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DIC ups global PPS capacity

Sun Chemical and its Japanese parent company DIC are to build a new production line for PPS compounds at the DIC Imaging Products facility at Oak Creek, Wisconsin in the US.

The plant will be the first for DIC in North America and is due to begin operations in autumn 2020. It will add 3,000 tonnes to the 43,000 tonne annual PPS compounds production capacity across the company's four existing sites in Japan, China, South-East Asia and Europe.

PPS compounds are used widely as alternatives to metals in automotive components and other products where their thermal and chemical resistance and dimensional stability are valued. The global market is expected to grow by 20% from 2017 to 2021, due to increased use in vehicle electrical systems and in hybrid and electric vehicles.

Mehran Yazdani, President of Sun Chemical Advanced Materials, said the decision to invest is "our response in meeting the expanding demand for PPS in North America and ensures a stable supply and shortened lead times".

› **www.sunchemical.com**

Celanese expands TPC unit

Celanese is to expand its Pibiflex and Riteflex thermoplastic co-polyester (TPC) production unit at the Donegani facility in Ferrara, Italy.

The company had started up an additional solid-state polymerisation unit at the facility in September 2018; it now expects to add a further line in the next 15-18 months.

TPCs combine the characteristics of vulcanised rubber with the easy processability of thermoplastics.

› **www.celanese.com**

More than 2,000 register for new US plastic exhibitions

More than 2,000 people have registered to attend the three plastics exhibitions focused on extrusion, recycling and compounding that will take place at the Huntington Convention Center in downtown Cleveland, Ohio on May 8-9, 2019.

The Compounding World Expo, Plastics Extrusion World Expo and Plastics Recycling World Expo will feature more than 250 exhibitors and five conference theatres with over 130 speakers across the two-day event. Free tickets for the exhibitions and conferences are available by registering in advance **HERE**.

"Bookings are still coming in fast and we expect this to be the biggest dedicated plastics industry event in the USA this year," said Nikki Whyman, Senior Marketing Manager at AMI, the organiser of the exhibitions and conferences and publisher of *Compounding World*.

The 2,000-plus people that have already registered to attend include representatives from industry-leading firms such as Abbott, Amcor, Ampacet, Associated Materials, Avery Dennison, Azek Building Products, Bemis, Berry Global, Bixby, Colgate-Palmolive, Dell, Envision Plastics, Ford Motor Company, Genova Products, HP, Lavergne, LyondellBasell, NAPCO, Nestle, PolyOne, Primex Plastics, Renolit, Reynolds, Royal Building Products, Southwire, Taghleef, Tarkett, TE Connectivity, Tekni-Plex, Teknor Apex, Trex, Veka, Whirlpool and more.

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› **ami.ltd/Register-AMI-Expos**

BASF's Ultramid PA meets fuel cell demands

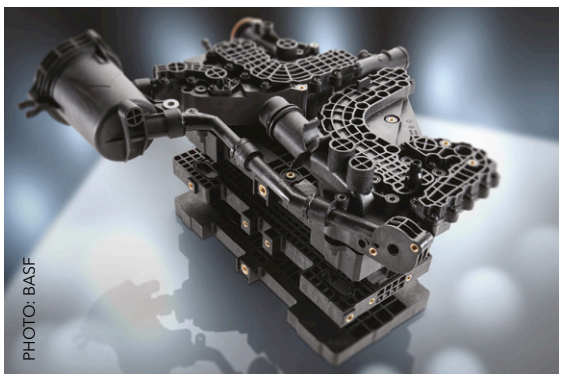

PHOTO: BASF

BASF's Ultramid A3WG10 CR and A3EG7 EQ grades of glass fibre-reinforced PA are being used to make parts for fuel cell systems in the new Mercedes GLC F-Cell, which combines a fuel cell with a rechargeable lithium-ion battery.

The company worked with Joma-Polytec and Mercedes-Benz Fuel Cell on the project. The two glass fibre-reinforced Ultramid grades are used to manufacture the anode and cathode end plates in the fuel cells.

The Ultramid A3EG7 EQ grade is also used to produce the media distribution plate and the water separator unit, which is exposed to a wide variety of media through the cooling water, air and hydrogen channel.

› **www.plastics.basf.com**

Ineos to buy Cristal's TiO_2 operations in US

Ineos Enterprises has agreed to acquire the North American TiO_2 business of Cristal from Tronox for $700m.

The move, which includes two plants at the Cristal complex at Ashtabula in Ohio will make Ineos the second largest producer of TiO_2 in North America. It also marks the company's first move into the pigments market.

"This is a great opportunity for Ineos to enter the pigments market by acquiring a competitive business, with excellent people and assets," said Ineos Enterprises CEO Ashley Reed. "Ineos has a strong track record of manufacturing excellence, running its businesses safely and reliably and working closely with customers to meet their growth aspirations."

Tronox is divesting the Cristal business to secure Federal Trade Commission (FTC) clearance for its proposed acquisition of Cristal's global TiO_2 business, announced in 2017. Eight other regulators, including those in the EU, have already approved the deal.

The new agreement with Ineos is itself subject to FTC clearance. It is supported by customers on both sides, according to Tronox.

› **www.ineos.com**
› **www.tronox.com**

Labtech grows its range to 36mm

Thailand-based laboratory compounder manufacturer Labtech Engineering has extended its range with the introduction of a 36mm unit suitable for upscaled production work.

The twin screw machine is available in two versions: standard specification for outputs up to 150-200 kg/h and the Maxi36 specification with 90kW motor for outputs up to 250 kg/h. Features of both include a modular barrel with simple access for mounting of side and top feeders.

The larger extruder is supported with a range of peripherals including the LW-300 24 strand water bath, LZ-200 strand pelletisers and LCL-80 classifier.

› **www.labtechengineering.com**

Right: The new 36mm model is Labtech's largest to date

PHOTO: LABTECH ENGINEERING

Lotte launches Evermoin

Korea-headquartered Lotte Advanced Materials has announced the global introduction of Evermoin, a non-silver antimicrobial technology available in ABS, PP and PC polymers.

Evermoin is said to offer protection against pathogens that cause healthcare-associated infections. According to the company, it has been proven to inhibit 99.9+ (3 log+) growth rate of both positive and negative pathogens, including *S. aureus* and *E. coli*.

The company said potential applications include medical housings, equipment and accessories, as well as various non-medical uses where its ability to inhibit bacterial and fungal growth is valued, such as cosmetics, electricals and electronics, appliances and kitchenware.

› **www.lotteadms.com**

NEWS IN BRIEF...

Italian plastics and rubber machinery association **Amaplast** says production was up by 0.6% to €4.7bn last year. However, the association said 2018 could turn out to be a "transisition year" for plastics machinery makers as global uncertainties threaten to bring a close to the current eight-year period of uninterrupted growth.
www.amaplast.org/en

Coca-Cola revealed it produced 3m tonnes of plastic packaging in 2017 in Ellen MacArthur Foundation's New Plastic Economy Report **http://bit.ly/2W5F4cx**. That is equivalent to near 1% of total global plastic consumption. The soft drinks firm was one of just 31 among the 150 featured companies to publish packaging volume data.
http://bit.ly/2W5F4cx

Covestro has joined forces with biotechnology company **Genomatica** to develop materials based on renewable biomass feedstocks. The project will combine the former's know-how in chemical process technology and application development with the latter's in developing industrial-scale bioprocesses to make common chemicals. No details have yet been disclosed about the likely products or end uses.
www.covestro.com
www.genomatica.com

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Mexichem expands in Europe

Mexichem Specialty Compounds (MSC) has installed a new production line at its facility at Melton Mowbray in the UK, increasing production capacity by an additional 10,000 tonnes/yr.

The additional line will double capacity for the company's Low Smoke Halogen Free Megolon compounds, where it reports growing demand from wire and cable manufacturers working to meet the latest EU Construction Product Regulation (CPR).

"Investing in the ability to rapidly service our customers' requirements is at the forefront of this initiative", said MSC General Manager, Daniel J DeLisle. "While global standards continue to evolve, and while technology continues to advance, our reaction time to the pace of business is critical to partnering with our customers and meeting their needs."

› **www.mexichemspecialtycompounds.com**

PHOTO: MEXICHEM

Above: Mexichem has upped European capacity with an additional line in the UK

Geiger picks Ravago recycled PP

Automotive supplier Geiger Automotive has selected Ravago's recycled, talcum-filled, heat-stabilised PP – Mafill CR HT 5344 H – for the air inlet on the engine radiators in the BMW X3. The parts are made at Geiger's plant at Suwanee in the US, and are 300-600 mm in size, with wall thicknesses of 1.2-2.0 mm.

Mafill CR HT 5344 H is Ravago's first globally-available recycled PP. It meets the same specifications irrespective of where the starting materials are sourced, which is said to have been a key factor in the Geiger decision.

