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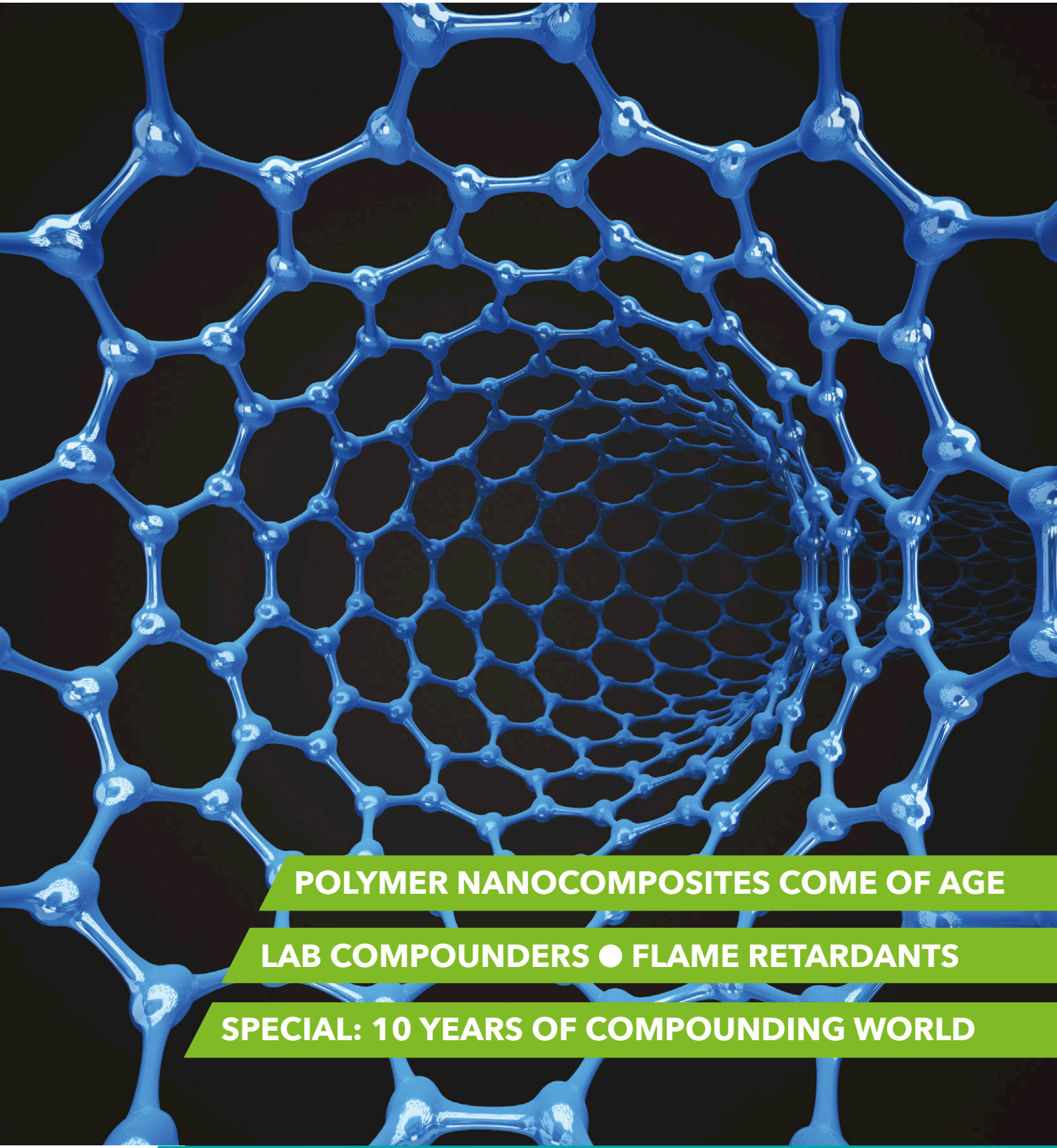

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DuPont invests $80m in Chinese compounding

PHOTO: DUPONT

New Chinese site will supplement DuPont's existing compounding operation at Shenzhen

DuPont is to invest more than $80m to build a new compounding facility at Zhangjiagang in Jiangsu Province in East China. The new facility is expected to commence production in 2020 and ramp up to full capacity by 2023. It will produce Zytel PA, Delrin POM, Hytrel and Multibase TPEs and specialty silicone materials.

The production facility will be built on the Yangtze River International Chemical Industrial Park and will support DuPont's Transportation & Advanced Polymers (T&AP) business unit. It will be equipped to support production of automotive adhesives and additional specialty products.

"This investment reinforces our commitment to China and the Asian market where we see strong growth potential across our businesses," said Randy Stone, President of DuPont Transportation & Advanced Polymers. "Our new manufacturing facility will position us well to support anticipated growth in the automotive sector due to strong customer demand for our advanced polymers and solutions from end users such as electric and hybrid vehicle manufacturers."

The T&AP business unit already operates a compounding plant in the west of China at Shenzhen, which opened in 2016. At the time, the company said the Shenzhen plant would become a regional hub and ultimately its largest global compounding facility.

A spokesperson for the company said that while part of the same T&AP business unit, the two locations are intended to address different geographical focuses within the region. For the immediate term, the Shenzhen facility will remain DuPont's largest compounding operation but that may change as the regional business develops.

› **www.dupont.com**

Kafrit acquires Polyfil

Israel-headquartered masterbatch and compounds producer Kafrit Industries has acquired Polyfil Corporation of Rockaway, New Jersey, US, from its owner Gerry Fabiano.

Polyfil has been making additive masterbatches for 35 years. Kafrit said the acquisition will enable it to both expand its US footprint geographically and add to its technology capabilities in the field. Avi Zalcman, CEO of the Kafrit Group, said the combined companies "will enjoy strategic advantages, allowing them to create a robust and technical portfolio that will substantially increase its operating strength".

Kafrit plans to offer a wider product range based on the two organisations' combined expertise. Fabiano will remain in place as an advisor, while Juan Castaneda will serve as General Manager.

› **www.polyfilcorp.com**

Albis adds Solplast FR TPEs to its line-up

Albis Plastics has added the Solplast series of halogen-free flame retardant, styrene-based TPEs from Slovenian compounder Uteksol to its portfolio. It has already been distributing Uteksol's Solplast TPS compounds since 2010.

The new grades, according to Albis, achieve V-0 classification in the UL94 test and pass the glow wire test at 960°C, both at 2 mm thickness. Their limited oxygen index is above 30%. They are available in the hardness range from Shore A45 to Shore A85 in natural colour as well as in black. They can be used for both injection moulding and extrusion. Applications include housing seals, grommets, cable bushings and assembly elements.

› **www.albis.com**

PHOTO: ALBIS

EERA warns on WEEE deca-BDE

The European Electronics Recyclers Association (EERA), which represents recycling companies treating waste from electrical and electronic equipment (WEEE) in Europe, has expressed "surprise" at a vote by the European Parliament on 15 November this year that set a 100-fold reduction in the threshold for the brominated flame retardant deca-BDE in WEEE.

"If this vote would indeed be converted into law, it will have devastating environmental effects and implies that the recycling of E-waste plastics in the EU will come to an end," the association warned.

"Consequently, it means that the targets set for e-waste recycling and the targets of the EU plastics strategy cannot be met and it would be in clear contradiction with the objectives of a Circular Economy."

PHOTO: SHUTTERSTOCK

Proposed European limits could make WEEE recycling unviable, claims EERA

Deca-BDE was listed as a 'new' persistent organic pollutant (POP) in the last meeting of the Convention of Parties to the Stockholm Convention and was listed under REACH in early 2017, with a threshold of 1,000 ppm that was based on an impact assessment.

EERA has stated in dialogue with MEPs that recyclers can deal with the REACH threshold but there are no validated measuring protocols for thresholds at this new level. It said the result will be to "end the recycling of the potential volume of 1.2m tonnes E-waste plastics". It is hoping that forthcoming discussions will lead to a more realistic result.

› **www.eera-recyclers.com**

Orion Carbons buys SN2A

Orion Engineered Carbons has acquired Société du Noir d'Acétylène de l'Aubette (SN2A), a specialist maker of acetylene carbon black based at Berre l'Etang, near Marseille, France, from LyondellBasell and its French affiliate. The deal, which includes provisions for long-term feedstock supply, closed at the end of October.

Acetylene carbon black is an ultra-pure premium speciality carbon black, with high electrical and thermal conductivity.

Corning Painter, CEO of Orion, described the move as a bolt-on acquisition and "a perfect fit with Orion's focus on speciality carbon blacks".

› **www.orioncarbons.com**

Ampacet looks to match metal

Ampacet has introduced its FauxFoil masterbatches to offer plastics procesors "a total lower cost alternative to metallization and coating processes that mimics the gloss and shine of metal in a single step".

FauxFoil is designed for use with a wide range of polymers, including HDPE, PP, PET, PC, ABS and PS. It can be processed by extrusion, injection moulding, blow moulding and thermoforming. According to Ampacet, FauxFoil masterbatches resist scratching and peeling better than other methods of achieving a metallic look, such as paint, and do not require any modifications to moulds or processing machinery.

Ampacet says FauxFoil is well suited to production of rigid structures such as energy drink bottles, caps and closures for bottles and jars, automotive aftermarket products, personal care products, consumer electronics and small appliances.

› **www.ampacet.com**

PHOTO: AMPACET

FauxFoil masterbatch can provide a durable, low cost alternative to metallization

BASF Kolon POM JV starts up

Kolon BASF InnoPOM, a 50:50 joint venture between Kolon Plastics and BASF, has begun operation at its 70,000 tonnes/yr, $220m POM facility at Gimcheon in South Korea.

According to Raimar Jahn, President of BASF Performance Materials, the new plant "sets an industry benchmark for the production of POM. It employs innovative environmental management standards that improve production efficiency, resulting in less energy use."

› **www.basf.com**

› **www.kolonplastics.com**

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NEWS IN BRIEF...

Environmental technology firm **Agilyx** and styrene monomer maker **AmSty** have signed a letter of intent to form a JV to take charge of the former's Oregon facility in the US, which converts used PS back to liquid styrene monomer via the PolyUs-able process. The intention is to develop a 5 tonnes/day PS recycling facility.
www.agilyx.com
https://amsty.com/

US-based engineering plastics distributor **Conventus Polymers** has opened a new satellite office and expanded warehouse in Houston, Texas. The new location will help the company enter the growing oil and gas industry, where it sees strong potential for increased use of engineering plastics as a replacement for steel, and to service the Southwest US region and Mexico.
www.conventuspolymers.com

Oxea has declared *force majeure* and restricted the supply of certain products from its production plant at Oberhausen in Germany until further notice. The move is the result of disruption of synthesis gas production by Air Liquide at the same site, leading to it being shut down. The company said on 20 November it had informed customers but could not provide information on how long this will last.
www.oxea-chemicals.com

BASF's future strategy has "verbund" at core

BASF has presented a new future strategy, which is intended to achieve above-average organic business growth through stronger customer focus, simplified structures and processes, a more targeted product portfolio, and strengthening of its verbund (integrated) manufacturing concept.

"We will transform our organisation to be more customer-focused and agile," said Dr Martin Brudermüller, chairman of the board of executive directors.

Key financial targets include an increase in EBITDA before special items of 3-5%/year, with a return on capital employed well above the cost of capital. To this end, BASF is beginning a new programme focused on production, logistics, R&D, digitalisation, and organisational development that will run from 2019 until 2021 and is intended to achieve annual earnings contributions of €2bn from the end of 2021.

Non-financial targets include maintaining greenhouse gas emissions at 2018 levels until 2030 despite the planned production growth, particularly at major new planned investments such as its verbund site in China's Guangdong province. The company also wants to generate around €22bn in annual sales through Accelerator products, which "make a substantial sustainability contribution in the value chain" by 2025.

BASF's strategy aims to maximise potential of its "verbund" manufacturing system

PHOTO: BASF

In addition, BASF will restructure its operations into six segments with increased decision-making authority from the beginning of 2019, all bar one of them containing two operating divisions. These include Materials (Performance Materials and Monomers) and Industrial Solutions (Dispersions & Pigments and Performance Chemicals). Some 20,000 of its approximately 110,000 global workforce may be affected by these changes, it said.

■ BASF said sales in Q3 rose by 8% year-on-year to reach €15.6bn. This was mainly due to higher selling prices in all segments, plus volume growth and acquisitions. Income from operations before special items declined by €232m to €1.5bn. Business was impacted by the very low water levels on the River Rhine, which are disrupting logistics.
› **www.basf.com**

Lifocolor expands in France

Germany's Lifocolor Farben, a manufacturer of colour masterbatches, additive preparations and compounds, is to invest more than €5m in a new plant at Izernore in France.

The new 5,300m² building will be located on a 15,000m² site with potential for future expansion. Commissioning is scheduled for 2H 2019 and, once complete, Lifocolor said the company will have 2,500 tonnes/yr of masterbatch capacity in France.

The company said the new investment is needed because its existing plant at Bellignat has reached its capacity limit. It added that the expansion "will allow for individual colour developments and productions to be handled with even more flexibility and shorter lead times".
› **www.lifocolor.com**

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Free registration opens for Compounding World Expo

Free online **registration** has now opened for the Compounding World Expo 2019, which will be held at the Huntington Convention Center in downtown Cleveland, Ohio on 8-9 May, 2019. Organised by AMI, the tradeshow will take place alongside the Plastics Recycling World Expo and the Plastics Extrusion World Expo.

By registering in advance, visitors will receive free admission to all three exhibitions, featuring more than 200 leading suppliers, plus free entry to five conference theatres hosting technical presentations, educational seminars and business debates. Attendees and exhibitors will also have the option to buy tickets (just $20 each) for a networking party at Cleveland's iconic Rock and Roll Hall of Fame on the evening of 8 May.

"The event will provide visitors with a great opportunity to meet and compare suppliers from around the world, as well as giving them the chance to learn from business leaders and technical experts in the conference theatres," said Rita Andrews, Head of Exhibitions at AMI. "Our debut compounding and recycling exhibitions in Essen, Germany attracted 4,024 visitors, and we are confident that our first Cleveland shows will build on this success and be the biggest plastics industry gathering in the USA in 2019".

The three expos, which will occupy the two largest halls at the state-of-the-art Huntington Convention Center, will feature a wide array of leading manufacturers of compounding, recycling, and extrusion equipment, plus suppliers of a huge variety of polymers, additives and related services.

The Huntington Convention Centre and Rock & Roll and Hall of Fame are located in downtown Cleveland

PHOTO: HUNTINGTON CONVENTION CENTRE

The exhibitor line-up already includes companies such as Coperion, Clariant, Entek, Milliken, CPM Extrusion, Dover Chemical, Farrel Pomini, Ferro, Leistritz, Cabot, NFM, Omya, JSW, BASF, Maag, Chemours, B&P Littleford, Wacker, Nordson, Lubrizol, Vertellus, Brabender, Modern Dispersions (MDI), Buss, Heritage Plastics, Mixaco, Paramount Colors, KraussMaffei Berstorff, Heubach, Schenck Process, Superior Graphite, Kennametal Conforma Clad, TPEI, Kaneka, Bay Plastics Machinery, Zoltek, Zeppelin, IMI Fabi, Promixon, Unibrom, CA Picard, Bekaert, Econ, Shamrock, Plasmec, Polyscope, Witte Pumps, Baerlocher, Una-Dyn/Piovan, Automotive Compounding Industry, Gneuss and over 100 additional leading suppliers.

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

The Compounding World Expo will include two dedicated conference theatres hosted by *Compounding World* magazine. They will feature more than 50 expert speakers covering the latest technology developments, market trends, and business issues. Speakers already confirmed for the three expos include senior representatives from A Schulman, Americhem, Aurora Plastics, Champlain Cable, Clariant, Deceuninck, General Cable, North American Pipe, Ravago Recycling, Recycle Across America, RTP, Sealed Air, Southwire, Techmer PM, Teel Plastics, Westlake, and many more.

To book your free ticket, which is valid for both days of the event and covers all three expos and the five conference theatres, please visit:
› **ami.ltd/Register-CWE**

Interseroh compounds direct with Corema

Interseroh has installed a Corema cascade recycling line at its plant in Eisenhüttenstadt, Germany.

The Corema line, which began operation in September, combines an Erema single-screw recycling extruder with a Coperion twin-screw compounding extruder. It allows dosing of additives, modifiers and fillers from levels of 0.25-40.0%.

"With this innovative technology...we are advancing to a new level in the field of plastics recycling," said Manica Ulcnik-Krump, Director of the Business Unit Recycled-Resource at Interseroh.

› **www.interseroh.de**
› **www.erema.com**

www.kraussmaffeiberstorff.com

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NEWS IN BRIEF...

Lehmann&Voss is to take over the operations of the **Osthoff Omega Group**. The group, which comprises Heinrich Osthoff-Petrasch and Omega Minerals Germany, is a major player in functional and lightweight fillers, such as hollow and solid spheres, ceramic foams and reinforcing fillers. Lehmann&Voss said the main Osthoff site at Norderstedt, Germany, will be retained temporarily and all the staff will transition.
www.lehvoss.de
www.osthoffomegagroup.com

Lanxess has increased capacity for its Bayferrox and Colortherm micronised red pigments by more than 5,000 tonnes/year via a debottlenecking operation at the Krefeld-Uerdingen site in Germany. The expansion is designed to meet growing demand from the plastics, paint and coatings industries.
www.bayferrox.com

Cabot Corporation has acquired NSCC Carbon (Jiangsu) – a 50,000 tonnes/year carbon black facility in Pishou, Jiangsu province, China, from Nippon Steel Carbon. It is described as a bolt-on acquisition that "will further support Cabot's growth objectives and broaden its capabilities to serve customers in China". The acquisition, and planned upgrades, is expected to cost around €50m.
www.cabot-corp.com

Compound Company to double capacity

The Netherlands-based The Compound Company is to invest €8m in a second plant at Enschede that will double its capacity for production of its EcoForte performance polyolefin compounds and Yparex extrudable adhesive resins.

The move, which will increase its capacity to 60,000 tonnes/yr, is a response to increasing market demand for its speciality compounds from customers in the building and construction, packaging, automotive, medical and photovoltaic sectors. "These investments will help us to meet the demand for our proprietary products and ensure capacity for our custom compounding partners," said Commercial Director Wouter van den Berg.

"There is a need for smaller, more flexible, more customised and more co-development type compounders, and this is exactly where we position ourselves," he said. "We are large enough and have the capabilities and cost structure to make our economics attractive, but unlike the huge compounders, we are not so big that we are inflexible and bureaucratic."

The Compound Company – which was known until 2017 as Resin (Products & Technology) and Yparex – began preparing the site for the 8,000m² plant last month with construction due to begin this month. Compounding lines will be installed in February next year and test runs and sample production is scheduled for March for start-up on 1 April.

The company said that the investment also includes an upgrade of the company's existing Enschede plant, which will include debottlenecking and the addition of seven new silos each able to store 70 tonnes of polymer.

› **www.thecompoundcompany.com**

SABIC adds gloss to PP

SABIC has launched PP PPA20, an impact copolymer grade of PP that, it claims, "offers aesthetically appealing surfaces, with potentially significant cost savings". Targeted at appliance applications, material is already available in the Europe, Middle East and Africa region, and will be phased in across the Americas in 2019.

PP PPA20 is said to offer high gloss, enabling it to compete with ABS in appliances, together with "well-balanced mechanical properties and easy processability", according to the company. These include higher scratch resistance and lower stress whitening than regular impact copolymers, plus more balanced impact strength and stiffness.

SABIC said the new material can provide both cost and energy saving potential due to its lower density, higher flow and faster crystallisation compared to currently used materials, which leads to shorter cycle times and weight saving design opportunities. In addition, it does not need pre-drying and can be injection moulded at lower mould and barrel temperatures than ABS.

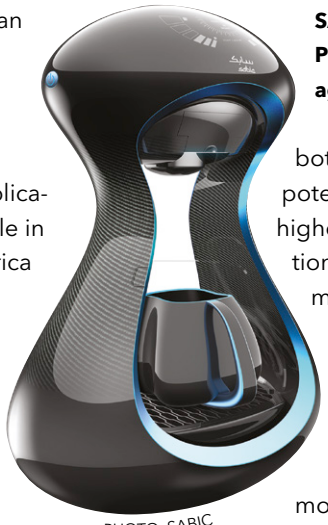

PHOTO: SABIC

SABIC is pitching its new PPA20 impact PP copolymer against ABS for appliances

Potential applications include household consumer good such as coffee makers, steam irons, vacuum cleaners, personal hygiene appliances and white goods, as well as high-end cosmetics and furniture.

› **www.sabic.com**

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Clariant to use Neste renewables

Under a newly-signed partnership agreement, Clariant will use renewable hydrocarbons from Finland's Neste in product development for its Licocene range of performance polymers and waxes. These are widely used in polyolefin plastics, as well as adhesives, coatings and other applications.

"This new partnership with Neste is a significant milestone in providing a sustainable future for Clariant and its customers. It is an exemplary cooperation because it provides a competitive advantage for our customers while making a sustainable impact across the value chain," said Christian Kohlpaintner, member of Clariant's executive committee.

The raw materials involved are C_2 and C_3 monomers, which are ultimately derived from waste and residue raw materials, such as used cooking oil and renewable vegetable oils. The monomers are said to provide drop-in replacements for those Clariant currently uses.

› **www.clariant.com**

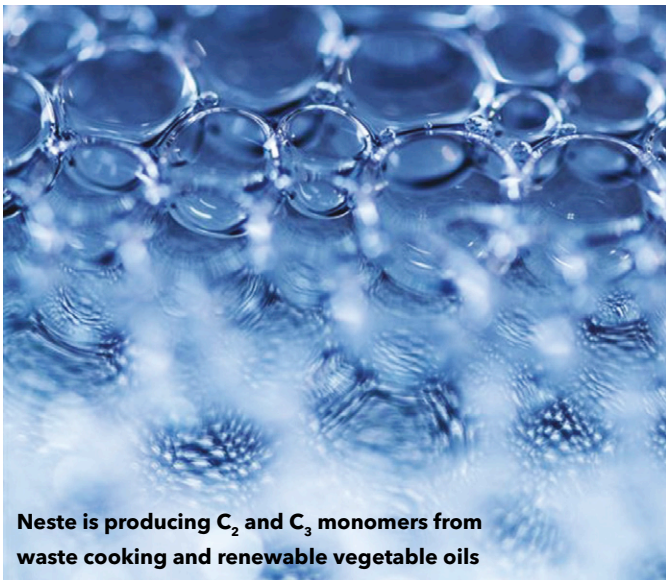


PHOTO: NESTE

Neste is producing C_2 and C_3 monomers from waste cooking and renewable vegetable oils

Chromaflo expands into Mexico

Ohio, US-based colorants maker Chromaflo Technologies has acquired the colourants business of Central de Colores Plásticos (Cecoplas), based in Querétaro, Mexico.

Cecoplas has been making colourants for plastics compounders for more than 20 years, primarily for the automotive, textiles, shoes and toys sectors. Production will remain at the Querétaro location, Chromaflo said.

