avient says that, compared to traditional PA66 glass fibre-reinforced alternatives, the bio-derived grades offer lower warpage together with very good surface appearance and colorability. The low-water-absorption formulations are also said to display very good dimensional stability and property retention after conditioning.

The new grades are expected to find application in automotive, consumer, industrial, and construction applications and can be processed by injection moulding or extrusion. They can also be custom formulated to provide specific performance attributes, such as laser welding or flame retardance. Nymax Bio materials are manufactured in Asia but are available globally.

Reliable hemp

Regulations in the US changed in 2018 to allow growing of hemp and, since then, biotech company **Heartland Industries** has been working to create a "reliable industrial hemp supply chain" to provide carbon-negative additives for plastics.

"De-risking and scaling are two key variables in creating a reliable supply chain," according to John Ely, CMO at Heartland. "We have created simple operating procedures that any farmer can follow to have a successful crop (much like corn and soy). This is paramount in the pursuit of reducing the risk for banks and insurance agencies. In addition to that, we work alongside farmers in different regions of the US to improve the resiliency of a crop in case there are weather related incidents."

Ely says that the first major US harvest is anticipated this year, and he expects to see commercial contracts in Q4 2022 for hemp additives.

Heartland announced a joint development

agreement with **Ravago Americas** in January this year to engineer hemp additives for polymer compounding applications. Hemp-filled plastic compounds are said to be "lighter, cheaper and more sustainable [with] enhanced thermal and acoustic properties." Ravago, which is a plastic recycler, compounder and distributor, is guiding Heartland in formulation of additives that will not require retooling for compounders or moulders.

Heartland's quality control of hemp fibre provides consistent size, moisture and surface area, while a proprietary engineering process improves processing and bonding with plastics. "The goal is to provide manufacturers with a 1:1 alternative that costs less with all other performance characteristics kept equal," says Ely. As one example, the company is working on a hemp-filled alternative to 20% talc-filled PP compounds. The fibres have also been evaluated in polymers such as PE, PVC, ABS, and PET.

According to Ravago, a 20% hemp-filled PP compound will have approximately the same tensile strength as a 20% talc-filled PP, with a 20% lower flexural modulus and 20% higher Izod impact performance. It also offers the additional benefit of reducing part weight by about 20%, says Chuck Taylor, Technical Director and Tolling Business Director, Ravago Manufacturing Americas.

Taylor says that it would be desirable to replace glass fibre with hemp fibre, but that is not yet possible. "We need to develop a viable chemistry to treat the hemp to get it to bond into the resin matrix to create a reinforcement. Until that time hemp will act as a filler," he says. However, that aside, he says customers are increasingly requesting renewable and sustainable products, and even seem to understand that these solutions might have an increased cost. This willingness to pay for sustainability "is dramatically different from what we have seen in the past," he adds.

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IMAGE: SHUTTERSTOCK

Decarbonisation, communications and EVs are all contributing to growing demand for wire and cable. Chris Smith explores some of the latest compound developments

New markets underpin cable market growth

The onset of the Covid pandemic in 2020 hit the wire and cable market, like many others, hard. Global volumes were down by more than 5%, with only China managing to hold positive numbers. However, 2021 saw a strong rebound and the outlook for 2022 – admittedly forecast before Russia's invasion of Ukraine – is for global volume growth of 3-4%, according to data presented by Benjamin Ferlay, R&D Director Central Eastern Europe at leading cable maker **Prysmian Group**, at the AMI Cables 2022 conference in Germany in March.

Key drivers in terms of infrastructure cable demand are identified as smart communications and the move to lower carbon power generation. Ferlay said that global volume demand for optical fibre recovered in 2021 and the pick-up is expected to continue into 2022. The main growth drivers include the roll-out of FTTH (Fibre to the Home) networks and the adoption of 5G mobile technology.

Turning to power cables, Prysmian identifies the main driver of growth for the coming years as the worldwide acceleration in demand for electricity, which the company forecasts will grow at twice the rate of total world energy demand. Major expansion of transmission and distribution networks will be required to meet new and higher demand for electricity for transport, heating and industrial applications. Meanwhile, rapid growth in renewable electricity generation such as wind and power – which Ferlay said are together predicted to account for 60% of power generation by 2050 – will require distribution systems with more flexibility and greater interconnectivity.

Alongside volume growth, cable producers continue to seek material solutions that improve performance and optimise cost. **Avient**, for example, recently introduced a number of new polyolefin compound options intended to enhance chemical resistance, flame retardance and productivity in optical fibre cables. The Eccoh 6151 – 6154 grades are targeted at micromodules and microtubes that are used to encapsulate the individual strands of glass optical fibre. They are said to be suitable for dry and gel-filled applications.

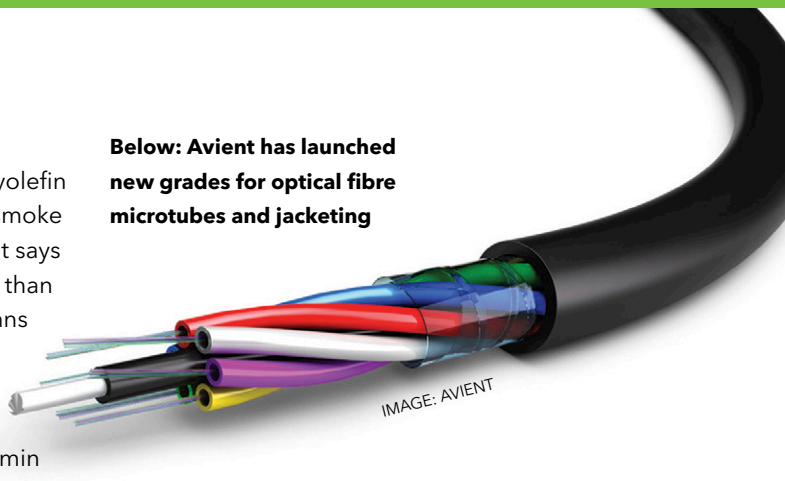
Compared to polymer materials traditionally used in these applications – such as PA12 and PBT – the company says its new compounds are easier and faster to extrude and are less prone to shrinkage, which can induce mechanical stress that might cause cable kinking and signal attenuation or loss. They are also said to be softer than both PA12 and PBT, which makes it easier to strip the microtubes/

Main image: New wire and cable markets such as EVs and photovoltaics call for new and often more demanding material requirements

micromodules during installation.

The company says the flame-retarded polyolefin formulations are halogen-free and offer low smoke and fume generation rates. In addition, Avient says fumes released on burning are less corrosive than those associated with PA and PBT, which means surrounding structures not directly affected by any potential fire are less likely to suffer damage.

With processing speeds of up to 1,000 m/min and a lower melting point than PBT, the new grades are claimed to provide opportunity for faster processing and can also contribute to reduced energy use during manufacturing. The company says the grades also offer potential to reduce wall thickness.



Below: Avient has launched new grades for optical fibre microtubes and jacketing

Flexible jacketing

Other recent additions to the Avient range for fibre optic cables include Eccoh 5565 and Eccoh 5978 UV, both halogen-free flame retardant grades intended for jacketing applications. Eccoh 5565 is said to offer good flexibility and environmental stress cracking resistance (ESCR), withstanding up to 20,000 flex fatigue cycles. It is capable of performing over a temperature range from -40 to +80°C, making it suitable for use in dry optical fibre cable applications or where improved resistance to low temperatures is required, such as indoor and outdoor duct cables, power-to-antennas, or hybrid cables for 5G networks.

Eccoh 5978 UV formulations offer flame retardancy up to EU Construction Products Regulation (CPR) class B2ca,s1,a1,d, together with good char forming, UV resistance and ESCR. The company says this makes them an appropriate choice for aerial drop cables, which are often under continuous stress from the clamps that hold them in place.

Demand for halogen-free flame retardant (HFFR) cable is on the increase as changes in regulations increasingly preclude the use of halogenated systems, according to **Adeka**. It says intumescent HFFR types are often selected for cable applications due to their combination of flame retardancy performance and smoke suppression.

Adeka's HFFR additive portfolio includes a P-N (phosphorus-nitrogen) intumescent range, as well as organophosphates and NO-alkyl based flame retardants. The company says the ADK STAB FP-2000 series of intumescent HFFRs for plastics have been proven in cable sheathing. ADK STAB FP-2500S is said to enable PE, PP/SEBS and PE/EVA cable sheathing grades to pass UL-94V V-0 at a 20-30% loading. Depending on the specific formulation, the company says it can also enable compounds to pass the UL VW-1 North American vertical cable flame test standard.

The latest addition to Adeka's intumescent flame retardant range is ADK STAB FP-2600U, which is targeted at thermoplastic polyurethane (TPU) polymers. With good mechanical strength, wear resistance and chemical resistance, TPUs are well suited to applications exposed to abrasion, such as robot cables.

Tests carried out by the company on a TPU wire and cable compound indicate that ADK STAB FP-2600U provides a high level of flame retardancy without sacrificing mechanical properties such as flexibility, which is one of the prime reasons for selecting a TPU (Table 1). Furthermore, cone calorimeter (CCM) smoke density test results show the fire retardant reduced and suppressed smoke emission compared to alternative FR system (Figure 1).

Table1: Fire resistance data for TPU containing ADK STAB FP-2600U (polyether-type TPU with hardness of 85 Shore A)

		TPU	TPU+FP-2600U
Flame retardant (wt%)		0	32
LOI (%)		22	36
UL-94V	1.6mm	No rating	V-0
	2.0mm	No rating	V-0
Elongation (%)		711	600

Source: Adeka Corp

Additive gains

The wire and cable market is a key target for Evonik's additive product lines. In particular, the company says its organo-modified siloxane (OMS) additive chemistry, which it markets under the Tegomer and Tegopren brand names, is able to allow increased loading of flame retardant additives with minimal impact on mechanical performance while simultaneously lifting compound output rates.

