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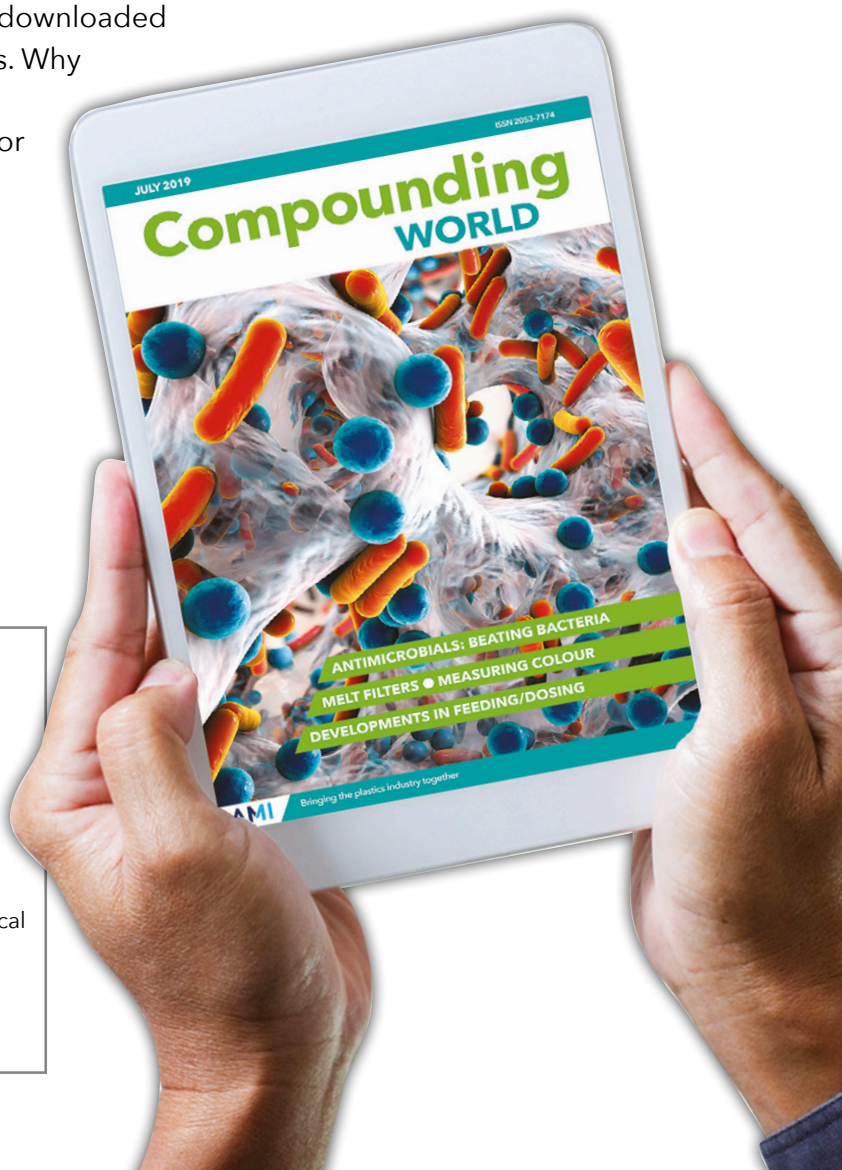

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Tad Finnegan
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Lanxess invests €30m in China

Lanxess is to invest around €30m to add a second compounding line for its Durethan PA 6 and 6,6 compounds and Pocan PBT at its site at Changzhou, China.

The investment will add around 30,000 tonnes/yr of capacity when it goes onstream in Q1 2023 and will take the company's total capacity in China to 110,000 tonnes/yr (shared between the Changzhou site and its plant at Wuxi).

Lanxess said the investment is mainly targeted at growing demand from the Chinese automotive industry. It said it sees e-mobility as a major field of application for both polymer product lines, as well as for its Tepex range of continuous fibre-reinforced composite sheet material.

Lanxess is adding compounding capacity at Changzhou

IMAGE: LANXESS

Durethan and Pocan grades are used in engine applications, door structures, body reinforcement, pedals, front ends and cross car beams, where they contribute to part weight savings of up to 50%.

› **www.lanxess.com**

Chroma Color buys J Meyer

US-based Chroma Color has acquired J Meyer & Sons, a manufacturer of colour concentrates and masterbatches with a strong presence in the medical and pharmaceutical markets.

Chroma Color CEO Shruti Singhal described the acquisition as part of the company's commitment to growing its healthcare business through both organic and inorganic activities.

The Meyer business, based in West Point, PA, will further strengthen Chroma Color's position in applications such as medical devices, medical disposables and pharmaceutical packaging, he said.

› **www.chromacolors.com**

Omya offers recycled $CaCO_3$

Swiss minerals group Omya has introduced a range of certified 100%-recycled calcium carbonate ($CaCO_3$) fillers for plastics.

The Omyaloop grades are produced at the company's site at Avenza in Italy from selected waste material from other mineral processing industries.

According to Olivier Seyvet, Director Key Account Management Polymers, they are premium materials that carry 100%-recycled certification from Bureau Veritas and comply with EU 10/2011 food contact requirements. Carbon footprint is comparable to conventional grades.

"To use the semantics of the plastics industry, Omyaloop is a post-industrial recycled material," said Seyvet, who added that the company has seen strong interest from customers.

Applications are foreseen in areas such as PVC flooring and pipes, where mineral filler levels are high and producers are looking to increase recycled content. As the characteristics of any mineral filler are influenced by its source, Omya said some formulation adjustment may be required to use the new products.

› **www.omyaloop.com**

Solvay targets E&E applications

Solvay has developed multiple new Amodel PPA materials at its site in Alpharetta, Georgia, US, aimed at advanced electrical and electronic applications in e-mobility.

Amodel PPA AE 9933 and AE 9950 joined the Supreme range and are designed for e-motor and inverter busbars operating at 800V and higher. The company said they combine high comparative tracking index (CTI) ratings with high thermal cycle shock resistance from -40°C to 150°C.

Amodel Bios HFFR R1-133 and HFFR R1-145 are halogen-free flame retarded grades with a CTI of >600V, heat resistance of >120°C and good dimensional stability. They are designed for integrated e-motor and gearbox applications.

Finally, Amodel Bios AE R1-133 is an electro-friendly grade developed for surface-mounted data connectors that can be reflow-soldered without blistering. It has higher impact resistance and weld-line strength than standard grades of PPA.

› **www.solvay.com**

Ascend moves in Mexico

PA66 specialist Ascend Performance Materials is to buy Mexico-based compounder DM Color Mexicana, based at San Jose Iturbide, to reinforce its position in the Latin American market.

DM Color Mexicana, a joint venture between Dainichiseika and Mitsubishi Corp, provides toll compounding and manufactures colour and additive masterbatch. Ascend said the deal is expected to close in the second quarter of 2022. Financial details have not been disclosed.

"We continue to invest in and grow our engineered materials business with a focus on regional production," said Phil McDivitt, Ascend President and CEO.

"This acquisition establishes our footprint in Latin America and allows us to produce our world-class materials closer to our global customers," he said.

› **www.ascendmaterials.com**

IMAGE: TEKNOR APEX

Above: Buying Lanier gives Teknor Apex a position in PVC colour concentrates

Teknor buys Lanier Color

Teknor Apex has bought Gainesville, GA, US-based Lanier Color Company, a supplier of colour concentrates (masterbatches) and specialty compounds with a particular focus on the North American building and construction sectors.

The move gives Teknor Apex a presence in the PVC colour concentrate market while strengthening its established position in specialty compounds for the construction sector. It also provides it with improved access to key markets and customers served by Lanier.

"Lanier Color Company's focus on superior quality and customer centricity directly aligns with our approach," said Suresh Swaminathan, President of Teknor Apex. "This acquisition comes on the heels of the acquisition of Dorum Color this past August and will help us further accelerate our strategic objectives while giving our customers access to a greater level of diversified products and solutions."

Lanier will continue to operate from its current location and will work in coordination with Teknor Color's current manufacturing locations in Kentucky and Texas.

› **www.teknorapex.com.**

Borouge 4 project signed off

ADNOC and Borealis have signed a strategic agreement to build the fourth Borouge facility at the polyolefin manufacturing complex in Ruwais, UAE.

The Borouge 4 facility will comprise an ethane cracker with 1.5m tonnes/yr of ethylene output; two additional Borstar PE plants each with 700,000 tonnes/yr capacity; a 100,000 tonnes/yr XLPE plant; and a hexene-1 unit producing co-monomers for certain grades of PE. The project represents a $6.2bn investment.

› **www.borealisgroup.com**

› **www.adnoc.ae**

Milliken adds viscosity modifiers for rPP

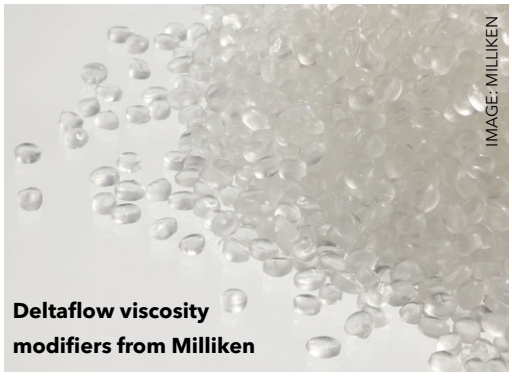

IMAGE: MILLIKEN

Deltaflow viscosity modifiers from Milliken

Milliken has launched the DeltaFlow line of viscosity modifiers for PP recycling. Supplied in easy-to-handle free-flowing pellet form, they can be used to increase the melt flow rate of recycled PP (rPP) in both extrusion and injection moulding processes.

"DeltaFlow-optimised resins allow for lower processing temperatures, which can enable converters to reduce cycle times, boost productivity and improve processability," Milliken said. They can also facilitate the replacement of virgin PP with rPP in many applications, the company said.

Deltaflow additives are currently produced in Germany in concentrations of 2%, 5% and 10% to meet varying applications and equipment requirements.

› **www.milliken.com**

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Simulation cuts CO_2 emissions

Swedish compounder Polykemi has completed a detailed Life Cycle Analysis (LCA) of its products and developed a new simulation tool – MaterialSmart – to allow customers to optimise selection to include climate impact as well as mechanical, physical, processing and economic factors.

The MaterialSmart simulation tool currently includes all products manufactured at Polykemi's plant at Ystad in Sweden and will be extended to cover its production site at Kunshan in China and its new locations at Chongqing, also in China, and Charlotte in the US.

"The simulation tool enables us to calculate the cradle-to-gate carbon footprint of all our materials. This enables our customers to assess the environmental footprint of the components they produce," said Henrik Palokangas, Sustainability Specialist at Polykemi. "We can demonstrate the difference material choices make and help select an optimal alternative in terms of customer requirements, costs and climate performance."

Above: MaterialSmart simulation allows climate impact to be optimised in material selection

Swedish injection moulder AD-plast has already made use of the system and claims to have achieved a CO_2 emission reduction of 2,000 tonnes annually (equivalent to the emissions from 1,200 cars).

"Polykemi helps us break down the material choice in greater detail, which is important for us. We are now able to show our customers the impact our product has on the climate," said AD-plast CEO Michael Jonsson. "I've seen similar tools at universities, but they are very complicated to work with. Polykemi's calculation tool simplifies this process and gives us as customer a clear answer, before we even make our choice of material."

› **www.materialsmart.info**

Cabot adds capacity in China

Cabot has signed a definitive agreement to acquire the Tokai Carbon (Tianjin) carbon black facility from Japan's Tokai Carbon for $9m.

Commissioned in 2006, the plant is located close to Cabot's current carbon black and speciality compounds facility and has 50,000 tonnes/yr of capacity. The deal should close in Q2 of fiscal 2022.

Cabot said it will invest to upgrade the plant to produce battery grades, as well as other carbon black products.

› **www.cabotcorp.com**

Norner opens polymer centre to extend its plastics research

Norwegian plastics research and testing firm Norner has completed its Polymer Exploration Centre at its new headquarters facility at Porsgrunn.

Covering 4,600 m^2, it describes it as a modern international research and technology centre for the plastics industry that will provide research services throughout the value chain.

The centre includes laboratories for advanced testing of chemical and mechanical performance, lab pilots for new process technology and catalyst evaluations, a variety of extreme polymer material performance testing and a high-tech plastic processing equipment, and a recycling, application and packaging centre.

› **www.norner.no**

Above: Norner CEO Kjetil Larsen in front of the Polymer Exploration Centre

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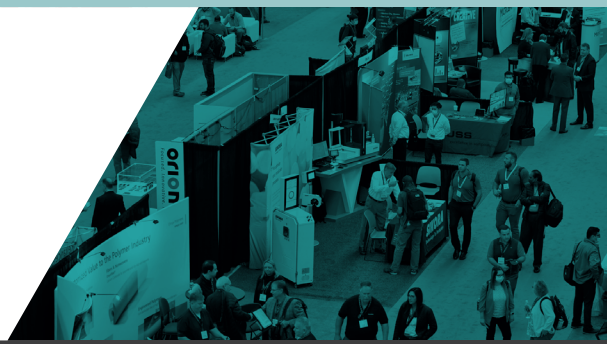

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Sirmax invests €10m to expand capacity

Italy-based technical compounder Sirmax Group is investing close to €10m to increase capacity across its sites in Europe and the US, with six new compounding lines planned to begin production between January and September 2022.

Three new compounding lines will be added at Kutno, Poland, with one each added to the company's headquarters site at Cittadella and its plant at San Vito al Tagliamento, Italy. The sixth line is destined for the Sirmax plant in Indiana in the US. Together, the new equipment will increase group capacity by 27,000 tonnes/yr (up 10% in Europe and 15% in the US).

The company said the investments will meet increasing demand for technical PP compounds (mainly for cars and household appliances), which over the first nine months of the year grew by 50% and 26% respectively.

"At a time when the polymer market continues to experience shortages, we are reaping the benefits of our correct strategic positioning," said Sirmax CEO and President Massimo Pavin. "Our regionalised and loyal supply chain means we do not depend on a single area of the world."

IMAGE: SIRMAX

Above: Sirmax CEO and President Massimo Pavin

Sirmax said it has seen a 22% increase in sales volumes over the first nine months of the year compared to the same period in 2020. This followed "an incredibly positive Q1 and Q2".

› **www.sirmax.com**

Owens Corning considers chopped glass disposal

IMAGE: OWENS CORNING

Owens Corning said it will "explore strategic alternatives" for its thermoplastic dry-use chopped strand (DUCS) business, which generates annual sales of $270m, including potentially divesting or repurposing the assets.

Used mainly in automotive and electronic applications, the company said the decision was consistent with its strategy of focusing on products and applications where it can build market-leading positions.

The plan was announced during the company's Q3 results, where it revealed a 16% year-on-year increase in net sales for Q3 2021, reaching $2.2bn.

› **www.owenscorning.com**

DuPont to divest ETPs; Lanxess restructuring

DuPont and Lanxess have both announced plans to separate their respective engineering plastics units from their core businesses. The two companies are both major producers of PA 6 and 66 resins – DuPont invented PA in 1935 –and other engineering polymers.

DuPont intends to divest a substantial part of its Mobility & Materials division, including its Engineering Polymers and Performance Resins lines of business as well as the company's stake in the DuPont Teijin Films joint venture. The product brands to be sold include Zytel PA, Delrin POM, Hytrel TPE, Crastin PBT, and Vamac ethylene acrylic elastomers.

The businesses being sold by DuPont represent $4.2bn in revenue and $1.0bn of operating EBITDA based on full year 2021

IMAGE: DUPONT

Above: DuPont CEO ED Breen wants to focus company on high growth markets

estimates. Ed Breen, DuPont Chairman and CEO, said: "We are sharpening our focus on high-growth, high-value opportunities in sectors with steady long-term secular growth trends."

Meanwhile, Lanxess plans to transfer its High Performance Materials (HPM) business unit to an independent legal corporate structure. HPM employs around 1,900 people at 14 sites worldwide. The main HPM brand products are Durethan PA materials, Pocan PBT and Tepex thermoplastic fibre composites.

Hubert Fink, member of the Board of Management at Lanxess, said: "The global market for new forms of mobility is developing very dynamically…In order to get the most out of the growth opportunities in this market and to be able to act flexibly, we will create a separate legal structure for the [HPM] business unit."

In September, DSM said it was looking to sell its Engineering Plastics business, which produces Akulon PA6/PA66, Stanyl PA46, EcoPaxx PA410, Arnite PET/PBT, Fortii PPA4T, and Xytron PPS.

› **www.dupont.com**
› **www.lanxess.com**

IN BRIEF...