"In-house testing has demonstrated that batches from both Europe and overseas are completely identical in quality," said Linus Winkler, Director of Supply Chain Management at Geiger. "Changing over on the fly from the European to the US material required no changes to machine parameters. Indeed, the low distortion and dimensional stability of the moulded parts were at the same high level."

› **www.resinex.com**

Nordson opens up in Münster

Nordson held a ribbon-cutting ceremony last month to mark the opening of the new 14,380 m² facility at its Polymer Processing Systems division's site in Münster, Germany, which was acquired from Kreyenborg in 2013.

The new facility will be the global hub for the company's BKG brand of pelletising systems and melt delivery components, such as screen changers and melt pumps.

The investment more than triples the amount of manufacturing, R&D, and office space at the Münster location and brings together capabilities that were previously spread across four separate sites. The facility also includes an enhanced technical centre for R&D and customer trials, as well as an after-market centre for BKG systems and Nordson's EDI brand of polymer extrusion and fluid coating dies.

› **www.nordson.com**

PHOTO: NORDSON

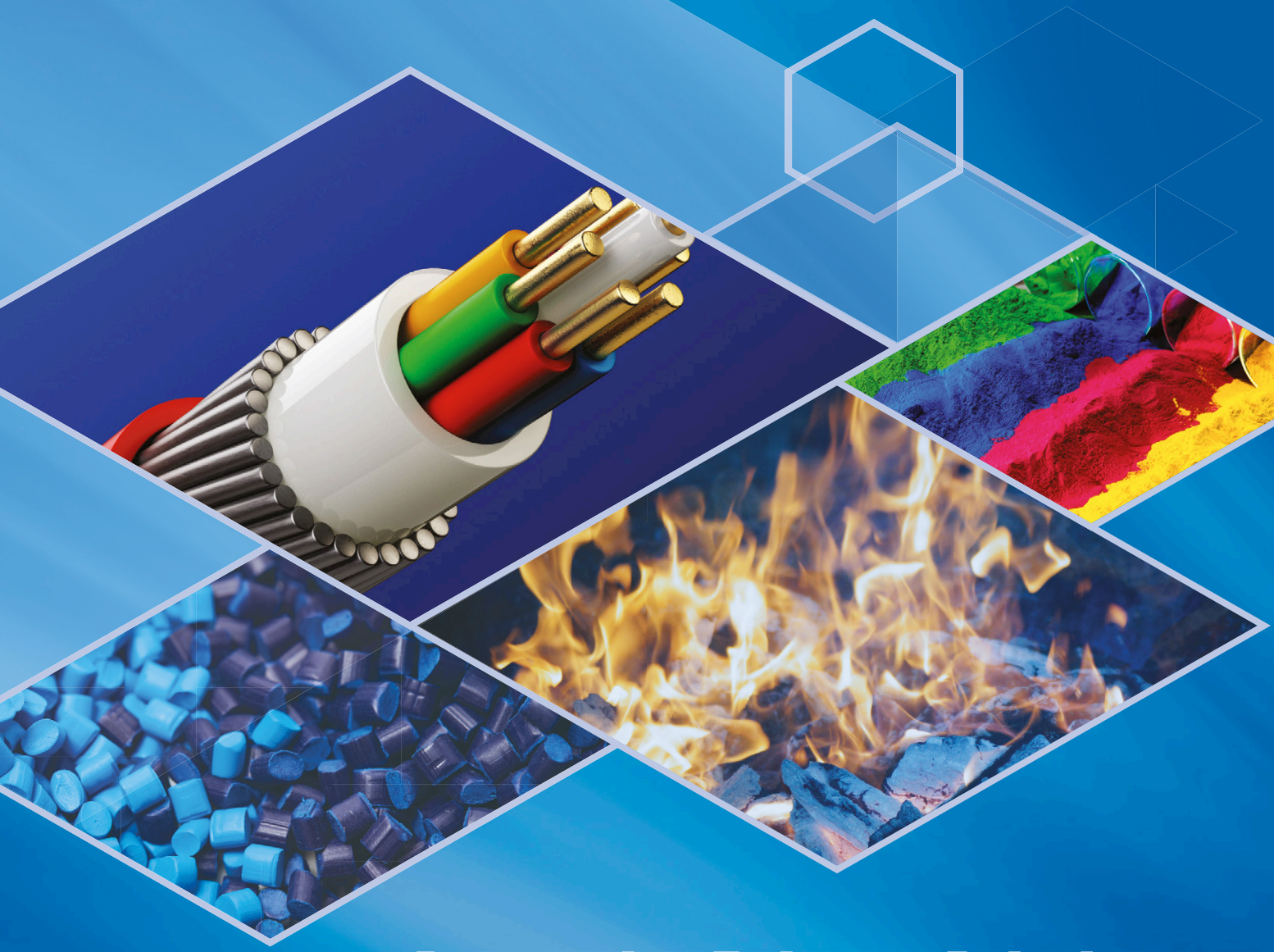
Grafe sets sights on auto ABS

Germany's Grafe has developed a new colour/additive combination masterbatch for ABS that the company claims meets the needs of automotive OEMs at lower addition levels.

"Our development goal here was to reduce the required addition dosage of the colour additive combination masterbatches from 6.5% to 4% without compromising quality," according to Dr Jan Stadermann, who is Head of the Material Sciences department at the company.

Designed to deliver a good surface finish and resistance to sunlight and elevated temperatures, the UV/TS variants can reduce raw material purchasing costs by up to 30% while also offering improved performance, according to Grafe.

› **www.grafe.com**



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Saudi Aramco buys into SABIC

Saudi Aramco has acquired a 70% majority stake in Sabic from the Public Investment Fund of Saudi Arabia. The private transaction was concluded for a total of about $69bn and is subject to certain closing conditions, including regulatory approvals.

The remaining 30% of SABIC will stay in public ownership. Saudi Aramco said it had no intention of acquiring this.

In a joint statement, the two companies said that the deal will be key to both "in the development of the petrochemicals industry in Saudi Arabia and reinforces aligned objectives to create a preferred global chemicals company".

Sabic CEO Yousef Al-Benyan said: "SABIC will benefit from the additional scale, technology, investment potential and growth opportunities Saudi Aramco will bring as a global leader in integrated energy and chemicals production."

› **www.sabic.com**
› **www.saudiaramco.com**

Mitsui adds LFT plant in China

Japanese chemicals giant Mitsui Chemicals is to set up a 3,500 tonnes/yr facility for long glass fibre-reinforced PP (LGFPP) at its 50%-owned subsidiary Mitsui Advanced Composites (Zhongshan) in Guangdong province, China.

The new site is due to be completed in early 2020 and will begin production in Q3. It will be the company's third LFT compounds facility, joining others in Japan and the US, and will increase the firm's global capacity to 10,500 tonnes/yr.

› **www.mitsuichem.com**

Xenia launches carbon PP

Xenia has introduced a new series of short carbon-fibre filled PP composite grades under the Xecarb 11 brand. The company said that the compounds represent "the ideal solution for a wide range of applications in chemical, industrial and sport system fields which require a high modulus to density ratio".

PHOTO: XENIA

Xecarb 11 grades are electrically conductive, due to their carbon fibre reinforcement, and offer a tensile strength at break of up to 115 MPa. Other claimed features include chemical resistance, high heat deflection temperature, improved dimensional stability, reduced post shrinkage, better surface hardness and good UV resistance.

› **www.xeniamaterials.com**

Polytechs purging rebrand

France-based Polytechs has rebranded its Clean X range of purging compounds as Clean Xpress.

The company, which has a capacity of around 23,000 tonnes/yr and also offers compounds and masterbatches and toll compounding services, said the Clean Xpress formulations remain unchanged. The existing grade names will be retained: Clean LDPE, Clean HDPE, Clean PP, Clean HT and Clean HP.

› **www.cleanxpress-polytechs.com**

Sabo to commercialise new UV stabiliser

SaboStab UV 2016 is aimed at agrigultural film applications

PHOTO: SABO

Sabo has announced the global commercialisation of SaboStab UV 2016, a new UV stabiliser system for agricultural applications. The decision follows six years of development including extended field trials in Southern Italy and North Africa.

The company said the new stabiliser shows "outstanding thermal and UV protection to greenhouse films with proven resistance to agrochemicals ensuring two or more years lifetime even in the presence of high concentrations of sulphur."

The new additive also has greater pesticide resistance than its SaboStab UV 119, which is widely used to stabilise PE-based greenhouse covers.

› **www.sabo.com**

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Expo to shine spotlight on women in plastics

Panellists in the Women in Plastics debate include (left to right): Lauren Hickey, Jennifer Profitt, Meli Laurance, Candace Sanders and Molly Bridger

Issues surrounding the professional development of women in the US plastics industry will be addressed in a panel discussion at next month's Plastics Extrusion World Expo, which takes place in Cleveland, Ohio, and runs alongside the Compounding World Expo (previewed on page 39 of this edition).