According to Evonik, Tegomer FR 100 siloxane EVA, Tegomer V-Si 4042 reactive polysiloxane, and Tegopren 6879 filler surface treatment offer high temperature resistance and do not generate

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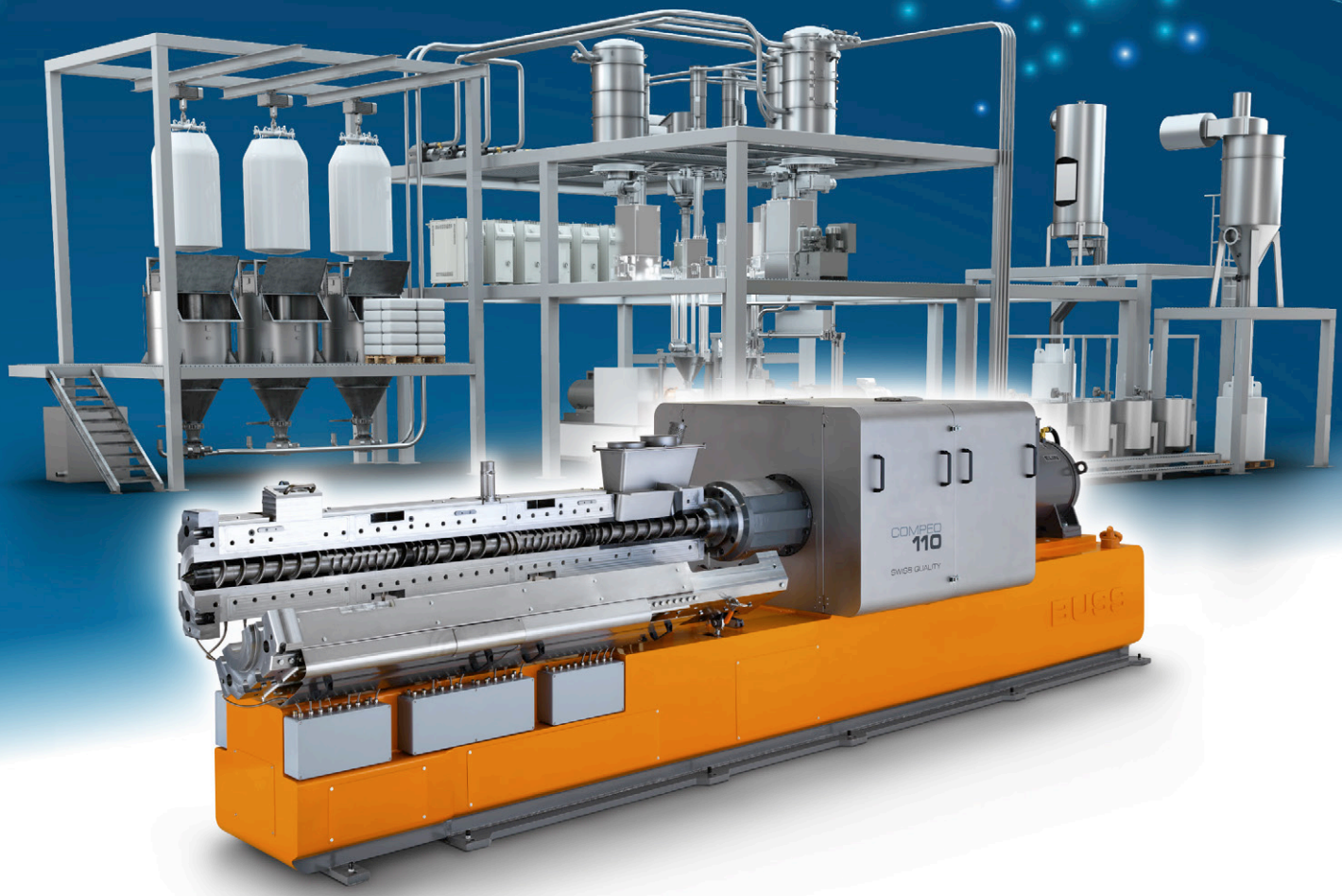

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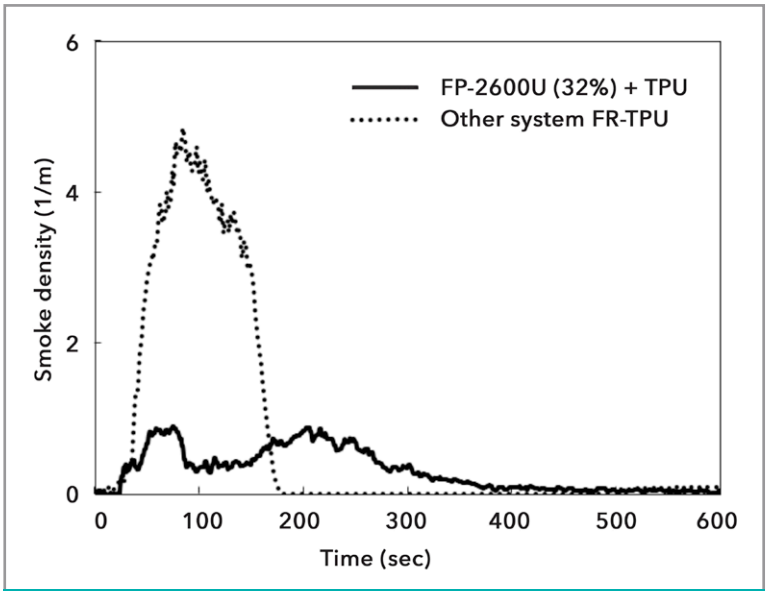
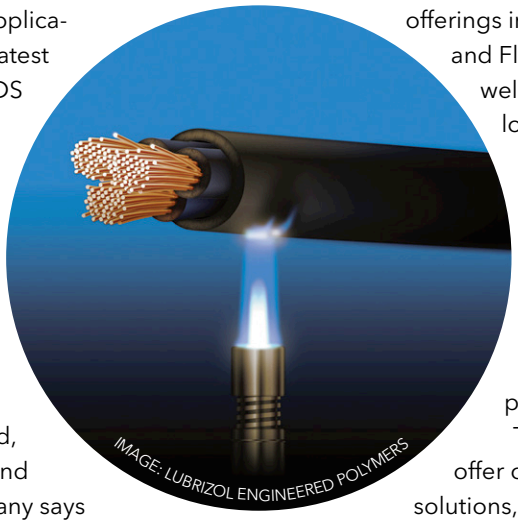


Figure 1: Cone calorimeter smoke density data for TPU containing ADK STAB FP-2600U compared with alternative fire retardant system
Source: Adeka Corp

degradative by-products. In terms of flame retardance, OMS chemistry is said to improve charring, delay the time of ignition, reduce HRR (heat release rate) values, generate less smoke, and increase LOI by up to 5 points.

Evonik's Accurel XP organic porous carrier technology for EVA, HDPE, and LLDPE simplifies the use of liquid additives in solid masterbatches for the cable industry. This helps ease dosing into the extruder, simplifying the production process and logistics while maintaining high additive performance and efficiency. The same chemistry can also be used with PA6 and PA12 polymers, such as those used in cable applications for tunnels. Among the latest developments is the Accurel DS portfolio, which the company says uses silane, trialkyl, and trially functionality to improve crosslinking efficiency in peroxide and irradiation cross linking wire and cable applications.



Right: Lubrizol Engineered Polymers developed its Estane ZHF TPU for HFFR cable applications

Earlier this year, **Lubrizol Engineered Polymers** introduced a non-halogenated, flame retardant TPU for wire and cable applications. The company says Estane ZHF 90AM9 NAT 01 TPU is a UV-stabilised grade that offers UL94 V-0 performance and delivers a UL 105°C temperature rating. It also passes the UL 1581 Sec 1061 cable flame test with a proven use case down to 8m diameter.

Lubrizol describes the new grade as a "one-stop solution" that provides compliance with key North American cable fire standards while providing good mechanical properties and surface aesthetics.

Evolving requirements

Cable manufacturers today work to some of the most rigorous standards, according to compounder **Teknor Apex**, and these standards continue to evolve with a focus on ensuring the highest levels of public safety. The National Electric Code (NEC) in the US and CPR in the EU are two of the most prominent examples.

New applications frequently bring new and more stringent requirements, the company says, citing data centres and electric vehicles as examples. "The number and size of data centres continues to grow rapidly to support growth in data heavy applications like YouTube, Netflix, Instagram and TikTok. Cables used in data centres to support these applications have to be designed to support high conductor/fibre count while still being flame retardant," says a company spokesperson. "As cable conductor/fibre density increases the jacket material must offer greater levels of flame retardancy to overcome the flammable material in the core."

Charging cables for electric vehicles are another example, placing demands on materials to provide high levels of insulation and to operate reliability in challenging outdoor environments where they may be exposed to low temperatures, impact and abrasion.

PVC retains a strong position in the North American cable materials market and Teknor Apex offerings in this sector include its Apex and Flexalloy flexible grades, as well as the Fireguard series of low smoke compounds. The latter are said to offer the high levels of flame retardance required for plenum cable applications with a more favourable cost profile compared to alternatives such as fluoropolymers.

Teknor Apex also says it can offer cost-optimised blended PVC solutions, such as PVC/TPU or TPU/nitrile rubber combinations. It says these can offer many of the performance benefits of TPUs at a lower cost.

Last year, the company also introduced four new additions to its Halguard low smoke halogen-free (LS HFFR) polyolefin compound range. The

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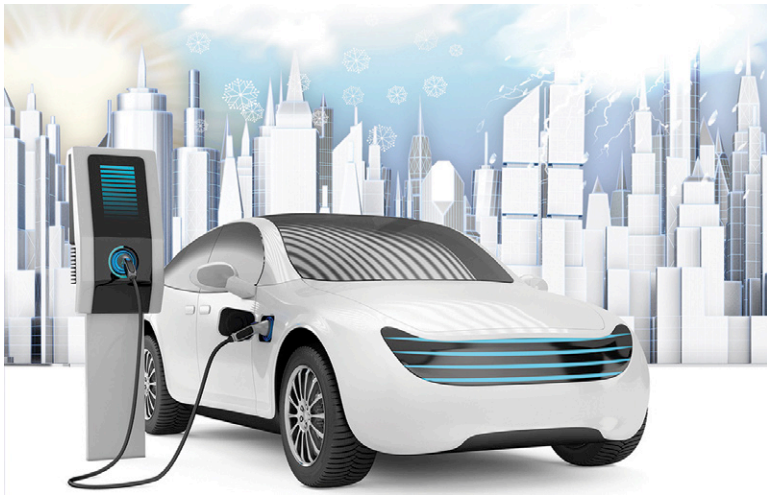
IMAGE: TEKNOR APEX



Above: EV charging cables introduce a new set of cable performance requirements

additions include EVA-based products with an enhanced balance of properties and highly flexible TPE-based grades with improved oil and sunlight resistance. All four grades carry UL 94 V-0 ratings and meet the UL 2885 standard for individual limits of less than 1,000ppm of fluorine, chlorine, bromine and iodine.

Power sheathing

The EVA-based Halguard 58240 and 58242 grades are claimed to provide high levels of flame retardance, resistance to heat shock and heat deformation, and ease of processing. The company says the compounds are suitable for sheathing power cables that comply with the UL 1685-FT4/ IEEE 1202 standard for vertical tray cables and the UL 1666 standard for riser cables. They are also said to be suitable for use in fibre optic data cables and for transit infrastructure applications such as tunnels.

The TPE-based Halguard E 59001 and E 59002 grades comply with UL 62 and UL 758 standards for flexible cord and appliance wire, respectively. Halguard E 59001 retains 80% of its tensile strength and 90% of its elongation at break after immersion in IRM 902 oil for seven days at 60°C. Halguard E 59002 retains 90% of its tensile strength and 95% of its elongation at break after 720h of accelerated weather testing.

"The Halguard LS-HFFR product line provides properties to meet a wide range of applications," says David Braun, Wire and Cable Industry Manager for the Teknor Apex Vinyl Division. "The growing list of grades with 'halogen-free' assessments by UL further expands options for customers."

At the beginning of this year, **Huber Engineered Materials** (HEM) completed the previously announced acquisition of the 50% share in the Magnifin Magnesiaprodukte joint venture, located at Breitenau in Austria, held by former partner RHI Magnesita.

Established in 1990, Magnifin manufactures premium coated and uncoated magnesium hydroxide (MDH) functional filler products. These are suitable for use as halogen-free fire retardants in a range of polymer applications, but particularly for thermoplastics and elastomers requiring processing temperatures in excess of 300°C, where alumina trihydrate (ATH) is not suitable due to its thermal sensitivity. In the cable sector, MDH grades can provide fire retardant properties for energy cables, data cables, and for automotive wiring.