ExxonMobil has made a final investment decision to proceed with a new petrochemical complex in the Dayawan Petrochemical Industrial Park at Huishou in China's Guangdong province in China. The project includes a flexible feed steam cracker with a nameplate capacity of about 1.6m tonnes/year, three performance PE lines, and two differentiated performance PP polymerisation lines.
www.exxonmobil.com

Evonik will launch a series of new plasticiser products based on isononanol (INA) next year. Branded Vestinol 9 and Elatur CH, they will be produced at the group's largest site at Marl in Germany, which will be updated to make the new grades. Key applications include flexible PVC products such as cables, flooring and roofing membranes.
www.evonik.com

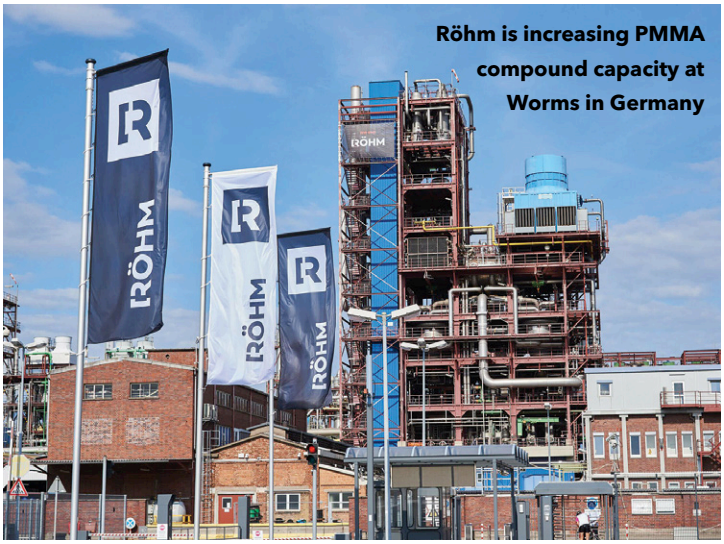
Röhm invests in Plexiglas compounds unit

Röhm has announced plans to invest a "double-digit million amount" to expand production of PMMA moulding compounds at its site at Worms in Germany by Q3 2023.

The investment will also include optimisation of the Worms production process and application of energy efficient processing systems. It follows the announcement in June of plans for a large-scale MMA plant on the US Gulf Coast.

Röhm supplies PMMA moulding compounds under the Plexiglas brand in Europe and the Acrylite name in the Americas. They find uses mainly in the automotive, construction, lighting and domestic appliances markets, offering durability, weather and UV resistance, colour fastness, transparency, and scratch-resistance.

› **www.roehm.com**



Röhm is increasing PMMA compound capacity at Worms in Germany

IMAGE: RÖHM

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Grupa Azoty grows its compounding capacity

Grupa Azoty Compounding is expanding capacity at its plant at Tarnow in Poland with the installation of a second line, which will lift capacity to around 40,000 tonnes/yr.

The new line will be built around an FED 72 MTS twin screw compounding extruder supplied by Feddem of Germany and will be installed early in 2022.

Feddem planned and supplied the original compounding line at the Tamow plant. Both the original and new lines use Feddem's high performance ICX technology.

"Increasing demand for our plastic compounds and the positive business development with our cooperation partner Akro-Plastic [a sister company to Feddem] quickly led to the utilisation of our current compounding capacity," said Dariusz Cholewa, Managing Director of Grupa Azoty Compounding. "We are therefore pleased to be able to cover the developing volume growth with a capacity expansion."

› **https://compounding.grupaazoty.com/**
› **www.feddem.com**

Celanese and Mitsubishi team up to recycle POM waste

Celanese and Mitsubishi Chemical Advanced Materials (MCAM) are to collaborate to develop mechanical recycling for post-industrial and post-consumer sources of POM. The partnership includes assessing options for converting waste streams into marketable, end-product formulations that Celanese will market.

The companies said the arrangement builds on Celanese's sustainable product offerings by initiating development of an up to 30% recycled content option for the Hostaform/Celcon range that will be marketed as POM Eco-R.

MCAM will take charge of feedstock collection, separation and processing, while Celanese will contribute formulation, product technology and production.

› **www.celanese.com**
› **www.mcam.com**

IN BRIEF...

German plant engineering specialist **Zeppelin Systems** has secured a majority shareholding in **Magdalena Kitzmann**, a supplier of solid and liquid materials handling systems with a strong presence in the PVC industry. The new acquisition will continue to operate as a standalone business from its Lengerich location and its existing management remains in place.
www.kitzmann-gruppe.de
www.zeppelin-systems.com

Netherlands-based **PlastChem** has installed two MB 66 Nextmover PVC granulation lines from **Bausano** at its plant at Hardenberg. The new equipment features Bausano's Smart Energy electromagnetic induction barrel heating technology, which is claimed to result in a 30-35% reduction in energy consumption.
www.plastchem.nl
www.bausano.com

Project "NXT-BATCH 2020" Completed

Located in Croatia's beautiful Istrian peninsula, Bifix is among Europe's leading black masterbatch producers. As part of its NXT-BATCH 2020 project — a recently completed structural project worth almost €6m that was co-financed by EU funds — it has commissioned major plant upgrades that further extend its product portfolio and increase its production capacity.

The NXT-BATCH 2020 project investments include two new state-of-the-art production lines (one dedicated to black masterbatch and one for white masterbatch products), as well as a new packaging facility and more efficient water and air treatment systems.

The new equipment investments significantly increase Bifix's production capacity, taking total capacity from 15,000 tonnes/yr to 30,000 tonnes/yr. It also extends its portfolio to include a number of new generation products, such as masterbatches based on PCR (post-consumer recycled) carriers, black masterbatches based on recycled carbon black, dessicant/degassing masterbatches and biopolymer-based masterbatches. Other benefits include a significant improvement in packaging and quality of the company's existing black masterbatch products.

The investments are also designed to position Bifix for the transition towards a resource-efficient society and circular economy by reducing electricity consumption within the masterbatch production process (the company has set itself the goal of reducing its carbon footprint by at least 55% by 2030). The newly installed equipment has also reduced the volume of production waste generated, taking it from a previous figure of around 1% of total annual production to just 0.5% of total annual production.

Commenting on the investments, Bifix CEO Ivan Štiglić said: "Bifix should and will continue to operate in direction of sustainable development based on resource-efficient and competitive economy."

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Trinseo set to exit styrenics

Trinseo is considering the disposal of its styrenics operations, including its Feedstocks and Polystyrene reporting segments and 50% stake in Americas Styrenics, and plans to launch a formal sale process in Q1 2022.

President and CEO Frank Bozich said the sale "would represent another key step in our transformation toward becoming a specialty materials and sustainable solutions provider". He said the company would prioritise investments in its higher growth, higher margin areas such as Engineered Materials.

The disposal plan was announced in the company's Q3 results, where it reported sales up by 87% on Q3 2020. This was attributed to high prices due to the pass-through of the rising cost of raw materials such as styrene and butadiene, as well as a contribution from acquired businesses within its Engineered Materials segment.

› **www.trinseo.com**

Compounding World Expo returns to US

The Compounding World Expo, Plastics Recycling World Expo and Plastics Extrusion World Expo made a successful return to the Huntington Center in Cleveland, Ohio, US, on November 3-4, 2021, and were joined by the new Polymer Testing World Expo.

Organised by AMI, publisher of *Compounding World*, the expos brought together more than 220 exhibitors and attracted more than 3,000 visitors, making it North America's largest plastics industry exhibition of 2021.

The event also provided the opportunity for the industry to get together after almost two years of lockdowns, travel bans and event cancellations. Many attendees were enjoying in-person meetings with customers and suppliers for the first time in 18 months.

"There is no substitute for face-to-face meetings within our industry," said Mike McCormack, Business Unit Manager at SACO AEI Polymers Distribution, adding: "Everyone I ran into was glad to be back". His view was echoed by Emily Burkhart, Process Engineer at 3A Composites, who said: "I gained so much from this well-organised show – learning, networking, catching up with industry friends, and getting inspired."

IMAGE: AMI

Above: US compounders got back to face-to-face meetings in Cleveland last month

The five conference theatres hosted more than 100 speakers and proved very popular, with attendees eager to catch up on the latest industry developments and market trends. The evening show party at the Punchbowl Social was also well attended and provided an extra opportunity for networking in a more relaxed environment.

"Exhibitors were delighted with the quantity and quality of the visitors to their booths," said Kelly DeFino, Expo Sales Manager at AMI. "More than 140 have already rebooked their booths for next year, and many visitors have expressed interest in becoming exhibitors."

The Compounding World Expo, Plastics Recycling World Expo, Plastics Extrusion World Expo and Polymer Testing World Expo return to Cleveland on November 9-10, 2022.

› **https://www.ami.international/exhibitions**

Merger creates an antimicrobials giant

Arxada, formerly known as Lonza Specialty Ingredients (LSI), is to merge with Troy in a move that will create a leading force in antimicrobial products and additives.

Troy is among the world's largest players in industrial preservation and biocidal technologies, including antimicrobials for plastics. Arxada described the move as "a logical next step in Arxada's strategy to strengthen its offering and enhance the capabilities of its Microbial Control Solutions business".

The merger gives Arxada production sites at Newark in the US, Horhausen in Germany, Moerdijk in the Netherlands, and Kabinburi in Thailand.

Private equity funds Bain Capital and Cinven, which bought LSI from Lonza in July, will be the majority owners, with Troy's owners also investing.

› **www.arxada.com**

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Innovative flame retardants extend fire safety options

Developing plastics applications in areas such as EVs and green energy installations are driving demand for more effective flame retardant technologies. Peter Mapleston explores the latest innovations

IMAGE: SHUTTERSTOCK

Selecting the best flame retardant for any plastics application is no easy task. Some excel at preventing ignition, others at minimising heat release in a fire or reducing smoke generation. Recyclability may be a key priority in some applications, while others may emphasise halogen-free formulations. Given the very broad range of flame retardant applications and the equally broad variety of flame retardant technologies, it should be no surprise that there is little consensus on the optimum solution. Where there is agreement, however, is that the ever expanding use of electrical equipment, electronics and other products with the potential to start fires requires development of flame retarded plastics that deliver levels of safety appropriate to the application. There are many routes to addressing that need and the options continue to grow.

It is fairly rare for a new class of flame retardants to come to the market but that is the claim being made by **Inovia Materials** for its ionic liquids. "In 2009, I filed for a patent in the USA featuring using ionic liquids as flame retardants, which turned out to be the first one in the world. In 2012, I founded Ionic Flame Retardant in Colorado. In 2016, the company was restructured. Now you see Inovia Materials," says Yanjie "Jeff" Xu, President of Inovia Materials. That US patent (US20110073331A1) has now been supplemented with patents in Europe, Japan, and Canada.

Xu defines an ionic liquid as a salt in which the ions are poorly coordinated, at least one ion has a delocalised charge, and one component is organic. He says examples containing elements such as phosphorus, nitrogen, and sulphur can be used as halogen-free flame retardants. Structures can be tailored to work with different plastic materials so that processability can be improved, optical properties are unaffected, and there is minimal effect on mechanical properties. The negligible volatility and ionic nature of the products also prevents the additives from leaching out and evaporating, he adds.

When used in combination with traditional flame retardants, ionic flame retardants improve compatibility between additives and plastics, further enhance flame retarding performance, and mitigate negative effects of additives on the properties of plastics.

"We have made a series of breakthroughs," claims Xu. "Our flame retardant can afford PMMA, both extrusion and casting products, high retardancy (V-0) and keep its transparency; our flame retardant for PC can afford thin PC products (0.06-1.5mm) high retardancy (again V-0) without affecting its transparency; our grade for TPU can enable V-0 at only 6-8% dosage, a significant reduction from 30% plus dosage level of traditional flame retardants; our retardants for polyamide provides not only robust retardancy, but also improves the mechanical, thermal, electrical properties compared to the virgin resin."

Another significant advantage, Xu says, is that

Main image: Producers of all types of flame retardant chemistries are working to produce more effective flame retardant systems to meet new application demands

IMAGE: SHUTTERSTOCK

Above: Fire continues to be a concern in portable electronic devices

the additives also function as flow enhancers so that compounds can be processed at lower temperatures than normal, or in a more efficient manner.

Xu says he is collaborating with a manufacturing partner in China to manufacture ionic liquids in Shangrao, Jiangxi province. "We have established the largest ionic liquids manufacturing capacity in the world, with a capacity of 6,000 tonnes/yr," he says.

Inovia is currently raising funds to establish a masterbatch factory and speed up global product registration. The company has already registered its products in the US and China and registration is underway in Europe, Korea, Japan, and Taiwan. The company has a supplier relationship with an undisclosed German chemical company, which Xu says will see Inovia's TPU and PA retardants in use once Europe REACH registration is completed. He expects that by the end of the year.

"An American company has already used tonnes of our PMMA retardant. They obtained a project contract from Disney, which is the first commercial contract using transparent retarding PMMA in the world. All the large polycarbonate companies are using our PC retardant now, in the film and thin product development," he says.

PN innovations

Also pioneering development of novel PN (phosphorus nitrogen) flame retardants is **FRX Polymers**. It produces three lines of phosphonate-based oligomer and copolymer HFFRs, branded Nofia, intended for thermoplastic polyesters (including polycarbonate). CEO Marc Lebel claims that in terms of performance, Nofia is one of the best flame retardants commercially available for use in PET.

Lebel highlights new applications for the company's Nofia products in recycling. He says FRX is involved in several big developments making durable products out of recycled plastics, citing flame retardant yarns and foams based on recycled PET as examples. "We have now got into injection moulding grades based on recycled PET and also recycled polycarbonate. One big stream is PET water bottles."

He says that many companies want to be seen to be moving to more sustainable materials and this is driving a move away from halogenated flame retardants. He claims that the polymeric nature of its products puts them among the most sustainable of halogen-free FRs. "It follows that Nofia is at the centre of many of these 'recycled-plastics-into-hard-goods' projects," Lebel says. "In addition, the Nofia product line has achieved benchmark 3 in the important Green Screen classification system, which is further proof of our sustainability credentials."

Recent projects that the company has been involved in include electronic device covers. FRX has been working with major brands producing well-known products in glass reinforced polycarbonate, glass reinforced PET, and also non filled PET.

Lebel also highlights how the rise of EVs is driving demand for flame retardant plastics. "The battery is always upper operating whether it is charging or discharging, and since it sits directly under the passenger compartment, the requirement for flame resistance is important," he says. This flame retardant performance is becoming more critical with the trend towards EV systems running on higher voltages. He says one FRX customer producing parts for EVs has introduced a product with a CTI of 1,000V.

Another development FRX is working on is flame retardants in PC/PBT and PC/PET blends. PBT or PET is used to improve chemical resistance but some of its effect is lost when compounds incorporate traditional flame retardants. FRX says it has a couple of commercial programmes using Nofia to maintain or even slightly improve chemical resistance in such blends. The company says Nofia not only enhances chemical resistance but can also improve flow and heat distortion temperature (HDT) while delivering a UL94 V-0 rating down to 0.8mm. Compounds containing Nofia can have an HDT as much as 30°C higher than compounds containing other HFFRs, FRX claims.

"We believe this is a trend that will continue," says Lebel. "It is more important in the age of COVID, with the increasing use of aggressive chemicals to clean medical devices which may have covers in PC/PBT blends."

Among compounders that have recently turned to FRX for use in blends and alloys, Lebel cites **Polymer Compounders** in the UK, which is now producing PC-based alloys containing Nofia; while in the US, speciality compounder **Polyvisions**

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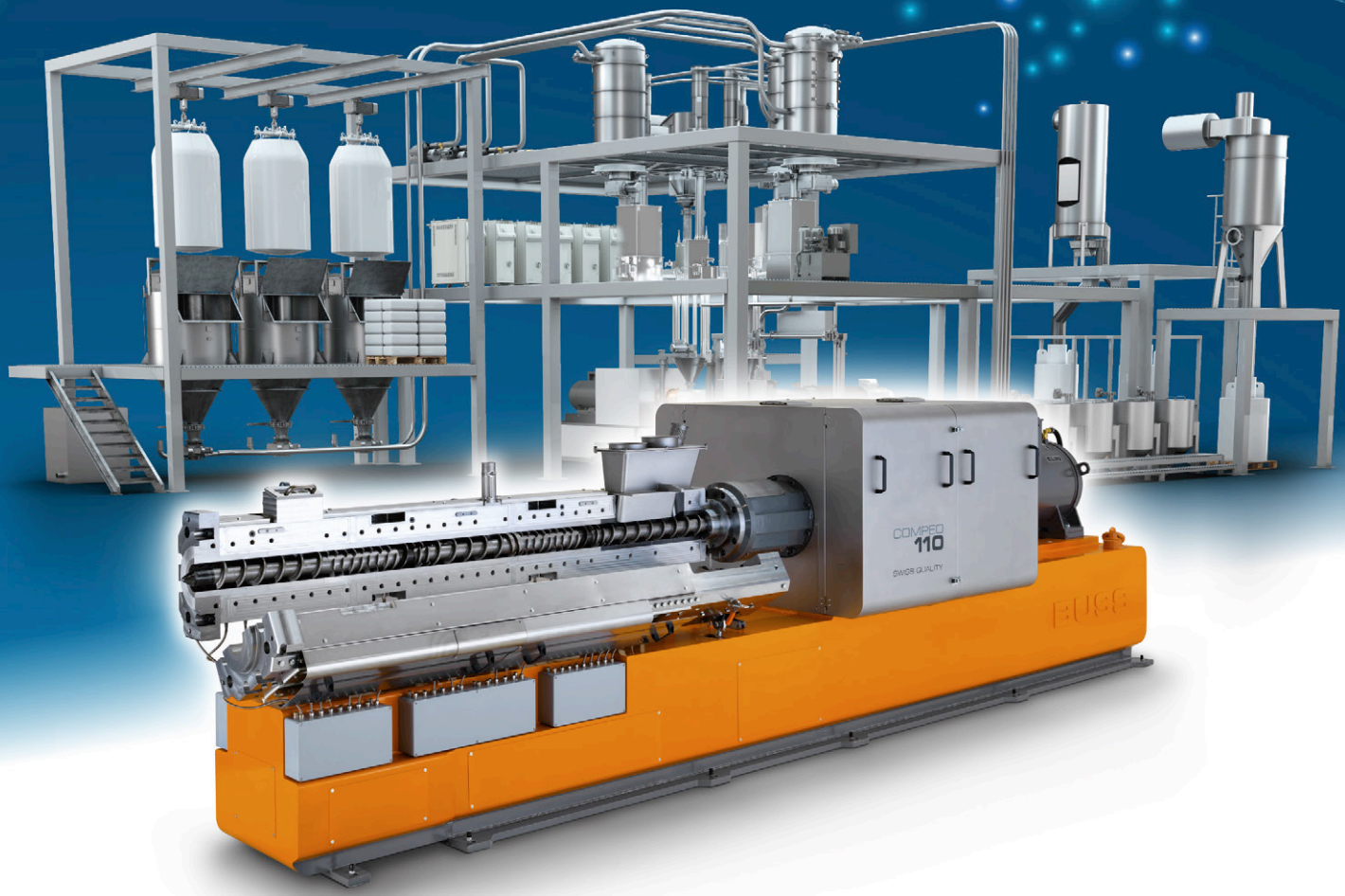

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IMAGE: SHUTTERSTOCK

Above: Electric vehicle batteries are driving demand for flame retardant plastics

recently commercialised graft-modified PET compounds incorporating Nofia additives.