'Women in Plastics: Empowering Industry Change' brings together several high-achieving women from across the world of plastics to share their perspectives on breaking through in this traditionally male-dominated industry. The 45-minute panel will look at the different paths these leaders have taken into the plastics industry, how the workplace is changing to become more inclusive, and future challenges and opportunities for the next generation of women entering plastics or other manufacturing professions.

The panellists include:

- Lauren Hickey, Director of Marketing and Product Management at masterbatch manufacturer Americhem;
- Jennifer Profitt, Plant Manager at profile and sidings producer Associated Materials;
- Meli Laurance, Regional Commercial Industry Manager for Plastics at global pigment specialist BASF Colors and Effects;
- Candace Sanders, Assistant Plant Manager at PVC product supplier Genova Products;
- Molly Bridger, Group Director of Marketing at thermoplastic materials manufacturer Simona America.

Organised by AMI, the Plastics Extrusion World Expo and Compounding World Expo take place at the Huntington Convention Center in Cleveland, Ohio, USA on May 8-9, 2019, alongside the Plastics Recycling World Expo. By registering in advance, visitors gain free admission to all three exhibitions, featuring more than 250 suppliers, plus the five conference theatres hosting technical presentations, educational seminars and business debates. To book a free ticket, which is valid for both days of the event, visit: **ami.ltd/Register-AMI-Expos**

Total in hood film project

Total is one of six participants in Belgium's Clean Site Circular Project, which aims to recycle pallet shrink hood waste from the construction sector in a closed system back to virgin-equivalent material.

Total Polymers developed the film recipe, which uses its Lumicene Supertough 22ST05, to boost the performance of the recyclates to meet market requirements.

Also involved in the recycling project are: shrink hood producer Oerlemans Packaging, construction materials firm Wienerberger, recycler Morssinkhof Rymoplast, and building materials association Fema.

The project is coordinated by the Belgian extended producer responsibility scheme for industrial packaging Valipac, which first implemented the Clean Site System 15 years ago for collection of wrapping films collected from the country's construction sites.

› **www.polymers.total.com**

PHOTO: MILLIKEN

Milliken grows in clarifiers

Milliken has started construction of its largest ever clarifier plant at Blacksburg, in South Carolina in the US. When complete in 2020, the new plant will boost global capacity for the company's Millad NX 8000 clarifier for PP by about 50%.

According to Allen Jacoby, Vice President of Milliken's Plastic Additives business, Millad NX8000 "is one of the most successful products in the history of plastic additives".

› **www.milliken.com**

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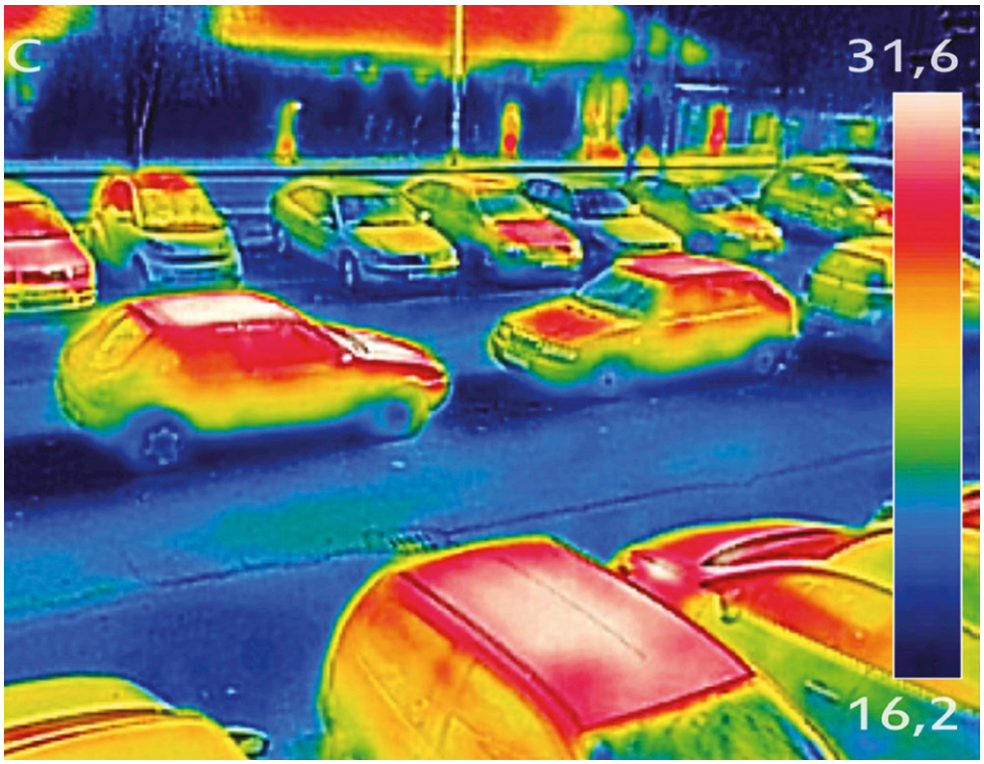

Applications for thermally conductive compounds are developing as their practical use becomes more extensively developed and understood. Mark Holmes finds out more

Keeping heat on the move

Plastics are not known for their thermal conductivity. However, interest in polymer compounds that offer enhanced thermal conductivity is developing as new applications emerge in areas ranging from automotive and electrical and electronics to medical devices and lighting. The move to reduced weight and the ongoing shift away from metals in many applications is also promoting their use. There are now a broad selection of additives available to improve thermal conductivity, but particular attention must be paid during compounding to ensure other important properties are not compromised.

The message from German company **Georg H Luh** is that while thermally conductive compounds have not yet reached mass market status, there are many interesting developmental projects currently going on in different industries. These projects will provide a boost to the thermally conductive compounds market and support further developments in the field.

Thermal management in the automotive industry is one area that is becoming increasingly important. "LED lights are getting more popular and have different requirements concerning heat management, which support the use of heat conductive compounds. In addition, battery systems in electric and hybrid vehicles create more heat than conventional battery systems, so there is a need for new concepts concerning heat management," says Klaus Rathberger, General Manager at Georg H Luh.

"Thermal management in the passenger cabin also becomes more important in electric vehicles because their use requires efficient usage of electrical battery energy. This provides great potential for intelligent solutions based on thermally conductive compounds. Similarly, the advantages of moulding, lightweight and corrosion-resistance will also support new applications in the chemical industry, for example," he says.

Rathberger believes that new thermally conductive compound solutions are going to require new additive developments. "Current additive solutions for thermal management are either efficient but costly, cheap but not efficient enough, or have other disadvantages like a major negative impact on the mechanical or corrosion properties of the compound," he says. "Some optimised additive solutions would be highly efficient, cheap and show only a small impact on the properties of the compound. There are unlikely

Main image: Automotive is expected to be a key market for thermally conductive plastics in the future

Right: LED lighting was one of the first high volume target markets for thermally conductive plastics

to be many solutions covering all of these aspects, but there is a lot of potential to create optimally customised solutions for specific applications."

The company has developed a number of heat conducting mineral additive products to meet some of these challenging applications, according to Angelina Schöffel, Customer Support & Marketing. These include modified graphite grades – marketed as GraphTHERM and GraphCOND – which can improve thermal and electrical properties in plastics and coatings applications. GraphTHERM is optimised for the highest level of thermal conductivity, while GraphCOND is designed for good thermal conductive performance at low filling rates.

Graphene nanoplatelets have been developed as a high-end material for specific applications. These materials enhance high thermal and electrical conductivity in combination, while mechanical properties such as strength and surface resilience can also be improved. And MagTHERM is a white mineral additive that improves thermal conductivity while maintaining electrical insulation.

Ready-to-use solutions

According to HPF The Mineral Engineers, a division of **Quarzwerke**, there have been ongoing material developments in the thermally conductive compounds arena for more than a decade. However, these ready-to-use solutions did not make an appearance on the market. "The reason was quite simple. There were no reasonable applications to use a thermally conductive material, except for those that were electrically conductive at the same time," says Péter Sebö, Head of Marketing & Market Development.

"End-users and OEMs now realise the value of such compounds and are engaged in looking at and considering thermally conductive materials in more detail, in terms of changing the design or construction of a part that needs replacing or completely re-developed," he says. "Over the past two years, the market has moved noticeably towards thermally conductive compounds for a number of reasons. These include an increasing number of applications, while the fear of using thermally conductive plastics instead of metals is now decreasing. In addition, a wide range of grades is now available worldwide, and the know-how of different companies within the supply chain is increasing, which gives much needed security and guarantees."

Below: Georg H Luh offers a number of thermally conductive modified graphites

E-mobility demands

E-mobility is currently one of the big driving forces in the development of thermally conductive compounds. "In electromobility, the objectives and achievements of future applications are closely linked to the use of new and innovative plastic materials and thermally conductive compounds will play an increasingly important role," says Sebö.