Magnifin grades are sold globally by Martinswerk as part of the HEM Fire Retardant Additives business, which operates four production sites in North America and two in Europe and is a leading producer of fine precipitated alumina trihydrate and magnesium hydroxide halogen-free fire retardants, as well as smoke suppressants and specialty aluminum oxides.

The company says the decision to take 100% control of Magnifin is in line with HEM's strategy of owning and operating specialty chemical and mineral companies with market leading positions. "This step forward demonstrates our commitment towards our customers to support their growth and our clear strategy to grow our halogen-free fire retardant and specialty material business globally," says Victor Dean, General Manager of HEM's Fire Retardant Additives business unit.

Indian investments

Last year's acquisition of a majority stake in Indian compounder Shakun Polymers further strengthened Orbia group company **Alphagary**'s position in the global wire and cable market. Shakun is a leading supplier of compounds to the cable industry across India, the Middle East, South East Asia and Africa. It operates three manufacturing locations and has a total installed capacity of more than 25,000 tonnes. The company supplies PVC, PVC/TPE, PE and HFFR PE compounds for application in power distribution, building, telecom, data and automotive.

According to Alphagary, India's wire and cable market is poised for significant growth in the years ahead with infrastructure investment and imple-

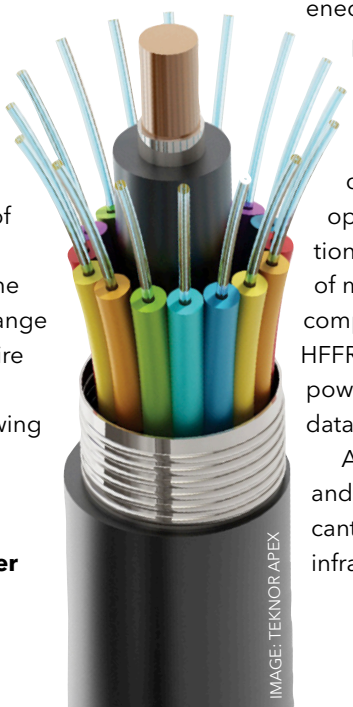


IMAGE: TEKNOR APEX

Right: Teknor Apex has extended its Halguard LS HFFR polyolefin cable compound portfolio

VTMOEOS silane added to EU's SVHC list

In January of this year the EU chemicals agency ECHA announced the inclusion of tris(2-methoxyethoxy) vinylsilane (VTMOEOS) on the Candidate List of substances of very high concern (SVHC) on the grounds of toxicity to reproduction.

The move sets VTMOEOS on the path to potential inclusion in REACH Annex XIV, which would prohibit its use in any application unless authorisation is provided by the European Commission. In the meantime, its inclusion on the SVHC candidate list places an obligation on those supplying articles containing more than 0.1% by weight to provide safe use information to customers. In addition, importers and producers must notify ECHA if an article contains a Candidate List substance within six months from the date of inclusion.

In the cable industry today the use of VTMOEOS is limited to use as a coupling agent in traditional elastomer formulations, according to silane supplier **Evonik**. It points out that vinyl trimethoxysilane (VTMOS) – which is used in various cable applications including, for example, for grafting of PE in moisture-cured PEX-b compounds – was not identified as an SVHC in ECHA's Substance Evaluation Report (published in 2020).

Helmut Buesser, head of Evonik Silanes' General Industry market segment

IMAGE: EVONIKA

However, as the first silane developed for high temperature applications (the boiling point of VTMOEOS is around 285°C compared to 120°C for VTMOS), Evonik says VTMOEOS is still an important product for some long-established elastomer and adhesive applications.

"VTMOEOS is only very rarely used in new development projects," says Helmut Buesser, who heads Evonik Silanes' General Industry market segment. "We have not shipped any samples for new development projects in the past years. Already in the late 1990s, Evonik Silanes introduced technically superior solutions like the silane oligomers Dynasylan 6498 and Dynasylan 6598 and other products."

Dynasylan 6498 and 6598 and other grades are used to promote coupling between the polymer and ATH or MDH flame retardant fillers in HFFR cable formulations, where they promote dispersion, ease processing and can significantly improve mechanical and electrical property characteristics.

Substitution of VTMOEOS with a newer and safer alternative is relatively simple for elastomer applications from a technical perspective, according to Evonik, but the effort and cost required to get a new formulation approved can be high. "There is a possibility that individual formulated products may no longer be available in the future," according to Buesser.

VTMOEOS previously featured in the **Wacker** product line-up but is not a current product. "While we did use vinyl-tris-(2-methoxyethoxy) silane several years ago for the formulation of very few and highly specialised niche products, Wacker is generally not selling any products containing significant quantities of the silane as of today and neither do we manufacture the substance," a spokesperson at the company told *Compounding World*.

› **www.evonik.com**
› **www.wacker.com**

mentation of technologies such as FTTH expected to be high among key drivers. It says the combination of the Alphagary and Shakun material portfolios will provide cable engineers with a variety of solutions for designing fibre optic and copper cables for voice and data, power, and other applications that meet evolving global fire safety standards.

The latest Alphagary developments include Megolon halogen-free, flame retardant compounds for Category 6 data cables that need to pass the European B2 level of CPR testing, as well as compounds for thin-wall CPR B2 applications. Garaflex TPE compounds have been formulated to provide the durability and flexibility required for electric vehicle (EV) charging station cables that must operate in challenging weather conditions.

The company also says its GCPE series of chlorinated polyethylene alloy materials provides cable designers with an effective solution for production of ethernet cables used in demanding environments that need to withstand hot oil while maintaining flexibility. And, together with Shakun, it can offer Escontek semi-conducting cross-linkable compounds for power cables that meet a variety of IEC specifications.

Improving POE

Germany's **Innospec** has previously demonstrated how its ViscoSpeed processing aid is able to improve the processability and mechanical performance of high filler content polyolefin-based

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Right: SACO AEI Polymers holds a strong position in moisture cured HFFR XLPE cable compounds

HFFR cable sheathing compounds, which it says it does by improving wetting and dispersability of fillers such as ATH, MDH and nano-scale silicates and clays. More recently, it has highlighted its role in development of polyolefin elastomer (POE) based formulations as an alternative to PE/EVA-based compounds.

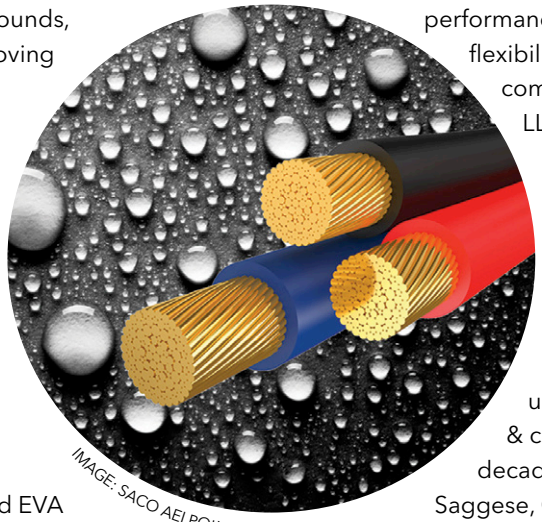

IMAGE: SACO AEI POLYMERS

According to Innospec, a considerable price gap has developed between POE and EVA over the past year or so. This gives POEs a potential cost benefit in HFFR applications, provided the traditional drawback of dripping during burning can be overcome. The company has been working with iPool, a materials development spin-off from the Italian National Research Council, to develop POE-based formulations suitable for production of HFFR sheathing that complies with the EU CPR.

At the AMI Cables 2022 conference in Germany in March, **iPool** Senior Technologist Dr Camillo Cardelli presented EN50399 CPR flame test results for five different flame retardant cable sheathing materials – a standard PVC, two low smoke PVC grades, a standard EVA/LLDPE HFFR formulation, and a new HFFR formulation based on POE/LLDPE using Innospec's Viscospeed additive. Both HFFR formulations used a combination of fine precipitated ATH and natural milled MDH flame retardants and the formulations were similar aside from the base polymer and the use of the ViscoSpeed additive (which allowed the total flame retardant content to be increased from 60% to 64%).

Data presented at the conference showed that the POE/LLDPE formulation gave a cable compound with improved crack resistance, heat release performance, and low temperature flexibility at competitive cost compared to the standard EVA/LLDPE HFFR formulation.

Tracking trends

Mega trends such as urbanisation, electrification, the shift to alternative energy, and adoption of 5G communications will underpin growth in the wire & cable market over the next decade, according to Luca Saggese, Chief Commercial Officer at **SACO AEI Polymers**. The company, which is about to mark its 25th anniversary, supplies grafted resins, compounds, masterbatches and additives for cable industry applications. Its technical expertise includes cross-linking, reactive compounding, and flame and smoke management, while its products meet global regulatory requirements including UL, CPR, EIC, IEEE and SAE.

The company holds a strong position in low smoke and halogen-free XLPE cable compounds. Its Pexidan HF X/T and Pexidan HF V/T moisture cure UL 44 XLPE formulations have been successfully used in building and transportation markets. It also has a range of compounds for photovoltaic applications. In the UL segment, its Pexidan X/T-UV and V/T2-UV grades are bulletined to meet UL4703 requirements for FV-1 and VW-1 respectively. In the IEC62930 segment, it offers the Pexidan HF SX650 zero halogen moisture cross linkable XLPE grade.

SACO AEI has recently introduced several advanced products to support new cable designs in the data communication and fibre optical cable sectors. Based on low smoke, zero halogen technology, Thermodan HF TP343 is a jacket formulation that can achieve CPR ratings of B2ca. Thermodan HF TP852 is a high modulus grade

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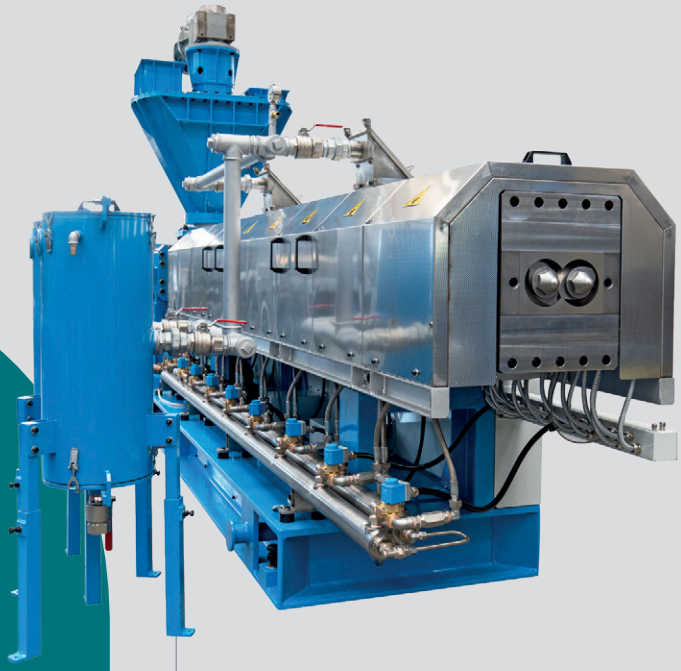

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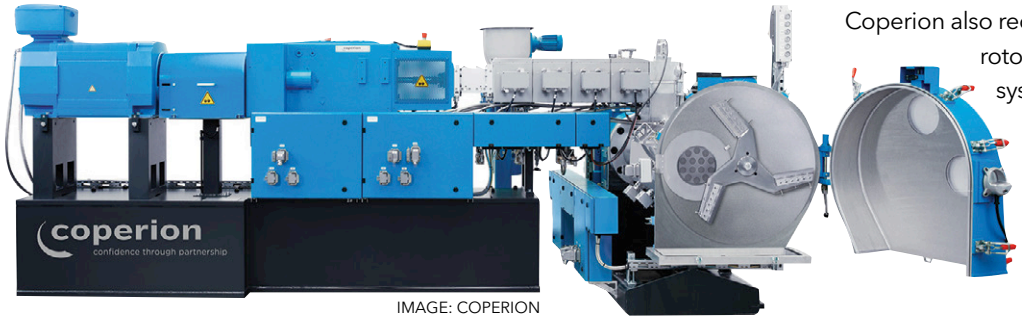

IMAGE: COPERION

Above: Coperion's two-stage Kombiplast system is used for PVC and specialty cable compounds

suitable for buffer tubes.