Scott Becker, president and CEO of Chromaflo, said that the acquisition "is consistent with our efforts in supplying quality colorants and additives for high performance thermoset products in the Americas' markets and beyond."

› **www.chromaflo.com**

German plastic packaging market continues to grow

The German Plastics Packaging Industry Association (IK) is forecasting a 5.1% increase in sales and 3.9% increase in volumes for plastic packaging production in 2018. This is ahead of 2017's figures and will take the sector's total turnover to more than 4.5m tonnes and a value of close to €15.5bn.

Revenue and volume growth is expected in all segments. In some, particularly bottles, this is largely being driven by price increases in raw materials. Revenues in this sector are expected to rise by 7.9% to just over €2bn. Pouches, carrier bags and big bags are expected to show a volume growth of 6.9%.

The projection is "based on generally very good economic conditions in Germany", according to IK industry expert Inga Kelkenberg. However, the association notes that a survey by GVM shows some companies are struggling with rising energy costs and skill shortages.

› **www.kunststoffverpackungen.de**

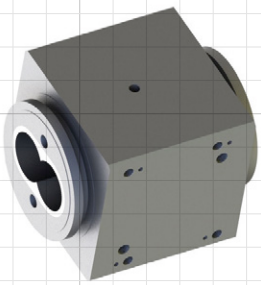
Recycling aim for artificial grass

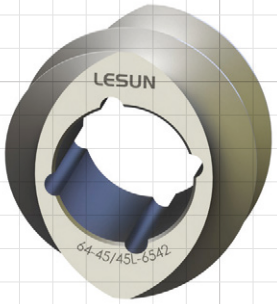
Three Italian companies – Eni subsidiary Versalis, fibre maker RadiciGroup and synthetic turf producer Safitex –are to join forces to make a recyclable artificial grass for sports surfaces. Currently, they say the material goes either to landfill or to incineration.

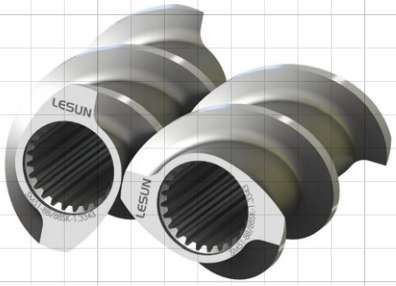
The three firms have carried out lifecycle assessments for their own products, quantifying the environmental impacts with scientific data and calculation rules valid in all European countries. The intention is that the material will be collected at end of life, shredded and processed for other sporting uses – shin guards, elbow pads or bibs – or for items such as garden equipment.

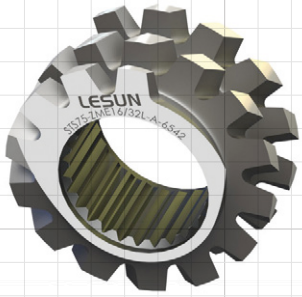
Versalis, RadiciGroup, a maker of fibres, and Safitex, a manufacturer of synthetic grass turf, announced the plan at the Ecomondo green technologies exhibition in early November. The companies said the project has been validated by the independent certification body Certiquality, which has issued Product Environmental Footprint (PEF) certificates.

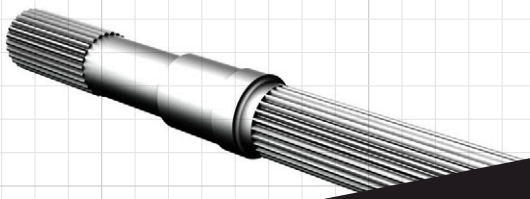
› **www.versalis.eni.com**











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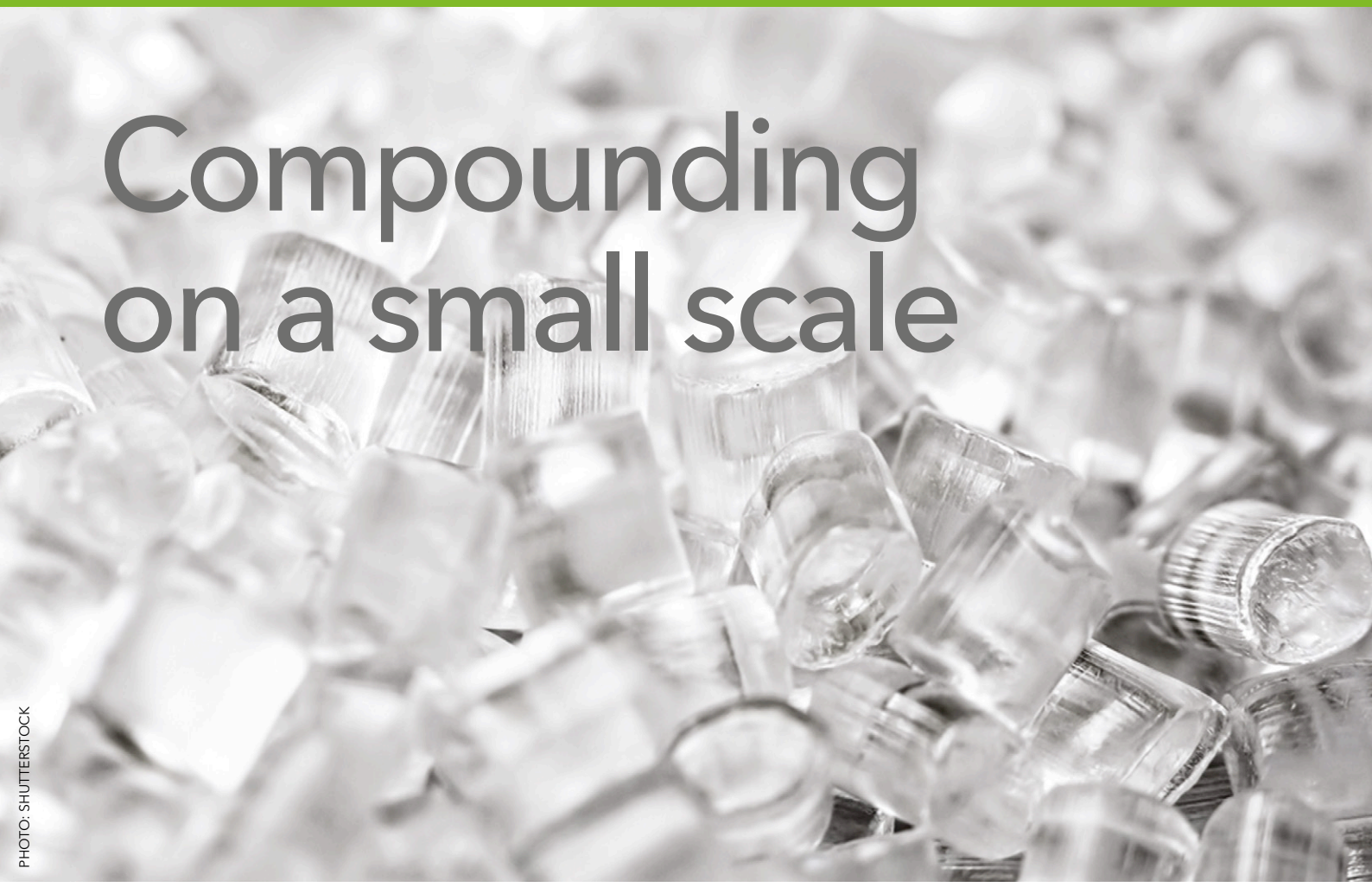


PHOTO: SHUTTERSTOCK

*Small enough to keep cost down, yet capable of scaling processes to production levels. **Mark Holmes** looks at developments in laboratory compounding equipment*

The laboratory compounder is an invaluable tool in research and development work and is essential in optimising new product formulations. For reasons of economy, lab-scale equipment must minimise the amount of potentially expensive materials used. However, it must also yield results that can be reliably scaled up to production equipment. Machinery designers and manufacturers are taking different approaches to meeting these goals.

Markus Schmudde, Head of Research & Development at **Coperion**, says extruder geometry is key. "Probably the most important requirement is that laboratory compounders have the same geometry as production extruders," he says. "For example, Coperion designs extruders from 18mm to 420mm outer diameter with the same basic geometry - a D_o/D_i ratio of 1.55. As well as the ZSK 26 Mc^{18}, to meet market requirements we have also introduced the ZSK 27 Mv PLUS laboratory extruder to provide a small-scale extruder in this product line. Another requirement is for the laboratory extruder to have a similar specific torque to that on the production line. Only if this is available can similar process conditions, in particular for torque limited processes, be established on each machine."

Laboratory compounding is required across many markets and application areas with almost all plastic compound producers using lab-scale equipment both to develop new products and for basic process research, according to Schmudde. "Often this is a question of cost and time because using a production line for development is usually more expensive. This is particularly the case for the special or high-end material laboratory lines used to develop new products. Research and development is highly important in this market, where materials are often expensive and the amounts for testing are small. Another important market includes the university sector, where small extruders are operated for basic material research," he says.

However, designing smaller extruders does bring some technical and engineering challenges. "Smaller dimensions often limit technical parameters, such as strength. In addition, the production of small screw

Main image: Lab scale compounding equipment must be cost effective yet able to deliver results and formulations that will scale reliably to production volumes

PHOTO: COPERION

Right: Lab extruders such as the ZSK 18 MEGAlab, must maintain the extruder geometry of larger production equipment, according to Coperion

elements or barrels made of special wear or corrosion resistant materials can be challenging. However, as long as they are not used as production lines like in the pharmaceutical industry, smaller extruders have less run time compared to production lines and so wear or corrosion often occurs more infrequently," he says.

Speed of cleaning and reconfiguration are also priority considerations, Schmudde says. "As laboratory equipment is often changed and rearranged for new requirements, easy handling can also often be an important factor. However, because mechanical forces are less compared with large scale extruders, special solutions for quick change screw couplings are possible for our small extruders, for example."

Lab to production

US-based machine builder **Entek** says it has sold laboratory compounding equipment to customers over the past few years that is required to meet both development and production needs. "R&D budgets can be tight but utilising a laboratory extruder for production for as much as one third of the year has helped justify the purchase of a machine," says Dean Elliott, Technical Processing Manager at the company. "Flexibility is often crucial, so we have developed 48 or 52:1 L/D extruders with multiple barrels that are interchangeable to either vent, side feed or liquid inject."

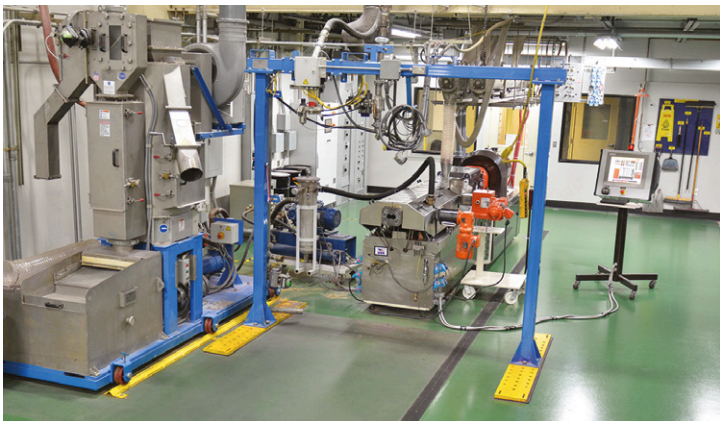
Elliott says many customers –and potential customers – highlight the challenges they face in compounding different types of materials and fillers and explains that this underlines the value of carrying out laboratory trials. "Entek has recently invested heavily on improvements to our in-house pilot plant at our Lebanon, Oregon, headquarters in the USA because this facility has become so important to both our own and our customers' product development. Experimenting and running trials is really the best way to prove-out new material formulations, and it has led to several enhancements to our machinery and equipment," he says.

"We have also seen a trend towards slightly larger laboratory extruders, for example Entek's 27mm and new 33mm QC^3 extruders. Customers are impressed with the quick changeover features of these two sized extruders; this equates to more seamless and efficient changeover during trials and also between R&D and production campaigns," he says.

Entek's QC^3 (Quick Change, Quick Clean, Quality Control) machine line includes 27mm, 33mm, and 43mm twin screw extruders and allows screw changes in five minutes or less. The ability to pull and replace the screws quickly and easily greatly reduces machine downtime, saving time and money. This is said to be particularly important in laboratory/small production runs.

Future development at Entek also includes training opportunities for customers running lab machines. "Laboratory compounders are sometimes managed and operated by scientists and chemists who often do not have hands-on operator or mechanical knowledge," says Elliott. "Providing training can be crucial to earning this business. Service contracts on laboratory compounders are

PHOTO: ENTEK



Entek has invested in its US pilot plant to help customers develop new production systems

PHOTO: ENTEK

Entek plans to offer dedicated training for lab staff that need to run compounding equipment

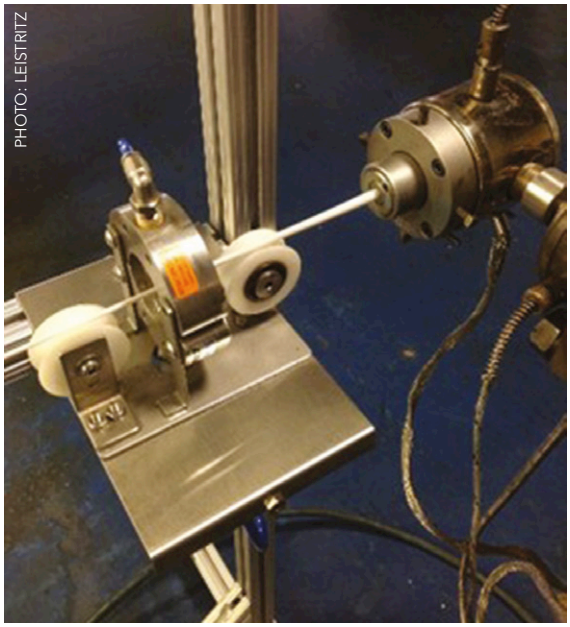


PHOTO: LEISTRITZ

Right: Leistritz demonstrated production of 3D print filaments on a ZSE 18 Maxx lab extruder at this year's NPE show

also important to these types of customers who do not want to deal with the maintenance of the equipment, however do want the equipment to be ready and available when needed for laboratory work."

KraussMaffei Berstorff says it is offering its ZE 28 BluePower laboratory extruder at a special price of €120,000 on 100 days delivery up until the start of next year to mark parent company KraussMaffei's 180th anniversary. The special anniversary edition is based on the ZE BluePower extruder, which comprises comprehensive basic equipment with standard options and will be delivered as plug-and-play solution. According to the company, research divisions and compounding companies will benefit from the ZE 28 BluePower anniversary model, which offers screw drive power of up to 42kW at a maximum speed of 1,200 rpm to provide maximum productivity. Equipped with a BPCTouch control system, the twin-screw extruder is claimed to provide ease of operation with intuitive user guidance throughout the entire process.

Lab compounding offerings from **Leistritz** include 18mm and 27mm diameter versions of its ZSE Maxx series (the company also offers a 12mm twin screw compounder but this is engineered for powder-fed pharmaceutical applications). Both plastics models can take on development work or short run production for masterbatch applications, for example.

Below: KraussMaffei Berstorff is offering a special anniversary version of its ZE 28 BluePower machine to the end of the year

The ZSE 18 Maxx model offers 18mm diameter screws with a D_o/D_i ratio of 1.66 and a rated torque of 11 Nm/cm³. Designed for production rates of up to 40kg/h, the unit can produce batch sizes of as little as 300g. The larger ZSE 27 MaXX is equipped with 28.3mm diameter screws. D_o/D_i is the same 1.66 as the smaller machine but torque rises to 12.5 Nm/cm³. It offers output rates of up to 350 kg/h. The company says scale up to production equipment is simplified by the consistent D_o/D_i ratio and the use of a modular design that allows production processes to be modelled in the laboratory.

PHOTO: KRAUSSMAFFEI BERSTORFF

Lab compounders can also be used in low volume production applications. At last year's NPE show in the US, Leistritz showed a ZSE 18 Maxx model configured with loss-in-weight feeders, gear pump, die, custom air-rack, belt puller, laser gauge and winder for development of 3D print filaments. The extruder was configured for operation at up to 425°C at throughputs of up to 20 kg/h. Leistritz said it saw the system as a development or low batch volume production system capable of "on-the-fly" recipe modification.

Changing needs

According to Corné Verstraten, Chief Sales Officer at **Dr Collin**, specific issues driving new developments in laboratory compounding at present include the need to incorporate fillers from renewable sources, the increasing use of biopolymers, and performance enhancement of polypropylene to allow it to compete with technical polymers. In addition, the company sees direct compounding being further developed. Examples include blown film or cast/sheet lines installed after the extruder, as well as installation of a compounder in a film extrusion line. He says that to achieve these tasks in the laboratory, a compounder must offer flexibility, modularity and reproducibility, with the configuration of the barrel and screw being able to be changed easily in a short time period.

Other current areas of interest in laboratory compounding include the development of new compounds with the aim of finding the limits of filler in certain polymers, as well as reducing

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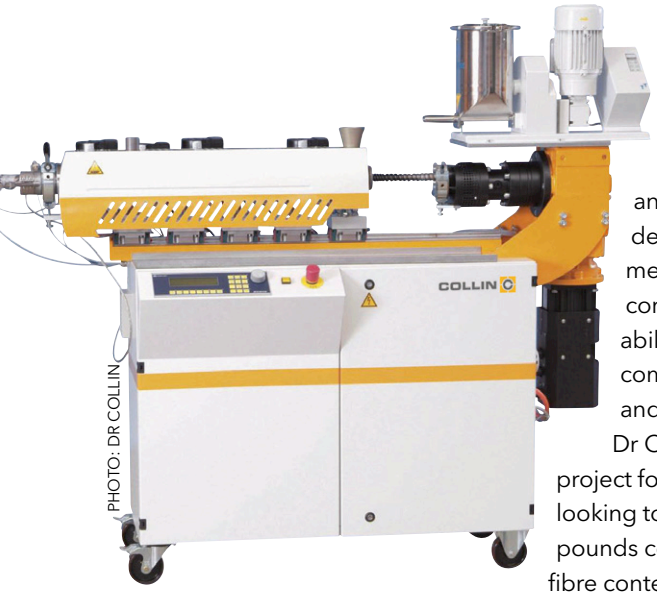


PHOTO: DR COLLIN

Above: Flexibility and reproducibility are key requirements of lab compounding equipment such as the Compounder E, according to Dr Collin

the weight of new compounds for the car industry and continuing the development of metal-replacement compounds. Sustainability is another common research area and recent examples at Dr Collin include a project for a customer looking to produce compounds containing up to 70% fibre content and installation of a compounding extruder in a 9-layer flat film line.

Verstraten adds that future developments will include new technologies allowing the use of fibres with very low bulk densities, as well as working with technical polymers, high temperature materials and fluoropolymers. The company also has initiatives in the pharmaceutical and medical sectors.

Compact developments

Farrel Pomini has made a number of improvements to its CPeX laboratory compact processor. Launched in 2016, the CPeX is a laboratory version of the company's compounding system – a continuous mixer that discharges into a single screw extruder for pelletising. Continuous mixing technology features two counter-rotating and non-intermeshing rotors and is claimed to be a good alternative to twin screw extruders for compounds and masterbatches with high filler loadings, for abrasive (high wear) materials and for temperature-sensitive materials that require intensive mixing while maintaining low processing temperatures. The company adds that, as a two-stage machine, the output rate of the extruder differs from a twin screw machine in that it is independent of mixing. The laboratory machine has the same fully functioning orifice as the production-sized machines to control fill level, which regulates the specific energy input to the material.

According to the company, the CPeX is designed to take on feasibility studies and other laboratory work and is targeted for production rates of 10–30kg/h. It is said to be particularly useful for training centres and universities and is well suited for processing a variety of compounds and colour concentrates.

The CPeX is designed to allow interchangeability between Farrel Pomini's standard CP rotor and its XL rotor, which has a longer ratio (10:1) and offers tighter temperature control and increased residence time. The company says that the two rotor configurations each have benefits and now can be compared side-by-side for a given material. While most customers use the standard format, the comparative capability will allow determination of when the CPXL rotor would be more beneficial.

Enhancements made to the CPeX in the past few years are primarily in the areas of the control system and reporting, as well as the addition of features that allow the CPeX to mirror production Compact Processors more closely. The CPeX control system is now configured with selections for the major feeder brands and the customer can choose up to three gravimetric feeders to accommodate full size resin pellets, fillers and additives. Both the feeder and mixer are pre-configured with integrated wiring and piping for 'connect and go' operation.

The PLC-based control system and touchscreen HMI are designed to be easy to use and provide optimal viewing control. A web-based supervisory control and data acquisition (SCADA) function, which enhances analysis and recipe building, is included and the control system now includes the ability to capture process parameters within any interval and generate reports. There is also a new historical data export feature that includes individual process parameters in addition to the process parameters of the entire machine.

In terms of scaling up, the CPeX has the same temperature control capability as the company's production size machines. Two melt temperatures are monitored – one at the mixer discharge and the other at the extruder die. The mixing chamber has all the process features of production size machines, including mixing dams, liquid injection segments and venting ports.

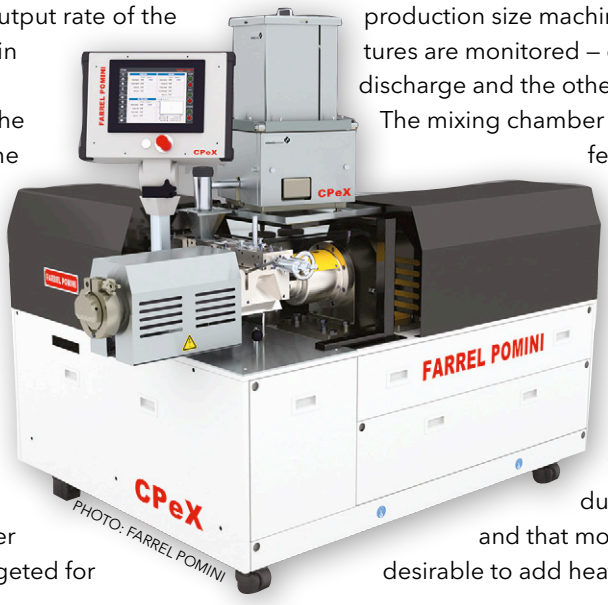
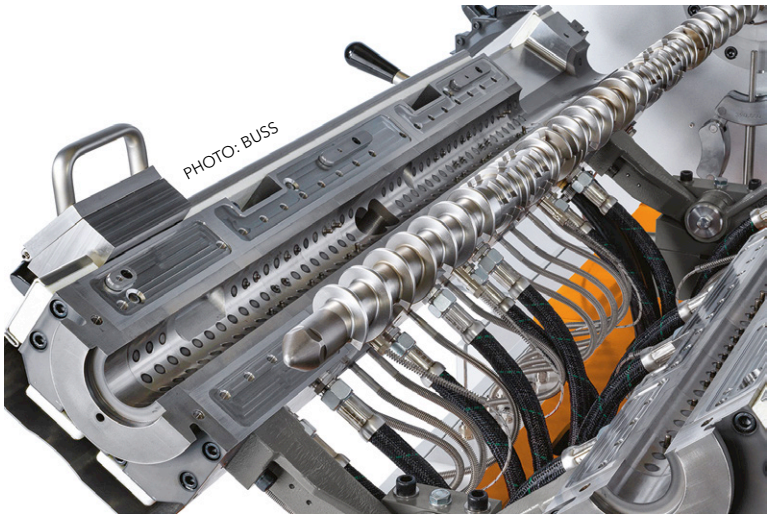


PHOTO: FARREL POMINI

Right: Farrel Pomini's CPeX lab processor is well suited to feasibility trials and formulation studies

Farrel Pomini says it is important to know how much heat is being imparted to the polymer during the mixing process and that most of the time, it is not desirable to add heat during pumping



Above: Buss engineers are developing a new lab compounding extruder around its recently launched Compeo Kneader design

through the discharge of the extruder. The design of the mixer discharge orifice closely couples the mixer to the extruder and allows molten material to be diverted from the mixer for evaluation prior to discharge into the extruder feed zone. This close-coupled design also eliminates exposure of the molten polymer to air, minimising oxidative degradation and making the unit well suited to trials as a processing reactor supplied with powder resin and additive masterbatch.