"The number of E&E applications in terms of automation, communication and security components is steadily increasing in the car of the future, particularly in e-mobility. The issue of heat generation and its effective conduction is a major challenge in many of these applications. In addition, in alternative power drives, battery technology has potential for heat conductive plastics, for example in battery housings and other components, as well as in the still costly and complex battery cooling systems. At the same time, a good choice and combination of plastics and fillers may offer a technical and economic alternative to metal. The resulting weight reduction can help to improve the reach of electrical cars," Sebö says.

"In addition, new developments in E&E, such as electrical tools, medical devices, lighting applications and tribology, are expanding the role of thermally conductive plastics. The increasing desire for higher levels of integration and downsizing of functional components requires the use of novel plastics for the realisation of highly functional system solutions. Thermally conductive plastics allow the possibility of achieving the required mechanical properties, heat dissipation function and electrical insulation in one automated production step. Design freedom and the good

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integration potential of plastics can be combined with effective heat dissipation and homogeneous temperature distribution," he explains.

According to Sebö, there are many new potential application areas that use high energy density electrical components – such as processors, light emitting diodes, electric motors, batteries and electronics – where efficient heat dissipation is required while maintaining electrical insulation. Integration of heat management/heat sinks into housings or enclosures, for example.

Processing considerations

"In addition, other considerations include processing or the targeted thermal conductivity of different additives and inorganic fillers, depending on the mechanical requirements," he says. "Independent of what kind of filler or additive is used to increase the thermal conductivity of the polymer, the main function must be adhered to. This means the higher the fill; the better the thermal conductivity. However, this will influence other material properties, such as mechanical. Processing is also influenced with an increased degree of filling. Furthermore, filler properties have to be considered in terms of density, hardness, grain size, colour, morphology and obviously price."

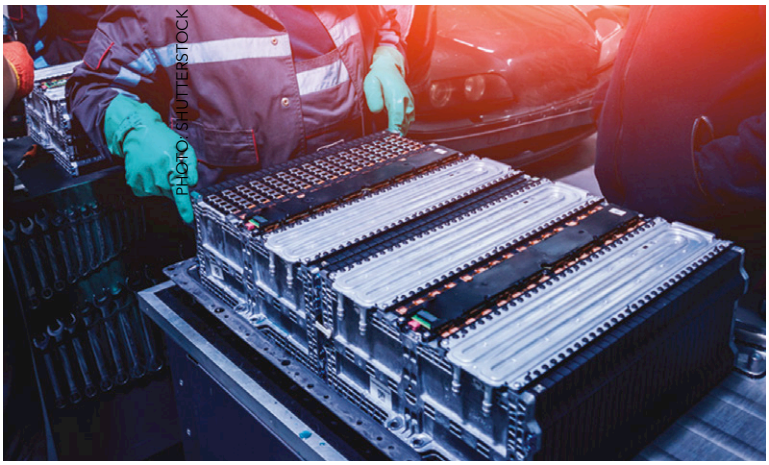
PHOTO: SHUTTERSTOCK

Above: Thermal management is a key requirement in batteries for electric vehicles

HPF The Mineral Engineers introduced its Silatherm product range in 2013. The company says that the fillers provide well balanced properties in a variety of polymer systems, including thermoplastics, thermosets and elastomers. The range can provide colourable solutions that offer good electrical insulation. Grain size can be optimised with bi- or tri-modular grain size distribution while surface treatment technology

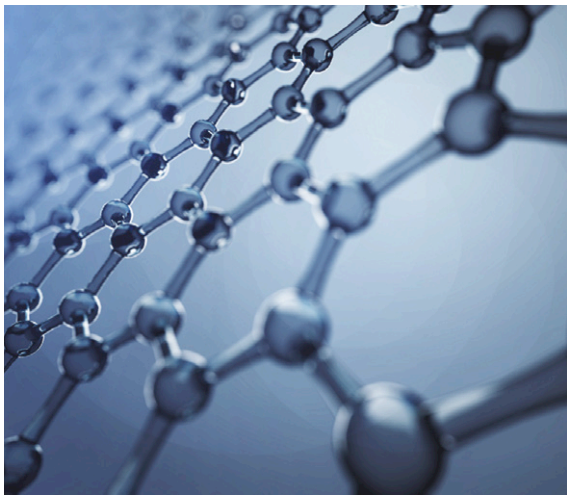

PHOTO: SHUTTERSTOCK

Right: Graphene is seen as a promising option for enhancing thermal conductivity

is used to expand possible applications and various filler blends. Ready-to-use solutions are available and higher thermal conductivity products offering isotropic properties have been developed that are said to offer a good mechanical property/price balance.

The latest product introductions include Silatherm 1466, which is based on alumosilicate. The company says that the 1466 grade is chemically similar to its standard Silatherm 1360 product but is much brighter in colour and offers better mechanical properties in compounds. A low grain size distribution of around an average 1.5 microns is offered. The Silatherm 1466-506 grade features a bi-modular grain size distribution.

The Silatherm Plus 1443 range is based on aluminium oxide and is said to provide a special morphology and tri-modular grain size distribution. This grade is particularly recommended for thermoset applications requiring higher fill densities, where it can achieve thermal conductivities of between 4–6 W/mK. The company says that a new Silatherm range and a number of experimental grades will be released at the upcoming K2019 trade show in Germany in October, where it will also show some new application examples.

Polyamide options

Huber Martinswerk, part of the Huber Engineered Materials division of J M Huber, has developed its series of Martoxid alumina-based thermally conductive powders for modification of a range of polymers. It says that the Martoxid TM-4000 series products are specially designed for polyamides. The latest addition to the series is Martoxid TM-4250, which is said to increase orientation independent (isotropic) thermal conductivity in PA6 and PA66 to 2.5 W/mK (in-plane and through plane). Addition levels of up to 75 wt% are said to combine with low viscosity and good flowability, allowing higher throughputs during extrusion at lower energy consumption.

According to Huber, tests conducted at Fraunhofer LBF in Germany on PA6 compounds confirm that the abrasion level of Martoxid TM-4250 is low (the company says it is much less abrasive than fillers with a lower Mohs hardness such as aluminosilicate and glass fibre). The morphology and surface treatment of Martoxid TM-4250 is claimed to enable formulators to achieve good elongation at break and Charpy impact results.

Huber says that the optimised rheological behaviour of the Martoxid TM-4000 series means they can be successfully employed in compounds for injection moulding of sub-millimetre wall thicknesses using standard moulding techniques. In addition, injection moulding production processes show a reduced cycle time of up to 50% compared to standard polyamide parts as a result of the faster cooling times possible from the higher thermal conductivity.

Below: An LED heat sink produced in a halogen free, flame retardant, thermally conductive PA6 compound from Witcom

PHOTO: WITCOM ENGINEERING PLASTICS

Developing applications

While there are currently only a limited number of applications, thermal conductive plastic is an area seeing increased interest and more applications should develop in the near future, agrees Christine Van Bellingen, Business Development Manager at **Witcom Engineering Plastics**. "The demand is primarily driven by metal replacement for weight reduction and the need for heat dissipation in more confined spaces. However, there are probably still some technological and commercial barriers preventing quicker market development, and the thermally conductive additive producers still have some room for innovation," she says.

"The original demand for thermally conductive plastics for LED lamps has become a commodity market, where high levels - above 50 wt% - of the

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Above: Many electronic applications will require thermal conductivity, electrical insulation and flame retardance

cheapest thermally conductive additives are used, or alternatively a thin metal layer is applied on virgin plastics," Van Bellingen says.

The combination of the known benefits of plastics with a better understanding of thermal system design is likely to help polymer-based application development. "Plastics solutions are ideal for overcoming the drawbacks of metal and offer corrosion resistance, lightweighting opportunities and a high degree of design freedom. It is now better accepted by industry that high metal thermal conductivity is not necessary to get outstanding heat dissipation from filled plastics; values below 5 W/mK and even between 1-2 W/mK through-plane can be enough to dissipate heat efficiently. While high levels of thermally conductive additives are still necessary to get the required performance, this may result in some brittleness especially when dispersibility or 'adhesion' with the plastics matrix is not optimal. When lower additive loadings can do the job, for example with expanded graphite, then higher viscosity will occur," Van Bellingen explains.

Formulation experts

"This is where a speciality plastics compounder can play the role of a formulation expert to overcome these drawbacks and deliver a correct, workable, solution," she says. "At Witcom, we develop customised compound solutions. For example, we have developed polyamide grades, all reinforced, that are thermally and electrically conductive, or thermally and electrically insulative, with some with halogen-free flame retardancy. As a customised engineering plastics compounder, we can develop any thermally conductive formulations based on various plastics, such as PA, PBT, PPS, PC and PEI."