The company says being a global supplier to the wire and cable industry means having both halogenated and halogen-free compound expertise. "We are often asked why the US industry has not switched from PVC to HFFR polyolefins on the scale that Europe has," says Saggese. "We believe the answer is related to several factors that, combined, present considerable challenges to the adoption of halogen free solutions in the North American market. These challenges include a fundamental difference in how the two continents view fires and flame spread; the presence of the 'Wet IR' test in the UL44 North American standards; and, the historical expertise and equipment infrastructure in North America, which exposes the temperature sensitivity and run speeds of zero halogen containing compounds."

Combined benefits

German machinery maker **Coperion** developed its Kombiplast KP two-stage compounding system for production of PVC and specialty compounds such as those used in the cable sector. It combines a twin screw extruder from the company's highest performing ZSK series with a single-screw ES-A discharge screw, which provides gentle pressure build-up for shear-sensitive products.

The latest developments of the KP system are focused on maximising product quality and improving handling of the equipment. For example, the company recently modified the ES-A screw design to provide a more uniform and gentle flow and pressure build-up before the melt passes through the pelletiser die plate. The result is said to be very uniform and high quality pellets.

Coperion also recently developed a new knife rotor for its EGR eccentric pelletising system, which makes it possible to produce extremely low-dust PVC pellets for cable compounds. Rotating directly on the die plate and using knives made from a specially-developed alloy, the rotor allows particularly smooth and gentle cutting of the polymer.

"Due to these technical optimisations the knives remain in particularly even contact with the die plate during operation," says Maria Hölzel, Head of Team Engineering Plastics EP2 Process Technology at Coperion. "The result is very high cutting quality that forms the basis for achieving the desired substantial reduction of the proportion of fines in the pellets."

The EGR knife blade system has also been modified so that the knives can be pre-assembled outside of the system then simply inserted to avoid down time. The pre-assembly is matched to the respective die plate.

Coperion says it is currently working on development of an alternative system for pressure build-up in production of demanding HFFR cable compounds. "The aim is to significantly minimise the time-consuming cleaning required by the units normally used. At the same time, the new system will ensure a very stable pressure build-up, especially in the preparation of highly viscous, sometimes very sticky formulations," according to Hölzel.

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Below: Upgrades to Coperion's EGR pelletising system enhance pellet quality and reduce fines, shown in the right image

IMAGE: COPERION

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IMAGE: SHUTTERSTOCK

The need to recycle often incompatible polymer resins has given new impetus to developers of polymer compatibilisers and coupling agents. Peter Mapleston learns more

Compatibilisers deliver performance blends

Additive suppliers and academics have a whole raft of solutions available – or in development – to allow incompatible polymers to mix together to form materials that deliver improved and more consistent performance. Many of the developments are geared towards upcycling recycled plastics, often but not exclusively post-consumer recyclate (PCR). Many, but not all, make use of maleic anhydride grafting technology to bridge the interface between polar and non-polar polymers, or between non-polar yet still incompatible polymers such as PE and PP.

US-based **Intermix Performance Materials** is a start-up that was set up last year to commercialise an ethylene-propylene multi-block compatibiliser additive technology development licensed from Cornell University. It was established by Tisch University Professor in the Department of Chemistry and Chemical Biology at Cornell Geoff Coates, Business Analyst Andrew Arriz and Principal Investigator Ting-Wei Lin.

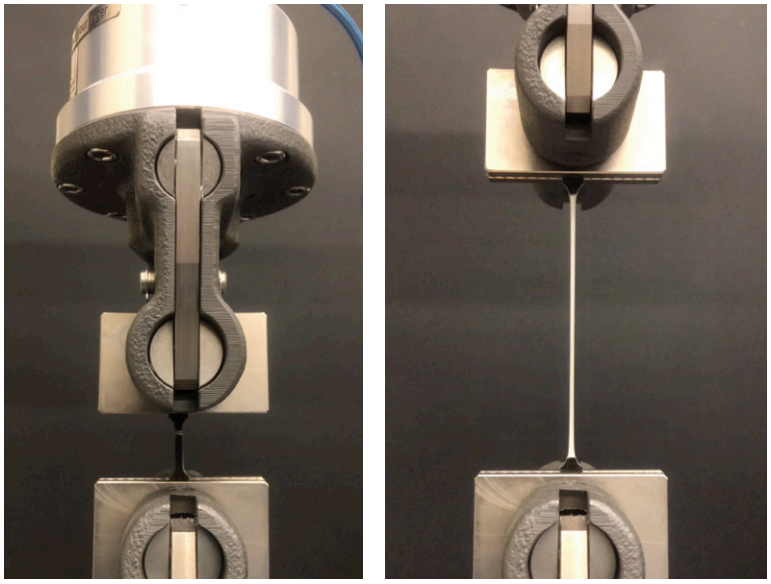
"High-density polyethylene and isotactic polypropylene (*i*PP), the world's most manufactured commodity plastics, share similar optical properties, which makes sorting process between these two plastics challenging in large scale," says Lin. "Despite the resemblance in chemical structures, HDPE and *i*PP are immiscible with each other and therefore result in brittle and valueless materials when melt-blended. This has hampered the recycle efficiency of these plastics. Only less than 7 wt% and 1 wt% of HDPE and *i*PP, respectively, are reportedly recycled.

Working with established plastics recyclers, Intermix obtained a batch of pellets mainly processed from used ropes and nets that were recovered from the ocean. The composition of these ocean plastics was approximately 1:1 weight ratio of HDPE and *i*PP. The company says blends displayed brittle mechanical properties and failed on stretching without much elongation. By adding 2 wt% of the company's compatibiliser, toughness was improved to more than 800% elongation at break.

Lin says compatibilised HDPE/*i*PP blends "now

Main image: The need to 'upcycle' mixed and difficult to sort plastic waste streams is giving new impetus to compatibiliser development

IMAGE: INTERMIX PERFORMANCE MATERIALS



Above: Tensile testing of an ocean plastic blend (left) and the same material compatibilised with 2 wt% compatibilisers developed by Intermix Performance Materials (right). Note the break in the uncompatibilised sample and the high elongation in the compatibilsed material.

become promising materials which could be reprocessed into products, regardless of the composition and inseparability of the recycled HDPE/iPP blends. This can significantly decrease the cost for plastics recycling and enhance the recycle efficiency."

Intermix currently has five employees focusing on research and business development for the products and is collaborating with a number of toll manufacturers to scale up production of the compatibilisers from gram to kilogram scale. "Products made of recycled HDPE/iPP blends may soon be realised," says Lin.

Sweden's **Nexam Chemical** has developed a concept it calls Reactive Recycling for improving the performance of mixed recycled polymer streams that are difficult to recycle. An example is recycled PP containing HDPE. "Nexamite R201 provides compatibilisation of PP and PE by reacting the polymers together creating a PP/PE hybrid," says the company's Chief Marketing Officer Lars Öhrn. "Tensile testing is showing less variations when R201 is added to an 85% rPP and 15% rHDPE mix."

Another application example is PE containing PA. Tensile testing has shown improved mechanical performance and surface appearance when adding Nexamite R405 to a mix of 93% HDPE and 7% PA6. Yield stress is also improved and break strength is said to be on a par with pure HDPE.

Öhrn does not disclose the specific reactive chemistry employed but says it is not based on maleic anhydride grafting. "It functions in polyolefins but can also bridge and react with polycondensates. As with all reactive extrusion you need to have proper mixing and energy input for best results," he says. Nexamite R201 and R405 are both offered in masterbatch form.

The latest addition to the **Nordic Grafting Company**'s portfolio is Acti-Tech compatibiliser 16MA11F. It is based on a Vistamaxx semi-crystalline copolymer from ExxonMobil grafted with maleic anhydride (MA). NGC, which is a licensee of ExxonMobil technology, says the new additive is compliant with the EU 10/2011 food contact regulation and offers recyclers and processers an easy-to-add and universal compatibiliser to enhance the value of blends containing various

Table 1: Comparison of key mechanical properties of HDPE and HDPE/PA6 blends with and without Nexamite compatibilisers

	Yield Stress (MPa)	Yield Strain (%)	Break Strength (MPa)
100% HDPE	25.6	12.9	42.7
93% HDPE /7% PA6	23.7	10	34.2
88% HDPE/7% PA6/ 5% Nexamite R405	27.3	10.6	42.6

Source: Nexam Chemical

Table 2: Comparison of key mechanical properties of rHDPE, rPP, and rHDPE/rPP blends with and without Nexamite compatibilisers

	Yield stress (MPa)	Yield strain (%)	Break Strength (MPa)	Break Strain (%)	Break Strain Std dev	MFI (g/10min)
100% rPP	27.6	11.3	33.1	632	62	2.5
100% rHDPE	34.7	8.8	30.3	747	123	1.2
85% rPP/15% rHDPE	27.1	10.2	24.9	505	150	2.4
80% rPP/15% rHDPE/5% Nexamite R201	27.2	12.5	30.1	648	18	1

Source: Nexam Chemical

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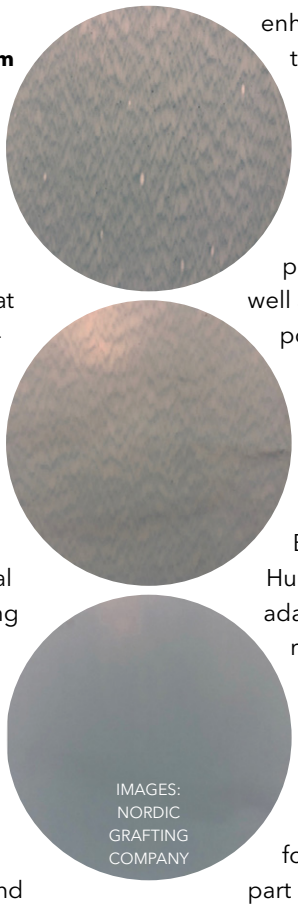
Right: Images showing the effect of Acti-Tech 16MA11F compatibilisation of recycled LDPE/PA/EVOH blown film. From top, blown film with no compatibiliser, blown film with 2% Acti-Tech (centre), and blown film with 4% Acti-Tech (bottom)



IMAGES: NORDIC GRAFTING COMPANY

diverse polymers typically found in packaging, including polyolefins, EVOH, PA and PET.

The Acti-Tech product can be added at various stages of the recycling process – at the converter during in-house or pre-consumer recycling, during repelletising with or without filtration at the recycler, or during reformulation at a recycler or compounder. "It represents an ideal solution to upcycle mixed polymer feeds from post-industrial recycling (PIR) or post-consumer recycling (PCR), but also from in-house waste, enabling the use of these recycled plastics into new or existing products without lowering end-properties," says the company.