Supply challenges

On the commercial side, Lebel says that producers of phosphorus-based and PN flame retardant additives have suffered from the Chinese government's decision earlier this year to curtail power to several provinces. He says this has caused ripples through numerous supply chains, one of them being the energy-intensive production of white or yellow phosphorus (P_4), Lebel estimates around one third of capacity was taken out, leading to prices more than tripling at one point in late summer/early autumn. Over 90% of halogen-free flame retardants (HFFRs) are based on P_4, according to Lebel, who says FRX sources supplies from outside as well as inside China so has not been shorted.

Phoslite flame retardant technology developed by **Italmatch Chemicals** using thermally stable inorganic phosphorus salts (hypophosphites) has been commercial for several years. Grades can be used alone or in combination with other FRs. The supplier says the versatility of its technology is due to the multiple mechanisms employed; it works in the gas phase and also has a charring effect and prevents dripping.

Grades are based on calcium hypophosphite and aluminium hypophosphite. The first is a relatively water-soluble salt with high phosphorus content (37%) and exceptional thermal stability; the second a low water-soluble molecule with very high phosphorus content (42%) and high thermal stability.

Among the company's most recent developments are Phoslite B85AX and Phoslite B64AM, which form the basis for thermoplastic polyurethane (TPU) formulations for cable compounds. They can be combined with Italmatch's Melagard MC melamine-based flame retardant to create products with a V-0 rating at 1.6 mm with a total additive loading of 30% (of which 25% is Phoslite B85AX).

Two new developments and entries into the thermoplastics marketplace are highlighted by **Huber** – the Kemgard 600 smoke suppressant series and Safire 400 nitrogen-phosphorus fire retardant technology.

The Kemgard 600 series is partially based on molybdate chemistry and comprises three grades: Kemgard 606, Kemgard 620 and Kemgard 631. Primarily intended for rigid and flexible PVC applications, they catalyse crosslinking in the polymer matrix, leading to improved organic char

Improving flame retardant dispersion

Evonik organo-modified siloxane (OMS) chemistry (branded Tegomer and Tegopren) provides intrinsic properties that can be advantageous for flame retardants, enabling homogenous dispersion of the flame retardants in the polymer matrix without compromising the mechanical properties.

The additives – which are resistant to high temperatures and do not generate degradation bi-products during fire – can be added during production of the flame retardant or as part of the compounding process to improve charring, delay the time of ignition, reduce heat release rate and smoke generation, and increase LOI (by up to 5 points). Tegomer V-Si 4042 is an example for such additives.

Evoniks's Tegopren 6875 and Tegopren 6879 additives create hydrophobic flame retardant surfaces. The surface treatment is not only suitable for oxides but interacts with nitrogen and phosphorus based flame retardants.

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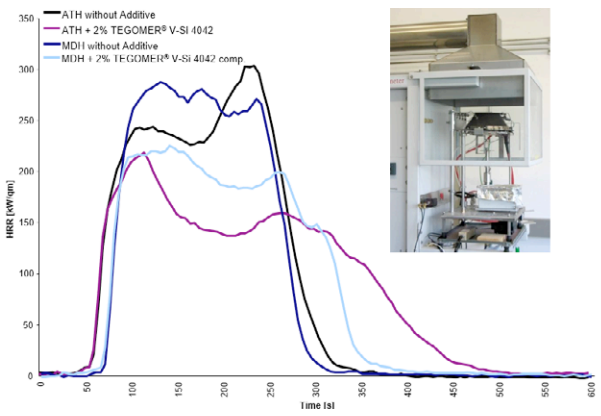

Heat release of EVA compounds containing 65% ATH and MDH with and without Evonik's Tegomer V-Si 4042 organo-modifed siloxane additive

Source: NGR

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formation and lowering heat and smoke release. Huber says the 600 series grades can partially or fully replace antimony trioxide (ATO) and zinc borate. It says they offer a good balance of price and performance for cost sensitive applications.

The Safire 400 nitrogen-phosphorus fire retardant is claimed to provide superior fire retardancy, smoke suppression and char formation compared to other commonly available phosphate products. Its technology also offers synergistic opportunities with Huber's existing alumina trihydrate (ATH), magnesium hydroxide (MDH) and Kemgard molybdate products. It is suitable for use with polyolefins, polyamides, and thermoplastic polyesters, as well as epoxies and polyurethanes.

Intumescent progress

Combining reinforcing agents such as glass fibres (GF) with flame retardants in polyolefin compounds can be a challenge when the preferred flame retardant is a halogen-free intumescent type, according to **Adeka**. Thermal stability can be a particular challenge as reinforced compounds require higher processing temperatures than unreinforced compounds. At these elevated processing temperatures the low thermal stability of conventional intumescent flame retardants can lead to premature initiation of the char formation reaction.

Adeka claims its intumescent flame retardants have a higher thermal stability than conventional intumescent type products, so this issue can be avoided. It says that the opportunity to combine reinforcing agents and halogen-free intumescent flame retardants in PP compounds could open up more metal-substitution applications.

In terms of fire safety, Adeka points out that glass fibres can enhance the performance of intumescent FR systems by acting as an anti-dripping agent. It says a 30% reinforced PP with 23% of ADK Stab FP-2500S can achieve UL94 V-0 at 1.6mm thickness; without reinforcement around 30% of flame retardant is typically needed to achieve the same rating. "Moreover, raising the dosage of ADK Stab FP-2500S to 28% allows V-0 at 0.8mm thickness to be achieved as well as 5VA rating at 1.6mm," the company says.

Long-term thermal stability can also be enhanced for automotive applications, Adeka says. Oven ageing tests at 150°C to assess crack formation in reinforced PPs containing various types of

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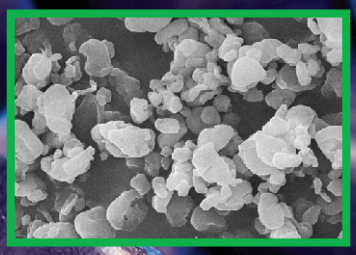

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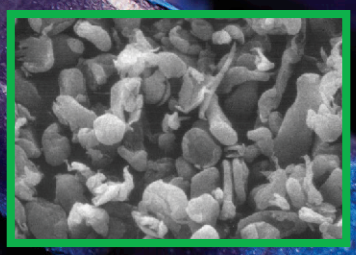

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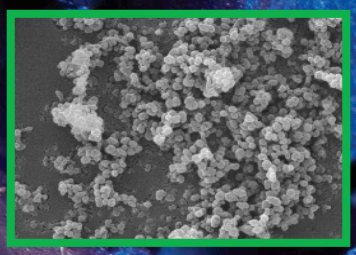

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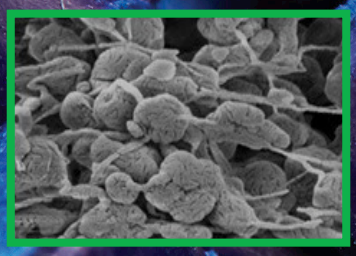

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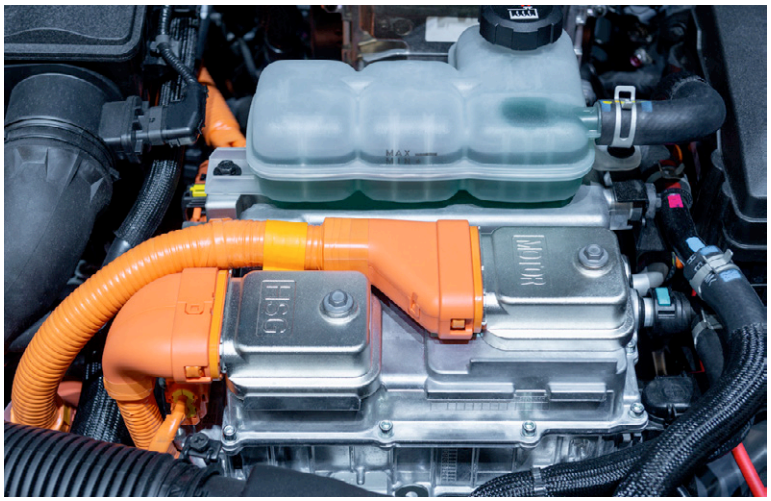
IMAGE: SHUTTERSTOCK



Above: Flame retardant systems for EV cables and connectors must allow good colourability

flame retardant have shown that satisfactory long term heat stability can be obtained with ADK Stab FP-2500S in PP stabilised with the common combination of antioxidants (ADK Stab AO-60 and ADK Stab 2112). The company says the results (Figure 1) also show that with this AO combination, long term thermal stability performance of ADK Stab FP-2500S is superior to APP and brominated flame retardants (with antimony trioxide).

"These studies proved that long term thermal stability of flame retarded GF PP compounds with ADK Stab FP-2500S could be greatly enhanced by changing the primary hindered phenolic anti-oxidant to ADK Stab AO-20," the company says.

As EVs become more popular, Adeka says tracking resistance (typically defined by CTI) may be considered just as important as flame retardancy in plastics compounds. It says it is possible to achieve a CTI of 600V in glass fibre reinforced PP compounds containing ADK Stab FP-2500S. This compares with 525V for a compound containing APP, while a compound containing a brominated FR also showed a CTI of 600V.

Reinventing automotive

The expectation that the rapid switch to EVs will see considerable growth in the use of flame retardants is also shared at **Clariant**. "Until recently, the automotive industry was not much of a market for our high-performing flame retardants. However, that is about to change dramatically," says Elmar Schmitt, Segment Manager for the company's flame retardant business. "In reinventing their product, car-makers will need new materials with safety built in to deal with a whole new set of challenges and requirements."

He says the company's Exolit organic phosphorus flame retardants have been used for near two decades in some of the most demanding industries, ranging from smart consumer electronics to home appliances."Exolit is non-halogenated, which makes it safer and more environmentally compatible than most solutions out there. But it is the improved material performance that makes it especially appealing to the EV industry," Schmitt says. He says that Exolit does not affect, and in some cases even improves the electrical properties (CTI) of plastics. It is also hydrolytically stable, does not compromise mechanical properties, can be laser welded, and is easily coloured.

US-based **Polymer Additives Group** (PAG) says it is bolstering its HFFR (halogen-free flame retardant) line through new product developments and a strategic partnership. The company has extended its Charmax NH family with a new line of intumescents for polyolefins and TPEs. It says they offer improved performance, higher thermal stability and lower water solubility than competing systems. PAG is now also the exclusive US distributor for precipitated magnesium hydroxide products made by Russian company Nikomag.

The new grades are significant for PAG as the company has traditionally been a producer for the PVC industry. "These new lines and products are getting us into the ever-growing polyolefin market," says Josh Elliott, Sales Manager and VP of New Business Development.

Germany's **Budenheim** highlights the use of its halogen-free additives in bio-composites such as wood-reinforced plastics (WPCs). Budit 620, which is based on coated ammonium polyphosphate, is said to provide effective fire protection in WPCs for indoor applications and especially in public buildings. It also offers very good stability and water resistance, which prevents the composite from swelling in outdoor applications. Composites formulated with Budit 620 can meet fire ratings

Figure 1: Crack observation at 150˚C oven aging of PP compounds containing different flame retardants, including Adeka's FP-2500S system, in combination with its ADK Stab AO-60, AO-20 and 2112 antioxidants

	No flame retardant	Adeka FP-2500S	APP (ammonium polyphostate)	Brominated flame retardant	Adeka FP-2500S
	AO-60 / 2112				AO-20 / 2112
Crack generation time/ h	900	1400	800	600	3600

Source: Adeka

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Mineral opportunities

Boron-based multifunctional fire retardants can function as flame retardants, smoke suppressants, afterglow suppressants and anti-tracking/anti-arcing agents. Borates function as flame retardants predominately in the condensed phase, with their performance able to be enhanced with the use of various co-additives. Used alone they can function as flame retardants in char-forming polymers such as polyethersulphone and polyimide.

According to Kelvin Shen, a consultant for **US Borax**, hexagonal boron nitride (h-BN) will play an increasingly important role in thermal management and flame retardancy in electrical and electronic applications. Commonly referred to as "white graphite" due to a plate-like hexagonal structure similar to graphite, it has been found to be a good flame retardant for many polymer systems.

H-BN is an electrically insulating and highly heat conductive additive having high anisotropic thermal conductivity properties that are desired for many applications. It is stable in inert or reducing atmospheres to about 2,700°C and in oxidising atmospheres to 850°C.

Graphite itself has potential for use as a flame retardant – expandable graphite forms a voluminous, thermally stable barrier residue in a fire. German company **Luh** is continuing research with the Institute of Polymer Technology of University Erlangen-Nuremberg aimed at providing the best possible flame-retardant effect at the lowest possible input quantity using its GHL PX 95 HT 270 product. The work is aimed at use in polyamides in particular and the company says low heat release with very low smoke production at filling rates as low as 15wt% is possible. A synergistic flame retardant system based on expandable graphite, aluminium phosphinate and melamine polyphosphate has also been developed.

With the current instability in polymer prices and availability, **Europiren** says it has devoted resources to supporting its wire and cable clients in overcoming problems by optimising formulations and developing alternatives based on available raw materials. "Although EVA is an important component in HFFR cable formulations, it appeared possible to minimise its amount or even exclude it

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A PE compound containing Byk Max CT 4260 clay (left) demonstrates highly effective char layer formation compared to a control without

Image: Byk

from HFFR cable compounds," the company says. It has also been working on improvements in compound flow characteristics and extrudate surface quality. The result is a new cable grade – EcoPiren Plus – available for lab and small industrial scale testing.

The benefits of clay as a char-forming material have long been recognised, but clay can be difficult to disperse and incorporate into polyolefins. However, **Byk** says its clay products have been engineered specifically for use in polyolefins to maximise ease of dispersion and flame retardant efficacy. The company supplies organophilic phyllosilicate clays to provide flame retardancy in polyolefins used in applications as wire and cable, decking, construction panels, and pallets. Typical application for HFFR applications is 5%.

Byk-Max CT 4260 prevents dripping in PE by forming a char layer, making it possible for compounds to achieve a UL94 V-0 rating, according to the company. It cites a study carried out to demonstrate char formation using CT 4260 in a typical ATH polyolefin formulation. This compared a control formulation with 65% ATH and a formulation with 58% ATH and 5% Byk Max CT 4260. The compounds were prepared in a twin-screw extruder then processed to a sheet and 3mm test pieces prepared and burned in an oven. The compound containing Byk Max CT 4260 demonstrated formation of a much more highly effective char layer than the control.

The addition level of ATH needs to be approximately 65% to provide required flame retardance, which negatively affects processability and mechanical properties. Byk says the addition of Cloisite 20 A to the formulation can improve dispersion, resulting in better compounding and mechanical properties. In an internal study, it compared a typical 65% ATH formulation with one containing 55% ATH and 5% clay. Addition of 5% Cloisite 20 A resulted in a 250% increase in elongation without any adverse effects on tensile strength and lowered the viscosity of the compound.

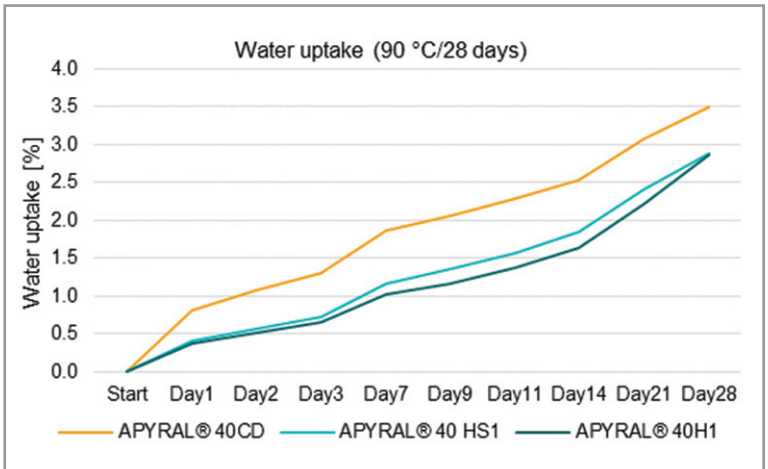

Figure 2: Water uptake of an LLDPE/EVA compound containing 60 wt% of three different surface modified Apyral fire retardant grades after four weeks at 90°C

Source: Nabaltec

Coating innovation

It is well-known that long term water aging of flame retardant compounds containing mineral fillers such as aluminium hydroxide (ATH) impacts on electrical performance, according to German flame retardants producer **Nabaltec**. "HFFR compounds so far show inferior wet electrical properties compared to compounds based on halogenated flame retardants," the company says.