Van Bellingen adds that graphene is increasingly being talked about as promising high tech theoretical solution. "As a compounder, the major technical criteria for thermally conductive additive selection include easy feedability, good dispersion that also influences mechanical strength, and impact on the rheology. Using lower additive levels – in the 10-20% range – is welcome, providing other properties can be maintained," she says.

Witcom says existing and potential applications for thermally conductive compounds include computer heat sinks, outdoor light housings, back parts of industrial cameras, and cooling parts for automotive batteries and engines. The materials can also find applications in parts that require a metal-like cool touch (thermal conductivity is a key factor in the surface haptic).

Future applications will, however, require a combination of material characteristics. "There will be increased needs for electrical conductivity, thermal conductivity, flame retardancy and EMI shielding, as related to e-mobility – electric and hybrid cars, autonomous driving, lightweighting and metal replacement, and higher safety concerns. Higher battery power, wider use of heat sensitive electronics and sensors, and the trend for smaller parts will call for more speciality plastics compounds with the combined properties of thermal conductivity and EMI, thermal conductivity, with EMI and flame retardance, and with electrical conductivity and flame retardance," Van Bellingen predicts.

Functionality matters

With increasing functionalisation of plastics in applications such as electronics and transportation, in particular, there is certainly a notable market demand for thermally conductive compounds, according to Sebastian Heitkamp, Global Marketing Segment Manager at **Cabot Corporation**. "The main trends are electrification of cars and increasing requirements with automotive and electronics 'merging' these two major plastic applications," he says.

Thermal management in the car is becoming more important as the batteries provide a new source of heat, Heitkamp explains. And as batteries are integrated into the structure of the vehicle, designers and plastic engineers will have to solve the heat transfer through plastic materials.

"Traditional and new additive solutions must not only perform in their thermally conductive behaviour, but must also function properly with additional levels of other additives such as stabilisers or flame retardants. With the growing need for functional plastics in demanding applications, the interaction between different filler types and additives must be understood to

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optimise the performance. There is also the additional need to consider how all these additives may impact the end products' mechanical properties, as well as how these raw materials interact with each other," Heitkamp says. "In addition, with the growing use of recycled grades, there is a need to analyse how thermal conductive additives will work with impurities."

Cabot has developed a range of thermally conductive compounds based on engineering thermoplastics with different formulations and specific additives. The most prominent recent development is a partial replacement of boron nitride, one of the more established thermally conductive additives. "With recent advances in nanomaterials we are addressing the need to develop solutions that have less impact on mechanical properties and at the same time are optimal in their conductive performance. A combination of traditional materials with the newly developed additives looks the most promising option," he says.

Lighting innovation

Italian compounder **LATI** recently provided a thermally conductive compound for use in a new LED lighting system produced by Romanian manufacturer Electromagnetica. Rapid evolution of LED lighting systems has led to development of increasingly powerful devices suitable for replacing conventional light sources even in the most challenging applications, for example lights for public and industrial use. The typical devices used in this sector are COB (Chip On Board) LEDs, where numerous diodes are joined together and mounted on the substrate to form a single large source.

LATI says the advantages of COB LED solutions include a reduction in the number of components, fewer welded joints, absence of lenses and higher light density. Management of the heat generated by such a structured system is vital for long service life and aluminium heat sinks have been considered as the only option for the maximum junction temperatures close to 150°C.

Electromagnetica, however, decided to use a thermally conductive plastic compound to develop its latest COB LED industrial projector, completing rigorous simulations and experiments to evaluate cooling performance and emitted light quality. The result is the Castor 2M, an industrial projector that houses two COB modules for a total power close to 70W. Technical simulation showed that a thermally conductive polymer heat sink would handle the large amount of heat generated in operation provided that the geometry of the radiating elements and the interface between the PCB substrate and the thermoplastic compound was suitably configured.

Electromagnetica selected LATI's Laticonther 62 GR/70, which is a PA6-based compound with 70% graphite filler. The average thermal conductivity of this material is close to 10 W/mK, even at high ambient temperatures and regardless of the orientation of the graphitic flakes. The thermal conductivity of alloys normally used to manufacture heat sinks is close to 150 W/mK, while that for pure aluminium is 237 W/mK.

The key to the performance of the heat sink is in the optimisation of the design; the thickness of the heat sink base as well as the shape and spacing of the fins have been carefully calculated for the most effective performance. In particular, an understanding of the thermal phenomena at the base was fundamental as radiation contributes in a similar way to convection in cooling. The higher heat capacity of plastics over alloy alternatives is also a valuable advantage as it reduces the thermal load to be transferred due to the increased heat storage capability of the sink. Laticonther advantages include low mould shrinkage and good dimensional stability required for assembly, and reduced weight due to its density, which is close to half that of aluminium. As a result of this optimised design process, the Castor 2M is able to provide a minimum luminous flux of 8000 lm without the junction exceeding a temperature of 80°C.

Below: The heat sink on Electromagnetica's industrial COB LED projector lamp is moulded in thermally conductive PA6 from Lati

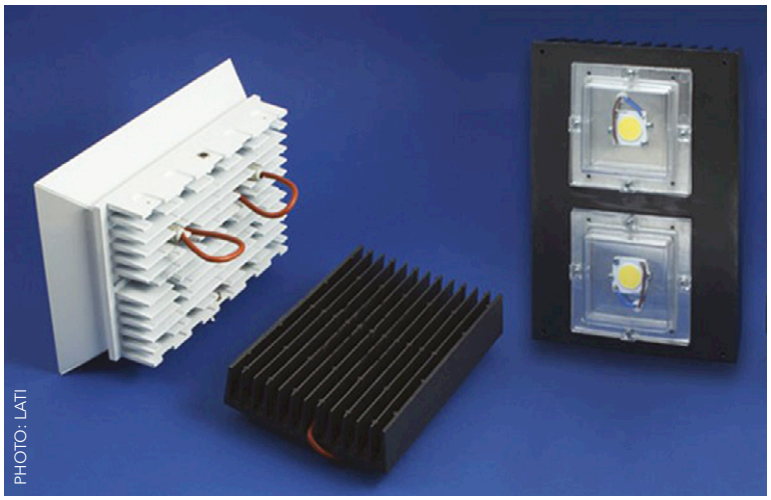

PHOTO: LATI

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PHOTO: POLYPLASTICS

Once an exotic novelty, PPS is now a versatile and widely available high performance polymer. Peter Mapleston looks at the history and explores the latest developments

PPS – an established novelty

Not so long ago, polyphenylene sulphide (PPS) ranked among the most exotic polymers around. One company made it in the beginning – Phillips Petroleum – and it was used for specialty coatings rather than plastics as its molecular weight was rather low. Phillips then made a version with higher molecular weight through a process of thermal cross-linking, found that it had excellent heat and chemical resistance and could be injection moulded. It named it Ryton.

Today, few suppliers of engineering thermoplastics does not have a PPS grade in its portfolio. The semi-crystalline polymer comes in numerous guises – crosslinked (branched) and linear – and there are new and more sustainable ways to make it. As a result, there are all sorts of compounds available based on PPS. These are almost always compounded with a fibre reinforcement or a mineral filler but now include flexible as well as rigid grades. PPS compounds provide an excellent complement to polyamides for applications requiring greater heat resistance – it has a melting point of approximately 280°C. The resin is also inherently flame resistant and mechanically strong (although brittleness can present a problem with some types).

Branched PPS polymer exhibits high rigidity under elevated temperature conditions and displays some novel benefits in regard to resistance to creep deformation. Linear PPS, meanwhile, offers better elongation and impact resistance. It is less prone to absorbing moisture under high heat and humidity conditions compared to the crosslinked polymer. Due to its low ionic impurities, linear PPS is a very good choice for fuel cell parts and other applications that demand strict electrical characteristics. Linear PPS also tends to be whiter in colour.

Applications for PPS continue to grow, many in automotive, electrical/electronics, aerospace, and chemical engineering, but increasingly also in other sectors such as medical and the water industry. It is used in injection moulding, extrusion, and in fibre production. In comparison with mainstream engineering plastics such as polyamides, volumes are relatively modest but growth is very healthy. Global PPS volumes stood at around 100,000 tonnes in 2016. ›

Main image: Automotive water pumps are a target application for PPS, exploiting its good temperature resistance and dimensional stability

PHOTO: SOLVAY

Above: Sensor housings are one of a growing number of demanding applications for PPS

The worldwide market for PPS compounds is expected to grow by 20% over the period 2017 to 2021 as the volumes of PPS compounds used in vehicle electrical systems and hybrid/electric vehicles – which contain a significant number of components that require superior heat resistance – continue to grow worldwide.

Phillips Petroleum's basic process patent expired in 1984 and that led to other companies introducing their own brands of PPS polymer and compounds products. Celanese, for example, pioneered linear PPS while DIC Corporation in Japan developed its own product line (it began by importing Ryton) as did Tosoh.