Increasingly high flexibility for lab equipment is currently seen as a priority for customers at co-kneader manufacturer **Buss**. "In terms of product first, this is where laboratory compounders must be able to prepare a very broad range of products and formulations, and in terms of process as laboratory compounders are not only expected to produce samples for testing purposes but also small batches…Those requirements impose additional constraints regarding the performance and operability of laboratory compounding equipment," according to Dr François Loviat, Head of Process at the Swiss company.

"The key strengths of laboratory compounding equipment are flexibility and scalability. Unlike large scale production machines that are usually designed for one specific application, often even tuned for a precise formulation, the exact compounding tasks to be performed on laboratory compounding equipment are usually not defined very accurately at the time the machine is built. High flexibility ensures that laboratory equipment will be usable for a broad range of applications," Loviat explains. "Results obtained on laboratory compounding equipment must reflect as far as possible the possibilities on larger industrial equipment. This makes it possible and meaningful to use laboratory compounders for feasibility studies, formulation development and reduces the scale-up risk."

Loviat adds that, in general terms, all markets where steady product development and formulation optimisation is an essential will have the need for a laboratory compounder. In addition, the machines provide a key development tool for industries or universities making use of expensive or not commercially available additives. Often these new additives or products must be synthesised in the laboratory at a gram or at best kilogram scale, making a small scale compounding machine essential.

Developing design

Buss Chief Operating Officer Marko Staehler says the company is currently working on a new laboratory machine that will be based on its new Compeo Kneader design. It will provide high flexibility, easy cleaning for frequent product changeovers and screening studies, improved stability for long term operation, and reliable scaling to production scale Compeo units.

Scalability, long term stability and suitability of the machine for continuous operation is being tackled by defining a machine size that reflects the process geometry of the company's production machines. Staehler says the machine will also offer the same process control possibilities, including screw tempering, to allow stable and reproducible

operation to be achieved. He says operation will be enhanced with a simplified and intuitive control system that will be aimed specifically at the needs of researchers and laboratory personal. A compact plug and play system will also support integrated equipment, such as HC units, discharge unit and pelletiser, and optionally including premixer and dosing system.

The **Thermo Scientific** Process 11 parallel twin screw extruder is a bench-top model intended for laboratory compounding and masterbatch development. It offers a throughput of up to 2.5 kg/h and can produce samples of as little as 20g. The 11mm diameter 40 LD screws offer a torque of 6 Nm and maximum speed of 1,000 rpm. The company recently added a sheet take-off to the range of accessories for the machine, allowing direct production of sample materials. The company says Process 11 results scale well to its larger compounding models, which include the Eurolab 16 XL and TSE 24 MC.

Single screw options

While most lab compounding is carried out on twin screw units, or perhaps internal mixers, there is a role for single screw extruders in producing high quality development compounds, argues Keith Luker, President of **Randcastle Extrusion Systems**. "This depends on the application, but there is now good evidence to support this," he says. "Laboratory single screw compounding has advanced and is slowly moving into production. In addition, small batch mixers are known to be an order of magnitude better than conventional batch mixers. In terms of laboratories, small batch mixers have downsized - a single pellet can now be mixed. This means that exotic, often otherwise prohibitively expensive materials, can be mixed. Structurally, the technology for single screw mixing is the same for the batch mixers. This is important for scale-up."

One area that Luker believes offers potential benefits in laboratory compounding is three-dimensional mixing. "Mixing is best advanced towards uniformity by stretching and folding. Orderly mixing requires an understanding of what is being stretched and the order of stretching. Mixing in all three dimensions is required in order to get effective, distributive mixing. Mixing in all three dimensions is not linear but exponential - to the cube - so it is vastly better than mixing in one (linear) direction," he says.

"Historically, single screw extruders have been poor mixers using shear, melt separation and recombination. Meanwhile, twins have used chaotic elongation for mixing which made them far

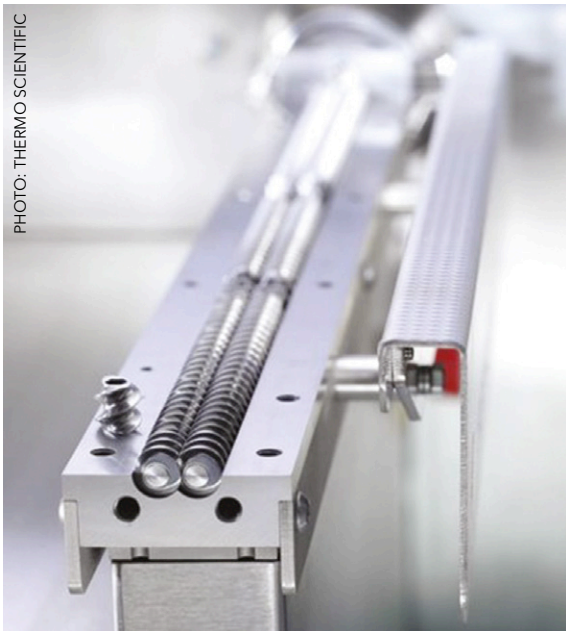


PHOTO: THERMO SCIENTIFIC

Right: The Process 11 twin screw extruder from Thermo Scientific is designed for R&D applications

superior for both distribution and dispersion to the single screw extruder. Single screw mixing can now be both elongationally dominant and orderly. The combination can yield results that are superior to twin screws for distributive mixing," Luker says.

"Polymers are viscous and they behave in an orderly way. By eliminating chaos from the mixing process, a single screw extruder can mix three dimensionally in an ordered fashion. This distribution has inherent advantages over the chaotic mixing inherently present within the twin screw extruder," he claims.

"We continue to make advances in 3D compounding through the Randcastle 3D Elongator. The 3D mixing technology increases mixing performance while maintaining the natural advantages of the single screw – high, stable pressures at low cost," he says. "There are many extruder mixing applications that require distribution rather than dispersion and self-wiping – the two main assets that a co-rotating twin screw has over a single. These include polymer alloying, fine mixing of immiscible polymer blends, mixing free flowing particulates, mixing of nano-scale objects, and mixing of plasticisers."

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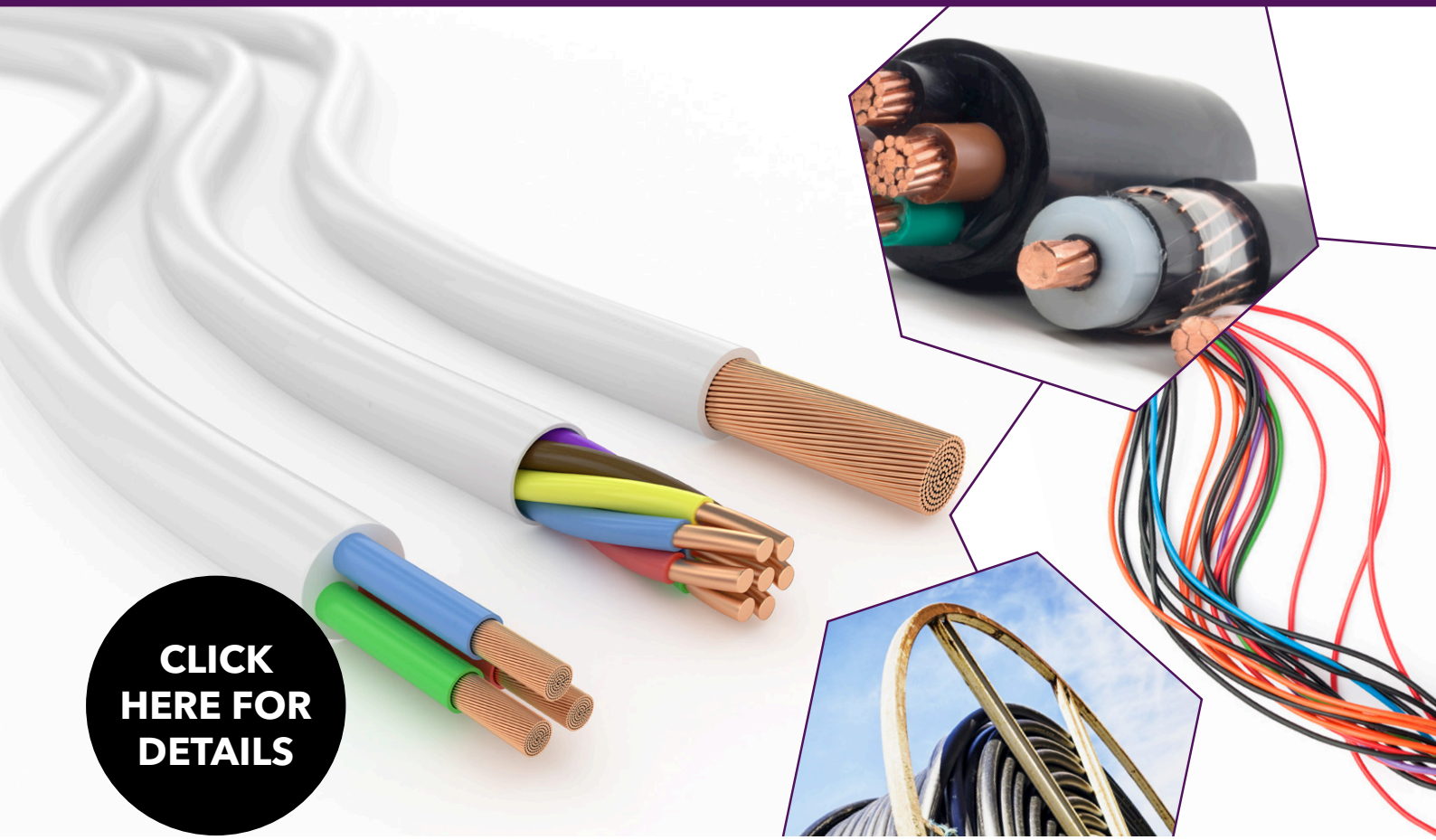

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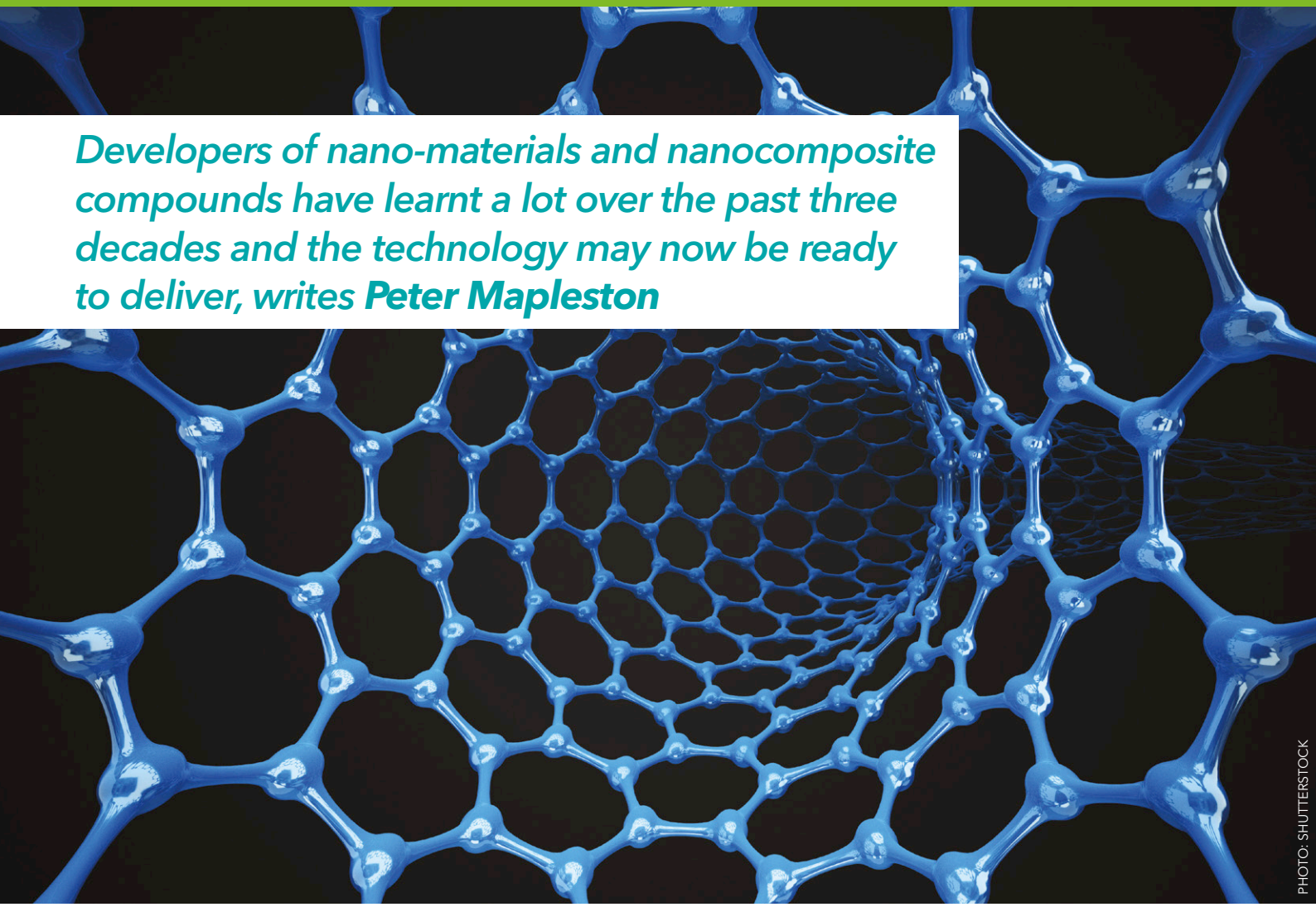

Developers of nano-materials and nanocomposite compounds have learnt a lot over the past three decades and the technology may now be ready to deliver, writes ***Peter Mapleston***

PHOTO: SHUTTERSTOCK

Nanocomposites are now ready to deliver

They may sound like novelties, but nanocomposites are now over 30 years old. Defined as a compound – it is unclear why the word composite was chosen – containing a filler having at least one dimension in the nanometre (10^9 m) range, nanocomposites were born in Toyota's research laboratories in the late 1980s and put to use, in the form of a nanoclay-reinforced PA6 , in a timing belt with enhanced mechanical properties in 1991. Since then, they have been a major area of research, with different nano-additives being used to improve not only stiffness and strength, but also fire resistance, gas barrier, electrical and thermal conductivity – all using much lower addition rates than are normally applied for established additives intended to do the same job.

Considerable development effort has gone into the preparation and incorporation into thermoplastics of nanoparticles having differences in shape, size, aspect ratio, structure and geometry; several types of nanoparticle have been recognised as possible additives to enhance performance properties. These include nanoclays such as montmorillonite and halloysite; and carbon in what might be considered almost one-dimensional form (single and multi-wall nanotubes or SWCNTs and MWCNTs) and in two dimensions (graphene). There are also carbon variants in spherical form, but these have to date found little application in nanocomposites.

Nanotechnology certainly has the potential for an important future in plastics compounds, but that future is possibly not as golden as was originally portrayed. Today, the evangelical fervour has waned to be replaced by more measured claims and expectations. "We remain believers in the

Main image: 30 years on from their first arrival, the hype of some nanocomposite pioneers has been replaced with more realistic and affordable solutions

tremendous potential of nanocomposites," says Richard Marshall, CEO of **TenasiTech** in Boston, MA, US. His company has developed anti-mar/scratch additives based on nanoclay technology for various polymers, including acrylics, polyamides, and polyesters.

"From a strategic point of view, in recent years, polymer producers have released fewer and fewer new polymers in the market. Rather, they extend resin performance by making small variations to polymer chemistry, or develop co-polymers based on their existing feedstock. This provides opportunity for nanocomposites in several ways," he says.

"First, innovation lies more and more with compounders or OEMs, who are more open to composite material solutions to differentiate their offering to end-users and have greater flexibility to deliver such solutions. Second, new co-polymers can suffer from other performance deficiencies which need fixing through additives; such as scratching in our case," Marshall explains.

"If we have one criticism, it is that the nanocomposite community can be prone to the whims of 'materials fashion!' We have seen this with nanoclays, which were highly publicised in academic and trade circles early on but fell out of favour when other materials became in vogue. Our philosophy is to complete the work with customers required to extract value from these materials, value we know is there to be exploited."

Compounding into polymers is usually not trivial for nanomaterials, Marshall says, noting that "a great

Tips for processing nanoparticles

"Processing of nanoparticles with thermoplastic matrices is always a challenge," says Raquel Llorens, a compounding specialist in the Compounding Department at Spanish plastics technology institute **AIMPLAS**. "The extraordinary high specific surface of nanoparticles compared with conventional reinforced fibres induce great attractive forces between the nanoparticles themselves, in different levels of aggregation, producing agglomerates (from 0.5 microns to 200 microns). Depending on the particle geometry, we can find different types of agglomerates: bunches for spherical particles, stacks for sheet particles, and balls for fibrillar structures."

Llroens identifies several key challenges to dispersion of graphene materials in thermoplastics. "Thermoplastics are high viscosity fluids in the melt form; graphene sheets can be broken by the effects of high shear and are very easy to bend and roll; there is great variability in the chemical behaviour of polymers, from highly polar to totally non-polar; dispersion methods must be able to scale industrially in a simple and inexpensive way; polymers are very large molecules with limited infiltration power between graphene sheets," she says.

AIMPLAS research has identified three key technologies for dispersing nanomaterials in polymer matrices: dispersion in liquids; "In-situ" polymerisation; and melt mixing (as used in conventional compounding). Table 1 spells out the pros and cons of each.

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Table 1: Advantages and disadvantages of different techniques for dispersing graphene nanoparticles in thermoplastic compounds

METHODS	Advantages	Disadvantages
"In-situ" polymerization	Good dispersion of graphene in polymer matrices	Increase in viscosity that hinders handling and maximum load level
	Strong interaction between graphene and polymer matrix	
Dispersion in liquids	Simple route to disperse graphene in polymer matrices	The use of surfactants can affect the properties of polymers
	Good dispersion of graphene in polymer matrices	The elimination of the solvent can cause the aggregation of the graphene sheets
		Not friendly to the environment
Melt mixing (compounding process)	More commercial and scalable	Poor dispersion of graphene compared with other methods
	More compatible with industrial practices	Can cause winding or breakage by high shear
	Environmentally friendly	Needs large equipment
	Suitable for mass production	

Source: Aimplas

deal" of nanotechnology relies on tailoring inorganic particles with organic chemistry to assist in exfoliation into the resins of interest. "Doing this industrially is the key to making any of these materials useful for consumers. Moving to larger extruders, say, is worth doing sooner rather than later."

TenasiTech's most recent offering is Solid-HT, designed for polymers processed at higher temperatures. "This means we are now selling to polycarbonate customers," says Marshall. "Scratching for polycarbonate remains a continual problem for many, whether moulding or sheet extrusion." He says that when processing PC incorporating the Solid-HT additive, extruded sheet can be thermoformed without losing the anti-scratch performance. He says this is a benefit that cannot be achieved with a traditional hard coating.

Tackling the hype

At **NanoSperse** – which is based in Kettering, OH, US, and focuses almost exclusively on aerospace nanocomposites for thermoset, thermoplastic and elastomeric systems – company President and CEO Arthur Fritts contends that nanomaterials were "over-hyped" from the beginning. "NanoSperse has been in business since 2004. We have seen so many competitors come and go I have lost count. The problem for particle manufacturers is the volume they need in order to bring unit costs down and make their business models work. We have always been focused on smaller niche applications with moderate economic barriers but extremely long transition timelines," he says.

"Nano materials are generally part of the solution, not the entire solution. NanoSperse continues to find ways to create value with nano composites. We find that patience, concentrating on genuine customer value creation, and living within a realistic expectation for volumes/time horizons produces results," Fritts says.

Researchers at **Michigan State University** (MSU) in the US have developed technology for improving the foaming properties of linear polypropylene through the incorporation of a nanoclay and a polymeric modifier. Linear polypropylene is not ideal for making foams for sealing purposes due to its poor melt strength, they explain. "Attempts to overcome this limitation by cross-linking a portion of the linear polymer or by adding a long chained branched polymer have resulted in

Right: With graphene –and most other nano-additives – a little goes a long way

unwanted side effects, such as a reduction in recyclability. Additionally, long chain branched polymers are expensive and increase foam cost."

Polypropylene foam made the MSU way can be re-melted and reformed. The nanoclay eliminates the need for cross-linking and means it is not necessary to add a long chain branched polymer to achieve the appropriate melt strength for foaming. It also increases stiffness. The nanocomposite approach is also said to be less complex, since foam producers can use the nanoclay in masterbatch form.

Flame retardant gains

Nanoclays have gained a notable niche as flame retardant additives, especially in wire and cable. Günter Beyer – who became an expert in nanoclays and their fire resistance properties at Kabelwerk Eupen and now has his own consulting company, **Fire and Polymers** – highlights work at NIST, the National Institute of Standards and Technology in the US, investigating the background for improvements of flame retardancy by nanofillers. "It is historically fortunate that the first investigated system was montmorillonite, since it has always shown the best flame-retardant improvements compared to other nano-dispersible fillers like carbon nanotubes, graphene or layered double hydroxides," he says.

The flame-retardant improvements were typically measured by cone calorimeter, which showed strong reductions for the peak heat release rate (PHRR). But nanofillers did little to improve properties measured according to UL 94, or in limiting oxygen index (LOI). "What is also important is that one finds no real difference in the cone calorimeter between exfoliated and intercalated structures…This is important to the industry because it allows the application of a wide range of compounding machines from roll mills to twin-screw extruders or co-kneaders," Beyer says.