It has developed a range of surface treated mineral flame retardants designed to improve compound performance after long term wet aging. The Apyral 40HS1 and newly developed Apyral 40H1 grades are said to show very promising results. Nabatec's tests show the special surface treatments significantly reduce water uptake in an LLDPE/EVA compound compared to the same formulation using its untreated Apyral 40CD grade (Figure 2). Furthermore, the surface modified Apyral grades allow volume resistivity of the filled compounds to remain at a constant level even after water aging at 90 °C for four weeks. The company says both grades offer the same good flame

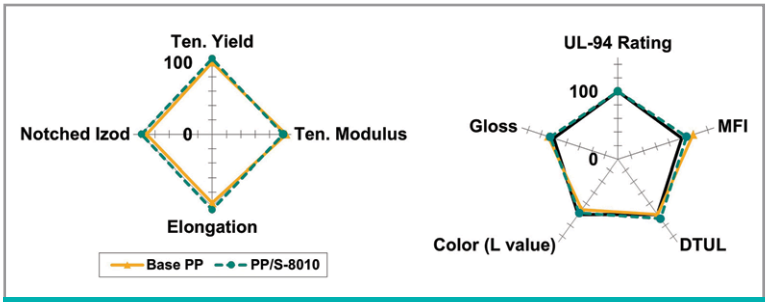

Figure 3: PP moulding compound containing Saytex 8010 retain its mechanical and physical properties after recycling loops
Source: Albemarle

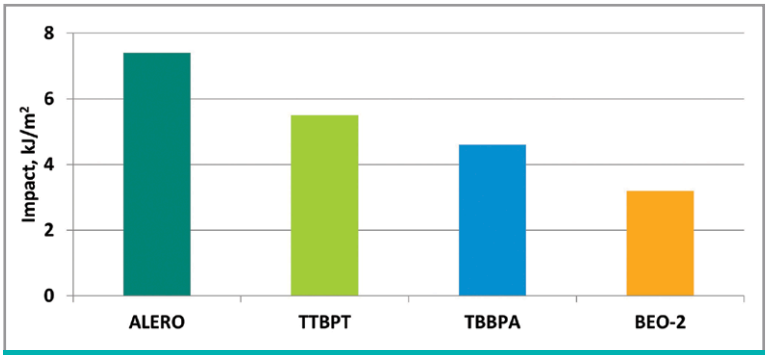

Figure 4: Comparison of notched Izod impact properties of various flame-retarded ABS compounds containing Albermarle's Satex Alero flame retardant), TTBPT (tris-tribromophenoxytriazine), TBBPA (tetrabromobisphenol-A), and a brominated epoxy oligomer (BEO-2)
Source: Albemarle

retardancy and smoke reduction behaviour expected of ATH.

Austria's **Kärntner Montanindustrie** (KMI) has a strong focus on micronised minerals with special particle shapes, more specifically with acicular, platy, or porous structures. It says that efforts to eliminate halogen in flame retardant formulations has revived interest in functional minerals in this application area, adding that high aspect ratio minerals such as mica and wollastonite can improve mechanical properties and dropping behaviour and support char formation.

Flame retardant formulations often benefit from the addition of effective synergists. Sweden-based **Paxymer** offers a growing selection of patented synergists for use with phosphorus and nitrogen-based HFFR flame retardants, expanding its offering from polyolefins into a wider range of plastics over the past year. These include PA, ABS, PC/ABS and PC. Managing Director Amit Paul says the company is working with customers to improve the performance of formulations both from fire and mechanical point of view, as well as reducing cost.

Paxymer's technology involves the use of acrylate functional polymers to propogate cross linking in the backbone. It works to improve char both density and flexibility, improving barrier properties as well as eliminating or significantly delaying dripping in thermoplastics. Addition levels in the range of 0.5-4wt% of the additive batch can reduce the total amount of flame retardant additive significantly, it claims. For a standard PP copolymer, it says up to 7wt% can be added while retaining the UL94 V-0 rating in a given formulation.

According to Paxymer CTO and inventor Dr Swaraj Paul, the company has been placing considerable focus on deepening its analytical framework for formulation guidance on zero halogen formulations. "We combine analysis of thermal properties in the condense phase as well as gas phase composition with analysis of the char in a novel way to compare between materials. This gives us a very powerful qualitative tool for comparing between formulations," he says.

Brominated developments

Interest in halogen-free flame retardants is certainly growing but brominated flame retardants still play a major role in the plastics industry and suppliers of brominated products are standing their ground, both working on solutions to mitigate environmental concerns while challenging the thinking behind some of them. **Albemarle**, for example, says it is committed to providing trusted brominated flame retardants (BFRs). "As we focus on providing exceptional fire safety solutions, sustainability is the cornerstone for our strategy," says Matt Von Holle, Vice President of Fire Safety Solutions at the company.

"Albemarle's extensive research shows that its BFRs are safe to use as additive and reactive components in plastics. Further, our Saytex branded products, including 8010, BT-93, HP-3010 and HP-7010, can be recycled and contribute to the circular economy," he says.

Von Holle cites recent work with Saytex 8010 in polypropylene (presented at *Compounding World* publisher AMI's Fire Resistance in Plastics conference in Dusseldorf, Germany, at the beginning of December), which showed little change in physical and mechanical properties while retaining flame retardancy (UL 94 V-0) after six moulding cycles (Figure 3). "These are large, thermally stable products that give stellar performance without sacrificing HS&E principles," he says.

Saytex Alero is claimed to offer excellent recycling performance in HIPS and is highly compatible in other styrenics such as ABS. Compared to other melt-blendable FRs, Albemarle says it shows improved mechanical properties, including Izod impact (Figure 4). The grade has only a marginal effect on flow properties of ABS. ›

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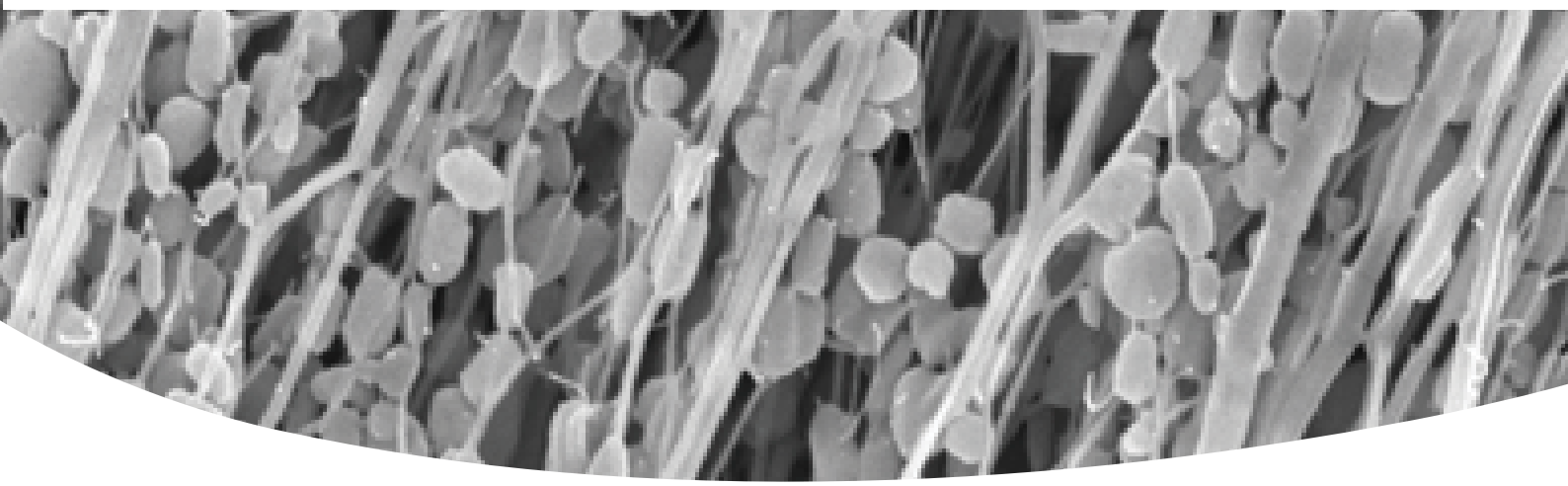

Introduction

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Key features of I-SAN

- PFOA Free
- Uniform granules
- Free flowing powder
- Excellent dispersibility in polymer resins and compounds
- Excellent anti-drip properties
- High Fibrillation

Grade	Units	I-SAN50	I-SAN60
PROPERTIES			
PTFE	wt.%	50	60
BD	g/l	450	450
D50	µm	500	500
MP	ºC	342	342
Flowability	g/10 min.	250	250
COMPLIANCE			
177.1550	Food Contact Surfaces	✓	✓
EC10/2011	Food Contact	✓	✓

Application

I-SAN can be used in many polymer compounds, such as PC, PC/ABS, PPO, PBT, PA, ABS, HIPS & PP, with typical dosing between 0.1% and 0.5% depending on FR requirement. These compounds can be used to produce molded or extruded articles or as a component of other industrial products. I-SAN enhances the ability of the polymer compound to comply with UL-94 V0.

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Figure 5: Mechanical properties of three UL94 V-0 at 0.8mm PBT compounds containing different flame retardant systems

	PBT 30%GF + FR-803P	PBT 30%GF + FR-1025	PBT 30%GF + DEPAL
Izod notched impact, J/m	63.1	73.9	50.4
Tensile strength, MPa	105.1	109.2	61.4
Elongation at break, %	2.0	2.5	1.3
Modulus, MPa	10,735	11,800	11,00

Source: ICL

Albemarle is currently exploring its performance in other polymers, including polyolefins. "We believe BFRs will have an increasing role to play particularly in high-growth areas such as EVs and 5G telecommunications," says Von Holle.

ICL says it has invested significant resources to confirm its flame retardant portfolio meets the challenges posed by new applications in EVs, most importantly in the power train, motor, power inverter and charging system, where extensive use is made of polyamides and thermoplastic polyesters. Its extensive application testing confirmed ICL brominated polymers exhibit outstanding results for critical parameters, says Technical Marketing Support Manager Marc Leifer.

"ICL's brominated polystyrene polymer (FR-803P), brominated polyacrylate polymer (FR-1025) and high molecular weight brominated epoxy (F-2400, F-3100) performances surpasses those of non-halogen flame retardants," he says. "This is especially true when it comes to high temperature polyamides, such as PA10T and PA6/66T."

Leifer says that polyamide FR compounds using brominated polymers can cost up to 50% less than halogen-free compounds (containing diethylphosphinate, DEPAL) with the same V-0 rating. They can also provide higher Glow Wire Ignition Temperatures.

In high-temperature stability tests on 30% glass fibre reinforced PBT rated V-0 at 0.8mm, he says its FR-1025 achieved an HDT (Heat Deflection Temperature) result greater than 206°C, while an HFFR option was less than 205°C. At the same time, melt flow tests indicated thermal decomposition and depolymerisation in the compound containing the HFFR, Leifer says.

Tests on various mechanical properties of the PBT compounds at ambient temperature also produced superior results for both FR-1025 and FR-803P, compared with the compound containing DEPAL (Figure 5). Hydrolytic stability was also said to be better.

According to Tom Griffiths, REACH Manager at the **International Antimony Association** (i2a), it is important to consider the full safety and environmental picture when reviewing any flame retardant component. Antimony trioxide (ATO) is a useful synergist in flame retardants in EVs, particularly halogenated types, he says, as it can help reduce weight. "REACH has the potential to have a significant impact on the use of all types of FR in the EU. However, when reviewing any potential restrictions of antimony-containing FRs it is important that the focus is not just on the chemical/hazard aspect but also on the impact on climate or circularity any restriction may have."

Recycling BFRs

Among the criticisms of brominated flame retardants are recyclability and the potential for legacy BFRs to leak into the environment. When it comes to polystyrene foams containing BFRs used for building insulation, this issue is being tackled head-on by the **PolyStyreneLoop** (PSL) cooperative. It was founded four years ago with the aim of developing a sustainable solution for treating PS foam waste arising from building demolitions containing HBCD (hexabromocyclododecane), which is classified as a persistent organic pollutant (POP).

ICL, which produces various flame retardants including BFRs, was one of the initiators of the project. It now involves more than 70 organisations across Europe. One of PSL's directors is Lein Tange, who is also Director of Sustainability at ICL-IP Europe.

The PSL cooperative has built a demonstration plant that removes HBCD from used foam at Terneuzen in the Netherlands. It incorporates a solvent-based polystyrene purification and dissolution process called CreaSolv and it started up in September.

The CreaSolv process was codeveloped by German company **CreaCycle** and Fraunhofer Institute IVV. Tange says the plant will demonstrate the economic and technical feasibility of recycling PS-foam demolition waste containing HBCD. The process purifies PS to a level allowing it to be used to make new X-EPS and XPS foam. Separated HBCD is treated in a Bromine Recovery Unit (BRU)

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PROFESSIONAL
MANUFACTURER OF
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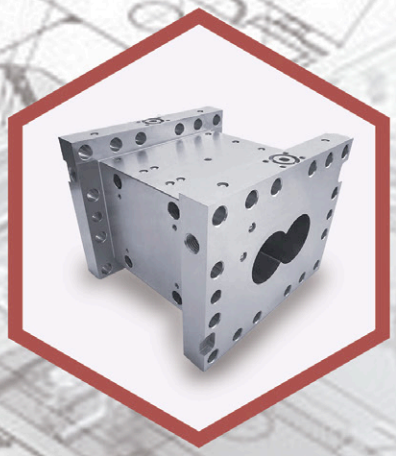

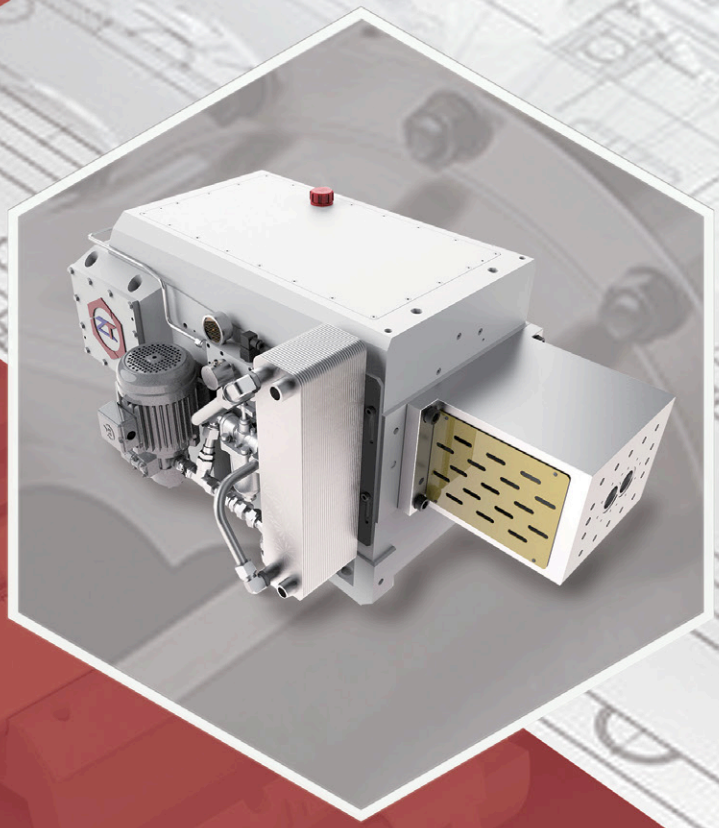

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Green energy shift raises fire concern

The move from fossil fuels is giving rise to a new set of challenges for suppliers of associated equipment, whether it be batteries for EVs or solar panels for houses. The Cefic sector group for flame retardants, **PINFA** (Phosphorus, Inorganic & Nitrogen Flame Retardants Association), says new energy systems are bringing new fire safety challenges.

Photovoltaics are not particularly fire-prone, but they are a potential fire cause – inverters in particular. "High performance FR solutions are needed to ensure fire resistance of panel backings, cables and electronic systems, with resistance to UV and weathering," PINFA says. "The EU's report on Ecolabel and Green Public Purchasing criteria for PV [May 2021] considers both fire safety and halogen content, showing that tomorrow's FR solutions will need to ensure both fire and material performance and green credentials."

› **www.pinfa.eu**

IMAGE: PINFA

Left: The EU's report on Ecolabel and Green Public Purchasing of photovoltaics considers the fire risk of PV systems

based at ICL Terneuzen (NL), which is said to allow recovery of the elemental bromine and the safe destruction of the HBCD. The recovered bromine is used to produce a new polymeric flame retardant (FR-122P), which can be re-used in the same application.

The plant in Terneuzen will not be able to treat all the PS-foam demolition waste containing HBCD produced in Europe. PSL says many more plants will need to be built in the years to come and says it is currently in discussions with investors for a second.

In a related move, **Agilyx Corp**, which has developed a chemical recycling technology for post-use plastics, said in July it had reached a significant milestone in collaboration with an undisclosed strategic technology partner that will allow for the recycling of brominated flame retardant-laden polystyrene into a high purity styrene monomer for direct use in downstream products including PS, EPS, ABS, SBR, SAN and unsaturated polyester resins.

"The integrated technologies of Agilyx depolymerisation open the pathway for previously unrecycled materials, such as construction foam and insulation, to be put back into use as new materials at a quality level equivalent to those manufactured from any other styrene monomer," says Agilyx CEO Tim Stedman. "The ability to recycle flame retardant-laden polystyrene not only allows this contaminated material to be part of a sustainable recycling value chain, but it will open up new markets that were previously closed due to the contamination associated with these materials."