According to NGC, Acti-Tech 16MA11F has shown improved dispersion and decreased domain size of PA and PET particles in polyolefin matrices (typical PA/PE ratio of 40/60). "Moreover, the addition of 4% Acti-Tech compatibiliser 16MA11F in recycled barrier film – LDPE(60%)/PA(30%)/EVOH(10%) – demonstrated a high recovery of film and optical properties compared to non-compatibilised mixtures, as well as cost saving compared to virgin material," says the company's Business Development Manager Quentin Le Piouff.

The Acti-Tech additive is currently being tested on various pre-consumer, post-industrial and post-consumer waste streams. These include multilayer barrier film packaging as well as shrink sleeves, blow moulded cosmetic and plant protection chemical containers, rigid packaging, reinforced/multiwall tubes and hoses, fish nets, mats, and carpets.

According to Le Piouff, Acti-Tech 16MA11F can also be used as a coupling agent for biobased (starch, cellulose), wood composite (WPC) and natural fibre (NFC) compounds. "Several applications using this universal compatibiliser will be commercialised in the coming months," he says.

Making an impact

Another part of ExxonMobil's polymer modifier range, the Exxelor portfolio, was acquired by **The Compound Company** in March. Exxelor grades are chemically modified polyolefin-based resins (MA-functionalised PP, for example) used to enhance the performance of engineering thermoplastics and other polymers. They can be used as impact modifiers as well as compatibilisers, coupling agents and adhesion promoters, where they increase the bonding strength of non-polar polymers with polyolefins, fillers and reinforcements as well as metals, thermoset rubbers and most polar substrates, including glass.

"We are in the middle of embedding the new business into our existing workflow, while keeping customers happy," says Netherlands-based The Compounding Company's Business Development Manager Frank Huijnen. "We have many plans regarding adapting our coupling agents. Tightened regulations for free MAH in end-products is a driver for those developments as well as sustainable materials."

The Compounding Company has lined up a portfolio for a wide variety of mixtures of thermoplastic materials for mechanical recycling. "Yparex, as part of The Compound Company, always has shown its capability to develop a range of MAH-modified polyolefins for thermoplastic processing. Since mechanical recycling has gained volume, Yparex has adapted to the needs to have compatibilisers which enable plastic processors to generate new value from their plastic waste streams," Huijnen says.

"With these compatibilisers we can cover recycling streams for injection moulding, but also for the more critical film processing," he adds. Yparex compatibilisers are also used in industrial waste stream recycling and in PCR recycling operations.

A variety of grafted and compounded solutions, including maleic anhydride functional additives, area available from **SACO AEI Polymers** under the Armidan and Linxidan trademarks. The Linxidan coupling agent family covers a broad range of resins including PP and PE. They are designed to improve adhesion between a non-polar resin matrix and a polar filler, such as wood flour, glass fibre, or halogen-free flame retardants. The result of this increased adhesion is improved mechanical properties such as notched impact, tensile strength and flexural modulus.

Linxidan LX4433 is a maleic anhydride grafted PE specifically formulated for use in wood-filled composites. "In these systems, the Linxidan products have been valued for their effectiveness at low loadings, helping lower formulation costs

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Right: Images showing the effect of Yparex OH17 compatibiliser on gels in a recycled PE film. The sample on the left has no compatibilizer; the sample on the right has a 10 wt% addition of Yparex

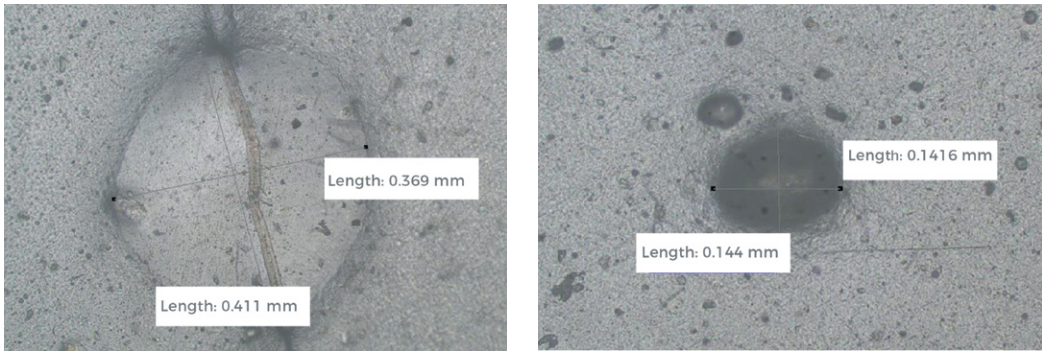

IMAGE: THE COMPOUND COMPANY

and enhancing physical properties," the company says. "In addition, because the product is well stabilised, it can be used across a large temperature profile in many compounding applications."

Extending reach

Netherlands-based **Polyscope Polymers**' core business is based on styrene-maleic anhydride and the company claims to have significantly grown its market share in this sector over the past decade. Its acquisition earlier this year by Vertellus is expected to support future its growth ambitions. "With this acquisition, Polyscope has expanded its reach within the specialty additives market," says Patrick Muezers, Polyscope CEO. "We will be able to leverage Vertellus' global resources, capabilities and strong market leadership to better serve [existing and new] customers."

Potential synergies between the Polyscope and Vertellus portfolios are currently being investigated. "New synergies will continue to emerge, but ZeMac, an ethylene MA copolymer offered by Vertellus, is already proving highly complementary to Polyscope's current offering," says Muezers.

"The combination of our additives will help us provide answers to our customers' questions about Xibond blend optimisers. We have seen an increasing demand for more sustainable solutions. For example, we have initiated projects where our additives will support the processing of bio-based plastics in PLA/PBAT combinations. In this case, our Xibond compatibilisers are essential to enable optimal performance across applications and developments, including the switch from traditional PE bags to bio-based shopping bags," he says.

"Furthermore, we increasingly see opportunities to offer solutions for the upcycling of various polymers. Some of our customers have even found that our compatibilisers can contribute to making blends from 'plastic soup' in combination with ABS, enabling PET/ABS blends that can be used in applications such as in housing for electrical appliances," Muezers explains.

"Finally, we have developed our experience around our Xibox service model, through which we help our customers to speed up the product development phase, reducing the length of the process by several weeks or, in some cases, months. We use a small tabletop mini extruder to undertake a quick screening of customers' formulations."

The Xibox screening concept is said to have been adopted by several customers facing challenges working with multiple recycling streams.

Olebond products from Turkey's **Tisan Engineering Plastics** are maleic anhydride grafted polymers produced by reactive extrusion. "According to grafting level and polymer type, Olebond help to improve compound performance by acting as compatibiliser, coupling agent, impact modifier and adhesive agent," the company claims.

Olebond 7401 grades based on PP and with high maleic content are used in PP compounds as a coupling agent between polymer and filler. The 7401 grade can also help improve mechanical performance characteristics in blends of PP and immiscible polymers such as PA, the company says.

Olebond 7402 grade is used as a compatibiliser and coupling agent in applications ranging from halogen-free cable compounds, multilayer pipes, composite panels and PE blends with other polymers. As a compatibiliser, Olebond 7402 is said to improve the interphase adhesion of PE to polymers such as PA and other polyolefins. "Olebond 7402 offers the best dispersion between mineral fillers, fibres and polymer matrix and increases the mechanical properties of polymer compounds. For example, when used in talc filled polymer compounds, Olebond 7402 doubles the dispersion of the talc," according to Tisan.

Other Olebond grades include ABS and EVA-based products that can be used as compatibilisers in different products. Olebond 7404 is an MA grafted ABS and Olebond 7405 is MA grafted ethylene vinyl acetate (EVA).

Korea-headquartered **SK Functional Polymer** (SKFP) offers a full range of compatibilisers and recycling boosters that are claimed to allow users

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IMAGE: SHUTTERSTOCK

Above: Lotader 4210, from SK Functional Polymer, can be used to upcycle a variety of mixed plastics waste, including EVOH and PA barrier film constructions

to convert mixed plastic waste streams into high value materials (the company was created through SK Geo Centric's acquisition of Arkema's functional polyolefins business in 2020).

"SKFP has focused significant research efforts on developing reactive polyolefins to compatibilise plastic blends by mechanical recycling. Lotader reactive terpolymers and Orevac grafted resins are widely used as compatibilisers of a wide range of blends. SKFP has solutions for recycled blends such as rPET/rPE, rPET/rPP, rPA/rPE, rPA/rPP, rPA/rPET... but also PE/EVOH blends," says Lolita Hauguel, Business Development Manager at the company's French operation.

The Lotader 4210 maleated grade has been commercialised to upcycle PE and EVOH multilayer waste (the final compound is limited to non-food applications). SKFP says another successful example is the use of Lotader AX for recycled PET contaminated with polyolefins not eliminated by the sorting process.

SKFP says it has also demonstrated that its new range of highly heterogeneous Lotryl T acrylate copolymers are highly efficient booster solutions for recycled styrenic resins enabling a significant increase in impact performance. The company also provides solutions to improve the impact resistance and adjust the viscosity of rABS compounds by combining non-reactive Lotryl highly polar copolymers and reactive Lotader AX. "The combination of polarity and reactivity of these resins is key to successfully upcycle plastics wastes," says Hauguel.

Orevac grafted polyolefins are said to be widely used as coupling agents for filled PP and PE compounds. The product range includes grafted PP, grafted HDPE/LLDPE and grafted EVA. They are available with a wide range of reactive maleic anhydride levels, but the grades with higher contents of reactive group are the more efficient coupling agents. They are suitable for use with ATH, MDH, other mineral fillers, and glass and natural fibres.

Compatibilisation of dissimilar polymers can be achieved using reactive grafted polymers such as maleated PP; bi-polar copolymers (such as SEBS); free radical grafting initiators such as dicumyl peroxide; and organometallic coupling agents (titanates, for example), according to Salvatore Monte, President of **Kenrich Petrochemicals**. "Most compounders only think of heteroatom titanate coupling agents when there are issues with fillers or adhesion to various substrates. But, in fact, they are thermally stable catalysts that repolymerise dissimilar polymers in the extruder melt much like titanocenes and Z-N catalysts are used in monomer polymerisation," he says.

"One of the benefits of heteroatom titanate catalysts is that the resultant polymer flows faster at lower temperatures with slightly increased tensile strength and significantly higher elongation. Using 0.2 wt% of an additive catalyst to lower process temperatures is a novel way to open the process window for dissimilar polymers, such as PC usually requiring high processing temperatures – greater than 300°C – and heat-sensitive rigid PVC," he says.

Providing examples, Monte says that at this addition rate the additive has doubled the extrusion output at a 47°C lower processing temperature for a clear uPVC computer chip housing profile. It has also improved the injection mould flow of a 40% glass fibre reinforced PC compound (which the customer had been using for many years to mould onto steel sheet to produce whetstone bases) at a temperature more than 100°C lower.

Modifiers and compatibilisers will play a key role in the move from a linear to circular economy, according to **Dow**, which is developing an expanding range of products to support recycling of non-compatible material combinations. Its Retain 3000 polymer modifier is intended for use in recycling of post-industrial films containing EVOH where it is claimed to minimise gels while Fusabond grades function as impact modifiers and compatibilisers in post-consumer polyolefin recyclates.