Right: These sports shoes use graphene-enhanced rubber soles to improve performance and durability

"The reason for the very good flame retardancy by nanocomposites can be explained by the formation of a barrier in the case of a fire which makes it difficult for the degradation products to escape and leave the polymer," he explains. "The reduction in PHRR is closely linked to changes in the degradation pathway which occurs in the presence of montmorillonite. Large reductions are found for PA, EVA, TPU and PS. SAN, ABS, PP and PE show moderate reductions and polymers like PMMA or PAN do not have a change in the degradation pathway and hence no significant change of PHRR."

The future of nanocomposites for flame retardancy is as one component of a multi-component system, according to Beyer. "It can be the combination of a condensed phase flame retardant with a vapour phase flame retardant: charring by montmorillonite and quenching of burning materials in the vapour phase," he says. "Due to the very large interfaces between the polar nano-dispersed montmorillonite and the polymer matrix, people need to be aware of migration /absorption of polar polymer additives like antioxidants or UV-stabilisers from the polymer matrix to the montmorillonite surface; this will lead to problems both for ageing and light stability. But that can be avoided by proper additive selections."

Graphene – the new black

Away from clays, the nano-material stealing much of the limelight is graphene, first extracted by two researchers at the University of Manchester in the UK using, the story goes, little more than sticky tape to successively peel layers from a piece of graphite. The technology is rather more sophisticated today. Last year, **Versarien**, which has a majority share of the university's graphene subsidiary **2-Dtech**, said

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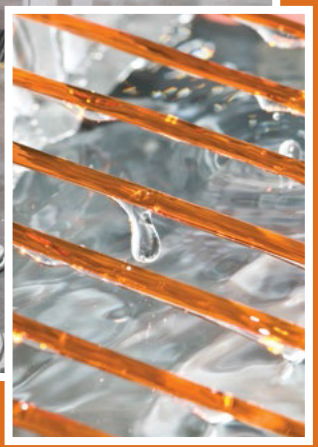
Jim Drew, Plant Manager, OptiColor, Inc.



Jim Drew, Plant Manager (left) and ENTEK's Linda Campbell at OptiColor, Inc.'s, Huntington Beach, CA Facility

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it had made a major advance in graphene platelet production that it says will accelerate potential commercial applications for graphene and graphene products.

The new process involves a mechanised exfoliation process in which a strong shearing force is applied to the surface of the graphene layers. "This process can be automated and allows graphene sheets to be produced in larger quantities and with greater chemical purity," says Versarien. "The 2-DTech production process provides significant amounts of single-layer graphene on an industrial scale."

The first sports shoes to utilise graphene were unveiled in June. Sports footwear and apparel company inov-8 developed what it calls a "graphene-enhanced rubber" (it doesn't say what type of rubber, or how the graphene is incorporated) in collaboration with graphene experts at the National Graphene Institute within the University of Manchester. The compound, used in outsoles of the company's G-Series shoes, is said to make them 50% stronger, 50% more elastic and 50% harder-wearing than regular sports shoe soles.

"Prior to this innovation, off-road runners and fitness athletes had to choose between a sticky rubber that works well in wet or sweaty conditions but wears down quicker, and a harder rubber that is more durable but not quite as grippy," says Michael Price, inov-8 product and marketing director. "Athletes now no longer need to compromise."

In the US, **XG Sciences**, based in Lansing in Michigan, has developed various grades of xGnP graphene naoplatelets, which it says provide multi-functional performance improvement in thermoplastics when used as an additive in low concentrations. At the Compounding World Forum in Fort Lauderdale last year, the company detailed how two grades were compounded into HDPE to produce masterbatches that were then used in production of blow-moulded bottles with varying graphene concentrations. Flexural modulus enhancement of as much as 11% was measured with xGnP graphene concentrations of 1%. In addition, manufacturing efficiency could also be improved due to the improvement in thermal conductivity, which meant less energy was needed to create a melt and part cooling was accelerated.

Below: Ford has been working with XG Sciences to conduct heat and strength tests on nanomaterial prior to production. First on-the-road projects are close to reality

PHOTO: XG SCIENCES

Moves on the road

This October, Ford Motor Company said it would soon start using XG Sciences graphene in vehicle parts. The car maker points out that graphene is 200 times stronger than steel and one of the most conductive materials in the world, as well as being able to provide sound insulation. And while it says graphene is not economically viable for all applications, it has, in collaboration with **Eagle Industries** (a producer of automotive NVH components) and XG Sciences, "found a way to use small amounts in fuel rail covers, pump covers and front engine covers to maximise its benefits."

The breakthrough is not in the material, but in the way it is used, according to Debbie Mielewski, Ford Senior Technical Leader, Sustainability and Emerging Materials. "We are able to use less than a half percent to help us achieve significant enhancements in durability, sound resistance and weight reduction," she says.

Ford says the graphene has been applied in foam compounds. "Tests done by Ford and suppliers have shown about a 17% reduction in noise, a 20% improvement in mechanical properties and a 30% improvement in heat endurance properties, compared with that of the foam used without graphene," it says. Graphene is expected to go into production by year-end for more than 10 underhood components on the Ford F-150 and Mustang and eventually, other Ford vehicles.

Also in October, XG Sciences said it approximately doubled graphene nanoplatelet production capacity at he larger of its two facilities to close to 180 tonnes/yr. In a further expansion, expected to be complete by year-end, capacity at the site will rise to 400 tonnes (and to around 450 tonnes/yr across both facilities).

Expansion in SWCNTs

Single-wall carbon nanotubes can be considered as rolled graphene sheets (although that is not how they are made), which is why leading producer **OCSiAl** has coined and sometimes uses the name "graphene nanotubes". It expects to sell "a significant amount" of its Tuball SWCNTs in 2019, according to Christoph Siara, the company's Sales

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Above: Compounds containing nanoparticles can be safe to handle

and Marketing Director in Europe. "OCSiAl has technology to mass-produce graphene nanotubes, and is scaling up production capacity in various locations worldwide," he says.

Siara says that, unlike multi-wall CNTs, carbon fibres and most types of carbon black that tend to disperse unequally in the material's matrix, SWCNTs create a uniform network at the same volume fraction. So while the percolation threshold for carbon black is between 20 and 40%, for its SWCNTs it is between 0.001 and 0.01%.

OCSiAl has developed applications in rubber latex, silicones, and polyurethanes, as well as polyolefins for rotational moulding. Siara says the company has succeeded in applying the nanotubes to processes including compound extrusion and injection moulding. He says the company exhibited at the recent Fakuma trade fair in Germany, which has a strong focus on injection moulding, "to motivate the market to build the technology to be able to use graphene nanotubes."

OCSiAl offers its SWCNTs in a neat form and also as masterbatches. The version for use in polyolefins is called Tuball Matrix 801 and is intended for dosage rates that start at 0.5% by weight. This is already being used in production of rotationally-moulded antistatic packaging for flammable and explosive liquids and powders. A second application is in semi-conductive shielding materials for medium and high-voltage power cables. A third in injection moulded PP casings with ESD characteristics.

Another possible addition option is to add the SWCNTs at the polymerisation stage. "This is a much more promising way to go," Siara says. "We have shown it is possible with polyamides and also polypropylene." He says this should further the cause of lightweighting in automotive applications by allowing polyolefins to be used in more demanding applications than is possible to today.

OCSiAl is currently building new facilities to produce SWCNTs in Luxembourg, and these are set to go into production between the end of 2020 and 2022. There will be five units in all, with a combined capacity of 250 tonnes/yr. The company already has production in Siberia: a 50-tonne standard production reactor plant and a 10-tonne pilot plant.

Also at Fakuma was **Cabot**, with its growing range of carbon-based solutions. Angelos Kyrlidis, the company's Research and Development Director, Advanced Carbons for New Product Development, gave a presentation at the event on new conductive formulations with what he calls Advanced Carbons. These include graphene aggregates, which the company is targeting at batteries, and reduced graphene oxide (rGO), for plastics and elastomers; as well as CNTs and Carbon Nanostructures, CNSs, described as forests of crosslinked branched nanotubes that are easier to disperse than CNTs.

Addressing the risk

OCSiAl recently engaged **Envigo**, an independent European research laboratory, to conduct studies on possible ecotoxic effects of Tuball SWCNTs. Their ecotoxicity potential was examined by treating algae, which are acknowledged as being a very sensitive species, with a saturated solution of the nanotubes for 72 hours, in accordance with OECD chemical testing guideline 201.

The measured algal biomass densities and thus the growth rates demonstrated that there were no toxic effects after exposure of algae to Tuball nanotubes. The company quotes toxicology consultant Detlef Schuler as saying: "There is no indication that dissolved Tuball single wall carbon nanotubes have any intrinsic ecotoxic properties at all when tested in solution as stipulated by the testing guideline. Furthermore, unlike multi wall carbon nanotubes and carbon fibres, single wall carbon nanotubes are highly flexible and may thus generally have a lower potential to harm the cell walls of algae."

The International Agency for Research on Cancer has categorised one type of multi-wall CNT (MWCNT-7) as a Group 2B substance, meaning "possibly carcinogenic to humans." It categorised all other types of MWCNT, as well as SWCNTs, as Group 3 substances, "not classifiable as to their carcinogenicity to humans".

Another company taking care of H&S aspects is **Nano4**. It was founded seven years ago with the goal of turning breakthrough nanotechnologies developed at the University of Mons and its research institute Materia Nova in Belgium into commercial products. Nano4 is active in nanoparti-

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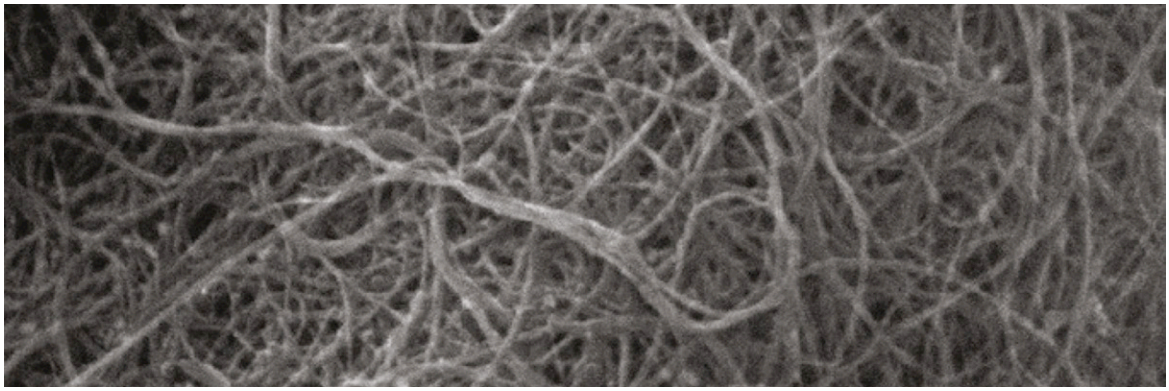

PHOTO: OCSIAL

Right: Testing to date shows that single-wall carbon nanotubes do not appear to cause cancer

cles and nanocomposites for applications that span healthcare, textiles, functional packaging, and beyond. "With its access to cutting-edge technologies, an important scientific background and processing and characterisation equipment, the company has specialist knowledge in extrusion compounding of the materials," says Product Development Engineer Vanessa De Wolf.

"The incorporation of nanoparticles includes safety risks for which there is not enough information on long-term toxicity," she says. "That's why the infrastructure at Nano4 is designed to assure maximum safety for the people handling them. Nano4 provides a dust-free product, which helps the customer to have a safe access to nanotechnology." Nano4 is specialised in small series compounds, with throughput rates ranging from a few kg to several hundreds of kilos per hour.

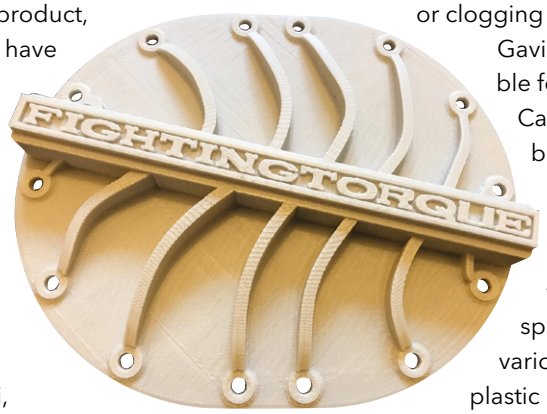

PHOTO: CARBODEON

Right: A 3D printed part produced using uDiamond filaments containing Carbodeon's nano-diamond particles

Abhishek Gupta, a Product Specialist at **Intelligent Materials** of Derabassi, India (it has a sister sales company **Nanoshel** in Wilmington, DE, US), says the company is investigating numerous nanomaterials, including single- and multi-wall carbon nanotubes, nanofibres and nanowires, and even gold, silver, titanium dioxide, silicon dioxide, and "quantum dabs" (based in graphene). Intelligent Materials has recently developed conductive nanocomposites based on MWCNTs in polymers ranging from polyethylene to PEEK for various industrial applications, including conductive flooring and other products with improved electrical, thermal and mechanical properties.

Improving 3D print

Meanwhile, **Carbodeon** of Finland has developed uDiamond compounds containing its nanodiamond additive for 3D printing by fused filament fabrication. The company says the materials will enable faster 3D printing, with improved mechanical and high temperature properties of the printed parts. The first product in the family is based on PLA (polylactic acid). Carbodeon says it has been able to retain the ease of processing of PLA in additive manufacturing systems, such as its easy bed adhesion, low warping and compatibility with ordinary brass nozzles, but has doubled the strength of printed parts and enhanced the high temperature performance. The company says that this is, in part, due to the spherical nanodiamonds acting like a lubricant so they do not increase wear or clogging of the printer nozzle.

Gavin Farmer, who is responsible for Business Development at Carbodeon, says: "We have been providing nanodiamond material for several years to tailor a wide variety of mechanical and thermal properties in specific applications of various thermoset and thermoplastic materials. We knew we could bring useful improvements to many of the polymers used in 3D printing."

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Automotive and construction drive developments in FRs

Tougher building fire regulations and the rapid development of EVs calls for more effective and more environmentally-acceptable flame retardant systems, writes ***Peter Mapleston***

Tougher building regulations and automotive electrification are two among many factors driving demands for improved flame retardance in plastics. And as has been the case for several years now, it is producers of halogen-free flame retardant (HFFR) systems who are making the most noise about their developments – even if more established halogenated systems still account for a significant share of the overall market.

PINFA (the Phosphorus, Inorganic and Nitrogen Flame Retardants Association) says the development of electro-mobility is one of many industry innovations behind a wider growth in demand for PIN (Phosphorus, Inorganic and Nitrogen) flame retardants. This growth is being driven especially by the construction, electrical and electronics and transport sectors, and by regulatory and industry pressure to move away from halogenated flame retardants.

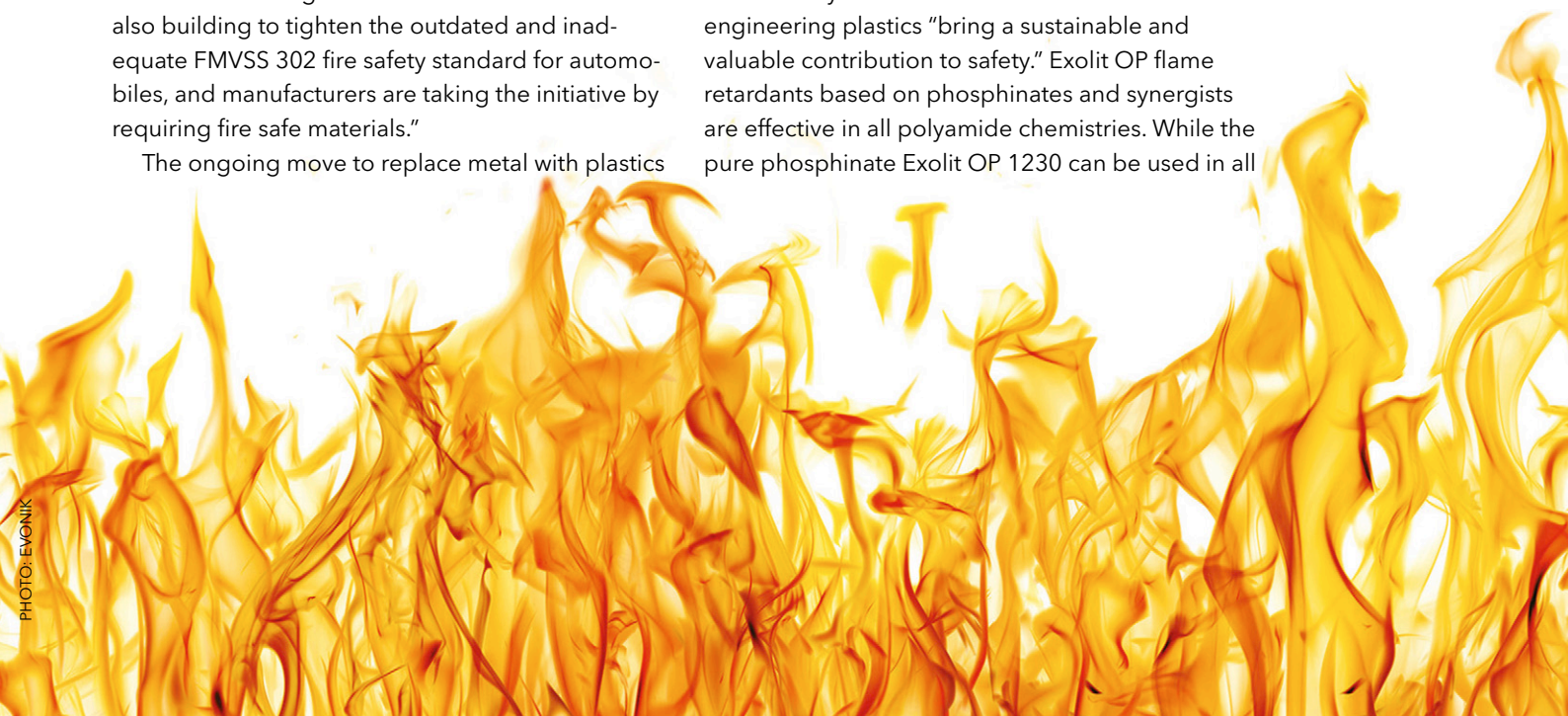
"Electric vehicles pose increased fire safety challenges because of high currents and energy storage," PINFA says. Voltages in some electric vehicle systems already exceed 400V, with some car makers looking to move to 800V. "Pressure is also building to tighten the outdated and inadequate FMVSS 302 fire safety standard for automobiles, and manufacturers are taking the initiative by requiring fire safe materials."

The ongoing move to replace metal with plastics in the automotive sector, for reasons of both cost and weight, also plays a part. "New materials for vehicles need to offer low weight as well as mechanical performance and temperature and chemical resistance. Automobile manufacturers are looking for environmentally preferable flame-retardant solutions which must respect IMDS [the International Material Data System] and GADS [Global Automotive Declarable Substance list]. New PIN flame retardant solutions enable to combine this with fire performance and low smoke," according to the association.

At AMI's Fire Resistance in Plastics 2018 conference (AMI is the publisher of *Compounding World*), which will take place this month in Cologne in Germany, new PINFA President and Head of Marketing and Advocacy for Clariant's Flame Retardants Business Line Adrian Beard is due to say the shift to electric drives in cars will provide new challenges for plastics: fuel and oil resistance of plastics is less important, whereas high voltages and currents mean a higher risk of fire due to electrical failures.

Beard says **Clariant**'s Exolit flame retardants for engineering plastics "bring a sustainable and valuable contribution to safety." Exolit OP flame retardants based on phosphinates and synergists are effective in all polyamide chemistries. While the pure phosphinate Exolit OP 1230 can be used in all

Main image: Resistance to fire is a top concern for many plastics users and specifiers. FR systems developers are working on more effective solutions that meet the needs of current and emerging applications, such as EVs



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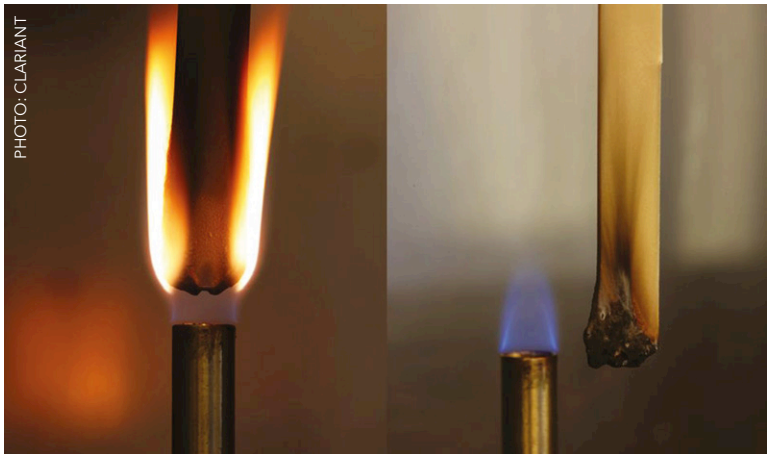


PHOTO: CLARIANT

Above: A polymer sample undergoing UL94 vertical testing at Clariant

polyphthalic polyamides, the synergistic blends Exolit OP 1312, Exolit OP 1314 and Exolit OP 1400 are the choice for PA6 and 66. "For bio-based and long-chain polyamides especially, Exolit OP 1400 shows good efficiency," according to Clariant.

"All Exolit OP products have good mechanical properties and a CTI (Comparative Tracking Index) of 600 volt in common. This, together with good colourability, makes them ideal for demanding applications like connectors used for e-mobility. At the same time sustainability and recyclability of flame retarded polymeric products is of critical concern," the company says.

Clariant adds that in a recent study conducted by the Fraunhofer Institute for Structural Durability and System Reliability (Fraunhofer LBF), PA6 and PA66 compounds containing Exolit OP were subject to multiple extrusion cycles followed by measurement of flammability and mechanical properties. "Both compounds kept the UL 94 V-0 classifications and showed the typical mechanical properties caused by shortening of the glass fibres after multiple extrusions, but no further effects," the company says.

Polymeric developments

At another PINFA member, **FRX Polymers**, Ina Jiang, VP of Sales and Marketing, says the company's Nofia polymeric platform technology suits a wide range of applications. For instance, in polyester fibres and filaments, Nofia FR delivers up to a 30% increase in tenacity. In lower tenacity applications, customers report up to a 30% higher fibre spinning speeds.

In PET applications (for both fibres and injection moulding), Nofia flame retardants can act as a chain extender, which Jiang points out is particularly valuable when combined with a recycled PET feedstock. Some automotive non-woven clients are said to have been able to increase the recycle PET content from 50% to more than 94%. "Nofia polyphosphonates repair the PET chain, which leads to improved mechanical performance while at the same time meeting the FMVSS302 and NF P 92 503-507 (M1) FR standard," says Jiang.