Below: The PolyStyrene-Loop demonstration plant for recycling PS building insulating foam and removing HBCD flame retardant

IMAGE: POLYSTYRENELOOP

Regulatory challenges

With all these technical developments going on, industry representative bodies continue to push back against legislation in Europe intended to restrict the use of brominated flame retardants. In July, **BSEF**, the Brussels-based trade association representing the international bromine industry, issued a statement in which it said it "categorically rejects the facile suggestion of the European Environmental Bureau (EEB) that all brominated flame retardants be listed as Substances of Very High Concern (SVHC). The suggestion has no regulatory basis and lacks any credible science to support it."

BSEF says bromine stands out from other elements used in flame retardants such as phosphorus, nitrogen, magnesium and aluminium, "as it's the most efficient in gas phase fire quenching reactions."

In its statement, it said: "Recently the EEB issued an updated set of 'tests' for improving EU chemical management processes with the objective of supporting substitution, protecting human health and the environment. Test 8 called on ECHA (the European Chemicals Agency) to 'accelerate the

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substitution of SVHCs by asking the Commission to propose the inclusion of brominated flame retardants as a group for candidate listing.'"

The association said that the call for ECHA to request the Commission to propose the inclusion of BFRs as a group for candidate listing lacks merit. "EEB suggests that all BFRs meet the criteria in Article 57 of REACH. This is not the case. Only a very few BFRs are restricted under REACH. Newer BFRs have very different properties from these substances and were designed to be safer and more sustainable solutions. This is well known to the Commission and ECHA. The EEB call, therefore, for a group listing of BFRs for inclusion in the REACH SVHC list isn't justified nor is it advancing EU sustainability and safer product goals."

BSEF also referred to the findings of the US National Academy of Sciences, Engineering and Medicine, and reported by the American Chemistry Council's North American Flame Retardant Alliance, that organohalogen flame retardants (OFRs) cannot be assessed as a single class. It said this confirms it is not scientifically accurate or appropriate to make broad conclusions or impose a one-size-fits-all regulatory approach for OFRs.

"Similarly, in Europe, Cefic (The European Chemical Council) states that 'grouping', when appropriate, should consider risk and hazard profiles in addition to structural similarity and the Identification of substances in a group should be based on a unique substance ID to facilitate digitalisation."

BSEF says it is fully aligned with the ACC and CEFIC positions on grouping. "There are significant differences within this family: larger molecules such as oligomeric or polymeric FRs, chemically reactive FRs which do not exist as a molecule and many other FRs which possess no toxicological or ecotoxicological classifications under CLH. The suggestion that such a diverse group of substances should be all considered SVHCs (in the context of REACH) and then listed in its entirety for regulatory restriction simply due to the presence of bromine in the molecule is devoid of any scientific merit."

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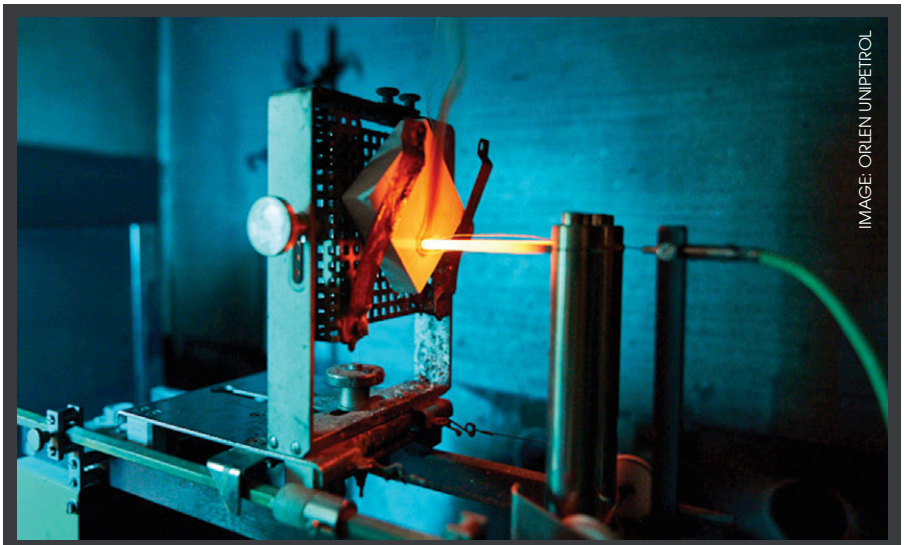
Orlen Unipetrol develops Makroflam® family of custom flame retardant masterbatches and compounds

Orlen Unipetrol offers custom-developed halogen-free flame retardant masterbatches and compounds for demanding plastics applications



Flame retardance testing of a Makroflam® sample at the Orlen Unipetrol laboratory

Flame retardants provide enhanced safety in a growing number of technical plastics applications that require exposure to long-term elevated temperature or open flame. International flame retardance specifications are frequently supplemented by policies and criteria developed by manufacturing companies and/or national authorities. The result is that flammability criteria may vary according to the individual state or the final application — automotive parts, pipes, cables, building profiles and sheets, films or fibres and nonwovens.

The most commonly-used flame retardants remain halogenated types based on chlorinated and brominated organic derivatives. However, toxicological risks and increasing environmental concerns mean many manufacturers are looking to halogen-free alternatives, including organic substances based on nitrogen and phosphorus, metal hydrates, graphite, alkoxylated amines, inorganic hydroxides, acrylate copolyesters or organically modified fillers and nanoclays. Each offer specific flame-extinguishing effects and physical properties.

Halogen-free FRs

Orlen Unipetrol's non-flammable and flame retarded plastics are developed entirely on halogen-free concepts. Due to the very different requirements of individual customers, it develops custom rather than standardised flame retarded plastics and masterbatches. These are part of the company's Makroflam® brand, which uses a range of 30 flame retardants. All function by creating intumescent porous layers, free gaseous radicals, or an endothermic reaction with water releasing effect.

Each flame retardant gives the final product different mechanical and thermal properties as well as processing behavior and natural weathering. During development of a new formulation, information about the expected flammability classification, flow properties during processing, type of processing technology, processing temperature, expected mechanical properties, visual appearance (colour, opacity or translucency), is considered in detail.

Orlen Unipetrol's laboratory is equipped to carry out accredited flammability testing according to the major international standards applicable to automotive, construction, electrical engineering, expanded and lightweight materials, thin wall packaging materials and textiles. Once laboratory scale development is complete, Makroflam® samples are validated by customer before series production is undertaken at Orlen Unipetrol's Polymer Institute Brno.

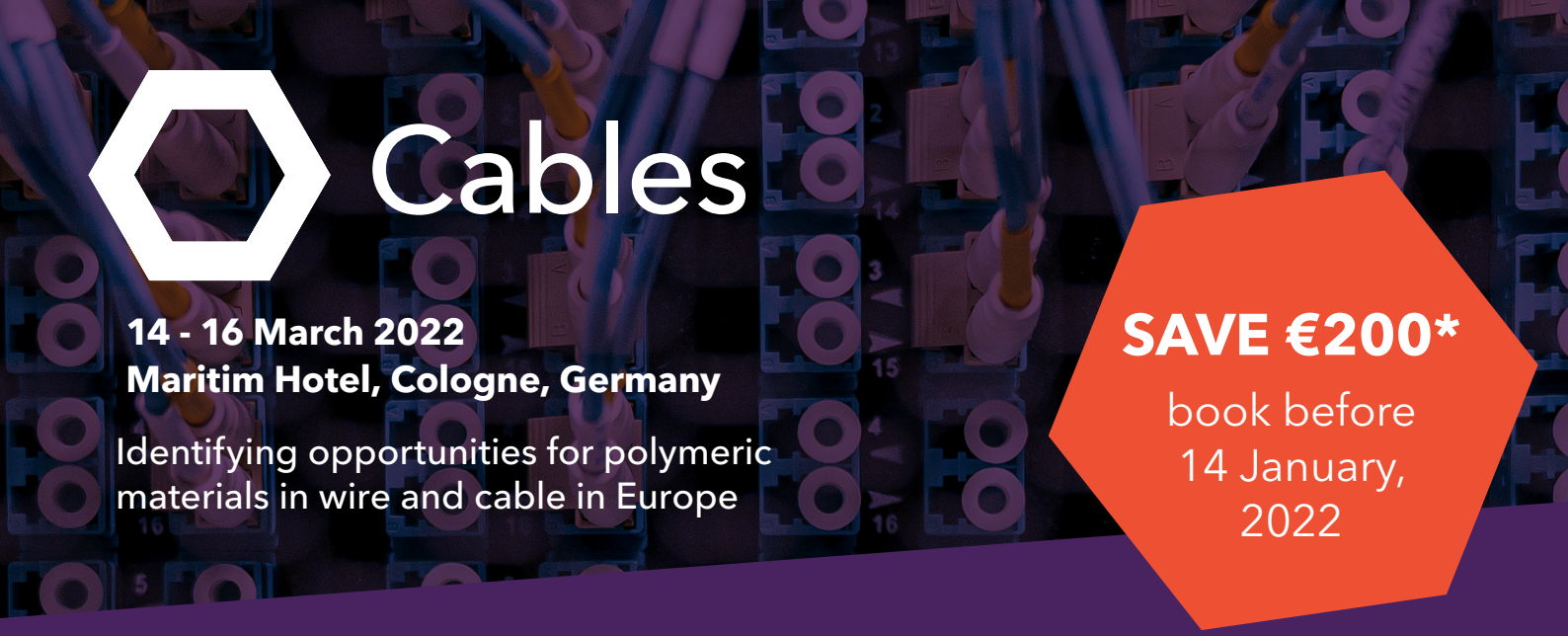
Colouring options

Makroflam® series grades can be coloured using color masterbatches from the company's M-Color® series or can be supplied as a final coloured compound. The materials can also be combined with Makrostab® UV and antioxidant stabilisers and Makroplus® series additive masterbatches containing nucleating agents, fillers, lubricants, antistatic agents, and chemical blowing agents.

Dosage of Makroflam® flame retardant masterbatches is determined by the flammability classification and other final properties but is typically in the range of 5 - 50% by weight. Makroflam® flame retardant compounds are designed for a single specific purpose. Further dilution is not recommended as the flame retardant component is blended at the minimum cost-saving level and any addition of other additives or polymers may result in non-compliance with the required specifications.

Orlen Unipetrol focuses mainly on polyolefin-based materials, but it can also offer flame retarded masterbatches and compounds based on PS, ABS, PC/ABS, polyamides, PBT, bio-copolyesters, POM, and other polymers.

To discover more about Orlen Unipetrol's Makroflam® masterbatches and compounds visit Orlenpolymer.cz/en



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Lab-scale compounders deliver big dividends

*Development, testing and scaling up production of new compounds makes laboratory machines a vital part of the compounding landscape. **Mark Holmes** finds out more*

Increased use of recycled plastics, bio-based polymers and the need to process shear and thermally sensitive materials makes developing new formulations and processing parameters an ever more challenging task. The ability to trial new materials in the laboratory and to be confident about moving into a production environment is now an essential part of the compound recipe and process development process. With that goal in mind, machinery manufacturers are designing compounders and ancillary items that fulfil laboratory requirements while demonstrating the ability to scale up in production.

According to **Leistritz Extrusionstechnik**, recycling and biopolymers developments, as well as the demand in the production of films for battery production, are leading to higher demands and new challenges for laboratory compounders. "When new materials become available to replace traditional ones, a lot of formulation development has to take place to fulfil the final product specifications. This takes place in the laboratory first before the fixed formulations are tested on the production line," says Christopher Helms, Head of the Process Department.

"The main requirements of a laboratory compounder are flexibility and easy adaptation to new processes, as well as a comparable set-up to the production lines. As the line needs to be designed to produce small batches to test new formulations, the process challenges also change quite frequently. Therefore, the machine needs to be highly flexible regarding the changing of screw geometries and adaptation of additional equipment," he says. "The second most important aspect is comparability to the production line. This means the process set-up, screw geometry and extrusion parameters, as well as the basic geometry of the extruder. Easy transferability from laboratory to production line and vice versa is only possible if there is geometric similarity between the two lines.

IMAGE: THERMO SCIENTIFIC

Main image: Feeding flexibility is a key requirement in many laboratory compounding applications

This is possible when using the ZSE MAXX line with a constant OD/ID ratio and constant specific torque density through the whole machine series."

The company's latest development, available on all extruders including its laboratory compounders, is intelligent process monitoring using the Leistritz Elongational Rheometer. "Melt quality is decisive for product quality. Errors in the extrusion process lead to waste of costly resources. At the same time, the challenge is to recognise these errors in advance in order to avoid mistakes. This is where the Leistritz Inline Elongational Rheometer comes in. It identifies melt parameters in real time and thus saves costs and improves product quality sustainably and reliably," says Helms.

The momentum towards sustainable materials, including both bio-based polymers and recyclates, and the rapidly changing landscape of formulas and potential applications is a dynamic force for all compounding operations today, including laboratory-sized machines, according to **Farrel Pomini**.

"The temperature sensitive nature of the materials, such as recycled PVC, PHA, PLA and

IMAGE: LEISTRITZ

Above: The Leistritz inline rheometer can be integrated to provide a constant viscosity check in lab compounding applications

natural fibre compounds, as well as intake of differently sized feedstock and the often-low bulk density of the material, present numerous challenges in laboratory compounding. In addition, when conducting feasibility and development work, it is important for the laboratory compounder to be flexible and allow for a variety of process conditions. It also needs to have a robust control and data acquisition system, as well as provide similar features to the production-sized equipment that the materials will ultimately be processed on when the development is successful," says Paul Lloyd, President & Business Unit Director at the company.

Laboratory assets

"Laboratory compounders are also an asset to colleges and universities for a polymer processing curriculum to provide students with valuable knowledge. A Farrel Pomini CPeX laboratory scale compounder is installed in the UMASS Lowell School of Plastics Engineering, where it is used for graduate and professional research utilising continuous mixing technology," says Lloyd.

The company's CPeX Laboratory Compact Processor allows compounders to conduct laboratory-scale product development trials, extend product application portfolios, expedite time to market, and reduce development costs. It is designed for feasibility studies and other laboratory work and is targeted at rates of 10-30 kg/h and is well suited for processing a variety of compounds and colour concentrates.

The CPeX allows interchangeability between Farrel Pomini's standard CP and XL rotors. The latter rotor has a longer ratio (10:1) and offers tighter temperature control and increased residence time. While most customers use the standard rotor format, the comparative capability is said to allow better determination of when using the XL rotor would be beneficial.

The CPeX control system is configured with feeder selections for most major brands and can support up to three gravimetric feeders. Both the feeder and mixer are pre-configured with integrated wiring and piping for 'connect and go' operation. The PLC-based control system and touch-screen HMI includes a web-based supervisory control and data acquisition (SCADA) function, which enhances analysis and recipe building. The control system includes the ability to capture process parameters within any interval and generate reports.

The CPeX provides the same temperature control capability as Farrel Pomini's production-size machines. Two melt temperatures are monitored, one at the mixer discharge and the other at the extruder die. The mixing chamber also includes all the process features of the company's production size machines, including mixing dams, liquid injection segments and venting ports. The mixer discharge orifice is designed to close couple the mixer to the extruder and allows for molten material to be diverted for evaluation prior to discharging into the extruder feed zone. The close coupled design also eliminates exposure of the melt to air, minimising the risk of oxidative degradation and making it suitable for trials processing reactor supplied powder resin and additive masterbatch.

Farrel Pomini can also offer a variety of hard surfacing options for both rotors and chamber liners. "These proprietary surfaces also increase drag flow, improving conveying efficiency of the compound, which increase production rates," says Lloyd. "In most cases, the mixing chamber can be supplied with replaceable hard metal liners. With a single-entry feed port, all materials are fed into the mixer separately, or as a pre-blend, while liquids can be injected directly into the mixing chamber. This straightforward feeding method eliminates the

IMAGE: FARREL POMINI

Right: Farrel Pomini's CPeX Laboratory Compact Processor provides the same temperature control capabilities as its larger machines

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IMAGE: ENTEK

Above: An Entek extruder installed in the Gala processing laboratory in the US

need for side feeders, which lead to increased energy expense and heat exposure to the polymer," he says.

Sensitive materials

Biopolymers and other shear sensitive materials are increasingly being used so the compounding industry needs laboratory extruders that can handle them properly, according to **Entek**. The company also reports an increase in companies buying laboratory compounders to bring R&D work in-house.

Entek Process Engineer Megan Dyer identifies some of the major requirements for a laboratory compounder as modularity in construction and the ability to reduce contamination, together with fast changeover features. She says these features allow a laboratory machine to be used to test many different compounds more efficiently. In addition, fast changeover features help overcome the widespread problem of keeping laboratories and equipment clean during trials, especially when running colours.

Introduced to the Entek product portfolio earlier this year, vacuum feed technology (VFT) can help with feeding of fluffy materials into compounders. "Entek has also released a new vent flow sensor that helps notify operators of vent flow upset conditions early on," says Dyer. "We have already experienced both technologies adding value to customer trials in our laboratory. VFT allows for higher specific throughputs in the cases of feeding fluffy materials into the extruder. The vent flow sensor monitors when material is coming up the vent towers for early detection and easier cleaning. This is especially useful in laboratories where vent flow is more common due to constant changing conditions."

Launched this year, **Thermo Fisher Scientific** says it developed its Thermo Scientific Process 16 Twin-screw Extruder specifically to satisfy the easy handling and workflow efficiency requirements of R&D, process development and small batch production. Easy cleaning and access are provided by the housing and split barrel design while a removeable top cover ensures customer-specific application flexibility. The company says that the 16mm diameter extruder is a good solution for a variety of compounding workflows, while accessories such as filament spooler, sheet take-off systems and pelletisers further extend its application potential. A hygienic version for food and healthcare applications is also available.