Polymerisation moves

DIC Corporation says it has been developing straight chain and high molecular weight branched polymers by increasing the molecular weight at the polymerisation reaction stage. "Branched PPS products exhibiting high impact properties, as well as development of grades with improved processing features such as reduced flashing and decreased volatiles, were successfully developed as a result of advanced polymerisation and compounding technologies," the company says.

DIC now also has PPS compounding operations in China, Southeast Asia and Europe. Operations in Europe are run by subsidiary Sun Chemical and, this March, the two companies said they would build their first US production line for PPS compounds at the DIC Imaging Products USA facility at Oak Creek in Wisconsin. It is scheduled to begin operation in autumn 2020 and will raise DIC's global PPS compound production capacity by 3,000 tonnes/yr to 46,000 tonnes/yr.

The Ryton PPS business is now owned by **Solvay**, which continues to develop the portfolio and now has linear as well as crosslinked types. In late 2017, the company introduced Ryton R-4-300 polymer, which it said offers improved performance in tensile strength and elongation as well as best-in-class weld-line strength. The material is suitable for thermal management modules and parts where complex geometries require robust mechanical properties.

At Fakuma last October, Solvay announced the launch of its first batch of extrusion

PHOTO: SOLVAY

Right: Solvay's Ryton PPS extrusion series is designed to complement its proven injection moulding materials for demanding automotive cooling lines. Continuous use temperatures are up 170°C

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Table 1: Typical mechanical properties of Solvay's new extrusion PPS grades

Property	XE3500BL	XE4500BL	XE5500BL
Density, g/cm^3 (ISO 1188)	1.30	1.25	1.20
Tensile strength, MPa (ISO 527)	55	45	40
Elongation at break, % (ISO 527)	15	20	80
Flexural strength, MPa (ISO 178)	100	80	60
Flexural modulus, MPa (ISO 178)	2500	1800	1500
Notched Izod impact strength, kJ/m^2 (ISO 180/1A)	30	30	50
Viscosity at 400 s^{-1}, 316°C (ISO 1188)	500	700	750

Source: Solvay

grades that complement injection moulding grades and are intended for use together in demanding automotive cooling line assembly applications. There are currently three Ryton PPS extrusion grades, with stiffnesses varying between 1,500 MPa and 2,500 MPa to fulfil requirements of flexible tubes with different wall thicknesses and diameters or for post-extrusion thermoforming (Table 1). Solvay says flexible coolant lines exhibit high melt strength with enhanced tensile elongation and impact strength, as well as "regular" PPS properties of high chemical resistance and thermal stability.

Solvay's injection moulding grades include Ryton XE5430BL (30% glass filled) and Ryton R-4-270BL (40% glass filled). "These materials have exhibited a proven fit in many existing connector and bracketry fittings to enable automotive OEMs to design fully harmonised and integrated coolant line assemblies for engines and transmissions," the company says.

"Under-the-hood temperatures are pushing existing cooling line design and material solutions to their limits, narrowing the safety margin," says Andreas Lutz, European Area Development Manager for Solvay's Specialty Polymers global business unit. "Engine downsizing along with the generalisation of high-temperature components such as turbochargers, superchargers, automatic transmissions, air conditioning and exhaust gas recirculation systems all crowded into a shrinking engine bay are leading to a 'space crunch' with hot spots that can exceed the thermal performance of conventional metal/rubber and polyamide designs."

Solvay says that since coolant lines are among the last components to be designed to fit the engine bay, materials must not only offer the design freedom to enable more complex routing, but also provide enhanced thermal and chemical resistance to ensure operational safety without adding weight, such as the need for additional heat shields. "The more complex a fluid handling line is, the more instrumental Ryton PPS can be in reducing weight as well as simplifying manufacturing and assembly costs," says Lutz.

Linear innovations

After Phillips, **Celanese** was one of the first to enter the PPS field with its Fortron range of linear polymers. Celanese says that, when compared to branched PPS products, the linear structure yields superior toughness, strength, colourability and processing consistency.

One of the principal characteristics of PPS is its stiffness. Celanese some time ago developed technology to make the polymer more flexible while maintaining its superior heat and chemical resistance. In collaboration with downstream partners, Celanese has commercialised Fortron flexible PPS in under-the-hood fasteners. It says that in these applications Fortron Flexible PPS has demonstrated superior heat and chemical resistance over polyamides, most of which are highly sensitive to moisture sensitivity and have a lower use temperature. The portfolio includes materials with a wide range of flexibility and viscosity to meet application needs and processing requirements for injection moulding, extrusion and blow moulding.

Celanese also highlights its Fortron PPS ICE grade, which is said to provide superior dimensional stability and robust resistance to automotive fluids such as coolants. It has been used in a variety of parts for EV coolant pumps that require dimensional precision and stability up to 150°C. "The additional benefits for Fortron PPS ICE are it significantly reduces

Right: Cable ties injection moulded in Fortron PPS from Celanese

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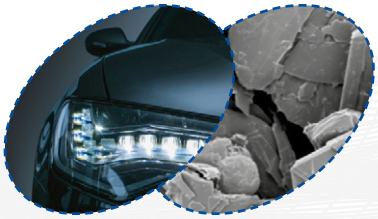

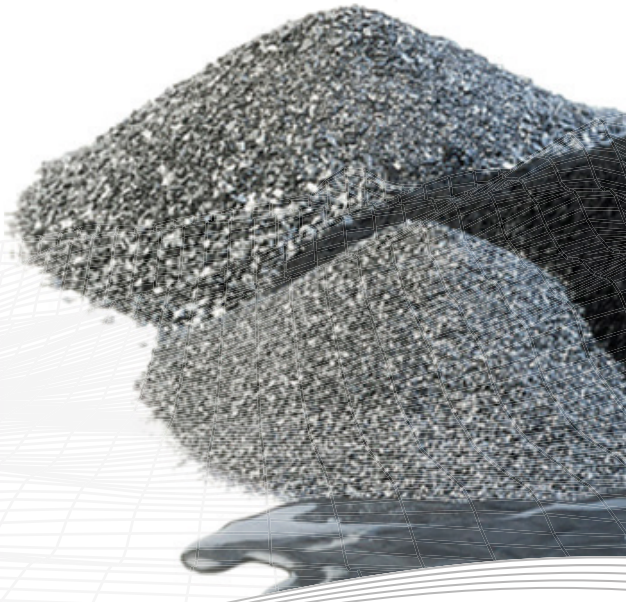

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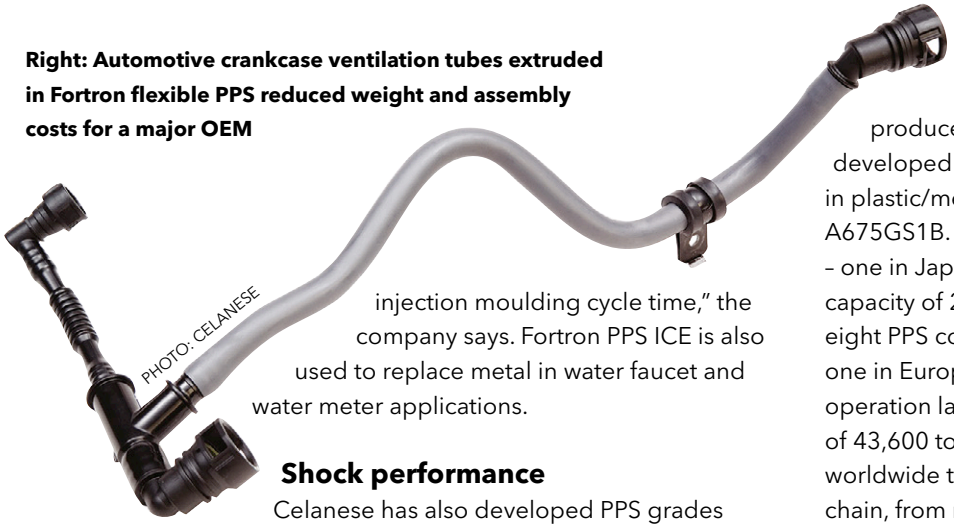
Right: Automotive crankcase ventilation tubes extruded in Fortron flexible PPS reduced weight and assembly costs for a major OEM



injection moulding cycle time," the company says. Fortron PPS ICE is also used to replace metal in water faucet and water meter applications.

Shock performance

Celanese has also developed PPS grades offering improved resistance to thermal shock, with over-moulding for automotive sensors a key target application. It explains that one of the challenges for such parts is that metal and plastics have different coefficients of thermal expansion and that the stress caused by thousands of cycles of heating and cooling could potentially lead to mechanical failures over time. Fortron toughened PPS with improved thermal shock resistance can withstand extreme temperature changes (-40 to 150° C) over long-term use and can outperform traditional glass fibre reinforced PPS, Celanese says.