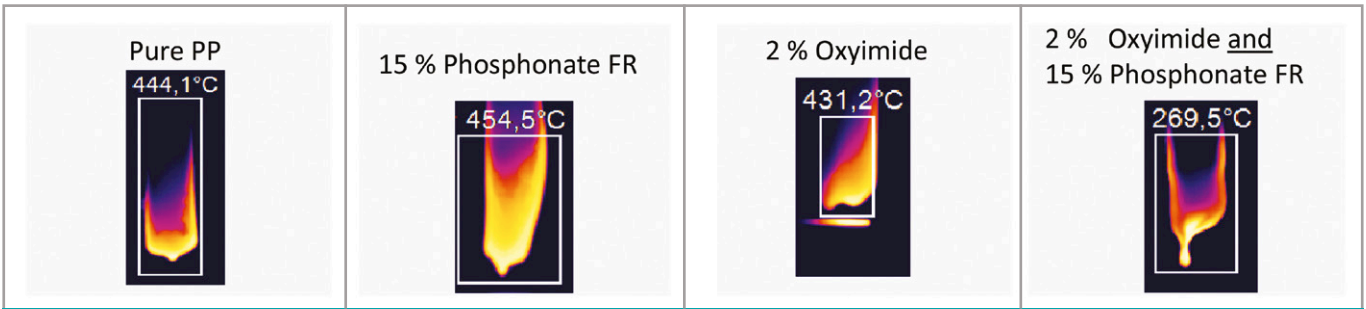
Jiang also points to the high resistance of Nofia FRs to the fairly aggressive chemicals used for cleaning (in hospitals, for example). She says that in PET-based formulations, they have been found effective in being able to withstand stress cracking associated with such disinfectants.

In the wire and cable market, Nofia polyphosphates provide UL1581 – VW1 fire retardant solutions for TPU and TPE systems in combination with other FRs, while maintaining a high-quality surface and strong physical properties, Jiang adds. "Nofia FR also enables full transparency of FR BOPET-based cable wrap, meeting the cosmetic requirements of designers and consumers for high-speed data cables."

Radical generators

Fraunhofer LBF is pursuing multiple avenues in its research on flame retardants. At AMI's Fire Resistance in Plastics conference, Rudolf Pfaendner, Division Director, Plastics, is due to discuss novel oxyimide radical generators, which have been shown to be efficient synergists for phosphonate flame retardants, as well as good FRs in their own right.

Radical generators are efficient flame retardants and flame-retardant synergists, according to Pfaendner. He says novel oxyimides show high and adjustable degradation temperatures up to 380°C,



Observation of the burning process for PP and three FR systems by infrared camera showing the resulting temperature profile
Source: Fraunhofer LBF

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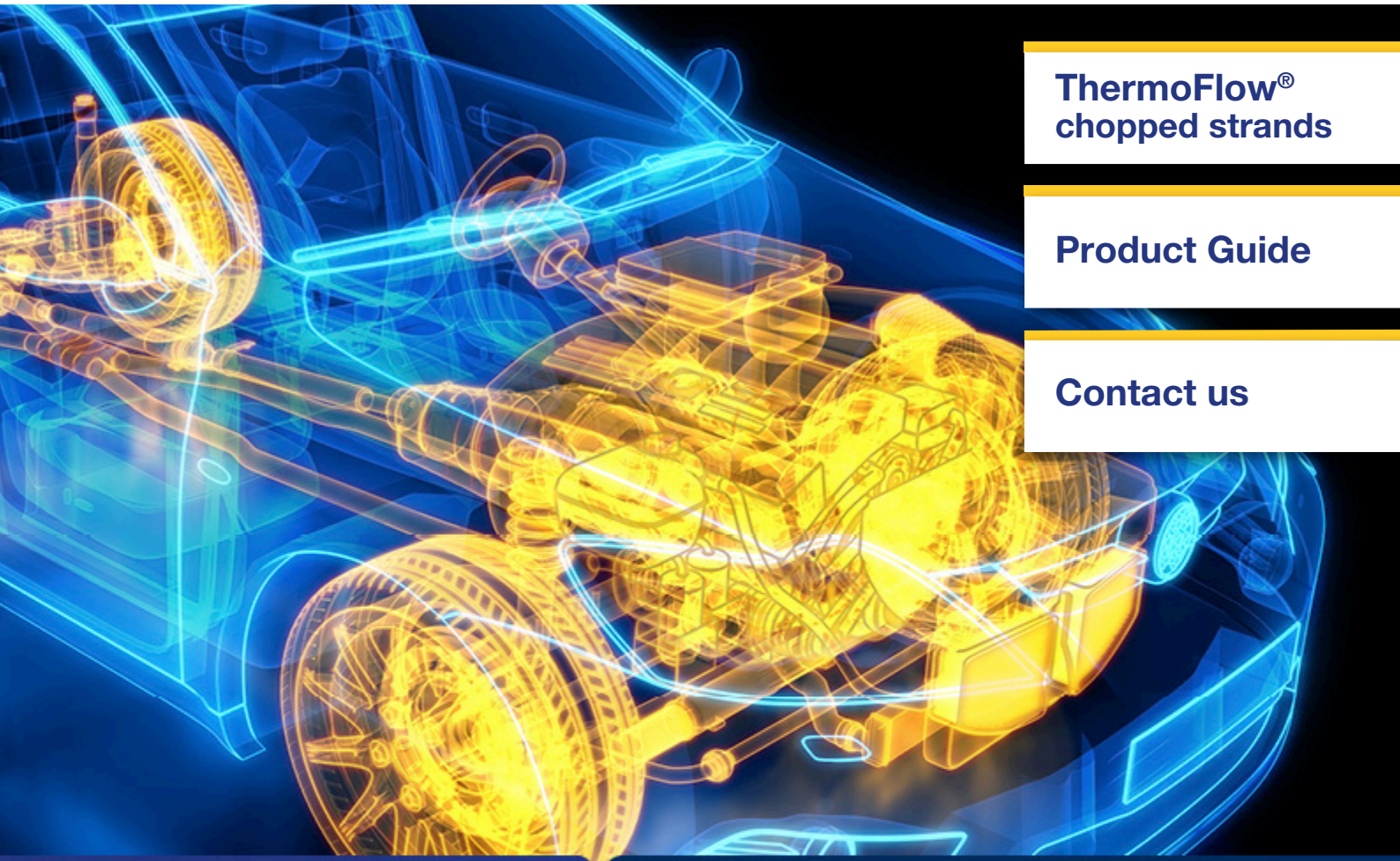

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meaning they are suitable for use in engineering plastics compounds. In combination with P-synergists, improved flame retardancy (UL 94 V-0) at very low loadings for polyolefins is provided. He also says they provide an efficient alternative to antimony trioxide in halogenated flame-retardant formulations.

The need for halogen-free solutions is growing for multiple reasons, says Kaan Serpersu, Research and Development Engineer at masterbatch and compound producer **Techmer PM**. The two main reasons are ongoing public health and regulatory concerns with halogenated FR technology and the globalisation of product lines. "Our customers are finding a need to develop one solution for a world-wide market. Regulatory challenges in Europe and Asia therefore are having ramifications on companies with a mostly North American market," he says.

Serpersu says Techmer's PPM114517 HiFill Non-Hal FR was designed as a glass-filled halogen-free polypropylene compound solution to provide a UL94 V-0 rating at 1.5 mm. It also does not contain any antimony, which he says avoids any SARA 313 concerns (this US regulation requires certain facilities to report routine and accidental chemical releases).

Polymer Resources extends UL options

Polymer Resources, a US-based specialty compounder, has extended its range of UL-listed resins and blends for electrical and electronics applications. The new products include an impact modified PC/PBT and a PC/ASA, both with UL94 V-0 ratings and stability under UV radiation.

Target applications for the PC/PBT include injection moulded parts such as electrical sockets and plugs for medical applications, residential switch plates and outdoor components for fibre optic installations; the PC/ASA is said to be a good choice for enclosures for medical and dental equipment that are exposed to high levels of indoor UV radiation, making it a possible substitute for flame-retardant PC/ABS.

The company's UL-listed product slate now extends to around 70 grades. It says that choosing a UL listed materials gives customers increased confidence that their end applications will also meet UL requirements, and accelerates the approval process.

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Building concerns

Building and construction has always been a key area of interest for flame retardant research, but recent events have further emphasised its importance. In October, in the wake of the fire at the Grenfell Tower in London that killed 72 people, the UK government banned combustible materials from the facades of all new high-rise residential buildings, hospitals, student accommodations and other buildings over 18 meters high. These new regulations will limit available building materials to the European classification of Class A1 or A2 (many European countries already have laws ensuring the use of only non-combustible products for construction of high-rise buildings). Products achieving an A1 classification do not sustain a flame, while products achieving an A2 classification can sustain flame for no more than 20 seconds.

Russian Mining Chemical Company (RMCC) produces various mineral-based flame retardants, distributed through Netherlands company **Europiren**. It highlights the Ecopiren magnesium hydroxide (MDH) that it says is used widely in TPO roofing membranes, ACP compounds, PVC cable compounds, PVC roofing membranes, PP compounds, and HFFR cable compounds.

RMCC says Ecopiren serves not only as a flame retardant, but also as a smoke suppressant and a means of reducing the acidity of the smoke. It says Ecopiren absorbs more heat than aluminium trihydrate (ATH) and forms a more stable char. "This is a big help to satisfy the CPR requirements for cables. Thanks to the high decomposition temperature (330°C) higher processing speeds are possible," the company says.

"Due to innovative mining and production methods, the products from RMCC can replace more expensive synthetic raw materials by offering the same performance at lower costs," the company claims. In July, it opened its third production plant for MDH, taking its total capacity to 150,000 tonnes/yr.

Halogen-free in PCB

ICL – probably best known for its brominated flame retardants – says that close monitoring of trends across its main markets has led it to broaden its portfolio and launch new flame retardants and technologies. One of these is PolyQuel P100, which the company says offers a high performance and

Results of UL94 flammability tests carried out on PA6 compounds containing different additive combinations

FR content	FR concentration	Burning time after first flame	Burning time after second flame	Flame dripping	UL-94 rating
Kaolin TEC 110 AST with Phosphinate [1]	30% Kaolin, 20% FR	7.06	9.87	0/5[1]	V-0
	30% Kaolin, 18% FR	16.19	10.4	0/5[1]	V-0
	30% Kaolin, 16% FR	16.67	14.8	0/5[1]	V-0
	30% Kaolin, 14% FR	19.2	3.0	0/5[1]	V-0
	30% Kaolin, 12% FR	68.4	5.7	0/5[2]	V-2
Kaolin TEC 110 AST with Phosphinate [2]	30% Kaolin, 20% FR	9.32	–	0/5[1]	V-0
	30% Kaolin, 18% FR	16.42	8.43	0/5[1]	V-0
	30% Kaolin, 16% FR	11.51	24.73	0/5[1]	V-0
	30% Kaolin, 12% FR	20.7	6.7	0/5[1]	V-0

Note: 1: None of 5 samples tested exhibited flame dripping; 2: All 5 samples exhibited flame dripping

Source: Quarzwerke

sustainable solution for printed circuit boards. "This polymeric, non-halogen and active ester curing agent provides high flame-retardant efficiency, lower dielectric constant (Dk) and dissipation factor (DF) than other commercial phosphorus-based flame retardants," it says.

"PolyQuel P100 improves critical electrical properties while satisfying all the thermal, chemical and mechanical properties required for optimal performance of printed wire boards. It provides high glass transition temperature, exceptional thermal stability and superior pressure cooker test performance." ICL recommends the new product for epoxy-based, halogen-free, mid to low loss CCL applications.

ICL has also developed and launched antimony trioxide-free solutions for polyamides, polyesters and styrenic compounds, "to deal altogether with the stringent fire safety requirements and the required cost efficiency of the E&E markets." It says they allow users to maintain the compound's mechanical, thermal and rheological properties, while improving devices' electric-shock resistance (as expressed by the CTI). "By lowering compounds' density, these innovative formulations allow a significant weight per part reduction, thus leading to better cost-efficiency performances," the company claims.

Antimony worries

Antimony trioxide has been in the cross-hairs of regulators, owing to its possible links to cancer. The National Toxicology Program, within the US Department of Health and Human Services, earlier this year produced a draft Report on Carcinogens (RoC) Review of Antimony Trioxide, which was published in revised form in August. It concludes that antimony trioxide is "reasonably anticipated to be a human carcinogen."

Considerable effort continues to be poured into development of synergistic FR systems. At the AMI conference, Peter Sebö, Head of Marketing & Market Development at **Quarzwerke**, will discuss the use of kaolin as a flame-retardant synergist. The company has been investigating the possible partial replacement of common flame retardants like phosphates and phosphonates by kaolin in engineering plastics such as polyamide.

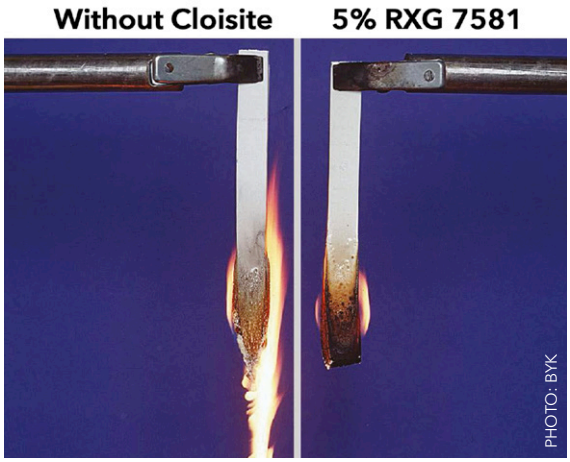
Sebö says that normally around 20% of a phosphonate or phosphate is required in a 30% glass fibre reinforced PA to achieve a V-0 rating at 0.8 mm. Kaolin loses around 14% water at around 400°C and is therefore suitable as a flame retardant for engineering plastics, he says. Quarzwerke looked at the replacement of the glass with kaolin and/or wollastonite, as well as the reduction of the amount of the FR additive. Researchers concluded that use of kaolin as a flame retardant "is possible and reasonable" and that the quantity of the flame retardant can be reduced and substituted by kaolin. Mechanical properties also show good results.

Also at the AMI conference, Jochen Wilms from **Byk** discusses the use of clay-based additives as synergists in HFFR compounds using ATH or MDH as the principal flame retardant. They can act to reduce dripping and also reduce heat release.

Byk-LPT 23617 is a new blend of flame-retardant synergists. Tests on its use in cable compounds show that it provides a considerable improvement in FR properties while leaving mechanical and wet electrical properties either unchanged or improved.

Applied Minerals – which owns the Dragon Mine in Eureka, Utah, US (the largest commercial source of halloysite in the western hemisphere) – says this clay mineral has also been shown to be an excellent char forming flame retardant synergist for non-halogenated flame retardants such as ATH and MDH. Halloysite, a tubular alumina silicate that functions as a thermal and electrical insulator and is

Right: Addition of a Cloisite clay-based additive to an HFFR compound can considerably reduce dripping



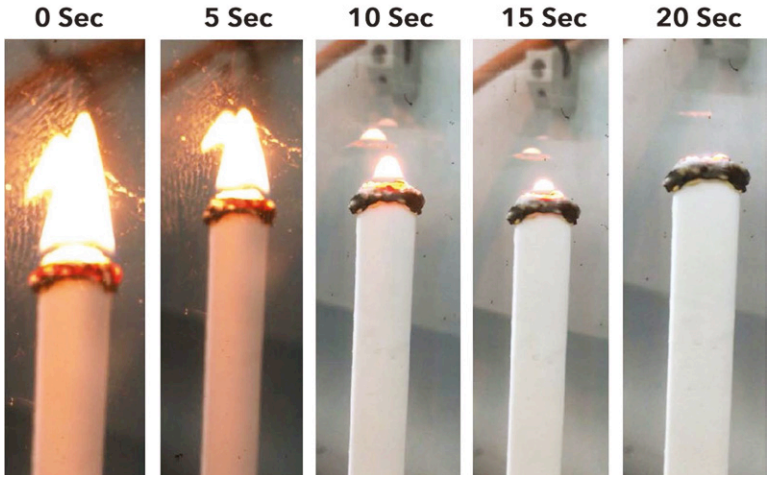
marketed by the company as Dragonite, can also be used as a substitute for antimony trioxide in halogenated systems.

"Dragonite APA grade is our next generation flame retardant that has been organically modified with a proprietary technology to enhance Dragonite's intrinsic flame performance," says Sales Director Brian Newsome. He says it allows users to reduce overall use of flame-retardant additives while maintaining a VW-1 rating. "Moreover, Dragonite, due to its large aspect ratio and surface area, has been shown to improve the mechanical properties of a polymer matrix," he adds.

A 5%-8% loading of Dragonite APA will improve the flame-retardant properties of a system, maintain or improve mechanical properties and allow for a reduction of approximately 10%-16% of the ATH or MDH used, Newsome says. In halogenated systems it can replace 75% of any antimony trioxide. "Dragonite APA not only presents a compelling cost-performance value proposition, but also received the highest toxicology rating of all halogen-free flame retardants by industry oversight firm Green Screen," he says.

Applied Minerals earlier this year announced that a leading developer of flame-retardant applications had completed a successful plant trial of Dragonite. Company President and CEO Andre Zeitoun says that Dragonite "outperformed all other competing flame-retardant additives evaluated by the customer.

Below: Limiting oxygen index (LOI) testing of an EVA-based compound containing 58% ATH and 3.6% Byk-LPT 23617 shows rapid char formation (tested to ISO 4589-1/2/3; 32% O_2)



Functional polymers

Paxymer is taking a different approach to synergists. Managing Director Amit Paul says the company continues to work with its synergistic technology based on functional polymers. Paxymer's synergist is focused for polyolefin-based plastics and works as a synergist both for P, P/N and mineral-based compounds. Paul says the company spent this year implementing and verifying its technology in a number of applications.

Electrical and optical conduits have been two successful applications, Paul says. "The interest in the company's synergistic technology has increased drastically and the main users are compounders. Development projects range from building and construction to electric and train applications.

"The first work was focused mainly as a synergist to Adeka products. User cases, guidance formulations and recommendations are now also being developed on how to synergise and optimise formulations based on Clariant, Thor, JLS, Budenheim and other leading PIN supplier products. The synergist allows for total FR content for a V-0 to be reduced to around 20-25% compared to 25-35% with the additives alone." Main benefits are lower total cost for the FR package, improved process and performance, improved FR including improved dripping and reduction of heat release rate, Paul concludes.

Intumescent FRs

Adeka itself says its ADK Stab FP-2000 series of intumescent flame retardants generate almost no black smoke and acidic gases during combustion, forming a hard char in various fire test scenarios. The company says tests carried out according to ISO 5659-2 (25 kW/m^2 with pilot flame and 50 kW/m^2 without pilot flame) on a polypropylene formulation containing ADK Stab FP-2500S showed that the additive could depress the generation of toxic gases to a level much lower not only than that produced with a PP formulation using a brominated flame retardant but also one containing no flame retardants at all: the CITG (Conventional Index of Toxicity) value registered was below 0.1.

The company has recently extended this series with ADK Stab FP-2600U, for thermoplastic polyurethanes (TPUs). It says that unmodified TPU

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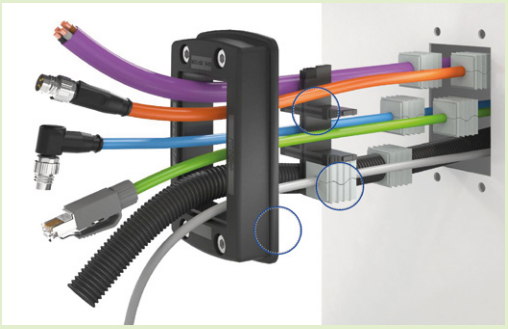
Kraiburg develops FR TPEs for PA bonding

Germany-headquartered TPE specialist Kraiburg TPE has developed a custom-engineered halogen-free flame-retarded TPE range that offers good adhesion to PA, making it possible to produce hard/soft components for demanding E&E applications.

More than a dozen different PA compounds with UL94 V-2 and V-0 classification were tested during the development of the materials, with the final focus on HFFR V-0 types. Adhesion testing showed widely varying results, depending on the



polyamide formulation and the PA/TPE combination. "The essential factor here is the modification of polyamides with appropriate flame retardants and additives," say Martina Hetterich and Dirk Butschkau at Kraiburg TPE.

"Along with the formulation of the polyamide, the flame retardant's temperature sensitivity is a major challenge. In multi-component applications, non-flame retardant TPEs are frequently processed at temperatures of 240 °C to achieve optimal adhesion," she says. The newly developed flame-retardant TPE materials are said to provide optimal adhesion when processed at a relatively low melt temperature of 190°C.

› **www.kraiburg-tpe.com**

has a marked tendency to drip during combustion, but addition of the new additive suppresses dripping and helps the material achieve a V-0 rating at 1.6 mm. Cone calorimetry testing shows smoke generation to be lower than an existing (but unidentified) commercial flame retarded TPU.

Adeka adds that ADK Stab FP-2600U can provide flame retardancy at least equivalent to that obtainable with established grades of the ADK Stab FP-2000 series, but at lower addition rates. This has the additional advantage of a reduced negative effect on mechanical properties.

Evonik reports new developments with its synergistic OMS (organo-modified siloxane) technology, which can be applied to various flame retardants. It says its Tegopren 6879 and Tegomer H-Si 6441P can be used in glass reinforced polyamide and PBT thermoplastic polyester compounds intended for E&E applications, including electric vehicles.

Tegopren 6879 is a liquid used for surface treatment of inorganic additives such as MDH and ATH, making them easier to disperse in thermoplastic formulations. Evonik says Tegopren 6879 makes the particle surfaces more hydrophobic, so that water uptake is reduced by up to 50%. This yields higher CTI values – obviously important for E&E applications. With compounds containing organic flame retardants, no whitening occurs in the water pelletising bath. Tegomer H-Si 6441 P is a polyester modified siloxane delivered in pellet form. It is said to have excellent compatibility in thermoplastic and thermoset resins.

Kathrin Lehmann, Head of Innovation Management Polymers, Interface & Performance, also highlights newly-acquired technology that she says brings much more flexibility to the FR market. Evonik can now produce open-cell foams capable of absorbing up to 70% of liquid additives, including phosphorus-based additives and also some plasticisers. Lehmann says this provides a new opportunity for compounders who cannot (or do not want to) directly handle liquids.

Evonik has also just announced that it plans to market Visiomer Hema-P 70M 2-hydroxyethyl methacrylate phosphate as a flame retardant (and an anti-corrosion agent). Until now, this monomer has been mainly used as an adhesion promoter. Evonik says that, because is serves as a reactive diluent or as a co-monomer bonded within the polymer backbone, it does not migrate. Visiomer Hema-P 70M further improves flame retardancy in combination with non-polymerisable flame retardants. It is a low-viscosity product containing 30% methyl methacrylate. Its low colour index suits it well to optical applications in acrylate and methacrylate systems.