The Process 16 Twin-screw Extruder includes user-friendly touch-screen operation, integrated feeder control, and easily removeable product contact parts. Its compact design minimises laboratory space and ensures easy cleaning. It supports throughputs of 0.4-20 kg/h, depending on the material and application.

Machine features include a segmented screw and removeable top half barrel. A screw length adjustment kit is available to support small quantity compounding while the fully ported barrel allows maximum flexibility for feeding and degassing. Contact parts can be selected from three steel grades. Accessories include dies, feeders, water bath, conveyor belt, strand or die face pelletisers, haul off and spooler. A granulation kit enables customers to switch between melt extrusion and wet/melt granulation.

Feeding flexibility

The Process 16 Twin-screw Extruder's fully ported barrel provides six top feeding ports and four side feeding locations for secondary feeding of sensitive or low bulk density materials. The company says top feeding provides a straightforward handling solution for a broad range of materials and typically works well where process requirements are not too demanding. However, side feeding is recommended where a large volume of material is to be introduced or where the material has a low bulk density as side feeding can help prevent clogging of the feed funnel. Two side feeding locations can be

IMAGE: THERMO SCIENTIFIC

Right: Thermo Scientific's Process 16 Twin-screw Extruder is specifically designed for R&D, process development and small batch production

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used simultaneously on the machine.

To demonstrate the advantages of side feeding, the company ran two compounding trials using a low bulk density wood fibre filler. Extrusion conditions were kept the same but the means of feeding changed between secondary top feeding and side feeding set-ups and the results compared.

The trials involved feeding 0.8 kg/h of polypropylene pellets in feed port 1 using a gravimetric single-screw feeder. In the first trial, secondary top feeding of wood fibre was undertaken using a gravimetric twin-screw feeder at feed port 4, while in the second trial secondary side feeding of wood fibre was made from the backside of the barrel between ports 3 and 4. In the top-feeding trial, the port clogged when throughput of wood fibre exceeded 0.2 kg/h. In the side feeding set-up, the feed rate of wood fibre could be increased up to 1.5 kg/h before the extrusion process reached its torque and pressure limit.

Coperion is seeing the emergence of a number of specific markets where laboratory scale compounding technology is increasingly in demand. "In addition to applications such as engineering plastics, these are markets in which a great deal of development work is currently being done," says Markus Fiedler, Process Technology, Team Leader of Chemical Applications.

"This includes the further development of the manufacturing process for fuel cells. As part of the research project GrabaT (Graphite-based Bipolar plate Technologies), Coperion is currently working with the University of Stuttgart's Institute for Plastics Technology (IKT), Robert Bosch and Matthews International/Saueressig, on the continued development of proton exchange membrane (PEM) fuel cells. Bipolar plates as a core element of fuel cell stacks, and in particular their thermoplastic graphite compound-based implementations, are the focus of this work," he says.

"Coperion has set itself the task to transfer all the experience gained in its years of feed-limited plastics compound manufacturing to the preparation of mixtures consisting of high amounts of graphite and low amounts of polymer. The Coperion ZSK twin-screw extruder is used to improve the addition of fillers to the polymer and to avoid creating agglomerates and degrading the polymer during compounding. The results obtained on a laboratory scale are the basis for future upscaling,"

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Right: Coperion has supplied a ZSK 18 MEGAlab compounding system to the University of Ghent to develop mixed plastic waste chemical recycling technologies

Fiedler says.

Bipolar plates are a core element of fuel cell stacks. Made from graphite-polymer compounds, they lend themselves to mobile applications due to their low weight. They combine properties such as electrical and thermal conductivity and gas non-permeability with markedly higher mechanical capacity than pure graphite plates can achieve. Moreover, they withstand the effects of moisture and acid media at typical operating temperatures over longer periods of time than do metal alloys, Coperion says. However, the company adds that the extremely high fill levels required place big challenges on the process technology.

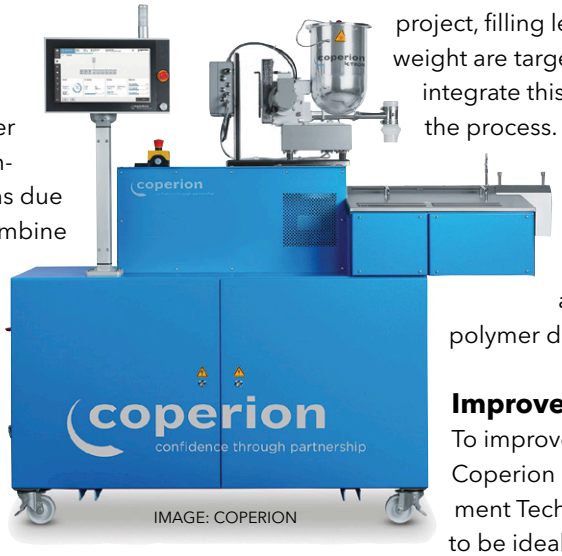

IMAGE: COPERION

"The high proportions of graphite at concurrently low bulk density requires special equipment to feed the mixtures into the extruder and increase the possible mass throughput," Fiedler says. "In this project, filling levels of well over 85% by weight are targeted. We want to optimally integrate this difficult material input into the process. Parallel to this, we are also optimising the incorporation of fillers into the polymer, to avoid creating agglomerates and degrading the polymer during compounding."

Improved intake

To improve intake behaviour, Coperion uses its Feed Enhancement Technology (FET), which is said to be ideally suited to the use of finer, non-compacted fillers. That incorporates a porous, gas-permeable wall in the intake section of the side feeder, allowing a vacuum to draw the air contained in the mixture out. As a result, bulk density increases and with it the material's absorption capacity in the side feeder. Coperion has also developed a process-optimised machine concept to homogenise the mixture.

Parallel to this, the company is using numerical

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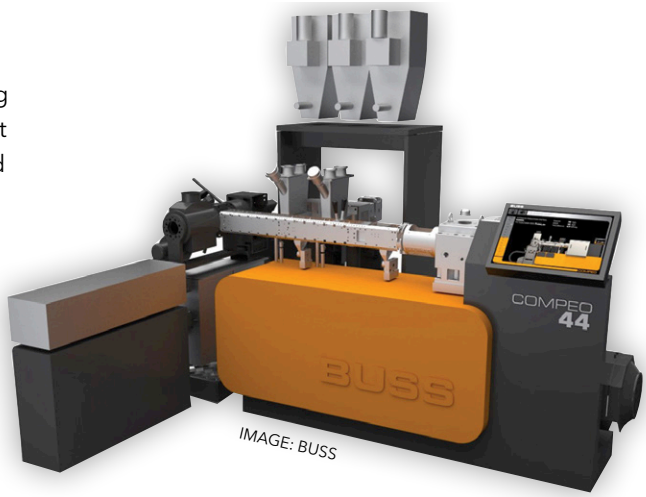

IMAGE: BUSS

Right: Buss will launch its Compeo 44 laboratory kneader next year with EV battery compound development in mind

3D flow simulations (CFD) for virtual and real optimisation of the polymer and filler mixing process. As part of this project, it is also developing an inline quality tool to detect process and product fluctuations. The aim is for regulation of compound quality in real time.

Another important area of laboratory compounding research is in chemical recycling of plastics. Plastic waste, especially packaging waste, is generally a mixture of materials with a high degree of contamination. Mechanically recycling this material mixture is usually difficult as sorting and cleaning is in many cases neither economically viable nor technically feasible. Chemical recycling is a promising technology that aims to recycle these material streams into chemicals, waxes or liquid energy carriers.

Coperion has supplied an extrusion system to Ghent University in Belgium for comprehensive research and development tasks in chemical recycling of mixed plastic waste. Coperion designed the laboratory system around a ZSK 18 MEGAlab twin-screw extruder, which has been specially configured for chemical recycling of post-consumer plastics waste within a throughput range of 1-10 kg/h. Along with the extruder, the system includes a feeder from Coperion K-Tron, as well as a vacuum unit.

The machinery maker says its twin-screw extruder technology is particularly well suited for chemical recycling of plastics as it allows a high level of mechanical energy to be applied to the material in a very short time due to the continuous surface renewal, intensive dispersion and high shearing along the twin screws. Within around 30 seconds, the mixed shredded waste is converted to a homogeneous, highly devolatilised melt at a temperature of up to 350°C. Further materials, such as catalysts, can then be added and mixed in as needed. Residual water or chlorine from PVC can be reliably extracted via vacuum devolatilisation in the extruder's process section.

Ghent University is involved in many forward-looking developments in the recycling field. Chemical reaction engineering and the kinetics of chemical reactions are major areas of the research done within its Laboratory for Chemical Technology (LCT). Activities include optimisation of existing industrial processes and development, as well as intensification and scale-up of novel technologies aimed at minimising waste streams and energy consumption.

IMAGE: CPM EXTRUSION

Right: CPM is now offering the laboratory-scale RXT as a cost-effective alternative to its CXE model

Reliable scaling

The CXE26 and CXE32 twin-screw compounding extruders from **CPM Extrusion Group** have been developed for formulation development and to support direct scale-up to production machines. Both extruders provide the same 1.55 diameter ratio and torque density of up to 18 Nm/cm^3. "Laboratory extruders need to operate at very low feed rates, such as 5-10 kg/h, for screening of raw materials, yet also have the ability to run at a higher capacity of 50-100 kg/h to replicate production conditions," says Adam Dreiblatt, Director of Process Technology.

"Flexibility to reconfigure the barrels to evaluate different feeding and/or venting positions for process development is achieved with the tie-rod design of the processing section for the CXE26 and CXE32," he says. "Screw and barrel metallurgy for laboratory extruders is often not as critical as for production lines, because they do not typically operate 24/7. However, there are specific applications, such as fluoropolymers, where materials of construction must be considered. CPM Extrusion Group offers the widest range of metallurgy in the industry for the CXE series extruders."

CPM Extrusion Group is now also offering laboratory-scale RXT series machines as a cost-

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Right: Maris has developed its TM20 Hi-Tech co-rotating twin-screw extruder for laboratory compounding duties

effective alternative to its CXE models. The RXT26 and RXT32 machines are designed around the same 1.55 diameter ratio as CXE models with screw speeds of up to 900 rpm (CXE models are available with a maximum 1,200 rpm).

These new RXT models feature control platforms from Allen-Bradley or Siemens, both of which can be serviced via an integral VPN router. A variety of screw and barrel materials can be selected for abrasive and/or corrosive compounding applications. Dreiblatt says the new RXT models are designed to provide the same process flexibility and scalability for product and process development as the CXE series laboratory extruders but are more suitable for smaller/start-up companies with a limited budget.

Laboratory kneading

Buss will introduce its Compeo 44 lab-scale compounder next year. The company says it is responding to increasing demand from its material supplier and academic customers for equipment to handle proof-of-concept studies, as well as manufacturing companies needing R&D capacity to carry out longer-term innovation for emerging markets and applications.

Flexibility is a major requirement of a laboratory compounder, according to Buss. "The key needs include flexibility in terms of processing conditions, materials use, dosing of small amounts and scalability by means of temperature, throughput and general parameters," says Dr Krischan Jeltsch, Head of Innovation & Digitisation. "In addition, a handy footprint and dimensions, as well as the ability to record and display all process parameters, are important requirements."

According to Buss, key development interest at present in laboratory compounding includes dosing of very small amounts, which requires careful adjustment through the selection of the right peripheral devices. Other key interest areas include high temperature applications, fibre-reinforced biopolymer composites, and high-performance engineering plastics.

The Compeo 44 laboratory kneader has been specifically developed to meet these R&D requirements. According to Buss, the Compeo 44 will be engineered to support future innovative applications in its traditional markets – such as HFFR compounds for wire and cable, PVC compounding, masterbatches and powder coatings – but will also be targeted at the growing battery compound sector.

Maris developed its TM20 Hi-Tech co-rotating twin-screw extruder for laboratory and small-batch compounding applications, ranging from general compounds, through technical compounds to polymeric alloys, reactive extrusion, and colour and additive masterbatches. The company says the extruder provides fast configuration change through its use of interchangeable and modular mechanical components. The machine is also said to be quiet, making it suitable for use in non-industrial environments such as educational and research organisations.

Features of the machine include closed loop water cooling circuits and electrical heating while barrel and screw element materials can be selected from a wide range of nitrided, anti-corrosive and anti-wear steels. The screw geometry is a self-cleaning two-lobe design.

The electrical cabinet is located inside the machine frame to give the TM20 Hi-Tech extruder a compact footprint. It houses the main motor speed regulator, PLC, ancillary motor drives, transformers, solid-state relays for control of the heating elements, and relays for the control of the electro valves. The operation panel is mounted on a swing arm fixed to the top of the main frame, which makes it easy to access extruder control parameters. The machine uses a Siemens PLC series S7 controller.

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Accelerated stress testing options for PE-HD resins

Martin Chytil, Deputy Head of Department and Senior Research Scientist at Orlen Unipetrol's Polymer Institute Brno, discusses options for accelerated stress testing of PE-HD

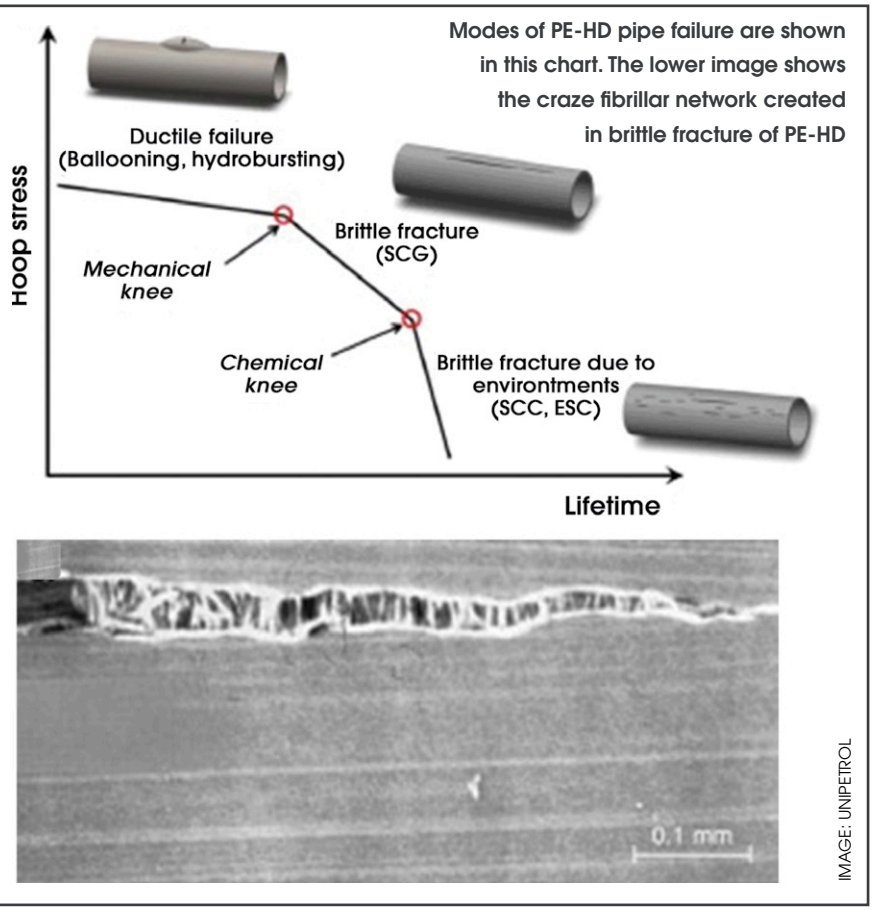
Mechanical testing of a polymeric material such as PE-HD can be performed on either a short-term or long-term basis, the latter crucial for applications such as blow-moulded containers and pipes.

There are two fundamental modes of failure of PE-HD responsible for reduction of lifetime: Rapid Crack Propagation (RCP) which is a ductile type of failure; and Slow Crack Growth (SCG) which is a brittle or quasi-brittle fracture.

SCG is initiated by formation of crazes — flat deformation zones consisting of a network of cross-tied fibrils at so-called stress concentrators (pre-created notches, heterogeneity in the molecular network, or a foreign particle) — under external stress. The crazes propagate perpendicularly to the external stress, creating fibrils that span the craze but eventually fail (the craze-crack transition).

For brittle failure to occur, stress must be kept at below $0.5\sigma_y$ (the yield point). Crack propagation is slow but can be substantially accelerated by an aggressive environment — Environmental Stress Cracking (ESC).

The traditional method for assessing lifetime of PE-HD pressure pipe is based on internal hydrostatic pressure loading by water measured at minimum of three temperatures and varying pressures. Experimental data is then extrapolated to 20°C and time of 50 years. PE-HD pipe grades such as PE80 and PE100 are classified in this way, with the number relating to the minimal required stress at the point of the extrapolation (so 80 corresponds to 8 Mpa). It is a costly and slow process.



Modes of PE-HD pipe failure are shown in this chart. The lower image shows the craze fibrillar network created in brittle fracture of PE-HD

IMAGE: UNIPETROL

Standard tests for characterisation of PE-HD test specimens include the Pennsylvania Edge Notch Test (PENT) and Full Notch Creep Test (FNCT). Both are based on uniaxial tension loading of test specimens of rectangular or squared cross-section having a notch in the middle – either a front notch (PENT) or circumferential full notch (FNCT). Testing is carried out at elevated temperature – usually 80°C – either in air (PENT) or in a solution of a nonionic surfactant (FNCT). Despite an acceleration over traditional pipe tests, FNCT and PENT have become tedious for new PE-HD pipe grades with a high resistance to stress cracking, such as PE100 and PE100 RC, as testing times extend to thousands of hours.