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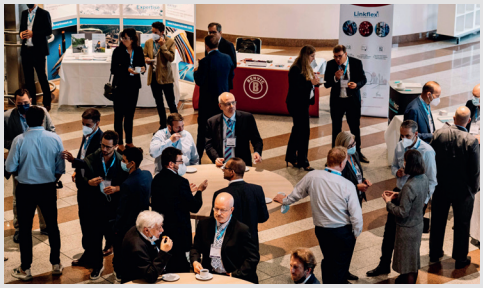

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IMAGE: VITO PALMISANO

Detroit set to welcome US injection moulders

The Injection Molding and Design Expo takes place in Detroit in the US this month. We take a look at what the free-to-attend exhibition and multi-stream conference offers attendees

The US city of Detroit plays host to the first Injection Molding and Design Expo later this month, a new free-to-attend exhibition and conference that brings together more than 130 leading suppliers to deliver a focused networking and learning experience for the North American injection moulding industry.

Organised by Crain Global Polymer Group – publisher of *Plastics News* – and AMI – publisher of *Injection World* and *Compounding World* magazines – the event takes place at Huntington Place in Downtown Detroit (formerly known as the Cobo and TCF Center) on 25-26 May. It will bring together key players from across the injection moulding supply chain, ranging from injection machinery suppliers, through mouldmakers and automation specialists, to materials and auxiliary equipment providers.

Injection moulding machinery makers showing in Detroit include Milacron, KraussMaffei, Wittmann Battenfeld, Absolute Haitian, Tederic, Shibaura, Yizumi-HPM, Wilmington Machinery and CH America. They will be joined by a raft of auxiliary suppliers, including Conair, ACS Group, Advanced Blending Solutions, Frigel, Matsui, Zeiger Industries, ASS End Of Arm Tooling, Frigosystem, Kongskilde, Bauer Compressors, Cincinnati Process Technologies, Intouch Monitoring, 2R Automation, Alpha Laser, Alkegen, Promess, Zerma and Filtroil.

Mouldmakers and mould components firms also feature among the exhibitors. They include Cavalier Tool, StackTeck, Accede, DME, Mastip, Progressive Components, Synventive, Spark Industries, PCS, EAS Change Systems, VEM Tooling, Osco, Mold World, and Action Mold & Machining. In addition, a number of Portuguese mouldmakers will be present with their trade association Cefamol. Injection moulding part and tool design software exhibitors include Sigmasoft, Moldex3D, EPS FloTek, CAE Services, TST and Simcon.

On the materials front, the list includes M Holland, Ampacet, Chroma Color, Chase Plastics, Domo, General Polymers, Amco Polymers, Star Plastics, Polykemi, Opticolor, Purgex, Polymax, Entec, Bamberger Polymers, Purgex, Slide Products, Rainbow Colors, SACO AEI Polymers, and iD Additives.

Training up

The Injection Molding and Design Expo is more than just a show, however. Several top US suppliers of training services – Beaumont, RJG, Routsis and Paulson – will be exhibiting and also running some practical seminars in the free Training and Development Theatre, where a number of other key processing-focused topics will also be addressed.

Day one training slots will see Todd Bryant,

Main image: The US city of Detroit hosts the first Injection Molding and Design Expo later this month, a focused free-to-attend networking and learning event

Detroit's Huntington Place is set to host the free-to-attend Injection Molding and Design Expo, bringing together more than 130 exhibitors and a comprehensive conference and training programme

IMAGE: TCF CENTRE

Senior Instructor and Technical Development Director at Paulson, examining the science behind profitable moulding and providing useful tips for boosting bottom line. Cory Hoeppner, TZERO Project Manager at RJG, will explain how to use advanced technologies to accelerate a tooling launch. And Jason Travitz, Senior Injection Moulding Process Instructor at AIMI, will cover knowledge-based strategies for solving moulding problems and defects.

The day one training agenda will also include a panel discussion covering factory safety. Expert participants in that include: Stan Glover, Director of Technical Sales at Zeiger Industries; Bruce Main, President of Design Safety Engineering; Ted Sberna Sr, Lead Consultant at White Horse Safety; Larry Keller, Director of Engineering at Milacron; and Dale Bartholomew, Technical Manager at JSW America.

Day two training topics include a critical look at processes to reduce changeover times, which will be given by Daniel Stephens, Vice President at Routsis Training. Then RJG Trainer Jacque Gibson will present an introduction to melt preparation and plasticisation. And AIMI's Jason Travitz will give a second presentation titled 'Moldflow versus mould floor'.

Other training topics include some tips on material selection, qualification and approval of materials for medical device applications from Josh Blackmore, Global Healthcare Manager at M Holland. Michael Devereux, Partner, and Mark Stevens, Principal at Wipfli will discuss business management risk management, delving into supply chain issues, labour shortages and tax

policy. And Kathy Kirk, Head of Consulting and Industry Solutions for Consumer and Life Sciences at Bristlecone, will speak about the use of AI and analytics to improve visibility and optimise mould management.

Expert insight

Visitors to the Injection Molding and Design Expo can also dip into the free-to-attend conference sessions. These run across two conference theatres over both days of the expo and include a selection of industry-leading speakers from the likes of Ford Motor Company, Berry Global, Faurecia, Amcor, Westfall Technik, Yanfeng Automotive Interiors, Teel Plastics, and Cascade Engineering. The two themed conference theatres are focused on 'Moulding The Future' and 'Designing The Future'.

Opening keynote presenters for the first day include Troy Nix, Executive Director of the Manufacturers Association for Plastics Processors (MAPP), whose talk is titled 'Working together to build a stronger molding industry in the USA'. Alper Kiziltas, Technical Expert for sustainability and emerging materials at Ford Motor Company, will speak about selecting materials for more sustainable vehicles.

Day two keynote speakers include Mark Gomulka, CEO of Westfall Technik – one of the world's most dynamic and fastest growing injection moulding groups – who will discuss business growth and expansion. And Grey Parker, Principal and CEO at leading industrial design consultancy Sundberg-Ferar, who will speak about transforming product design through innovative design thinking.

Both of the conference theaters will also feature a series of expert panel sessions. In the Moulding the Future theatre, the question of 'What makes a successful moulding operation?' will be discussed by: Patricia Miller, CEO of Matrix 4; Gary Hulecki, Executive VP at MTD Micro Molding; and Mike Ruggieri, President of Comar. And a separate discussion on the future of mould making will feature: Laurie Harbour, President and CEO of Harbour Results; Camille Sackett, VP of Sales and Project Management at Accede Mold & Tool; Dale Hermiller, President of HS Die & Engineering Inc; Jordan Robertson, Vice President of Business Development and Marketing at StackTeck; and Brian Bendig, President of Cavalier Tool & Manufacturing.

The Designing the Future Theatre will focus on trends in automotive, rigid packaging, medical and sustainability. Panel experts include: Katie Roco, Customer Engineering Director at Faurecia; Jeff Stout, Executive Director at Yanfeng Automotive Interiors; Carla Bailo, President and CEO of the Center for Automotive Research; David Clark, VP Sustainability at Amcor: Diane Marret, Sustainability Manager for Consumer Packaging at Berry Global; Jeff Totten, Chief Engineer at Cascade Engineering; Millie Nuno, Director of Business Development for Hoffer Plastics; Thierry Fabozzi, President and CEO of Plastic Technologies Inc (PTI); Jose Ochoa, Director of Sales USA at Greiner Packaging; Megan Tzanoukakis, VP Supply Chain at Sussex Injection Molding; and Christian Herrild, Director of Growth Strategies at Teel Plastics.

Technology tips

Between the panel discussions, the conference theatres will include a series of technology talks from leading suppliers covering: specifying hot runners; harnessing factory data; microcellular foam moulding; lights-out automation; Industry 4.0; advanced control systems; innovations in process simulation; and selecting materials to minimise a product's carbon footprint.

A number of presentations will focus on specific applications and new technologies. For example, Gene Altonen, Chief Technology Officer at iMFLUX, will discuss his company's innovations in adaptive processing. Steve Beasley, Regional Sales Manager at KraussMaffei will discuss the injection moulding of lightweight door modules incorporating natural fibre prepreg sheets. Craig Crossley, Applications Engineer at Fortify, will talk about 3Dprint tooling for injection moulding and how to select appropriate parts. And Robert Jergens, Midwest Regional Sales Manager for the IMM Division of Wittmann Battenfeld, will speak about the use of Industry 4.0 techniques to create connected production networks and condition monitoring.

To find out more about the Injection Molding and Design Expo and to secure your free visitor registration, go to **www.injectionmoldingexpo.com**

Network to the sound of the Motor City

Injection Molding And Design Expo visitors staying over the night of 25 May in Detroit can maximise their networking potential at the Expo Networking Party, which takes place a short walk from the expo hall at the Grand Riverview Ballroom. $50 buys a buffet dinner, two drinks and a live Motown band primed to deliver the soundtrack of Motor City. **Click here** to learn more

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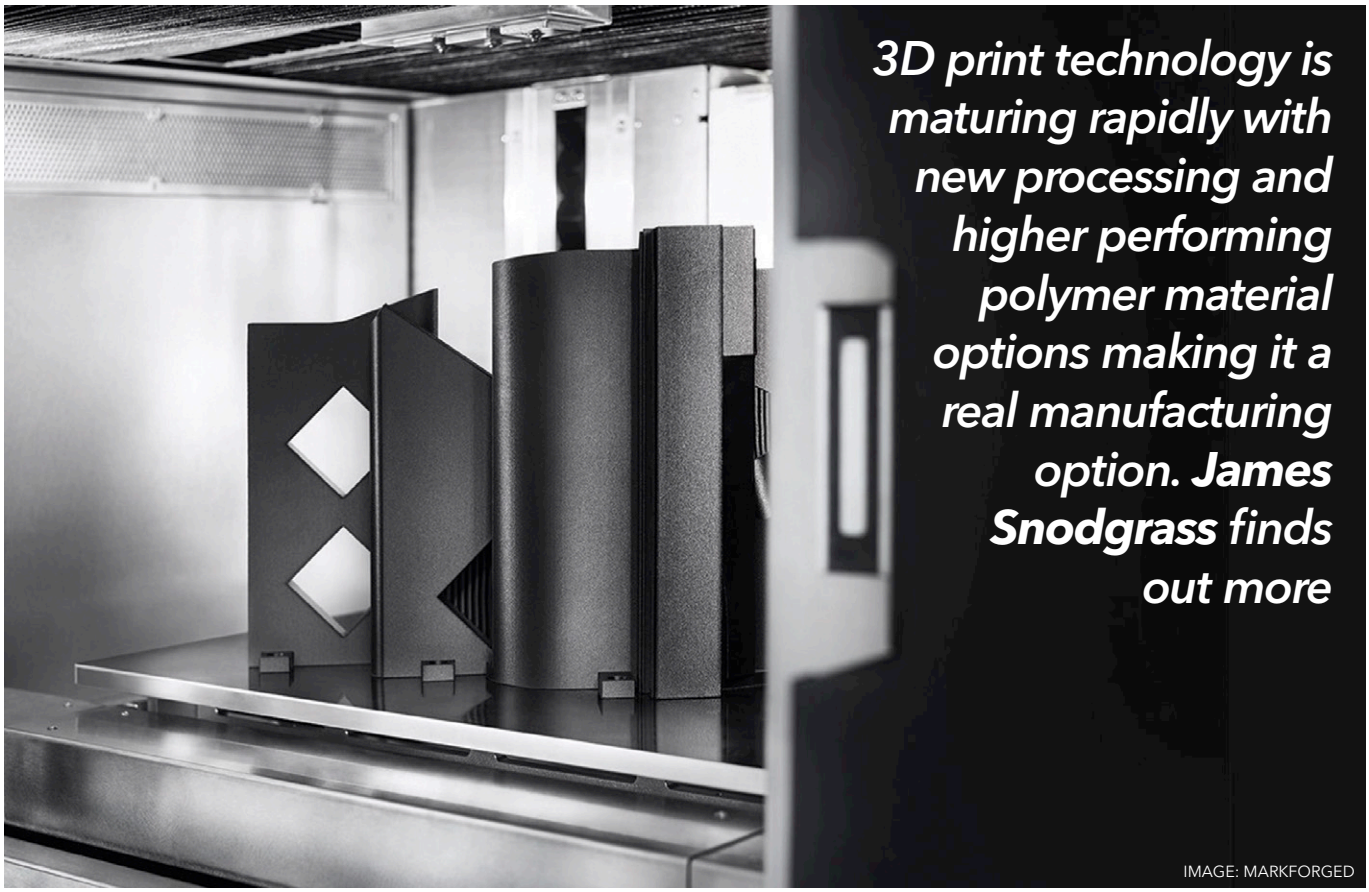