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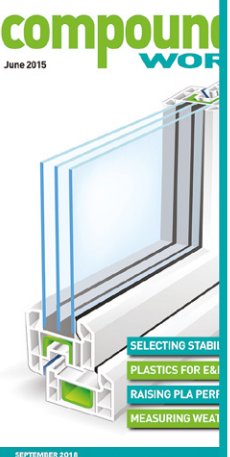
Compounding World marks its first decade

*Compounding World marks its 10th anniversary this month. Editor-in-chief **Chris Smith** looks back at its beginnings and tracks some of the big industry events we have covered over the past decade*



It is difficult for many of us here at AMI to believe it but this edition of *Compounding World* – the 116th – marks the magazine's 10th anniversary. Of course, time moves fast in the world of digital products but, while the idea of a digital magazine for mobile consumption may not seem particularly unusual today, back in December 2008 it was quite a leap – Apple's iPhone had only then been on the market for 18 months, the first Android phone had been launched just two months earlier and the iPad was no more than a sketch on a notepad in California (that now ubiquitous item did not arrive until January 2010).

Certainly, we felt we were breaking new ground when we released that first edition. Not for technical reasons, as the software to present a traditional "magazine" on a computer screen had been available for almost a decade. But few publishing companies had adopted it and even fewer were prepared to abandon established, albeit often declining, print models. Most publishers' response to the "threat" of the internet was to simply turn to "breaking news" at the cost of researched content .

AMI had no history in magazine publishing but realised the opportunity that digital technology presented was less speed and more reach. Our business was – and still is – global and built on expert plastics insight and high value industry databases. Digital magazines presented a way to deliver high quality information and to do that globally without the restrictions imposed by the costs of print and postage. So, in December 2008, the web link to the very first edition of *Compounding World* was emailed to 13,000 compounding industry experts. And how things have changed – today we email links to more than 29,600 people in more than 150 countries.

Launch editor Andy Beevers spelt out the *Compounding World* strategy in his introductory letter to the first edition – a high quality, editorially-independent, and expert-written monthly magazine 100%-focused on the compounding and masterbatch industry and its supply chain that would be delivered digitally globally. "Whether you're a compounder in Kuala Lumpur, a concentrate company in Cleveland or a masterbatch maker in Munich, you can access *Compounding World* as soon as it is published," he said.

Compounding then – and now – receives limited coverage in general plastics industry magazines but it plays a critical role in the development of new plastics solutions and

applications. *Compounding World* is written exclusively for compounders about the technology, business issues, and market developments that impact on the compounding industry. We aim to deliver real value to both readers and advertisers (the latter benefiting from cost-effective delivery of their advertisements to their target market all around the world).

From the outset, our aim was accessibility. We have always made a downloadable PDF edition available but the launch of the Apple appstore in 2008 (with just 500 apps, incidentally) offered a more user friendly alternative that allowed downloaded editions to be saved and used offline. In 2012 the first *Compounding World* app was released to the Apple and Google Play appstores. Over the first 12 months the app was downloaded 3,030 times from more than 70 countries. At the time of writing that total stands at 13,777 from more than 90 countries. If you've not yet tried it please give it a go – you'll find it in your appstore.

Compounding World has now been joined by four other free process-specific digital plastics magazines and apps –*Film and Sheet Extrusion*, *Pipe and Profile Extrusion*, *Injection World* and, most recently, *Plastics Recycling World*. All are available free and our on-line archive makes it as easy to access a five-year old edition as the current issue. The editorial team has grown, too, now comprising six journalists with a combined total of more than 130 years of plastics industry expertise.

And *Compounding World* has grown beyond its magazine origins. More than a thousand readers have already joined us at our Compounding World Forum in the US, the Compounding World Congress in Europe, and at Compounding World Asia. And last year we stepped up another gear with the Compounding World Expo exhibition and conference in Germany. That attracted more than 4,000 visitors and moves to Cleveland in the US next year. We hope to see some of you there as we continue to put the compounding industry on the world map.

Over the past 10 years, AMI's digital magazines business has grown from an idea to become a major player in plastics publishing and, we hope, a truly valuable source of information to our readers. And it all started here! Over the next few pages we take a look back to some of the news and events of Compounding World's first 10 years. We hope you find it an interesting read. ›

2009

The focus for the first year of *Compounding World* was without doubt the global economic downturn. Our first edition detailed cost cutting moves and shutdowns at BASF, Ineos, LyondellBasell, Nova Chemicals and SABIC. Later editions that year included similar news from A Schulman, Cabot, Clariant, Dow Chemical, Ferro Corp, Formosa, Huntsman, PolyOne and Sinopec. BASF acquired Ciba and SK Capital bought Solutia's PA business, now Ascend Performance Materials, in 2009 and both Chemtura and Tronox filed for Chapter 11 bankruptcy protection.

But 2009 had its upside, too. RTP Company and Teknor Apex installed more capacity at plants in the US; Radici expanded its Italian compounding operations; and Gabriel-Chemie upped its global masterbatch capacity. DSM and PolyOne set up compounding operations in India; SABIC increased compounding capacity in the US, China and Saudi Arabia; So.f.ter opened a TPE production plant in Mexico; and Ter Hell added three lines at its Chinese joint venture operation.

Perhaps unsurprisingly, given the gloomy economic circumstances, Clariant Masterbatch predicted that the hot colours for 2010 would be beiges and browns, saying that consumers would be seeking harmony, tranquility and authenticity.

From a technology perspective, nanotechnology was a big thing. Nanocyl and Bayer said they would invest in carbon nanotube (CNT) production capacity; Arkema and CNano prepared to join the list of CNT producers; and PolyOne, A Schulman and Showa Denko struck development and patent deals with Zyvex Performance Materials, NanoScience Engineering and Hyperion respectively.

Sustainability was also on the up. At 2009's NPE show in Chicago, Teknor Apex and PolyOne both debuted full or partly bio-based compounds; the US recycling association Napcor and the European Plastics Recyclers association both independently warned of the potential risk to their industries from the use of oxo-degradable additives; and Toyota committed to using more bio-based plastics after revealing they accounted for 60% of the interior surface of its Sai hybrid saloon.

Above: Borealis opened its €50 Innovation Centre at Linz in Austria in 2009

2010

Chemtura, still in Chapter 11 as 2010 began, sold its PVC additives business – now Galata Chemicals – and revived the Great Lakes name for its flame retardants operations, since sold to Lanxess. Other significant deals included BASF's sale of parts of the pigments division of recently-acquired Ciba to Dominion Colour Corporation; Celanese buying the German LFT producer FACT; Teknor Apex acquiring the DSM Sarlink TPV business; and Sweden's Hexpol buying VTC TPE from the UK's Vita Group to create Elasto.

While the plastics industry was still suffering the fall-out of the 2008/2009 downturn – an AMI study published that year estimated it had wiped five years of growth from the European plastics market – investment was accelerating. SABIC opened what it claimed at the time was Europe's biggest ever greenfield compounding operation – a 130,000 tonnes/yr PP compounding operation at Genk in Belgium – and committed to an LFT production unit in Mississippi in the US. Other polymer producer investments included both Solvay and Borouge building compounding plants in China.

Specialist compounding businesses were investing, too. In Europe, RTP Company opened a new plant at Ladenburg in Germany; Gabriel-Chemie announced investments in Germany, Poland and Italy; Grafe expanded its capacity in Germany; and Polykemi expanded in Sweden. US investments included capacity expansions by Teknor Apex, Plastics Color Corporation and thermally conductive

Left: Clariant's pigments added colour to three stadiums used to host the FIFA World Cup in South Africa in 2010

2011

plastics producer Cool Polymers (since acquired by Celanese). China was also seeing heavy investment activity, too. Local compounders Kingfa Technology and ChinaXD Plastics both completed big Chinese capacity expansions, while 2018 also saw Lanxess up its compounding capacity by 50% and Akro-Plastic committed to a new production plant in the country.

That year's K show in Germany saw some significant technical introductions, with Coperion launching its 18Nm/cm^3 torque ZSK MC^{18} machine line and Leistritz unveiling a 15Nm/cm^3 ZSE Maxx model. The show also marked the debut of Feddem, the former Decroupet twin screw machinery maker that had been acquired earlier by Akro-Plastic parent KD Feddersen.

In the area of sustainability, the US EPA named phthalates and PBDE flame retardants as "chemicals of concern"; Albermarle, Chemtura and ICL committed to phasing out the production and sale of the flame retardant decaBDE by 2013; Baerlocher said its UK PVC stabilisers plant at Bury had become the first in Europe to convert to lead-free products; and BASF said it would end production of oxo-degradable additives to focus on its compostable Ecoflex and Ecovio products.

Below: Eastman expanded its non-phthalate plasticiser capacity in 2011 with the acquisitions of Sterling and Scandiflex

2011

Aside from its devastating human toll, the earthquake and tsunami that hit Japan in March of 2011 had a global economic impact with a number of specialty chemicals operations – including a Merck pigments plant and a BASF unit producing Irganox and Irafos antioxidants – taken out of production. Evidence was also emerging, however, that that the global recession was coming to an end. Data from the German plastics machinery association VDMA, for example, forecast that 2011 sales would be 18% above 2010 levels at €5.8bn.

Industry restructuring continued, however. Solvay paid €6.6bn for the Rhodia PA business; Lubrizol was sold to investment group Berkshire Hathaway (and acquired the Merquinsa TPU

operation); Braskem bought Dow's US and European PP business; PolyOne bought liquid colorant maker Colormatrix; Mexichem acquired Alphagary; and Italian compounder So.f.Ter snapped up PGroup. Meanwhile, the then number two player in carbon black, Evonik, sold its carbon black plants; Klesch Group acquired Arkema's PVC business; and BASF and Ineos gained regulatory clearance to set up Styrolution.

With AMI data showing the market for polymer compounds in Asia and China had grown by 7% in 2010 it was no surprise the region was attracting investment. China XD plastics upped its capacity to 250,000 tonnes; Ticona doubled its LFT capacity; BASF and SABIC expanded their existing compounding operations there; and Elasto announced its first production plans for the country. Elsewhere, DSM announced plans to compound in Russia; Americhem, Alliance Polymers & Services, Foster Corp and Lanxess were expanding in the US; Penn Color opened a masterbatch plant at Venray in the Netherlands; and Johns Manville announced plans to rebuild its E-glass furnace at Trnava in Solvakia to meet growing polymer industry demand.

The year also saw pressure mounting on phthalate plasticisers. The European Commission put six phthalates, including DEHP, DBP and BBP, on its REACH list of Substances of Very High Concern (SVHC). Eastman said it would end production of DEP and DBP phthalate plasticisers from the end of 2011 and BASF doubled capacity for its Hexamoll DINCH non-phthalate plasticiser.

2012

As 2012 unfolded, concerns were growing that the global recovery may falter as many countries implemented austerity drives. The compounding industry's response was strategic investments and disposals designed to focus portfolios, maximise scale and improve their positions in growing markets. Key compounding investments in 2012 included Lanxess opening its first engineering plastics compounding plant in the US; SABIC adding capacity for its Stamax LFTs at Genk in Belgium; Mitsui and Prime Polymer investing in PP compounding lines in the US, Mexico and China; and Grand Siam adding 18,000 tonnes of PP compounding capacity at Rayong in Thailand.

Portfolio moves included A Schulman buying the French Elian masterbatch operation and US-based ECM Plastics; RTP Company acquiring Clariant's electrically conductive compounds business; PolyOne acquiring Spartech; Washington Penn State opening a compounding operation in Slovakia; and Albis Plastic investing in its first

Above: A fatal fire at Evonik's Marl Chemical Park in Germany in March disrupted PA12 supply for most of 2012

compounding capabilities in China. Meanwhile, on the supply side, Huber bought the Almatic flame retardants business; PMC Group acquired Arkema's PVC stabilisers activities; and Cytec opened a UV stabilisers facility in China.

Some of the compounding industry's big equipment names were also in the M&A headlines. Coperion was acquired by the US-based Hillenbrand Group (already owner of K-Tron) for €408m; KraussMaffei was sold to Canadian PE group Onex for €568m; and Maag Group was acquired by the US-based Dover Corporation.

In the US, the NPE plastics fair was held in Florida for the first time. Worries that the exhibition would suffer from the move from Chicago after 40 years proved unfounded but leaving a trade show to return to hotels full of holiday makers and Disney enthusiasts proved a strange experience.

Pressure also continued to grow on the flame retardants sector. Following the European Commission's move the previous year to add HBCD to the REACH SVHC candidate list, studies were published in both the US and Europe highlighting its pervasive nature.

2013

Portfolio adjustments carried over into 2013. Dow sold its stabilisers business to PMC Group, which had bought Arkema's stabilisers operations in 2012; BASF announced job cuts in its additives and pigments operations; Solvay and Ineos announced a merger of their chlorvinyl activities: PolyOne revealed plans to close six of the 30 Spartech sites it acquired the previous year; Chemtura sold its antioxidants and UV stabilisers business to SK Capital; and Turkey's Oyak Group acquired the Chemson polymer additives activities.

In the US, Americhem bought Infinity Compounding; Lehmann&Voss ended its JV with

Ford continued its foray into natural reinforcements in 2013 with the introduction of rice husk reinforced PP wiring harness parts in its F-150 SUV

Techmer PM and established its own US operation; Asahi Kasei expanded its Thermylene PP compounding activities in Michigan; Plasticomp added LFT capacity and extended its product range to carbon fibre; and Citadel Plastics bought Lucent Polymers. European investments included Mitsubishi Chemical buying CTS; GCR expanding its Granic masterbatch activities in Spain; and Coperion opening the "world's largest compounding test centre" in Germany.

China's compounders were becoming increasingly active. Kingfa Technology took a stake in India-based PP compounder Hydro S&S Industries while ChinaXD announced plans to build a 300,000 tonnes/yr compounding plant at Nanchong in China.

K2013 continued its growth path with 218,000 visitors making their way to the Dusseldorf fairground in October. The show saw Nordson launch its Polymer Processing Systems group, bringing together its Kreyenborg, BKG and Xaloy brands; KraussMaffei Berstorff introduced its ZE BluePower twin screw extruder; Leistritz showed a ZSE50Maxx concept extruder offering 20 Nm/cm^3 of torque; and Akro-Plastic gave polyketone compounds a second lease of life (the novel polymers were originally developed by Shell back in 2000 but reintroduced by Hyosung of Korea.)

In the patent area, both lawyers for Milliken and Clariant warned companies in China they claimed were infringing their respective IP in clarifiers and flame retardants. And Bayer surprised many with its decision to pull out of the nanotube business saying significant commercialisation was not likely in the foreseeable future.

2014

Polymer producers continued the seemingly endless process of restructuring their activities through 2014. Ineos acquired BASF's share of their Sytrolution JV; Chevron Phillips sold its Ryton PPS business to Solvay; and BASF disposed of its liquid masterbatch and PolyAd Services additives operations. In the PVC sector, OpenGate Capital acquired the Benvic PVC operations from Solvay and the Kem One PVC business (formerly owned by Arkema); Vinnolit was sold to Westlake Chemical; Vestolit acquired by Mexichem; and Viking Polymers sold to Teknor Apex.

Compounding investments in the US included S&E Specialty Polymers and RTP Company expanding their toll compounding capacity; Tosaf investing in its first local compounding operation; So.f.Ter starting up its compounding operation in Tennessee; and Lanxess committing to doubling its engineering plastics compounding capacity. A Schulman acquired Prime Colorants and the Specialty Plastics division of Ferro (it had unsuccessfully attempted to buy the whole of Ferro in 2013); Washington Penn Plastic bought ExxonMobil's North American specialty PP compounds business; Americhem added LTL Color Compounders to its Infinity Engineered Compounds business; and Celanese bought thermally conductive compound producer Cool Polymers.

In Sweden, Polykemi added two compounding lines and Elasto installed two more medical TPE lines. Lifocolor invested €4m in its Czech masterbatch operation. And Akro-Plastic bought the PHA compound business from struggling bioplastics firm Metabolix. 2014 was not a good year for bioplastics producers as Cereplast also filed for bankruptcy.

Regulation continued to impact on the plastics industry. With HBCD flame retardants still under pressure, Albemarle and ICL revealed plans to set up a JV to produce polymeric flame retardant alternatives using technology licensed from Dow. ❯

Aston Martin recalled 17,950 cars in 2014 after counterfeit PA6 compounds were found to have been used to produce throttle pedal parts

2014

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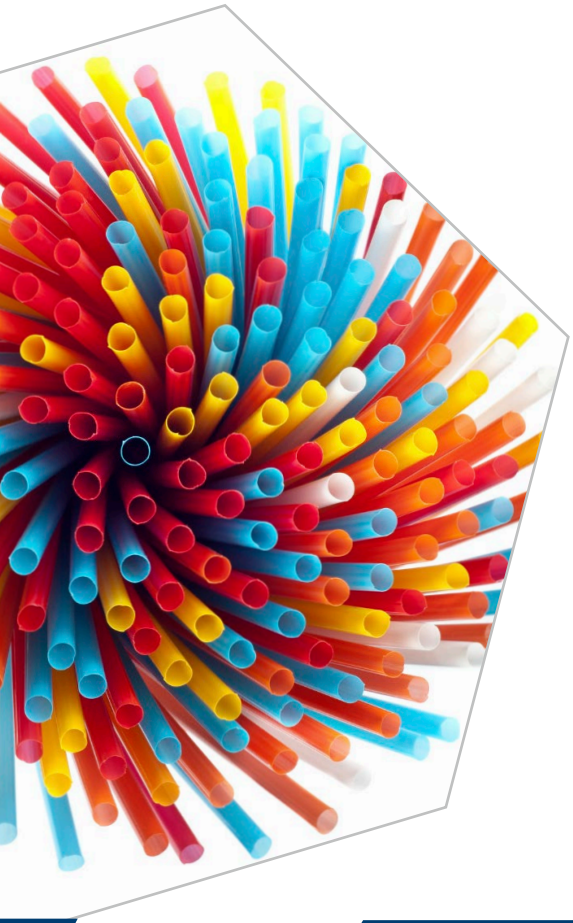

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2015

Right: UK-based Luxus marked its 50th anniversary in 2015 by commissioning a new 12,000 tonne/yr Coperion compounding line

2015

One of the big stories of 2015 was the tight market for polymers, particularly polyolefins. Various European downstream associations, including the European Compounders and Masterbatch Association (EuMBC), said that the industry had seen 40 force majeure announcements in just four months. One of those was by BASF and covered PA66 – a taster for things to come?

Three new names appeared on the polymer scene this year: DuPont's Performance Chemicals division was spun off and began trading as Chemours; Bayer Material Science became Covestro; and Ferro's US plastics additives business was sold to become Valtris Specialty Chemicals.

In the Americas, A Schulman paid $800m to buy Citadel Plastics in a deal that was to prove costly for it when claimed quality reporting issues emerged. Other significant investments included Hexpol buying RheTech and Domo Chemicals acquiring Technical Polymers, while Sirmac, PolyOne and Riken Elastomers all upped capacity.

In Europe, Penn Color doubled its masterbatch capacity in the Netherlands; Lehmann&Voss bought German compounder WMK Plastics; Teknor Apex sold its Beetle brand and other UK assets to Petlon Polymers; and Solvay acquired German LFT specialist Epic Polymers. While in Asia, LyondellBasell acquired Indian compounders SJS Plastiblends and Zylog Plastalloys.

2015 was an active year for machinery firms. Maag, which already owned Automatik, added RE Scheer and Gala to its pelletising portfolio; JSW acquired Korean twin screw extruder producer SM Platek; ProTec Polymer Processing bought German LFT production systems maker PolymersNet; and B&P Process Equipment bought US mixing equipment firm Littleford Day.

The NPE 2015 trade show kept up the momentum of the first Florida-located event, helped in part at least by the continuing strong performance of the US economy. One of the big themes at the event was 3D print with a number of established polymer names, including Teknor Apex, Eastman, SABIC, Techmer ES and PolyOne, showing materials optimised for the new manufacturing technology.

And in two signs of changing times, Lego set up a sustainable materials group to help meet its target of replacing petroleum-based polymers by 2030 and US firms A&R Logistics and rail operator Union Pacific revealed plans to develop a plastics transport and packaging facility near Dallas to exploit the forecast future US polymer export boom.

2016

2016

The big plastics industry news of 2016 was the announcement of the planned merger of Dow and DuPont to create a new materials business with sales of more than $40bn. Other M&A activity included Lanxess acquiring the Chemtura flame retardants business; BASF investing €200m in its global additives operations; Radici Group buying Invista's PA compounding operations in the US and Europe; Celanese acquiring Italian compounder So.f.Ter; Ineos Styrolution buying the Chevron Phillips K-Resin business; and Valtris acquiring PVC additives firm Akcros.

However, at a compounding level, the year's surprise story was A Schulman exposing some costly quality reporting issues at Lucent, part of its 2015 acquisition of Citadel Plastics. That saw the firm initiate legal action against the vendors and the replacement of CEO Berhard Rzepka with Schulman stalwart Joseph Gingo. Also in the news was PolyOne's acquisition of the Kraton TPE assets; Clariant's plans to invest €7m in its global masterbatch units; and China's Kingfa Technology expanding compounding capacity in both Germany and the US.

Other notable activity included, in Europe, Sirmax buying Nord Color; Gabriel-Chemie acquiring TEMA; Borealis buying German post-consumer plastics recycler MTM Plastics; and Mexichem acquiring UK-based Vinyl compounds. In the US, Americhem bought Vi-Chem; Asahi Kasei opened a second US compounding operation in Alabama; and Albis set up a US JV with recycler

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William Barnet to build a 15,000 tonne compounding operation. Meanwhile, Domo Chemicals started up its first PA compounding in China and DuPont opened an engineering plastics compounding plant at Shanghai.

For plastics machinery makers, the economic climate was excellent. Germany's VDMA machinery association said production would for the first time break the €7bn barrier. In the US, plastics machinery shipments were up for fifth year in succession to $1.29bn. And Italian plastics machinery exports also hit an all-time record of €2.9bn. Against that background, it was little surprise that the K2016 show attracted a record attendance – more than 230,000 people. The big theme for the show was Industry 4.0 – the so-called fourth industrial revolution – and major compounding machinery players such as Coperion and Leistritz showed developments that exploited some of the new digital opportunities.

2017

M&A activity continued into 2017 but it soon became evident that seeing an opportunity was, in some cases, a lot easier than realising it. While the Dow Dupont merger completed in 2017, others proved more challenging. Huntsman and Clariant's plans to create a €13bn chemicals group were defeated by shareholders; Tronox's proposed acquisition of Cristal's TiO_2 business was referred to regulators and has yet to gain US clearance; and BASF is still negotiating with European regulators over its planned purchase of Solvay's PA business.

Some deals – albeit much smaller scale –did complete, however. PolyAd Services was bought by Altana and integrated into Byk; Celanese acquired Israel-headquartered Nilit; Trinseo bought Italian TPE compounder API; Carolina Color and Breen


PHOTO: COVESTRO

Covestro was one of many companies to expand production capacities in China during 2017

We can't ignore it! In 2016, the UK voted to end its 45-year membership of the European Union, causing uncertainty and concern across European industry. Two and a half years later and after seemingly-endless discussion – most within the UK itself – the shape of the ongoing EU-UK trading relationship and regulatory framework is still no clearer

Color Concentrates were purchased by investment group Arsenal Capital; Albis Plastic bought carbon fibre compounds maker Wipag Group; and Evonik acquired 3M's Accurel porous polymer additive carrier business.