Toray, which is the biggest producer of PPS globally, has also recently developed a product to withstand thermal cycling in plastic/metal over-moulded parts – Torelina A675GS1B. The company has two polymer plants – one in Japan and one in Korea – with a total capacity of 27,600 tonnes/yr and no fewer than eight PPS compounding operations – six in Asia, one in Europe and one in the USA (which went into operation late last year) – with a combined capacity of 43,600 tonnes/yr. It is also the only company worldwide that spans the complete production chain, from monomers through crosslinked and linear polymer (branded Torelina) to film, stock shapes and fibres.

Last April, Japan's **Tosoh** said it too had developed a PPS compound featuring enhanced thermal shock resistance, claiming an 80% improvement over current industry-standard products. It says the new grade features improved weld strength and flow and can be expected to contribute to further reductions in the weight of automobiles through thin-walling. Tosoh is currently considering mass production of the new compound.

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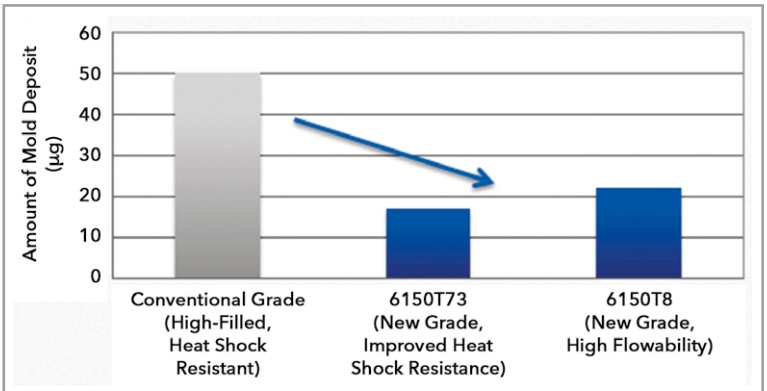

Table 2: Mould deposit test results for the latest PPS grades from Polyplastic (determined by weight gain after 1,000 shots; mould temperature 140˚C, barrel temperature 340˚C
Source: Polyplastics

Another company to introduce high-toughness grades with improved thermal shock resistance is **Polyplastics**, which is 45% owned by Celanese (the remainder owned by Daicel Corp of Japan). Up to 2011, Celanese and Polyplastics divided their global market coverage but since then they have been competing around the world and Polyplastics now has sales offices with engineering capabilities in Europe as well as the US. It sells compounds based on linear PPS.

Until recently, Durafide 1130T6 (30% glass fibre) and Durafide 6150T6 (high filler content) were Polyplastics' leading thermal shock-resistant grades. However, volatiles from the impact modifiers used in these grades generated mould deposits, necessitating frequent mould maintenance. In addition, the trend toward parts with thinner walls that require materials with higher flow don't fit well with the need for thermal shock resistance.

Designing a PPS material that has both high flowability and high heat shock resistance has traditionally been a difficult task, says Polyplastics. The company claims to have found an answer to the dilemma with its new highly-filled, high toughness grades Durafide PPS 6150T73 and 6150T8, which are based on modifications to the polymer and improved compounding techniques. Durafide PPS 6150T8 exhibits high flow and improved heat shock resistance while Durafide PPS 6150T73 benefits from even higher heat shock resistance. Both grades also demonstrate low outgassing (low mould deposit) characteristics.

Polyplastics adds that its ongoing developments include PPS polymer with a reduced level of residual chlorine. It already offers one low-chlorine grade commercially, 1140A66.

Broadening choice

The number of ETP suppliers adding PPS to their portfolios has been rising noticeably over recent years. Late in 2017, **Radici Group** officially entered the market with its Raditeck P range. "The Raditeck P products were created as part of RadiciGroup's strategy of expanding its speciality products portfolio," says Erico Spini, Marketing Manager Europe at RadiciGroup Performance Plastics. The company presented five grades at the show, ranging from a 40% glass-fibre reinforced material to a 65% mixed mineral and glass fibre reinforced compound. It does not say where it sources the base polymer.

That was around a year after **DSM** and Zhejiang NHU Special Materials (NHU), inaugurated a joint venture to produce high performance PPS compounds in China. The JV, announced in 2015, was established in Zhejiang province close to NHU's linear PPS polymer plant in Shangyu. DSM has a 60% share in DSM NHU Engineering Plastics (Zhejiang) Co, with NHU holding the remaining 40%. Products are branded as Xytron PPS and DSM markets them globally, including China.

DSM NHU Engineering Plastics (which assumed NHU's existing compounding capacity) commenced operation with two standard commercial grades – Xytron G4010T with 40% glass fibre reinforcement and Xytron M6510A with 65% glass fibre and mineral filler. Recently, it has added a 30% glass reinforced grade and a 40% glass reinforced low-chlorine grade. New options under development include PPS compounds with enhanced wear resistance and low friction, high flow/low flash moulding characteristics, and increased impact strength.

Japan's Teijin and Korean SK Chemicals originally established their PPS joint venture – **Initz** – back in 2013 to develop, produce and distribute PPS compounds at a 12,000-tonne/yr production plant at Ulsan in Korea. Last August, Initz says it was entering the automotive parts marketplace with what it says is a next-generation PPS that is completely chlorine-free.

Initz has commercialised its Ecotran PPS

Right: Initz has developed special PPS compounds that minimise haze build up in automotive headlamp assemblies

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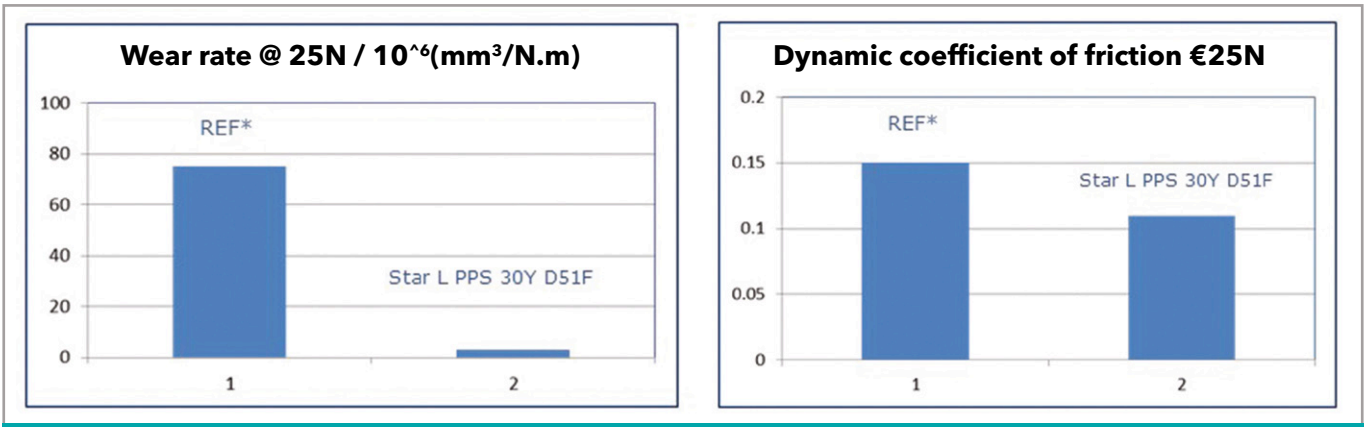

Table 3: Wear and dynamic friction coefficient of Eurostar's Star L PPS 30Y D51F grade, which contains carbon fibre and PTFE, compared to a reference grade ***Source: Eurostar Engineering Plastics***

compounds in collaboration with global automotive parts supplier Hyundai Mobis. It says Ecotran – a special glass fibre reinforced PPS – is the first material in the global auto industry that addresses the problem of headlamp haze, which it says is a chronic headlight issue. The company attributes this to the generation of volatiles when the temperature inside the headlamp space rises to more than 200°C. On cooling, the gas condenses and adheres to the interior surfaces, forming a thin film layer that interferes with light projection.

Meanwhile, in early 2018 **Teijin** launched the Solfiga PPS compounds, which are based on Initz's resin technology. Production takes place at Teijin's Mihara Plant in Hiroshima Prefecture. Teijin is expecting Solfiga sales to reach around $260m by 2025. It also plans to produce Solfiga products in China and Thailand.

The full Solfiga line-up incorporates a variety of Teijin high-performance reinforcements, as well as a specialised polycarbonate (PC) resin. The product portfolio includes a carbon fibre/PPS grade that offers high strength, high tenacity and conductivity for structural parts, as well as an aramid fibre/PPS grade providing resistance to abrasion, wear and shock in gear and sliding parts.

Managing wear

Independent compounders are also upping their game in PPS. "Brittleness and wear are two aspects where many standard grades of PPS fail to deliver. **Techmer PM** has developed several grades of PPS which have better impact and wear properties over traditional off the shelf grades of PPS," says Techmer PM Director of Application Development Jack Chiang.