3D print technology is maturing rapidly with new processing and higher performing polymer material options making it a real manufacturing option. James Snodgrass finds out more

IMAGE: MARKFORGED

Main image: Markforged's FX20 is a high performance 3D print system capable of handling continuous reinforced high temperature polymers such as carbon PEI

Look back just 10 years and the 3D printing landscape was very different from today. Setting aside the top end liquid stereolithography and powder-based SLS additive manufacturing systems for the moment, solid 3D print materials were principally filaments of either PLA (polylactic acid) or ABS (acrylonitrile butadiene styrene). And these filaments were largely produced by small start-ups operating to the 'homebrew' principles of the machines used to print them – typically open-source designs using stepper motors from inkjet printers and often built around a laser-cut plywood chassis.

In recent years, however, the 3D printing market has matured and most of the major polymer materials companies now supply 3D print compounds in one form or another. The technology is also pivoting away from prototyping and towards, if not mass manufacturing then, at least, medium volume manufacturing. The biggest evidence of this shift has been the emergence of print farms (equipped with hundreds or even thousands of machines in a single location working on the same parts, or several parts of a whole) and new, faster printing techniques such as SAF (more on that later).

A key area of development has been in build materials based on continuous fibre reinforcement. Belgian materials firm **Solvay** has been working with Switzerland-based advanced manufacturing solutions provider **OEM 9T Labs** to help bring additively manufactured carbon fibre-reinforced plastic (CFRP) parts to mass production. This joint effort uses 9T Labs' additive manufacturing technology to produce low-to-medium volume size parts for the aerospace, medical, luxury/leisure, automation, and oil and gas industries.

Solvay's contribution is its performance materials expertise, which includes carbon fibre-reinforced polyetheretherketone (CF/PEEK), CF-reinforced bio-based high performance polyamides, and CF-reinforced polyphenylene sulphide (CF/PPS) composites. As a result of the partnership, 9T Labs has been able to significantly expand the portfolio of neat and carbon fibre-reinforced materials it can offer to customers.

"With 9T Labs' innovative process and equip-

IMAGE: MARKFORGED

Above: SABIC now offers a continuous carbon fibre PEI filament for Markforged's FX20 production system

ment and Solvay's high-performance thermoplastic materials, we are well positioned to address problems that have long plagued manufacturers in many industries trying to use advanced composites – namely high incremental costs, high scrap, and problems achieving repeatability and traceability at high volumes. We believe this collaboration will help solve many challenges and will open entirely new markets and mass production applications to CFRP materials," says Marco Apostolo, Director of Technology at Solvay.

"For the fabrication of structural parts, metals still prevail because the manufacturing of structural CFRP parts has not been cost-competitive," says Giovanni Cavolina, 9T Labs' co-founder and Chief Commercial Officer. "The Red Series platform in combination with Solvay's high-performance and recyclable materials will change this and make CFRP parts more sustainable, accessible and cost-competitive, especially at higher volumes."

9T Labs claims its hybrid manufacturing technology enables high-performance structural parts – in challenging small-to-medium size and thick sections – to be produced in carbon fibre-reinforced thermoplastic composites in production volumes ranging from 100 to 10,000 parts/year. By combining 3D printing (which offers design freedom, part complexity, and control of fibre orientation) with compression moulding in matched metal dies (providing rapid cycle times, high production rates, very good surface finishes with low voids, plus high repeatability and reproducibility) this hybrid production system offers a combination of both additive and conventional manufacturing.

Earlier this year **SABIC** introduced a 3D printing filament with continuous fibre reinforcement designed specifically to work with **Markforged**'s latest printer, the FX20. Markforged is best known for its metal and carbon fibre 3D printing product, The Digital Forge. Its new printer is designed specifically for printing with carbon fibre reinforced polymer. The FX20 can make flame-retardant, high-performance thermoplastic prints using Sabic's Ultem 9085 PEI filament in combination with Markforged's proprietary continuous fibre reinforcement technology to produce high-strength, heat resistant, and high performance parts that meet the needs of demanding industries such as aerospace, defence, automotive, and oil and gas.

The FX20 uses a heated build chamber capable of maintaining a temperature of up to 200°C temperature and has the capacity to print parts up to 525mm by 400mm by 400mm. It operates up to eight times faster than the default print settings on Markforged's existing line of composite printers and prints nearly five times larger builds than the company's next largest printer, the X7.

"Markforged continues to build on our innovative legacy and lead the way in composite 3D printing – the future of manufacturing. With the releases of the FX20 and continuous fibre reinforced Ultem 9085 filament, we're now fulfilling that promise to manufacturers who previously, in the most demanding environments, were unable to experience the benefits of the Digital Forge and our unique materials," says Shai Terem, President and CEO of Markforged.

Filament innovation

The technique most lay people associate with 3D printing today is that which builds objects using a molten, extruded polymer filament. It is a process many refer to as FDM (or fused deposition moulding) but as that name is a registered trademark of **Stratasys** it is also referred to by the generic acronym FFF (fused filament fabrication).

Brazil's **Braskem** has expanded its 3D printing product portfolio to include PE and glass fibre-reinforced PP filaments for FFF production, claiming that its products are easier to print, exhibit less warpage, display minimal shrinkage, and have better interlayer adhesion than comparable alternatives.

"Braskem continues to evolve its product portfolio for the rapidly growing 3D printing market. Braskem's polypropylene and polyethylene products have superior printing capabilities with minimum warpage and are the ideal solution for 3D printing," says Jason Vagnozzi, Braskem's Commercial Director for Additive Manufacturing. "Unlike other materials on the market, Braskem's PE is perfect for packaging and consumer applications and can be used anywhere HDPE would normally

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IMAGE: STRATASYS/MAKERBOT

Above: Makerbot has extended its Method qualified material list with three engineering grades from LehVoss

be used, while our new glass-fibre reinforced PP has added strength and durability which makes it a great solution for automotive, aerospace, medical, robotic, and industrial applications."

The FL500PP-GF glass fibre-reinforced PP filament is based on a co-polymer specifically developed for additive manufacturing. The formulation is designed to maximise printability, dimensional stability, and surface finish, while minimising warpage and bed adhesion issues. It is intended for automotive, aerospace, medical and robotic applications and is available in 1.75mm and 2.85mm diameters.

Glass fibre-reinforced PP filaments have a lower density than traditional FFF plastics; they are claimed to be 30% lighter than PLA and up to three times stiffer than ABS. In addition, PP filaments do not require drying before printing (unlike materials such as PA), which makes it more efficient to work with. Braskem says these properties, combined with PP's recyclability, make it an attractive material for a wide range of 3D printing applications.

PE filaments have historically been difficult to print due to warpage and shrinkage. Braskem says its 100% HDPE FL300PE filament has been specifically engineered for 3D printing applications. It offers easy printing and lightweight together with good chemical and moisture resistance. The company says it is well suited for packaging and prototyping, and for any industrial and consumer goods applications where HDPE resins are typically required.

This year, Stratasys group company **Makerbot** added three new high performance filament materials from **LehVoss Group** to its list of qualified materials for use with the LABS GEN 2 Experimental Extruder option on its Method and Method X 3D printers. The new materials include Luvocom 3F PA HT 9825 NT high-temperature reduced water uptake PA (suitable for continuous service at up to 100°C), Luvocom 3F PA HTCF 9891 BK (a carbon fibre reinforced version of the 3F PA HT 9825 NT grade offering even lower water uptake and continuous service up to 150°), and Luvocom 3F PET CF 9780 BK carbon fibre reinforced PET (offering temperature resistance up to 120°C). All are semi-crystalline materials optimised for the FFF process.

"The MakerBot Method and Method X machines offer unique heated chamber capabilities which allow semi-crystalline materials to have their full properties out of the printer, avoiding the need of post-processes," says Thiago Medeiros Araujo, Global Product Manager Luvocom 3F at LehVoss.

Powder alternative

Last year, **Stratasys** took full control of 3D print technology company Xaar 3D. The company, the 3D-printing spin-off of industrial inkjet printhead maker Xaar, was working on finessing the process of selective absorption fusion (SAF) invented by Xaar's Professor Neil Hopkinson. Stratasys had previously held a 45% stake in the company and had announced its intention to launch a family of machines using the technology. The first of these is the recently announced H350 Printer.

SAF aims to speed up 3D printing by using a powder-based technology that is more like conventional 2D printing. While there are companies using inkjet-style technology to extrude molten polymer onto a plate, SAF takes a different approach. It uses a series of printheads spanning the entire width of a bed of powdered polymer and which scan across it, depositing an "ink" that is actually an infrared sensitive liquid – a HAF (high absorbing fluid). The printhead path is followed by an infrared light and where the HAF has been deposited, the powdered polymer is fused. A new layer of powder is then added and the process repeated until the three

IMAGE: STRATASYS

Right: The Stratasys H350 is the first production system to use selective absorption fusion (SAF) powder technology

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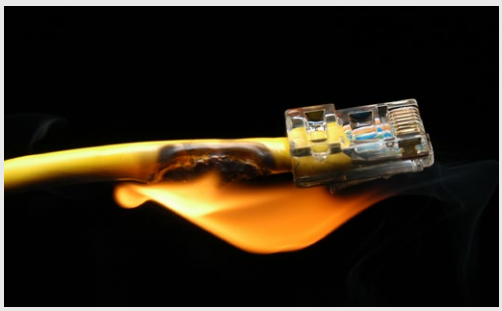

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dimensional form is complete.

Stratasys has remained tight-lipped about the compounds that will be compatible with the H-series, with no indication of their partner compounder. All a Stratasys spokesperson was prepared to say was that the launch material will be a "sustainable PA11".

Recycling ideas

Sustainability is as much a priority in the 3D print sector as it is elsewhere in the plastics industry and there is a developing interest in utilising waste streams. At this year's 24th annual SXSW Innovation Awards in the US, Israel-based **UBQ Materials** won the Speculative Design category for a waste-based 3D printing filament made from a material it simply calls "UBQ".