Alternative accelerated methods include Strain Hardening (SH) or Cracked Round Bar test (CRB). The SH test is a modified tensile test performed at 80°C and constant strain rate to very high strain, typically 1100%. At high tensile elongation, strain hardening occurs accompanied with the load increase with the strain. The slope of the curve in the SH region is proportional to the Strain Hardening modulus, $\langle G_p \rangle$, which correlates well with PE stress crack resistance (SCR). Duration of this test is typically 20 min or less per specimen.

The CRB test is a cyclic fatigue test using cylindrical test specimens with a circumferential notch in the middle that are stressed at a sinusoidal load at frequency 10 Hz (for PE-HD) at 23°C. The number of cycles to failure (Nf) is plotted against level of stress ($\Delta\sigma$). Advantages of CRB include the absence of a corrosive environment (detergent), testing at laboratory temperature, and a relatively short duration even for PE100 RC grades.

Accelerated testing of new PE pipe grade lifetimes, including SH and CRB testing, is very important and is a key capability at Orlen Unipetrol.

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IMAGE: SHUTTERSTOCK

Accelerated testing aims to quickly estimate how long a plastic material will survive in real-world conditions exposed to environmental factors such as heat and light. ***Jennifer Markarian*** *reports*

Speeding the route to material insight

Reliable assessment of the long-term durability of plastics is an essential, but not simple, task. And, of course, that assessment frequently has to be made quickly using testing tools that deliver results fast. Fortunately, accelerated testing methods have increased in sophistication over the years, as equipment suppliers and users have gained a deeper understanding of the complex interactions of environmental conditions – including the combined effects of light, temperature, moisture and chemicals – on plastics degradation.

Accelerated test methods enable comparison of additive formulations designed to protect plastics from degradation and, within an appropriate context, can be used to estimate service life. Many have been highly studied in attempts to create methods that correlate accurately to real-world conditions.

While outdoor weather conditions are particularly harsh on plastics, indoor light exposure (such as inside a car or building) is also a significant concern, so the light source is a key variable. Both fluorescent UV and xenon arc lamps are widely used in weathering systems. While xenon arc lamps produce a full light spectrum, filters can be added to block certain wavelengths to simulate specific conditions, such as light coming through a window.

North American firm **Eye Applied Optix**, which is a division of Iwasaki Electric's EYE Lighting International subsidiary, offers an alternative lamp technology that is said to further accelerate weather testing of plastics. The Super UV (SUV-W161) test chamber uses Iwasaki's metal halide light source, which is said to achieve a higher UV irradiance than both fluorescent UV and xenon lamps.

The Super UV technology uses filters to prevent heating by far visible and infrared light and to remove the short UV wavelength not present in natural sunlight. Results have been shown to correlate to accelerated testing with a xenon lamp and to outdoor data, says Doug Vermillion, Director of Eye Applied Optix. Chambers using the technology can decrease the amount of time needed for

Main image: Accelerated testing is allowing faster and more reliable prediction of the impact of weathering on plastics

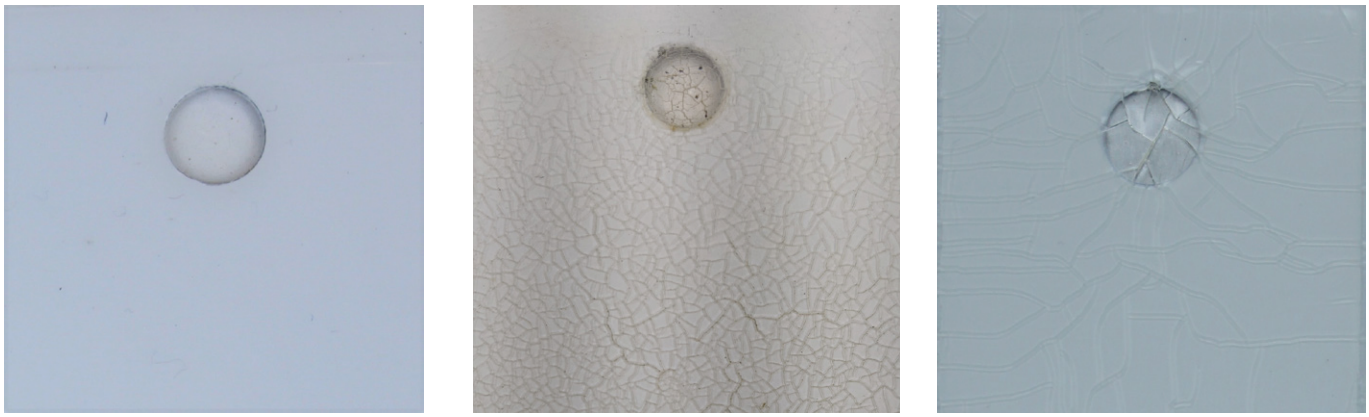

IMAGE: EYE OPTIX

Above: Images showing an unaged sample of a transparent construction film (left) compared with the same film after 180hrs exposure in an Eye Optix Super UV system (centre) and to 24 months of Florida sunshine (right)

screening tests when compared to conventional xenon or fluorescent UV, he adds.

In a recent project, a building products manufacturer wanted to test the long-term UV resistance of a transparent film intended for outdoor use. The manufacturer was concerned about mechanical performance of the film as well as its colour and gloss retention. Vermillion says the first step in the project was to evaluate a well-understood subject material in the Super UV chamber.

"We do have benchmark test methods for a variety of materials, but differences in test subject material formulations and properties will likely require several iterations to fully understand the interaction between high irradiance, and other control variables such as temperature and time," explains Vermillion. "It is important to fully understand your product failure modes from natural weathering and their root causes."

Failure benchmark

While the initial benchmark experiment reproduced the failure mode (colour change) correctly, the researchers ran several further experiments to determine the optimal Super UV test conditions to best match the degradation observed in static outdoor weathering including surface cracking. It was known that water exposure can contribute to the cracking, so the time of wetness was increased in the second experiment by reducing the temperature and increasing the relative humidity during the dew cycle, says Vermillion.

In outdoor exposure, colour change and surface cracking occur simultaneously; in the final two test iterations, the researchers aimed to fine-tune the temperature settings to synchronise the failure modes. This was achieved by first adjusting the temperature during the dew cycle to increase the rate of reactions occurring during the dark phase and after that by evaluating the effect of temperature during UV irradiance of the sample.

"The customer has found that the Super UV results correlate to xenon and outdoor weathering, and confirmed that highly accelerated weathering tests can be used effectively for product qualification. Some upfront work is required to validate correlation with natural weathering, but this is true when using any type of laboratory weathering equipment," says Vermillion.

UV disinfection

A growing concern for plastics materials is the effects of ultraviolet UV germicidal irradiation (UVGI); this high-energy UV short wavelength light (generally 200-280nm) has been increasingly used as a disinfection method for surfaces during the Covid-19 pandemic.

UVGI with UVC light has been used for many years for disinfection in limited medical applications, but in the past two years UVGI has been more widely used for commonly touched surfaces in a range of public places. UVC light, however, is very different from natural sunlight or the light that is normally simulated by accelerated weathering testers. Radiation from sunlight has wavelengths longer than 295nm, which is primarily in the UVA range (315-400nm) with a small amount in the UVB range (280-315nm).

While the effect of UVA/UVB light on plastics durability is well characterised, the effect of UVC exposure is largely unknown, according to Matt McGreer, Director at **Atlas Weathering Services**. He points out that a wide range of UVC sterilising devices are available for use in private homes, as well as by commercial cleaning services, and with this broad use it is difficult to know what dosage of UVC materials are being exposed to.

There are two available test methods for UVC exposure but neither were designed for the current use conditions, says McGreer. Groups at ASTM and

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ISO are currently considering developing more appropriate standards. Despite some unknowns, suppliers of plastic compounds and parts need to begin to estimate the effect of UVC on the durability of their products.

The Atlas UVCTest is a new device designed to test the durability of materials exposed to UV radiation from UVC-254 lamps (centered at 254nm radiation). These are designed to simulate the UVGI used by many sterilisation devices, says McGreer. Atlas scientists have also developed an Excel-based "UVC Test Duration Calculator" that calculates the accumulated radiant exposure simulated by the equipment. Users can input variables, such as the level of radiant exposure per application and the number of expected applications, to determine appropriate times to expose materials in the test device. Exposed samples can then be measured to determine how much degradation has taken place.

Data acquisition

Atlas also released a new web-based data acquisition system in July 2021. The WXView II application remotely collects test parameter, control system and other data outputs in real time from any Atlas Ci4400 instrument connected to the user's local area network. "The application allows users to access the information from their instrument from anywhere in the world, and the data is secure and encrypted," says McGreer.

"Data files from archived tests can be viewed, downloaded and imported into other applications for more detailed analysis and report generation. Instrument status and information on alarms, maintenance, and instrument configuration may also be displayed on the touchscreen user interface," he adds. The current version resides on a company network but future versions may be Cloud-based.

Launched by **Q-Lab** earlier this year, the QUV/uvc accelerated weathering tester uses a UVC lamp with light concentrated at 254nm. The new QUV model has additional light baffles and safety features to prevent UVC light from exiting the device. The company has also added UVC testing capabilities using the new device at its Florida (US) and Saarbrücken (Germany) contract test laboratories.

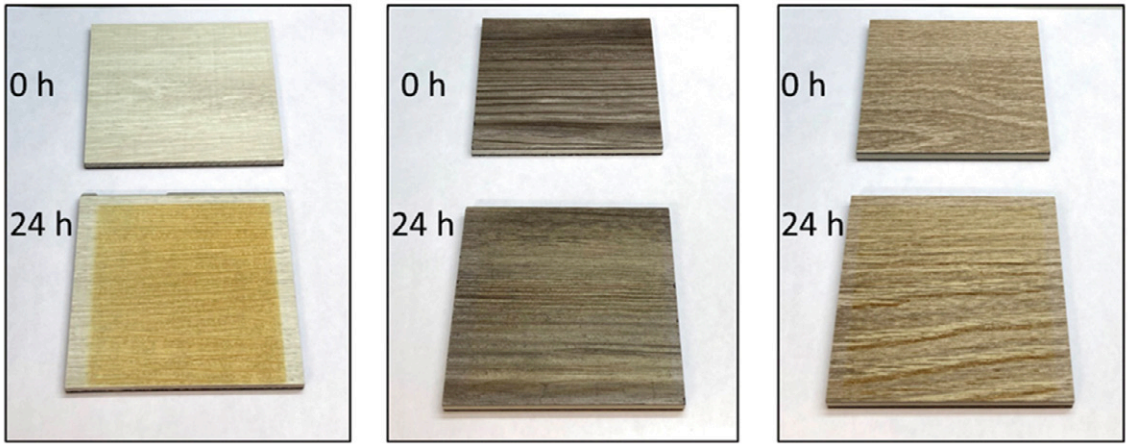
Bill Tobin, Senior Technical Marketing Specialist at Q-Lab Corporation, described UVC testing in a presentation at the Compounding World Expo held in North America in November. He pointed out that the UVC-254nm lamp produces much higher irradiance at 254nm than xenon and fluorescent UV, so the test times to simulate UVC exposure will be much faster than standard weathering tests.

For initial tests using the new device, Q-Lab researchers chose an irradiance of 6 mW/cm^2, a 35°C black panel (using active cooling to keep the panel close to room temperature), and ran continuously for 200 hours. It was expected that UVC light could cause more degradation because of the higher energy of UVC photons, and testing showed this to be the case. For example, a vinyl flooring material showed discoloration after just 24 hours of UVC testing.

Based on estimates of normal UVGI exposure, daily UVGI cleaning accumulated over one year would correspond to about 17 hours of QUV UVC irradiance (at 6 mW/cm^2); 100 test hours would represent about 5.9 years of daily UVGI exposure. Weekly UVGI cleaning for one year would be simulated in 2.4 hours of accelerated testing. More testing needs to be done to determine if higher irradiance testing can provide good correlation to the degradation caused in real world UVGI exposure.

Under pressure

A high-pressure autoclave test (HPAT) is being studied for accelerating ageing of plastics at Germany's **SKZ**. The test is particularly aimed at



Examples of various vinyl flooring samples before and after 24hrs exposure to UVC radiation in Q-Lab's QUV/uvc system

Image: Q-Lab

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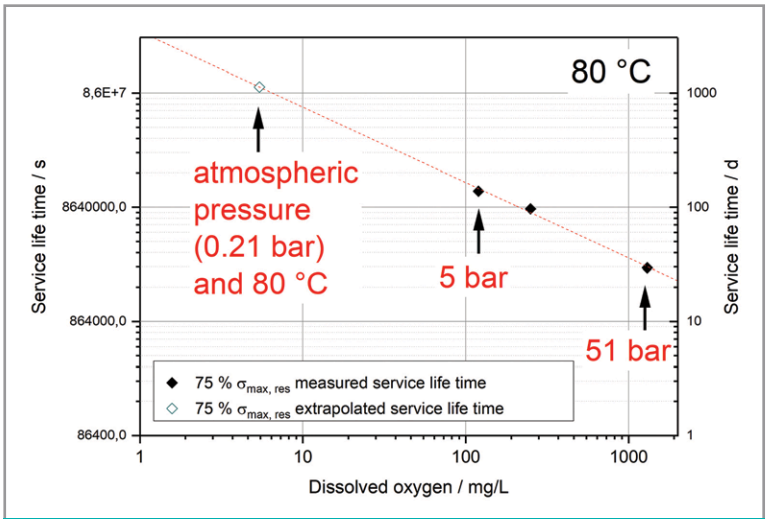

Figure 1: Results of a High Pressure Autoclave Test (HPAT) carried out on PE at SKZ showing extrapolation to failure at ambient temperature
Source: SKZ

assessing long-term use of polyolefins, where oxidation is a primary degradation mechanism, according to Wilma Hahn, Project Manager at the plastics institute, in a presentation given at AMI's Compounding World Expo in Essen in September. Although in real-world conditions other mechanisms besides oxidation may be at work, the accelerated test can be used to estimate service life, she suggests.

SKZ's laboratory conducts various tests on plastic parts, with durability tests including methods to measure resistance to UV, chemicals/leaching, and oxidation. The HPAT tests, conducted according to EN 1348:2005, are performed at elevated temperature and oxygen pressure and in aqueous medium. SKZ performs the tests at different oxygen pressures and temperatures and prolongs the ageing until the material degrades. Product standards that require HPAT tests include pipes and geosynthetics. Hahn says that the lab has tested other products as well, such as roofing sheets.

To date, the SKZ laboratory has primarily tested PE products using HPAT. Typical test conditions cover temperatures of 60 to 95°C and 0.6 to 51 bar oxygen, with sodium bicarbonate (pH 10) as the media. Degradation is accelerated by the higher temperature and the availability of oxygen.

As shown in Figure 1, tests were run at 80°C and several pressures, with the "service life" measured at the point where the sample had 75% residual stress at break (meaning the material had lost 25% of its strength). The service life could then be extrapolated to the real-world condition of atmospheric pressure. Additional tests allowed extrapolation to real-world temperatures.

"Choosing appropriate ageing conditions and estimating the corresponding failure times requires a high level of experience," says Hahn. Similar to other ageing tests, there is a trade-off in test speed and correlation to real-world conditions. "The lower the temperature and pressure, the longer the test duration (and higher the costs), but the closer the test is to real life," she adds.

Hahn says that while this test is not yet widely used in industry, SKZ is continuing to evaluate it and to run long-term tests to correlate it to other ageing tests. For one product, for example, the lab has HPAT data and data for several years of heat ageing in an oven at different temperatures that correlate.

"Due to the increased oxygen pressure, and therefore oxygen availability, ageing is accelerated and temperatures can be reduced," says Hahn. "A life-time estimation for the application temperature can mostly be completed within less than one year and often leads to service lives of >100 years at 40°C. A minimum life-time of 100 years is very often required for polymeric products within construction sectors. Using conventional thermo-oxidative ageing methods, the life-time estimation for these well-advanced products leads to much longer test durations compared to HPAT."

Circular thinking

Assessing the degradation behaviour of polymers and its impact on the service life of materials is crucial in the circular economy, says Arjen Boersma, Senior Scientist at **TNO**, a contract research organisation based in The Netherlands, in a presentation at AMI's Compounding World Expo in Germany. "In the circular approach, a polymer should last a long time, but it should remain suitable for recycling and not emit microplastics when it degrades during use," he said.

Boersma described how accelerated ageing tests can be monitored with analytical techniques, including infrared spectroscopy to assess chemical changes, indentation hardness to assess surface stiffness, and tensile or flex modulus to assess bulk stiffness. Differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA) can also be used to evaluate changes in polymer structure, crystallinity and stability.

As an example, he described a method for predicting the service life of the polymer encapsulation in buried power cables. The cables were exposed to high pressures and a range of high temperatures in salt water, and the material properties were evaluated at different times. Exposure to high temperatures up to 140°C can be used to predict behaviour at ambient temperatures; above 140°C, other phenomena (for exam-

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Right: TNO believes weathering tests could be used to help reduce microplastic shedding from plastics during service

ple, depolymerisation) will affect the degradation results and extrapolation is not reliable, Boersma says.

In another test, high mechanical stress was placed on notched samples of PVC water pipe to accelerate failure due to crack growth. The stress at failure was plotted against time to failure. This plot can be extrapolated to estimate the amount of time before the pipe would be expected to fail, which in this experiment was approximately 50 years.

When the durability projects were started, the aim was to identify reliable measurements to predict integrity of products. A new question to be studied, says Boersma, is whether ageing and degradation of polymers affects the level of microplastics in the environment. Boersma says TNO is currently studying whether microplastic formation can be correlated to a decrease in any particular mechanical parameters.