Compounding expansions also continued apace. In the US, Clariant added medical compounding capacity and Polyram Group announced plans to build a compounding plant in Indiana. In Europe, Ampacet announced expansions in Belgium and Luxembourg; Teknor Apex said it would build a new plant in Germany and Akro-Plastic added two compounding lines at its facility; Toray said it would construct a PPS compounding unit in Hungary; and Hexpol added capacity at its German location. Russia was also attracting investment again – local firm Polyplastic said it had upped compounding capacity at Engels to 72,000 tonnes/yr and Gabriel-Chemie said it planned a new masterbatch plant in the country.

In the machinery sector, CPM Extrusion acquired Extricom of Germany; Erema set up its Powerfil division to sell melt filters; while Coperion celebrated the 60th anniversary of its ZSK twin screw compounding extruder design.

Other notable events included two regulatory decisions by ECHA. The first to add BPA to the REACH SHVC list and the second to classify TiO_2 as a Category 2 carcinogen. And later in the year Ascend Performance Materials announced investments to increase PA66 capacity – perhaps a warning of the issues that were to appear in early 2018. ›

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2018

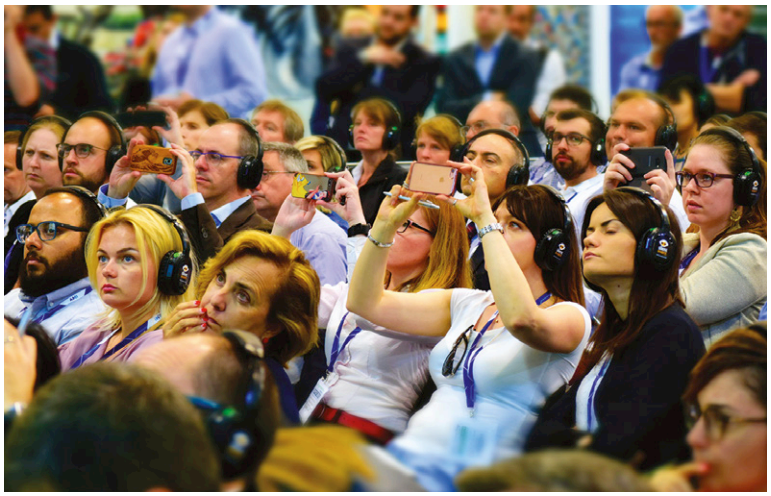
2018

The biggest compounding story of 2018 was LyondellBasell's acquisition of A Schulman. It paid $2.25bn for the company, which had been weakened since its costly acquisition of Citadel Plastics back in 2016. The move created a global compounding group with a broad product slate and sales of more than $4.6bn. Other notable compounding acquisitions included Croda International buying Finnish inherently dissipative polymers maker IonPhasE; Celanese acquiring US-based Omni Plastics and India's Next Polymers; Nexam Chemical buying Plasticolor Sweden; PolyOne buying Spanish specialty colorants firm IQAP and US LFT producer PlastiComp; and Ascend Performance Materials acquiring Brittania Techno Polymer to give it a wholly-owned compounding operation in Europe.

2018 also saw SABIC secure a stake in Clariant after the failure of the 2017 Hunstman merger plans while Akzo Nobel sold off its specialty chemicals businesses (including carbon black). In the distribution sector IMCD bought Velox and Univar acquired Nexeo.

Compounding plant investments included RTP Company building a new facility in Poland; Albis investing €1m at Wipag in Germany; and Sirmax investing €30m in a new plant in Poland where it plans to make its first TPEs. In the US, Polymax Thermoplastic Elastomers and BPC Toll Compounding & Blending added more capacity while Turkish compounder Elastron started its first North American TPE production unit.

After eight years of uninterrupted – and at times high – growth, the first signs of a machinery investment slowdown began to emerge, according to some manufacturers. Not enough to halt growth but maybe sufficient to moderate it. Weakening comes on the back of some record numbers though; Euromap said European plastics machinery production was up by 7% in 2017 and reached €15.3bn.



The free conference sessions were a prime attraction at the Compounding World Expo in Germany in June. The event moves to the US for 2019

2018's compounding machinery moves saw Maag Group add Ettlinger to its portfolio, Coperion begin production of its high end ZSK extruders in China for local customers, and CPM Extrusion Group doubling production capacity at its Ruiya Extrusion plant in China. And Buss launched its first new kneader compounding extruder model for 10 years – the Compeo.

The EU also unveiled its Plastics Strategy and propsed bans on a variety of single-use plastic items – including plates, cutlery and straws. And 2018 saw some major brand names go bio. Kartell bought a stake in Italian bioplastics firm Bio-On; Lego started producing its first parts in bio-based PE from Braskem; and Ikea's parent company Ingka Group announced an investment in Austrian recycling machinery maker Next Generation Group (NGR). In Sweden, Stora Enso started up "Europe's largest wood fibre composite operation".

Invista joined Ascend Performance Materials with announced investments in capacity for PA66 feedstock adipontrile (ADN). However, with most of the new capacity coming on stream over the coming four years the impact on the current PA66 shortages seems limited.

2018 was another NPE year, with an estimated 56,000 visitors making their way to the Orlando Convention Center in the US. It also saw the launch of the first Compounding World Expo. More than 4,000 visitors attended the focused two-day compounding exhibition and conference in Essen in Germany in June; the event moves to Cleveland in the US for 2019. You can find out more and register for your free ticket **HERE**.

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Although legacy test protocols may be entrenched, industry is working to improve weathering test equipment and methods to obtain faster results and better correlation to real-world outcomes. Jennifer Markarian reports

Speeding up weather testing

In the real world, the potentially detrimental effects of high temperature, intense light, aggressive chemicals, and other environmental conditions on the integrity and appearance of plastics will usually take place over an extended time. Companies developing plastics materials, additives, and parts, however, can't wait that long to find out if their product will perform as needed. Accelerated testing speeds up the effects of degradation to be able to compare different formulations and, in some cases, attempts to approximate performance in actual conditions. Long-term degradation such as wear, heat aging and environmental stress cracking can all be analysed, but perhaps the most complex and widely used procedure is accelerated measurement of weathering.

Accelerated weathering testing options include outdoor exposure in extreme environments, such as Florida (hot and humid) or Arizona (very hot and dry); accelerated outdoor exposure using mirrors and/or rotating devices to increase the amount of direct sunlight; and accelerated laboratory testing inside chambers using lamps (to simulate the effects of light and heat) and water spray (to simulate rain or dew). Traditional lamp types for accelerated laboratory weathering include fluorescent UV and xenon arc.

Xenon arc lamps produce the full spectrum of light, but filters can be used to target specific wavelengths and simulate conditions such as daylight, sunlight through a window, or indoor light. The Atlas Right Light Glass Filter, for example, was designed to better match Miami sunlight. This filter is being more widely adopted since its

Main image: The ability to speed up weathering tests is essential to ensure long term colour and mechanical stability of exposed plastics

PHOTO: SHUTTERSTOCK

Above: New equipment developments aim to better match testing spectra to real world light conditions

specification in ASTM's D7869 standard (2013), says Matt McGreer, Senior Product Manager at **Atlas Material Testing Technology**. Some materials are particularly sensitive to different wavelengths of light, so matching sunlight is a better simulation of exposure.

Q-Lab's Q-SUN xenon arc test chamber models Xe-2 and Xe-3, using a Window-SF5 optical filter to filter out nearly all UVB radiant energy, have been approved by the Ford Motor Company for its BO 116-01 test method, "Resistance to Interior Weathering" of automotive interior trim materials, Q-Lab said in May this year. "The method is based on SAE J2412, but with the Window-SF5 optical filter and a slightly shortened dark step in the test cycle. Q-Lab worked closely with Ford for several years on this update to ensure reproducible results between the included xenon arc test chambers. Part of this work included creating a technical specification of the spectral power distribution curve achieved by the SF5 optical filter, which did not exist in earlier versions of BO 116-01. Round-robin testing verified that the Q-SUN provided comparable results to other chambers," according to Q-Lab.

In addition to light, temperature affects the degradation of polymers. Controlling the specimen temperature in a laboratory test is crucial, says Bill Tobin, Senior Weathering and Corrosion Technical Marketing Specialist at Q-Lab. The configuration of the equipment (for example, an uninsulated black panel versus an insulated black panel) can significantly change the chamber air temperatures and sample temperatures. Understanding and properly controlling temperature can provide more reliable results. ❯

Alternative sources

A metal halide (MH) lamp technology is another lamp type that has the potential for even faster results than conventional options. The technology, from **Iwasaki Electric**, has been used in Japan for 25 years and has been available in North America for six years through **Eye Applied Optix**, a division of Iwasaki's subsidiary, EYE Lighting International of North America. The Super UV (SUV-W161) test chamber generates test results in as little as 1/30th the time of traditional xenon or fluorescent tube weathering test chambers.

"MH tools use higher UV irradiance with no far visible or infrared spectrum providing heat energy. MH produces highly accelerated results that customers have proven correlate to xenon and outdoor data," says Doug Vermillion, Director of Eye Applied Optix. At AMI's Polymer Testing & Analysis conference in September 2017, Mark Alessandro, Product Durability Engineer at **Avery Dennison**, presented results of PVC film aging and demonstrated that results in a Super UV chamber were quite comparable to testing in a xenon arc chamber (Figure 1). In addition, 10 days in a Super UV test showed a similar failure mode and a small difference in energy at failure compared to three years in Arizona outdoor aging for the PVC film. This test demonstrated the Super UV predicted failure to within five months in a real time scale (Figure 2).

The Super UV is well suited for comparative testing in formulation development and other R&D, and perhaps in the future may be useful for compliance testing as well, according to Vermillion. An ASTM committee is developing a standard method for operating a metal halide apparatus (WK46431), which should be published in the not too distant future.

Eye Applied Optix expanded its testing lab in September 2017. The laboratory is equipped with a full-spectrum xenon lamp XER-W75; two, 30-sun UV SUV-W161 weathering test chambers; and an IEC BBA compliant full-spectrum 0.5m x 0.5m solar soaking system, which is useful for IEC and other standards for photovoltaic modules and components as well as material testing applications requiring 1-sun, full-spectrum irradiation.

Balanced results

Striking a balance between accelerating weathering testing and having accurate results is key, says McGreer at Atlas Material Testing. He advises that appropriate conditions of light, temperature and moisture should be chosen depending on the end-use as well as on the polymer type, colour and formulation, because these all affect degradation and failure modes. Some common legacy test methods are not based on end-use conditions. ASTM G155 and ISO 4892-2 for xenon-arc testing, for example, call for cycle times of 102 minutes light/18 minutes light with water spray because this was the capability of the earliest equipment set-ups, not on any parameters related to the real world, he says.

Over many years of investigation, however, weathering experts have been building a better understanding of the real effects of conditions such as sunlight, temperature and moisture (rain or condensation) on the surface of plastics. A new test method, ASTM D7869 (Standard Practice for

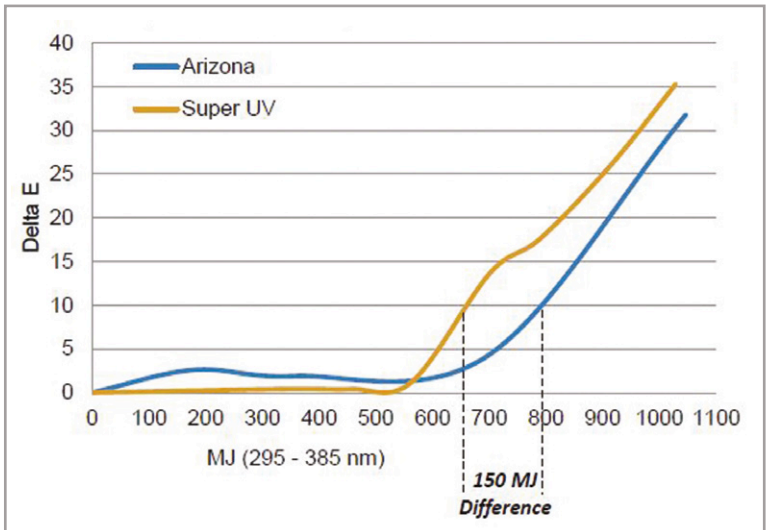

Figure 1: Comparison of different accelerated testing techniques on PVC film. Materials with primary sensitivity of UV light show equal aging in Super UV and xenon equipment. The sample showed no response to QUV testing as wavelength sensitivity was outside the UVA spectrum
Source: Avery Dennison

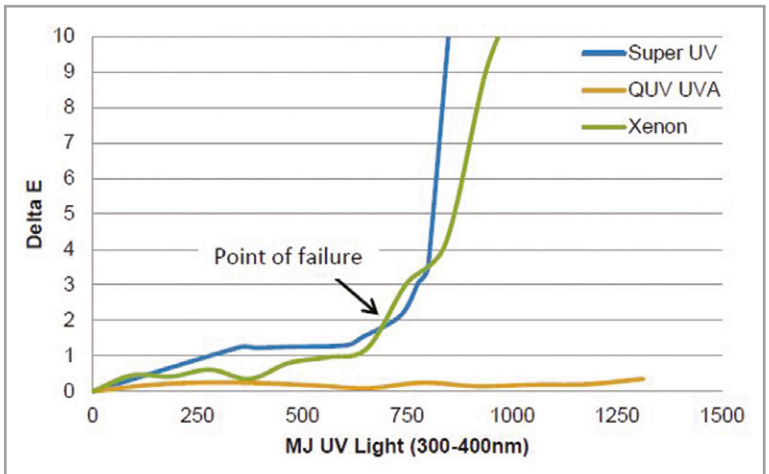

Figure 2: Delta E comparison to outdoor aging for an unprinted dual layer PVC film PSA construction. Arizona 45° three-year exposure at 350MJ per year, Super UV exposure for 10 days. Note similarity in curve shape and failure mode. Super UV predictive failure within five month energy equivalence of real life.
Source: Avery Dennison

PHOTO: SHUTTERSTOCK

Above: Car maker Ford was part of the consortium that developed the ASTM D7869 test method, which recognises the important role of moisture in polymer weathering

Xenon Arc Exposure Test with Enhanced Light and Water Exposure for Transportation Coatings), was published in 2013 after 10 years of development by a consortium that included car maker Ford, weathering equipment and other suppliers. Although initially developed as a weathering method for coatings, it has recently been adopted in certain plastics markets.

The researchers realised that moisture uptake was a more significant issue than previously thought, says McGreer. They determined that weathering was affected by a synergy of specific wavelengths of light, temperature's effect on the rate of reaction, and moisture causing physical degradation. The new test uses cycle parameters designed to match south Florida conditions, and researchers in the consortium believe it gives a more accurate representation than previous methods.

As with any new weathering test method, there is a challenge in how to correlate data from the old method with the new. This will take place as people use the new method, says McGreer, and use will become more widespread once the new method is written into standards (for example, automotive supplier standards). "Validation with real world data can take three to five years," says McGreer. "You need to make sure that you are not getting false failures. You need to identify good parts as good and catch the bad parts."

According to Vermillion at Eye Applied Optix, this validation is all part of the continuous process of improvement in testing. "For both compliance testing and for R&D, you need to review results to make sure they make sense."

Xenon innovation

Last year, Atlas Material Testing Technology introduced its next-generation instrument in xenon-arc weathering testing, the Ci4400 Weather-Ometer, which replaces the previous Ci4000 model. The new model provides test results that are consistent with legacy instruments, but it has improvements such as more efficient air flow for better tier-to-tier and within-tier uniformity, better PID control of parameters for greater reproducibility, and a new deionised water-cooling system for greater reliability. Other new features include a larger chamber door, a 10% increase in specimen capacity with no increase in footprint over the previous model, an improved rotating specimen rack, and an optional AIOS (All-in-One Sensor) sensor to measure irradiance, chamber temperature, and relative humidity at the specimen exposure plane.

The last in that list is a significant addition in terms of stability. "The system may be controlling at set points as required by a standard, but what is actually happening at the sample plane, especially in terms of the air temperature and humidity, may be quite different in different sizes or different configurations of instruments. Differences in temperature and humidity could lead to different rates of degradation," explains McGreer. The at-sample-plane sensor solves this problem because it can be used to measure at the sample plane and control to the set-points. Because the AIOS has an internal battery and storage, it can be moved to different locations. "It could be used to determine reproducibility of testing conditions (at the sample plane) in different instruments or confirm parameters at the sample plane in different makes/models of instruments to ensure 'equivalency'," says McGreer. ›

Q-Lab adds calibration in Germany/China

Q-Lab has expanded its capabilities worldwide for ISO/IEC 17025 calibration of irradiance, temperature and relative humidity (RH) for its weathering and corrosion chambers.

Q-Lab Germany is now officially accredited for laboratory and field calibrations and Q-Lab China has expanded its scope to include field calibration. With these additions and reaccreditation of its existing capabilities, Q-Lab is fully accredited for laboratory and field calibration from its offices in the US, Germany, UK, and China.

The accreditation procedure was carried out by the Maryland, US-headquartered American Association for Laboratory Accreditation (A2LA), an independent accrediting body for ISO/IEC 17025.

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BASF's irradiation mapping database will allow stabilisation of products such as greenhouse films to be tailored to geographical location

PHOTO: BASF

The sensor could also be used to measure conditions in an end-use environment, and this data could be used for test method development. The ability to collect more and better data presents an opportunity to further improve the industry's understanding of weathering mechanisms and potentially further accelerate weather testing.

Calibration concerns

When performing accelerated testing, maintaining and calibrating your instrument is key, according to McGreer. Irradiance, reference surface temperature, chamber temperature, and relative humidity should all be calibrated. Lamps, filters, panels, and spray nozzles may require maintenance. Testing a weathering reference material can be used to determine reproducibility, can identify drift, and quickly shows if there is a problem with the equipment.

Atlas advises that best practice for testing includes use of testing replicates (at least three, according to McGreer) and taking interim test results (rather than just at the beginning and end) to get a better indication of the rate of change of a property. Despite all the efforts to improve the usefulness of accelerated testing, evaluating samples outside, under real conditions in real time, is still important. McGreer says that non-accelerated tests provide perspective to accelerated results and can be used to verify conclusions.

Below: The Ci4400 is the latest addition to the Atlas Weather-Ometer line, offering improved test uniformity and parameter control

PHOTO: ATLAS MATERIAL TESTING

Global understanding

Light irradiation is not a constant but varies around the globe. **BASF** has partnered with the German Aerospace Center (DLR) and the US NASA Goddard Space Flight Center to create a mapping database that more accurately shows how much solar UV radiation reaches the ground in a given location. BASF is using the database to maximise the service life of plastic products by precisely matching plastic additives to the predicted intensity of UV radiation in the region where the product will be used. When BASF receives enquiries about stabilisation systems, the company's researchers can refer to relevant past data as well as use the new maps to look up UV-radiation data in that region.

"The data will be used to extrapolate the UV radiation for the required timeline into the future. It will also include the consideration of wet-time (rain, dew) and temperature (thermal stress)," says Dr Volker Bach, head of BASF's Global Competence Center Plastics Additives. "This 'weather-extrapolation' is then correlated to the corresponding data of well-known weathering/aging locations, where we have accumulated extensive experience with various stabilisation systems in the field. These sites include Miami [Florida], Phoenix [Arizona], and a BASF Plastic Additives in-house site in Bologna [Italy]. Understanding a material's durability at a certain location under known weather conditions gives a gauge of its lifetime at other locations or regions."

BASF also has a dataset showing the durability of certain materials at different outdoor weathering locations compared to measurements in accelerated weathering equipment. "These studies are the basis for proper and accurate lifetime prediction," explains Bach.

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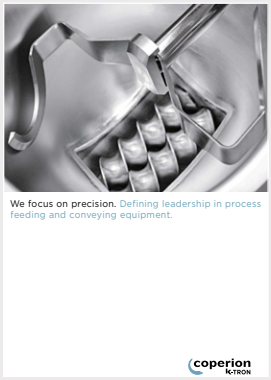

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LEISTRITZ: MASTERBATCH SYSTEMS

Additive and colour masterbatch production places specific demands on compounding equipment. This 16-page brochure from Leistritz explains how its ZSE 35 iMAXX masterbatch twin screw extruder rises to the challenge.

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CPM EXTRUSION: SYSTEMS AND PARTS

This new brochure from CPM Group details the extended range of compounding extruders, production lines and replacement parts available from the company following its recent acquisition of Germany-based Extricom.

› CLICK HERE TO DOWNLOAD

COMAC: COMPOUNDING LINES

This four-page brochure details the key features of the twin screw extrusion and associated equipment developed by Comac for the compounding of plastics, including feeding and degassing options.

› CLICK HERE TO DOWNLOAD

COMAC: MASTERBATCH LINES

Find out more about the range of twin screw extrusion equipment and feeding and dosing options developed by Comac for production of colour and additive masterbatches in this four-page brochure.

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BAY PLASTICS: STRAND PELLETISERS

Bay Plastics provides strand pelletisers and associated equipment to handle just about for any application. This four-page brochure details its full range of pelletisers, wet and dry-cut slides, water baths, air knives and dewatering units.

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

Learn more about AMI's upcoming conferences

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

FIRE RESISTANCE IN PLASTICS 2018

AMI's Fire Resistance in Plastics conference takes place on 10-12 December 2018 in Cologne, Germany. Now in its 13th year, the event provides a forum to debate fire safety requirements and regulatory and technical developments.

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PLASTICS REGULATIONS USA 2018

Following two successful events in Europe, AMI's first North American Plastics Regulations conference takes place in Pittsburgh, PA, USA, on 11-12 December and will examine the evolving nature of US and global chemical, plastics and food contact regulation.

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POLYMERS FOR 3D PRINTING

Polymers for 3D Printing is a new conference from AMI exploring the development, production and application of polymers for 3D printing and other rapid manufacturing technologies. The event will be held in Düsseldorf, Germany on 11-12 December 2018.

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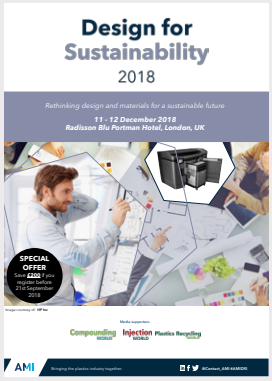
DESIGN FOR SUSTAINABILITY



A new conference, Design for Sustainability on 11-12 December 2018 in London, UK, discusses how innovations in polymer materials and processes can help designers meet the sustainability challenge in packaging, automotive, electronics and other markets.

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THERMOPLASTIC CONCENTRATES 2019

Now in its 22nd edition, Thermoplastics Concentrates 2019 is the essential meeting point for all involved in the production and use of concentrates in North America. The 2019 event takes place in Coral Springs, FL, USA on 29-31 January.

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PIPELINE COATING EUROPE 2019

AMI's 11th Pipeline Coating conference returns to Vienna in Austria on 12-14 February 2019. This high level international event examines the very latest developments in pipe coating materials and application technology.