UBQ Materials claims to have a technology that takes household waste from landfill and transforms it into "UBQ" thermoplastic. The company divulges little about the composition of this material but its patents detail a mechanical process that is said to create a composite of non-meltable waste within a thermoplastic encapsulating matrix. It says its plant in Israel can produce 5,000 tonnes of UBQ material per year, most of which is currently used by local manufacturers.

A partnership with R&D company **Plastics App**, founded in May 2021, has led to the development of a 3D printing filament based on UBQ. The company claims its material is a "climate positive" thermoplastic that can significantly reduce the carbon footprint of additive manufacturing. "With this innovation, 3D printing may become the most environmentally conscious means of production available," says Jack "Tato" Bigio, co-CEO and co-founder of UBQ Materials.

Another initiative focused on plastics waste is Sweden's **Solaris Community**. It is targeting plastic waste in the oceans, specifically oceans in Asia, as a partner in the United Nations ESCAP (Economic and Social Commission for Asia and the Pacific) initiative, *Closing the Loop*. As part of a programme called the Ocean Plastic Project, Solaris and other social enterprises are harvesting plastic from the oceans of southeast Asia, using satellites and AI data to pinpoint areas of plastic pollution.

IMAGE: SOLARIS COMMUNITY/IWK

Right: IWK and Creamelt are involved in the "Closing the Loop" project to reuse ocean plastic in 3D print applications

Solaris subsidiary Tide, based at Ranong in Thailand, co-ordinates the collection process and the collected waste is taken to one of five islands in the Andaman Sea where local fishermen have been employed to gather and sort it. The material is then registered, washed, and shredded in a social enterprise implemented by the Swiss non-profit Jan and Oscar Foundation and the International Union for Conservation of Nature (IUCN).

The shredded material is tested prior to compounding by project partner the Institute for Materials Technology and Plastics Processing (**IWK**) at the University of Applied Sciences in Rapperswil, Switzerland. IWK claims to have developed a means to reverse the damage caused by ultraviolet exposure and saltwater penetration. The upcycled polymer is then converted to filament and the end product sold by the Swiss 3D printing filament company **Creamelt** which, like IWK, is based in Rapperswil.

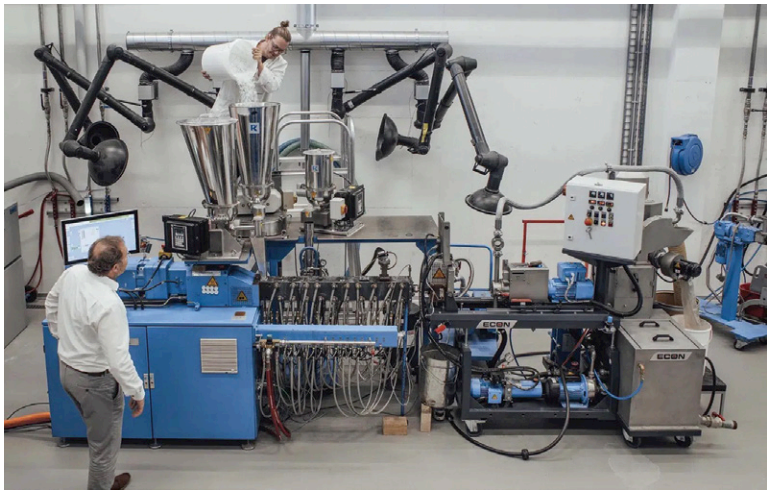

IMAGE: SOLARIS COMMUNITY/IWK

Below: Compounding of ocean-recovered material for 3D print filament production at IWK

Thinking big

Large Format Additive Manufacturing (LFAM) is analogous to FFF, in principle. In scale, however, it is vastly different. Both systems extrude a molten polymer onto a print bed but while FFF extrudes from a filament in quantities measured in g/h, LFAM extrudes in kg/h. Extrusion rates of 50kg/h or higher are possible and at that ouput rate waste mounts up. Large parts that didn't quite print as expected can contain potentially hundreds of kilograms of waste polymer.

To tackle this waste, **SABIC** worked on a joint

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IMAGE: 3D SYSTEMS

Right: Tooling cores produced using Accura AMX Durable materials on 3D Systems SLA equipment

study with Local Motors (the since-defunct US startup that aimed to build low-volume additive manufactured specialist vehicles) to validate the feasibility of recycling scrap thermoplastic parts and shavings from the 3D printing process.

The study aimed to explore more sustainable alternatives to landfilling for large, printed LFAM parts in anticipation of wider adoption. It included analysing the printability and mechanical properties of SABIC's LNP Thermocomp AM reinforced compound after being printed, reclaimed, ground and reprocessed into pellet form. The study determined that material from post-production parts and scrap could potentially be reused in LFAM or other processes, such as injection moulding or extrusion, at amounts up to 100%.

"As adoption of large format additive manufacturing accelerates, it is essential to find sustainable alternatives to landfilling large, printed parts," says Walter Thompson, Senior Applications Development Engineer at SABIC. "Our study showed great potential for reusing these materials and marks a first step in supporting reuse within the value chain."

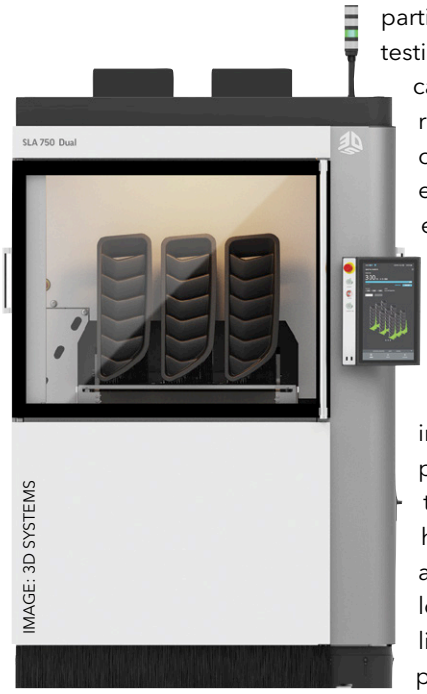
There are challenges to reusing large, printed parts. No established value chain exists for reclaiming post-production LFAM parts and scrap. This complex sequence of steps includes managing the logistics of locating, collecting and transporting large parts to a facility capable of cleaning, cutting, regrinding and repurposing the material. Another challenge is the potential degradation from multiple heat cycles (grinding, re-pelletising, re-compounding). Each adds to the cumulative heat history.

The SABIC/Local Motors study included evaluations for printability, throughput and mechanical properties. Six material samples of LNP Thermocomp AM compound were prepared containing levels of reprocessed content at 0, 15, 25, 50, 75 and 100%, respectively. The samples were monitored for changes in throughput and melt flow rate on SABIC's Big Area Additive Manufacturing (BAAM) machine. Supplied by Cincinnati Incorporated – the pioneer, along with Oak Ridge National Laboratory in the US of LFAM – the BAAM machine is located in SABIC's Polymer Processing Development Center in Pittsfield, Massachusetts.

Each sample was used to print a single-wall hexagon, which is Sabic's typical test part geometry for processing and material characterisation. All printed well, with a smooth, shiny surface and straight, even layers that demonstrated no issues with material flow.

For the mechanical property evaluation, specimens were cut from each hexagonal printed part. These were tested for tensile properties using Test Method D638 and for flexural modulus using a three-point bend test following a modified ASTM D-790 test method. Results showed very good tensile properties in the part samples containing smaller percentages of regrind and only incremental declines in the samples that included larger percentages of regrind. The 100% regrind sample experienced just a 20% reduction in tensile properties in the X-axis and a 15% reduction in the Z-axis. For flexural properties, the same gradual trend occurred, with flexural modulus declining by just 14% in the X-axis and 12% in the Z-axis for the sample containing 100% regrind.

As expected by the study's participants, tensile and flexural testing showed decreasing mechanical strength as the percentage of regrind increased. This is typical of regrind used in other processes such as injection moulding and extrusion.



Right: 3D Systems pioneered 3D printing; the SLA 750 Dual is one of its latest production systems

Back to the future

3D printing is considered a new technology by many but it is now 36 years since the invention of the first 3D printing process – stereolithography – and the process inventor **3D Systems** has introduced new machinery and new resins with the aim of lowering the cost of stereolithographic printing and post-processing.

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The company's latest offering comprises three complementary technologies, its new SLA 750 and SLA 750 Dual machines (the latter being the first synchronous, dual-laser stereolithography printer) as well as the company's new Accura AMX Durable Natural material and the PostCure 1050 post-processing system. The company claims this system is optimised for cost-effective SLA batch part production at up to twice the speed and triple the throughput of comparable stereolithography systems.

Accura AMX Durable Natural resin is designed to withstand repeated high mechanical loads and shocks with a combination of mechanical properties including impact resistance, tear strength, and elongation at break. The new material is tested to ASTM D4329 and ASTM G194 standards and is claimed to meet indoor mechanical performance requirements for up to eight years and outdoor weathering for up to one and a half years. This material displays similar stress/strain toughness performance to standard thermoplastics and exhibits isotropic mechanical properties to help ensure part strength in any build orientation, according to 3D Systems.

One application that 3D Systems forsees for the new material is production of large and complex mandrel tooling cores that can be easily removed from convoluted tubing. Such components are said to be invaluable as manufacturing aids for large cooling ducts, pipes, and manifolds used in automotive, aerospace, energy, and consumer goods applications.

Additional reporting by Chris Smith

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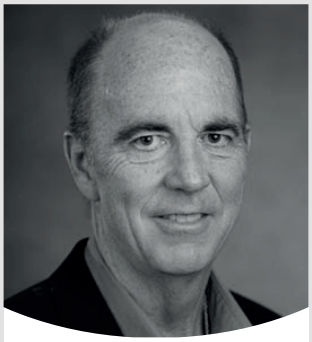

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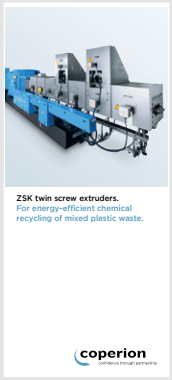

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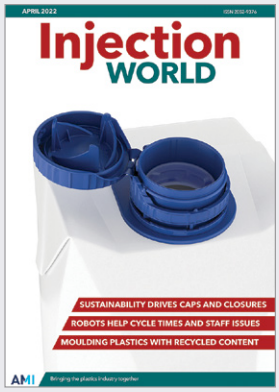

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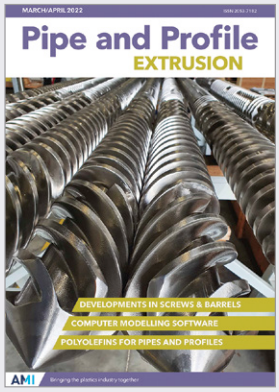

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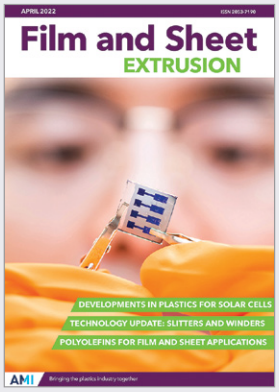

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	25-26 May	Injection Moulding & Design, Detroit, MI, USA	https://injectionmoldingexpo.com/
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	26-30 September	Colombiaplast, Bogota, Colombia	www.colombiaplast.org
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