In a study of unstabilised PP exposed to accelerated outdoor weathering, cracking formed particles that decreased in size over time to less than 10 microns. Although the study did not evaluate microplastics in the environment, Boersma suggests that microplastics formed by cracking can enter the environment when a mechanical force (such as wind and erosion) removes them from the surface. Accelerated testing can predict service life and products could be removed before they severely degraded.

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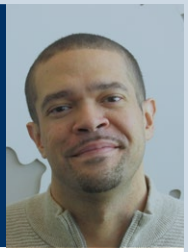

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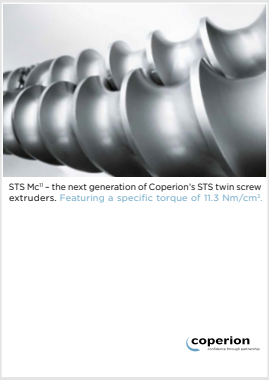

Coperion's STS Mc11 line of twin screw extruders provides performance at a competitive price. This brochure describes the full features of the range, from the compact 90 kg/h 25mm diameter laboratory model to the 4,200 kg/h 96mm version.

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MIXACO: MIXING TECHNOLOGY

Mixaco has been driving innovation in PVC mixing technology for more than 50 years and has 7,500+ machines installed worldwide. This brochure explains some of the details that make its HM and KMH heating cooling mixers stand out.

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BUSS: COMPEO KNEADER

The Compeo is the latest generation of kneader extruder from Buss and is designed to provide the utmost flexibility in application. This 12-page brochure details key features and model specifications.

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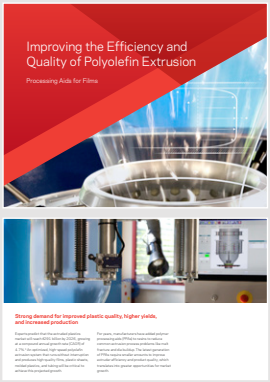

In this brochure, Improving the Efficiency and Quality of Polyolefin Extrusion, Chemours explains how issues including melt fracture and extrusion instabilities can be addressed with its Viton FreeFlow products, the next generation of polymer processing aids.

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KLK OLEO: GREEN ADDITIVES

KLK OLEO provides a series of products for industrial applications. PALMOWAX and PALMESTER provide green lubricant solutions for polymer processing; PALMERE and PALMERA are green ingredients for PVC additives/ plasticisers.

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Heat dissipation has become an important consideration in many plastics applications. Find out how the thermal properties of Huber's Martoxid, Magnifin and Martinal fillers can be used to create thermally conductive polymer compounds.

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

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AMI publishes five process-specific FREE plastics industry magazines. Simply click on the cover below to read each magazine. Or download the issue in the relevant Apple or Android app

Compounding World November 2021
The Compounding World November edition looks at issues around safety and sustainability in black and white pigments, inline measurement systems for compounders, new mixing equipment and the use of additives and reinforcement.

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Compounding World October 2021
The Compounding World October issue looks at how graphene is expanding into additives in polymer compounds. Features also cover twin screw extruders and the use of recyclate. Plus previews of the Compounding World Expo in Cleveland, US, and Fakuma in Germany.

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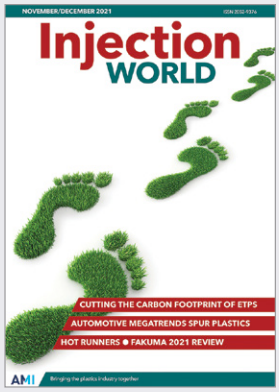

Injection World November/December 2021
The November/December 2021 edition of Injection World magazine looks at the steps engineering plastics producers are taking to reduce carbon footprint. It also explores hot runner innovations and developments in automotive moulding.

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Plastics Recycling World November/December 2021
The November-December edition of Plastics Recycling World has a lead feature on progress in chemical recycling projects around the world. Other features cover PET depolymerisation and quality measurement in mechanical plastics recycling.

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Pipe and Profile November/December 2021
The November-December issue of Pipe and Profile Extrusion has features on improving performance in infrastructure pipes, advances in wood-plastic composites, and wear protection for screws and barrels. Plus reviews of the Plastics Extrusion World expos in Essen and Cleveland.

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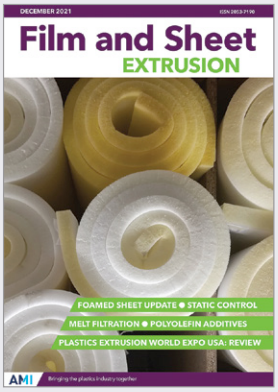

Film and Sheet December 2021
The December edition of Film and Sheet Extrusion looks at the latest innovations in foaming technolgy. It also reviews developments in melt filtration systems, web static management, and additives for enhancing performance of recycled resins.

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GLOBAL EXHIBITION GUIDE

2022	**25-28 January**	Interplastica, Russia, Moscow	www.interplastica.de
	8-10 March	JEC 2022, Paris France	www.jec-world.events
	8-11 March	Plastimagen, Mexico City	www.plastimagen.com.mx
	5-8 April	FIP, Lyon, France	www.f-i-p.com
	3-6 May	GreenPlast, Milan, Italy	www.greenplast.org
	25-26 May	Injection Moulding & Design, Detroit, USA	https://injectionmoldingexpo.com/
	26-30 September	Colombiaplast, Bogota, Colombia	www.colombiaplast.org
	27-29 September	Fachpack 2022, Nuremburg, Germany	www.fachpack.de
	3-7 October	Plastex, Brno, Czech Republic	www.bvv.cz/en/plastex/
	19-26 October	K2022, Dusseldorf, Germany	www.k-online.com
	9-10 November	Compounding World Expo USA, Cleveland, USA	www.compoundingworldexpo.com/na/
	1-3 December	Plast Print Pack West Africa, Accra, Ghana	www.ppp-westafrica.com
2023	**1-5 February**	PlastIndia, New Delhi, India	www.plastindia.org
	14-15 June	Compounding World Expo Europe, Essen, Germany	www.compoundingworldexpo.com/eu/
	5-8 September	Plast 2023, Milan, Italy	www.plastonline.org/en
	17-21 October	Fakuma, Friedrichshafen, Germany	www.fakuma-messe.de

AMI CONFERENCES

25-26 January	Ocean Plastic Virtual Summit 2022 **VIRTUAL EVENT**
25-27 January	Thermoplastics Concentrates, St Augustine, FL, USA
1-2 March	PVC Formulation USA, Cleveland, OH, USA
14-16 March	Cables Europe 2022, Cologne, Germany
29-30 March	Chemical Recycling North America, Houston, TX, USA
26-27 April	Fire Retardants in Plastics 2022, Houston, TX, USA
10-12 May	Masterbatch Europe, Frankfurt, Germany
7-8 June	Compounding World Congress Europe, Cologne, Germany

For information on all these events and other conferences on film, sheet, pipe and packaging applications, see
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DECEMBER 2021 EDITION

Extrusion Solutions

THE LATEST EXTRUDING NEWS FROM ENTEK

ENTEK Opens New Facility in Henderson, Nevada

ENTEK Manufacturing has announced the opening of a new manufacturing and engineering facility in Henderson, Nevada. The new 98,000 square foot building will be home to wear parts production, fabrication and assembly, and engineering.

"We are expanding our business to better meet the needs of our customers' growing businesses," said Kim Medford, President of ENTEK Manufacturing, "Our greatest success comes from ensuring the success of the product manufacturers that our equipment supports."

Linda Campbell, VP of Sales for ENTEK Manufacturing, said the company is experiencing record growth and needed the additional space to keep up with demand. "We recently expanded our machine shop at our Lebanon, Oregon headquarters, and we already need more space, and more workers, to keep up with our wear parts business," she said.

Medford said ENTEK is investing over $10 million USD in new equipment for the Nevada facility and has begun interviewing and hiring. She expects to have 50 or more new team members working there by late 2022. "Once fully operational, our new facility will allow us to stock parts for rapid customer response," she said.

"ENTEK chose Nevada for the new facility because it is a growing area of the country with a strong labor market with attractive business-friendly incentives," said Medford. "We used an outside firm to do a multi-city survey, and the greater Las Vegas metro area came out first when it came to the availability of skilled labor such as machinists and engineers," she said. "It's a good location for us, and not far from our headquarters in Oregon."

ENTEK's business outlook is strong, said Campbell. "We have an aggressive forecast for new business in 2022 and 2023," she said. "This expansion is the first step in what we expect to be a very active period for our company."

Growing to Better Serve Our Customers

Welcome to the latest issue of ***Extrusion Solutions***.

Kim Medford

> *"I would also like our customers to know that we will always seek continuous improvement as a company to better serve their needs."*

Our New Facility

As you can see by our story on page 1, our growth here at ENTEK continues as we are opening a new 98,000 square foot facility in Henderson, Nevada. Since we first announced this news in October, we've been busy interviewing candidates for the many open positions we have available to staff our new facility. I'm pleased to announce that we have already hired several new employees who are currently in training at our Oregon headquarters.

We hope to have 50 or more new employees working in Henderson by late 2022. We have numerous job openings available; check out our list of positions at https://entek.com/careers/us/. If you or someone you know is interested in joining our growing company, please contact us today!

Continuous Improvement

We recently reached an amazing milestone with our continuous improvement program. With over 1,000 improvements and counting, this program has really helped us make great progress towards improving virtually everything we do as a company.

Personally, I believe this is a great example of what makes ENTEK special. Every employee here has a say in how to make this company a better place. Our 'Fix What Bugs You' message encourages everyone to contribute their ideas, and as Mark Dvorak, our Lean Leader says, 'we celebrate all improvements and ideas, the small ones as well as the big ones.'

I want to thank all of our employees for their suggestions. I would also like our customers to know that we will always seek continuous improvement as a company to better serve their needs.

Hoping to See You in 2022

ENTEK recently exhibited and presented at two excellent industry events, the AMI-sponsored Compounding World Expo in Cleveland and the Plastics News 'Women Breaking the Mold' conference in Austin, Texas. We are happy to be back doing in-person events, and our Sales and Marketing Teams are busy preparing for numerous trade shows and conferences in 2022 (see the complete list on p. 5). If you plan on attending any of these events, please plan to stop by to see us to learn more about our products and services.

Thank you to all of our customers for your continued support.

I encourage you to contact me anytime at kmedford@entek.com.

Sincerely

Kim Medford

Kim Medford
President

1,000 Improvements and Counting!

by Mark Dvorak, Lean Leader at ENTEK Manufacturing

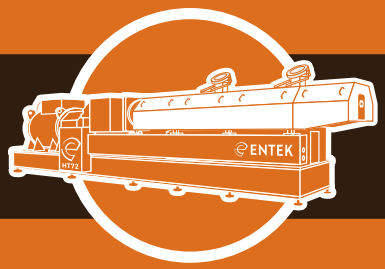
In January 2020, ENTEK started its '2 Second Lean' approach, with the goal being to empower all employees to engage in continuous improvement. We did this by providing daily lean training, 5S supplies and providing our employees with the time they needed to make improvements. The message we sent encouraged everyone to stop and "Fix what Bugs You!"

Several improvement idea boards were set up around the company, where employees could outline larger ideas that take more time and resources than the smaller projects. However, we celebrate all improvements and ideas, the small ones as well as the big ones.

We documented many of the improvements using before and after pictures and videos. All improvements are shared in daily morning meetings and in a weekly email blast.

Since starting, we have documented 1,110 improvements on pictures and/or video! Some save seconds, others save hours per day. All safety improvements are also captured and celebrated in the same way. Click here to see a short video clip on reaching the 1,000 improvements milestone.

Continuous improvement is just that; we will continue to encourage all employees to contribute to the process. Overall, we have made great strides in our quality, safety and overall job satisfaction at ENTEK. We have also improved our customer experience with improvements that have made the quoting process much faster and easier for our customers.



Attend Our Upcoming Webinar: The Future of Compounding is Now

Wednesday, December 15, 2021 2:00 PM ET

Compounders in the commodity and masterbatch markets typically run medium-to-large batch production sizes, and high production rates are particularly critical for them, which they typically run on a 24/7/365 basis. Learn how a newly developed compounder with the highest free volume at 18 Nm/cm^3 torque density of any co-rotating twin screw extruder on the market is suited for these and any other torque- or power-limited applications.

Other design features of this machine include ease of maintenance, machine health status tracking and an operational friendly interface. This extruder meets the needs of a fast-paced manufacturing environment where management can observe the OEE (overall equipment effectiveness) at a glance.

Agenda:

- How a compounding extruder achieves industry leading output rates for both torque- and volume-limiting compounds
- How a compounding extruder achieves industry-leading output rates for both high-shear and shear-sensitive compounding requirements
- Combining and meeting the needs of management, maintenance, process and operations in a new twin-screw compounder

Dean Elliott
Technical Processing Manager

Ryley Jones
Mechanical Engineering Supervisor

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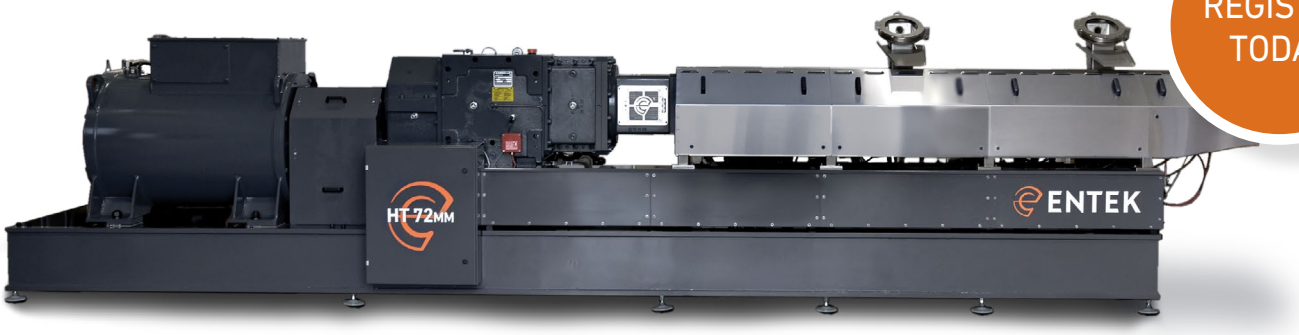

ENTEK Presentations at Recent Industry Conferences

It has been a busy fall season for trade shows and conferences in the plastics industry. In-person events have returned, and ENTEK was proud to be an exhibitor, presenter and sponsor at two of them.

Sponsored by AMI, the Compounding World Expo was held in Cleveland on November 3-4, as part of an event that also included the Plastics Recycling World Expo, the Plastics Extrusion World Expo, and the Polymer Testing World Expo. ENTEK had a booth and Dean Elliott, ENTEK's Technical Processing Manager, gave a presentation on 'Biopolymer Compounding Done Right.' Attendance was excellent, and Dean gave his presentation to a standing-room only crowd on the opening day of the show. Click here to see a short video from ENTEK's social media on this event.

One week later, Plastics News held its annual 'Women Breaking the Mold' conference in Austin, Texas. ENTEK's Melissa Jensen-Morgan was inducted into the WBTM Class of 2021, and she and Tammy Straw gave a presentation titled 'Managing a Project from Start to Finish'. ENTEK was a sponsor of this event, and hosted a wine tasting reception on the opening night.

"It was good being back at in-person events," said Tammy Straw. "We were very pleased with the turnout at both of them and look forward to getting back to exhibiting and attending at more shows in 2022."

Upcoming Events

ENTEK will be exhibiting at the following events in 2022. If you plan on attending any of these shows, please stop by to see us!

Plastics Recycling Conference
Washington, DC
March 7-9, 2022

PlastImagen
Mexico CIty,
March 8-11, 2022

PT XPO
Rosemont, IL
March 29-31, 2022

PT Extrusion Conference
Chicago, IL
October 2022

Compounding World Expo
Cleveland, OH
November 9-10, 2022

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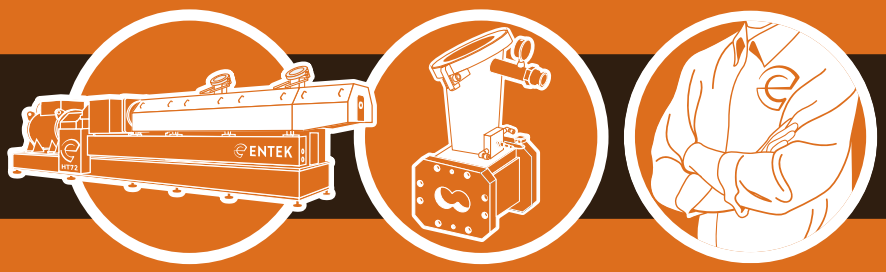

Have You Seen Our Latest Ads?

Our latest ads, appearing both in print and online in the leading plastics industry trade publications, highlight our newest products and technologies.

In continuing with our 'people' theme, that's our own Ryley Jones, Mechanical Engineering Supervisor and HT72 Project Leader, and Micah Woody, Pilot Plant Technician, appearing in our new ads. Ryley led the team that developed the HT72 twin-screw extruder for the past three years; Micah runs trials in our in-house Pilot Plant and helped develop our new Vacuum Feed Technology (VFT).

Our new HT72 twin-screw extruder provides high-torque for high throughputs, and is ideal for continuous 24/7/365 commodity compounding and masterbatch production. Click here to watch our video and hear Ryley talk more about its features and benefits.

ENTEK's patented Vacuum Feed Technology helps compounders overcome the challenges of processing 'fluffy' materials, and can help boost extruder output by almost 2x. For more information on the features and benefits of VFT, click here to watch our video.

Watch Our Demonstration Videos

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