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Learn more about AMI's upcoming conferences

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

PVC FORMULATION USA 2019

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

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CABLES 2019

Taking place in Dusseldorf in Germany on 5-7 March 2019, AMI's 19th Cables conference will explore the key commercial and technical innovations in polymer-based materials for cable industry applications.

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LONG FIBER THERMOPLASTICS USA

This brand new event for the USA explores the technologies, processing and application of weight-saving long fiber reinforced thermoplastics. It takes place in Dearborn, MI, USA, on 5-6 March 2019.

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SINGLE-SERVE CAPSULES USA

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

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POLYMERS IN FOOTWEAR USA

Taking place in Woburn, MA, USA, on 5-6 March 2019, this brand new North American conference explores material trends and application opportunities for innovative polymers in the footwear industry.

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MASTERBATCH ASIA

The most established event for the Asian masterbatch industry, Masterbatch Asia returns to Bangkok in Thailand on 14-15 March for its 15th edition. Learn from and network with the industry's leading experts.

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

Automotive Compounding Industry

Head office location:	Guarda, Portugal
Date founded:	2011
General Manager:	Fernando Amaral
Ownership:	A division of Perplastic Group
No. of employees:	63
Production capacity:	38,500 tonnes (company data)
Sales 2017:	€37m
Plant locations:	Guarda, Portugal; Vitoria de Durango, Mexico
Profile:	Automotive Compounding Industry (ACI) was established in Portugal in 2011 by the family run Perplastic Group, which dates back to 1986 and manufactures compounds for the footwear industry. ACI's main area of activity is the manufacture of compounds for the production of cables and wiring, primarily for the automotive industry. In 2015, it started production of PVC compounds for automotive cable applications at a new manufacturing site in Mexico.
Product line:	ACI specialises in production of PVC and polyolefin compounds. It offers a portfolio of 29 basic compounds, which includes PVC-based composites and speciality polymers such as silicone that meet the specific application requirements of the automotive electrical wiring sector.
Product strengths:	ACI compounds are formulated to provide good stability and balanced mechanical properties. Key performance characteristics include low volatility and self-extinguishing fire behaviour, allowing them to be used in the most demanding automotive applications.

To be considered for 'Compounder of the Month' contact Elizabeth Carroll: elizabeth.carroll@ami.international

Compounding WORLD FORTHCOMING FEATURES

The next issues of Compounding World magazine will have special reports on the following subjects:

January 2019
Polymer foam/blowing agents
Pelletising systems
Film additives
Polymer analysis

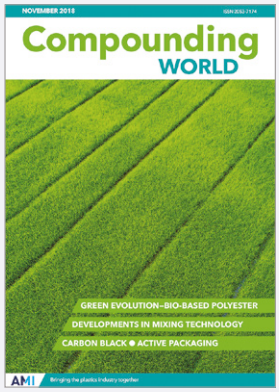
February 2019
Electrically conductive compounds
Materials handling
Additives for polyamides
Surface modification

Editorial submissions should be sent to Chris Smith: chris.smith@ami.international

For information on advertising in these issues, please contact:
Claire Bishop: claire.bishop@ami.international Tel: +44 (0)1732 682948
Levent Tounjer: levent.tounjer@ami.international Tel: +44 (0)117 314 8183

Keep informed: read our latest editions

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 2018
The November edition of Compounding World contains features on bio-based polyesters, mixing technologies, carbon black and additives for active packaging. Plus there is a review of Fakuma and key findings from AMI's European polymer distribution report.

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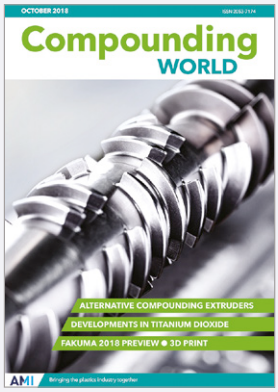

Compounding World October 2018
The October edition of Compounding World considers alternative options to extrusion for compounders, such as kneader technology. The issue also features titanium dioxide issues, 3D printing and a compounding preview of Fakuma 2018.

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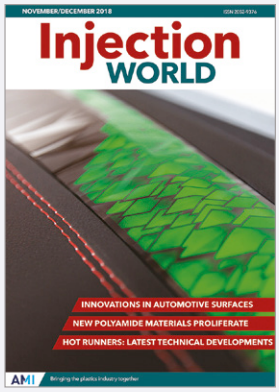

Injection World November/December 2018
The November/December edition of Injection World magazine reviews the latest innovations in automotive surface decoration. It also takes a look at developments in hot runner technology and polyamide compounds.

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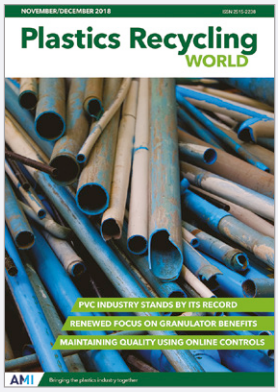

Plastics Recycling World November/December 2018
The November/December 2018 edition of Plastics Recycling World takes a look at the PVC industry's progress in recycling in Europe and Australia. It also reviews the latest developments in process control and plastic granulation.

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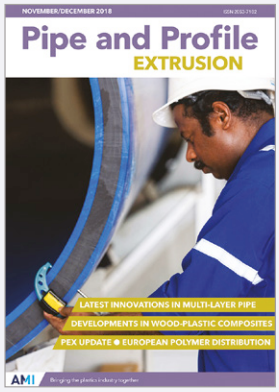

Pipe and Profile November/December 2018
The November/December edition of Pipe and Profile Extrusion features the latest multilayer pipe dies which can make products more flexibly and efficiently. Plus features on PEX and wood-plastic composites.

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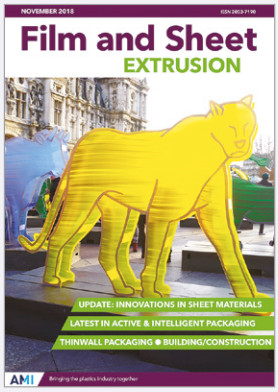

Film and Sheet November 2018
The November edition of Film and Sheet Extrusion has features looking at developments in the sheet sector, construction market, thin wall packaging and active packaging. Plus, AMI analysis of the European distribution market.

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Compounding WORLD
Film and Sheet EXTRUSION
Pipe and Profile EXTRUSION
Injection WORLD
Plastics Recycling WORLD

GLOBAL EXHIBITION GUIDE

2019

5-8 January	ArabPlast, Dubai	www.arabplast.info
27-30 January	Saudi Plastics & Petrochem, Jeddah	www.saudipp.com
29 January-1 February	Interplastica, Moscow, Russia	www.interplastica.de
28 February-4 March	Indiaplast, Delhi	www.indiaplast.org
12-14 March	JEC World, Paris, France	www.jeccomposites.com
12-15 March	Pro-Pack Africa, Johannesburg, South Africa	www.propakafrica.co.za
12-16 March	Koplas, Goyang, Korea	www.koplas.com
19-21 March	EU Coatings Show, Nuremberg, Germany	www.european-coatings-show.com
25-29 March	Plástico Brasil, São Paulo, Brazil	www.plasticobrasil.com.br
26-28 March	PlastPrintPack Nigeria, Lagos	www.ppp-nigeria.com
28-30 March	Mecspe, Parma, Italy	www.mecspe.com
2-5 April	Plastimagen, Mexico City	www.plastimagen.com.mx
8-12 April	Feiplastic, Sao Paulo, Brazil	www.feiplastic.com.br
10-12 April	Utech Las Americas, Mexico City	www.utechlasamericas.com
8-9 May	Compounding World Expo, Cleveland, US	www.compoundingworldexpo.com/na
8-9 May	Plastics Recycling World Expo, Cleveland, US	www.plasticsrecyclingworldexpo.com/na/
8-9 May	Plastics Extrusion World Expo	www.extrusion-expo.com/na/
8-9 May	Plastteknik Nordic Malmö, Sweden	www.easyfairs.com
21-24 May	Chinaplas 2019, Guangzhou, China	www.chinaplasonline.com
21-24 May	Moulding Expo, Stuttgart, Germany	www.moulding-expo.com
11-12 June	PDM Event, Telford, UK	www.pdmevent.com
16-23 October	K 2019, Dusseldorf, Germany	www.k-online.com

AMI CONFERENCES

29-31 January 2019	Thermoplastic Concentrates 2019, Coral Springs, FL, USA
26-27 February 2019	PVC Formulation USA, Pittsburgh, PA, USA
5-6 March 2019	Long Fiber Thermoplastics USA, Dearborn, MI, USA
5-6 March 2019	Polymers in Footwear USA, Woburn, MA, USA
5-7 March 2019	Cables 2019, Dusseldorf, Germany
14-15 March 2019	Masterbatch Asia, Bangkok, Thailand

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

www.ami.international

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OCTOBER 2018 EDITION

Extrusion Solutions

THE LATEST EXTRUDING NEWS FROM ENTEK

OPTICOLOR INC CHOOSES ENTEK

Southern California-Based Color Compounder Uses ENTEK for Masterbatch, Concentrates for Lighting and Optics Applications

When it comes to producing the highest quality compounded materials for the lighting and optics industries, OptiColor is an expert in the field. Founded in 1995 by Daniel Neufeld in Huntington Beach, California, OptiColor specializes in producing small-to-medium sized lots of colored and tinted materials for some of the world's leading lighting and eyewear companies.

Because of the inability to produce highly-concentrated compounds in-house on their single-screw extruders, Dan Neufeld reached out to ENTEK in 2012 and made the trip up the coast to Lebanon, Oregon to visit the company and learn more about their twin-screw extruders. After running material trials at ENTEK's In-House Pilot Plant, he made a call to Jim Drew, OptiColor's Plant Manager.

" 'We're buying an ENTEK', he said," laughed Jim in a recent interview. "I had joined Dan early on when he was preparing to expand the business, and Dan always wanted a twin-screw to help us compound more materials in-house. After running the trials at ENTEK's plant, he was sold."

Jim went up to ENTEK as well and tested several materials on the twin-screw. "I was impressed by the helpfulness and thorough training provided by ENTEK," he said. "We purchased a 40mm machine that year and have been running it ever since. It has really helped us grow our business."

Bringing More Business In-House

Until 2012, OptiColor was producing compounds in-house on their single-screw extruders, but these machines were only suitable for running small amounts of colorants (2% or less) with the virgin resin. After purchasing the new ENTEK twin-screw extruder, the company began running materials that were heavily loaded with up to 50% colorants and additives.

Doing the heavy duty mixing on the ENTEK machine helps keep the plant clean, and OptiColor takes pride in running a clean operation. "A clean shop leads to clean materials, and no cross-contamination of products," said Jim Drew. "That's extremely important in our business."

In addition to cleanliness, the ENTEK twin-screw extruder opened up new possibilities for OptiColor. The machine has helped OptiColor make products for their own internal use that they used to have to go outside the company to get. Concentrates and masterbatches are now produced both for customers and for OptiColor's own in-house use on the ENTEK machine.

It's the People

Since installing the new ENTEK machine in 2012, OptiColor has visited ENTEK several times to run additional trials over the years. "ENTEK has some of the nicest people we've ever worked with,' said Jim Drew. "Anyone at ENTEK will help you no matter what your question is – they are very willing to help with any problems or questions you have. They always follow up, call you back, and never leave you hanging."

Future Plans

The materials processed at OptiColor for lighting, lens and eyewear applications include acrylics, nylons, and polycarbonates, mixing with colorants and additives that are proprietary. The advent of LED lighting has driven a lot of new product development at the company.

(continued on page 3)

20 Years

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

Dr. Kirk Hanawalt

> *"Today, ENTEK has hundreds of twin-screw extruders in operation around the world, and we're growing at a record pace."*

20 Years of ENTEK Extruders

Back in 1998, ENTEK, a company that had been in business for 14 years, decided to embark on a new venture – to manufacture and supply twin-screw extruders to the plastics compounding industry. We had some experience – after all, ENTEK was already known as a leading supplier of highly-filled sheet for battery separators, and we used commercially available twin-screw extruders for this application.

But there was a problem – we were wearing out screws and barrels with our materials, and we weren't satisfied with spare parts availability. Our engineers and machinists took on the challenge of producing our own screws and barrels in-house – and then we decided to build our own twin-screw extruders as well. We felt our machines were second to none, and the decision was made to become a machine supplier to the industry.

Here we are 20 years later – and we're happy to report that our decision back in 1998 was a good one. Today, ENTEK has hundreds of twin-screw extruders in operation around the world, and we're growing at a record pace. We now offer machines ranging from 27mm to 133mm and have an excellent staff at our Lebanon, Oregon headquarters and in the field supporting our customers every step of the way.

Thank you to all of our customers – your business is much appreciated. We will continue to work with you to help you improve your compounding operations and look forward to our continued, mutual success in the future!

Growth – Continued

In the article on p. 4 you will see we are once again expanding our facilities here in Lebanon. Due to our continued growth we needed more space in our manufacturing area for fabrication, assembly, testing and shipping. We're excited to have this latest expansion completed so we can create a better workflow through the building, which will help us operate even more efficiently.

NPE Recap

In the last issue of *Extrusion Solutions*, I wrote about the upcoming NPE show in Orlando. The show was held from May 7-11 and I'm happy to report it was a great show for ENTEK, and for the plastics industry. Enthusiasm was high, and we enjoyed seeing existing and prospective customers.

I enjoyed seeing large crowds gather at our booth twice a day to see our live screw change demonstrations. Colt McDaniel, who works in our Pilot Plant, was chosen to perform the screw changes and he did a great job under pressure – after all, we told the world that the screw change could be done in 5 minutes or less! We timed Colt and I believe his fastest time was in 3 minutes 30 seconds. Visitors to the booth were impressed. As anyone who has performed screw changes on a twin-screw extruder knows, it can be a difficult task and usually takes over an hour or longer. ENTEK has found a way to take that task and reduce it down to 5 minutes or less – a real advantage for compounders who do frequent color changes and need to change out screws on a frequent basis.

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

As always, I encourage you to contact me anytime at **khanawalt@entek.com**.

Sincerely,

Kirk R. Hanawalt

Dr. Kirk Hanawalt
President, ENTEK Extruders

20 Years of ENTEK Extruders

2018 marks the 20th anniversary of ENTEK Extruders. While ENTEK has been in business since 1984, the Extruder division of the company was established in 1998. The story of how and why ENTEK Extruders came to be is not really typical for a leading machine supplier to the plastics industry.

The Early Years

ENTEK began operations in the 1980's as a processor, compounding materials and producing highly-filled, specialized sheet used in battery separators for the automotive industry. The materials used in this application were challenging to run on twin-screw extruders, to say the least. The wear on the screws and barrels in the extruders created the need for frequent replacement of these critical parts, and ENTEK was dealing with long lead times to get replacement parts from their machine suppliers. Downtime was not an option, so ENTEK began producing its own wear parts, which led to making its own twin-screw extruders for in-house use.

"ENTEK's experience with its own 24/7 for 355+ days per year extrusion operation taught us the importance of equipment reliability, locally sourced parts, and outstanding customer service," said Dr. Kirk Hanawalt, ENTEK President. "ENTEK's background in running extrusion lines really guided our development as an extrusion line supplier. We know that running extrusion lines to make money is hard work and as a supplier we have to go the extra mile in our technical support and service to ensure our customers are successful."

In 1998 the company decided to branch out and market its twin-screw extruders to the plastics industry, and made its first sale. The company that purchased ENTEK's first machine in 1998 has continued to purchase ENTEK extruders over the years, including a recent purchase of multiple machines in 2018.

(continued on page 4)

Left: ENTEK's Bill Petrozelli (right) sharing his processing knowledge in 2000
Center: ENTEK's Al Bailey monitoring production on a 2001 control system
Right: ENTEK's booth at NPE2006

ENTEK was honored with the "100 Best Companies to Work For" award in 2010 by Oregon Business magazine

OptiColor Chooses ENTEK

(continued from page 1)

The 40mm ENTEK machine that OptiColor purchased in 2012 was the right machine for them at the time; they process mostly small lots of materials, and it's not unusual for them to produce 50-200lb lots. The 40mm machine was ideal for this and also robust enough to support their small to large production quantities.

"We're looking at a second, larger ENTEK machine to support our rapid growth in markets we serve that require high quality concentrates," said Jim Drew. "Our niche is producing specialty colors and small lots with concentrate production quantities ranging from 300 to 50,000 lbs. As we continue to grow and the time comes to add another twin-screw extruder, we would start with ENTEK."

Company Growth

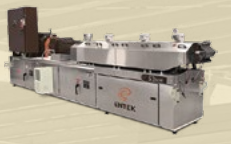
Some Highlights Along the Way

ENTEK grew steadily over the years with numerous highlights along the way. Some of these included:

- NPE shows: After exhibiting at its first NPE show in 1997 with a small 10' booth, ENTEK has been a major exhibitor at every NPE since. In 2018, ENTEK had a 40' x 50' island booth at NPE featuring QC^3 33mm and HR3 73mm machines, interactive screw design layout programs, and live 5-minute screw change demonstrations
- Markets: In its early years, ENTEK began working with leading color compounders who embraced our new extruder design. We offered then and still offer today extruders with the electrical, cooling, heating, and lubrication components onboard within Stainless Steel cabinets; easily sourced electrical and mechanical components; and the willingness to provide custom solutions to suit our customer's unique needs. Today, ENTEK is the leading twin-screw supplier to this market and has become a leading supplier in other markets including wood-plastic extrusion, packaging, bioresins, and specialty materials.

- QC^3: After several years of research and development, ENTEK introduced its new line of QC^3 twin-screw extruders in 2015. QC^3 stands for Quick Change, Quick Clean and Quality Control. Virtually every aspect of the machine was examined and redesigned, if necessary, to improve on all of these key parameters. The machines feature the ability to change screws in 5 minutes or less – a function that takes hours on competitors' machines.

Today . . .



After 20 years in business, ENTEK has several hundred twin-screw extruders in operation in 14 countries – from the US, Canada and Mexico to Europe, Asia and Australia.

"We pride ourselves on the fact that many of our customers have continued to purchase from us over the years," said Linda Campbell, ENTEK's Director of Sales. "We're also proud that five members of our sales team have over 20 years with ENTEK."

From that first machine sale in 1998, ENTEK now manufactures eight sizes of twin-screw extruders ranging from 27mm to 133mm in size. "We have a machine for virtually any materials compounding application, from small machines for lab environments to machines for ultra-high masterbatch production," said Linda Campbell.

ENTEK thanks its many loyal customers who have worked with the company over the years and welcomes new prospects who would like to learn more about the company's twin-screw extruders and wear parts. Contact ENTEK any time to speak with one of our expert staff, or even better, plan a visit to Oregon to tour ENTEK's facilities, meet our people and run material trials in our state-of-the-art Pilot Plant. "We're proud that we've been in the twin-screw extruder business for 20 years, but we're even more enthusiastic about our future," said Kirk Hanawalt.

Continued Growth

The sounds of progress continue to be heard outside at ENTEK's headquarters in Lebanon, Oregon. We are in the midst of another expansion of our ENTEK Extruders facility!

Our shop area is being increased with a new 30,000 ft^2 addition. The new area will be used for fabrication, assembly, testing and shipping.

"As our business continues to grow, we needed to expand our shop area," said John Burke, ENTEK's Director of Manufacturing. "We are applying lean principles and will be rearranging the facility flow through the existing and new building to optimize efficiency and production."

Pilot Plant News

By Dean Elliott, Technical Processing Manager

There has been a steady increase in the use of the ENTEK Pilot Plant over the last 18 months. To best serve our customers, prospective customers, and our employees, we have taken steps to improve the efficiencies and safety of the Pilot Plant along with increasing our full time employees assigned to the Pilot Plant.

We are close to achieving Pilot Plant utilization of 40 to 45 weeks per year. Some of the improvements include purchases to support our QC^3 extruder series (Quick Change, Quick Clean, Quality Control). These include:

1. A 2nd set of screw shafts. This helps to have a built screw set ready to go for quick change overs.
2. Doubled screw element inventory to assist with #1, along with increased processing flexibility.
3. Additional Gala underwater cutter dies to cover a larger range of pellet sizes and to also achieve quick changes (a die can be prepared off line while the extruder is running)
4. Additional strand dies to cover a larger range of pellet sizes and to accomplish quick changes.
5. Modifications to our strand air belt for safer operation.
6. Multiple Water and Air hose reels as well as 110Volt cable reels. This mitigates tripping hazards.
7. A dedicated Pilot Plant forklift – no more hunting down and borrowing forklifts from other departments.
8. Additional platform ladders for loading feeders along with catch trays to minimize mess on the floor.
9. Buckets designed specifically for loading feeders to minimize mess.
10. Modified and specially designed feed hoppers that are easier to fill with materials in order to minimize mess and reduce airborne particulates.
11. Additional air extractors along with carbon filters for fumes to create a dust free and non-toxic environment.
12. A diaphragm pump for transferring fluffy/fluid powdered materials to the feed hopper. This removes the manual "bucket dump" into the feed hopper which causes particles to become airborne.
13. Detailed Pilot Plant trial plans along with trial preparation check lists to ensure a "Ready to Go" mentality. The equipment starts up on Day 1 of the trial as per customers' expectations.

Schedule Your Trial Today!

Our Pilot Plant and our experienced technical staff is available to help new and prospective customers to sample their materials and compounds on our machinery. We consider our Pilot Plant and staff second to none – put this resource to work for you! We are ready, willing and able to work with you to help prove-out or improve your compounding applications. For any questions or to schedule a trial, contact me at 541-259-1068 or **delliott@entek.com**.

ENTEK at NPE 2018

For one week in May, the global plastics industry descended on Orlando, Florida for NPE 2018. The latest NPE broke records in numerous categories including number of exhibitors, square footage of booth space utilized, and more.

ENTEK would like to thank everyone who stopped by to visit our booth at NPE – we once again enjoyed a great show. Our twice-a-day, live demonstrations of screw changes in less than 5 minutes on our QC^3 33mm twin-screw extruder were a huge hit and drew big crowds. We also featured:

- a HR^3 73mm twin-screw extruder in our booth, which was sold to BPC Toll Compounding & Blending and shipped to them after the show;
- two computer stations with hands-on demonstrations of our screw design layout program;
- replacement wear parts and end products displays, and...
- daily happy hour with Oregon beer and wine!

ENTEK's Tammy Straw, who served on the show organizer PLASTICS' 'Attendee Acquisition Committee', said "The quality of the leads we got at NPE were even better than expected, and we have already visited and booked Pilot Plant trials with many potential new customers.'

She continued, 'Being on the NPE 2018 Committee was a great experience and it was exciting to see the show come together from the organizer's side. I look forward to serving again on the NPE 2021 Marketing Committee."

Upcoming Events

See ENTEK at the following upcoming events in 2019:

Dec 4-5, 2018 – AMI Compounding World Forum
Ft. Lauderdale Marriott Coral Springs
Coral Springs, FL

March 11-13, 2019 – Plastics Recycling
Gaylord Nation Resort and Convention Center
Washington, D.C.

May 8-9, 2019 – Compounding World Expo
Huntington Convention Center
Cleveland Ohio

Who to Contact

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