"Recently a customer in the oil services industry came to us to help them improve the drop strength of oil well plugs; which were continuously being damaged before installation during shipping and the installation process. The customer used our Hifill PPS IM to improve the impact strength, and they have since seen a drastic drop in damaged returns," he says. "Techmer PM can modify PPS with reinforcements, custom colours, and other specialty products to fit specific applications and design goals."

As part of its Star L product line, **Eurostar Engineering Plastics** has co-developed with CETIM (the technology institute of mechanics based at Senlis in France) a number of self-lubricated PPS grades for highly demanding applications. These have been benchmarked against a best-in-class semi-finished self-lubricated PPS grade for bearing applications using a Cameron Plint tribometer and procedures described in ASTM G-133.

The Star L PPS D93F compound contains aramid fibre and PTFE; the Star L PPS 30Y D51F also contains PTFE but is reinforced with carbon fibre. Both are said to have shown a wear rate to the limit of measurable value of the tribometer. "These grades found application for bearing running at elevated temperatures. They were also found to be very insensitive to moisture," says Alexis Chopin, Head of Technology at the company.

CLICK ON THE LINKS FOR MORE INFORMATION:

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- **www.celanese.com**
- **www.toray.com**
- **www.tosoh.com**
- **www.polyplastics.com**
- **www.radicigroup.com**
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- DOVERLUBE METALLIC STEARATES

AMI's Compounding World Expo makes it way to North America for the first time next month. We preview the event, which takes place in Cleveland, Ohio, on 8-9 May

Cleveland show has it all for plastic compounders

AMI's Compounding World Expo will debut in North America next month when it opens its doors on 8-9 May at the Huntington Convention Center in Cleveland, Ohio, US. The exhibition and conference for all things compounding will be taking place alongside the Plastics Recycling World Expo – both had very successful first outings in Essen in Germany last year – and the brand new Plastics Extrusion World Expo. Each combines a tightly-focused free-to-enter exhibition with high quality free-to-attend conference streams targeted at their respective markets.

Visitors can move freely between each expo, which together will be one of the largest plastics-focused events in North America this year. More than 250 companies have taken booths and more than 2,000 visitors have already registered to attend.

The quality and breadth of the companies exhibiting at the Compounding World Expo can be seen in the preview of exhibitors featured on the following 19 pages. Visitors will find most of the compounding industry's key players there and will be able to learn more about the latest innovations in machinery and auxiliary equipment, polymers and additives.

The Compounding World Expo will include two dedicated free conference streams covering business issues, technology trends and process optimisation issues. The business debates proved to be big attractions at the first Compounding World Expo in Europe and will likely be just as well attended in the US. They will cover the future outlook for the technical compounding, concentrates, cable compounds and PVC compound sectors. Find all the details in the **CONFERENCE PROGRAMME**.

There will also be three more conference streams running in the extrusion and recycling expo halls. Altogether, more than 130 expert speakers will address key issues facing their respective industry sectors at the Cleveland exhibition centre.

Click here to register for your free ticket

COMPOUNDING WORLD EXPO

Dates: 8-9 May 2019 – Free-to-attend expo and conference
Opening hours: 9am to 5pm on both days
Venue: Huntington Convention Center, Cleveland, Ohio, USA
Online registration: https://compoundingworldexpo.eventkit.live/usa

Right: SI Group will focus on the latest Addivant antioxidants, including its food contact approved Weston 705

Aaron Equipment
Aaron Equipment has been providing quality used equipment to the process and packaging industries for more than 75 years. It can supply single items through to complete production plant.
› **www.aaronequipment.com**

ACI
Established in 2011, the main focus of ACI (Automotive Compounding Industry) is production of plastic compounds for cables and wiring for the automotive sector. The company set up a PVC cable compounding facility in Mexico in 2015.
› **www.aci.com.pt**

Acrison
Acrison manufactures dry solids metering and handling equipment designed to provide maximum flexibility and performance at low cost-of ownership. Its range includes volumetric and gravimetric feeders, as well as continuous blenders/conveyors, bulk bag unloaders, dust collectors and control systems.
› **www.acrison.com**

Addivant/SI Group
SI Group is a leading global manufacturer of performance additives and chemical intermediates with a strong position in the plastics, rubber and industrial resins industries. The Addivant antioxidant, UV stabilisers, polymer modifiers and inhibitors business was integrated into SI Group last year.
› **www.siigroup.com**

Aesse Sales and Distribution
Aesse Sales and Distribution sources and distributes materials used in the plastics industry, including flame retardants, coupling agents, impact modifiers, lubricants, compatibilisers and anti-scratch additives.
› **www.aessesd.com**

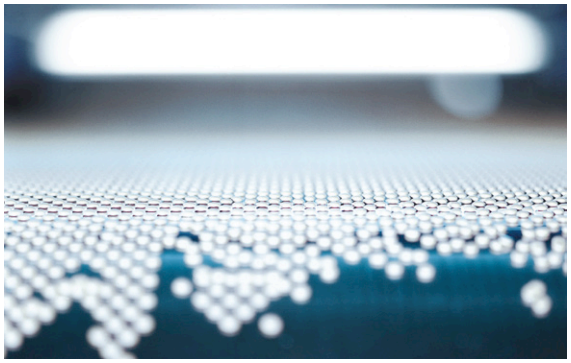
PHOTO: SI GROUP/ADDIVANT

Akron Rubber Development
Akron Rubber Development Laboratory provides analytical and physical testing services and compound formulation and processing development to customers in both the plastics and rubber industries. Test services range from colour analysis and impact testing through to rheological assessment.
› **www.ardl.com**

Alandro Plastic Resources
Alandro Plastic Resources is a plastics recycling and custom compounding company offering purchase, collection, processing and supply of recycled plastic materials. Products include HDPE, LDPE, PP, PVC and PS as well as engineering polymers such as PC, PC/ABS, PA, PBT and TPO.
› **www.alandro.net**

Alok Masterbatches
Alok is India's leading masterbatch/concentrate provider. Its core product offering for the compounding industry is the Chromanox range of single pigment concentrates (SPCs), which includes standard and custom formulations containing talc, calcium carbonate and mica.
› **www.alokmasterbatches.com**

PHOTO: BAERLOCHER



Left: Baerlocher's additive products are available in a variety of formats, including easy-to-handle pastilles

Apex Engineering - Modular Extrusion

Apex Engineering and Apex Controls Specialists offer a range of modular compounding systems. Its CME (Compounding Modular Extrusion) line allows the customer to select equipment and control platforms to meet their specific manufacturing requirements.

› **www.apex-engineering.com**

Asbury Carbons

Asbury Carbons provides carbon and graphite and non-carbon additives to enhance thermal and electrical conductivity, friction and wear performance, structural reinforcement, processing, and fire resistance. It is also a leading producer of graphite nanoplatelets.

› **www.asbury.com**

AZO

Founded more than 70 years ago, AZO is a market leader in custom-designed material handling systems for the plastics industry. Its turnkey solutions include unloading, storage, conveying, screening, feeding, weighing, filling, and process control.

› **www.azo.com**

B&P Littleford

B&P Littleford's product range for the compounding industry includes twin-screw extruders, continuous kneaders and the TriVolution line of compounders, as well as an extensive range of horizontal batch mixers. Equipment ranges from laboratory extruders to high-performance turnkey compounding systems including material feed and downstream equipment.

› **www.bplittleford.com**

Baerlocher

Baerlocher is a leading supplier of additives for plastics compounding. Key products include Baeropan additive one-packs for PVC, Baerostab liquid stabilisers, Baeropol additive systems for polyolefins and Baerolub lubricants. All are available in a variety of forms and formulations.

› **www.baerlocher.com**

BASF Colors & Effects

The Colors & Effects brand includes BASF's colorants and effect pigments for the coatings, plastics, printing, and cosmetics markets. Learn more about Deep Gloss and Living Coral - Pantone Color of the Year 2019. The latter has been implemented in a new family of plastics shades.

› **www.basf.com/us**

Bay Plastics Machinery

Bay Plastics Machinery offers a complete line of strand pelletisers, conveyors, water baths, air knives/strand dewatering units and spare parts. It also provides customers with a range of essential support services including rotor sharpening, rebuild/repair and technical support.

› **www.bayplasticsmachinery.com**

Bekaert

Bekaert is a leading producer of stainless steel fibre solutions for application in electrically conductive and shielding thermoplastics and elastomers. Materials are available in continuous bundles or grains and are suitable for compounding and injection moulding processes.

› **www.bekaert.com**

PHOTO: BASF

Above: BASF Colors & Effects has extended its Deep Gloss colour portfolio

Bergen International

Bergen International supplies chemical foaming agents for low-density foaming processes. Its Foamazol chemical foaming agents can provide improved physical properties, reduced polymer usage, and increased throughput.

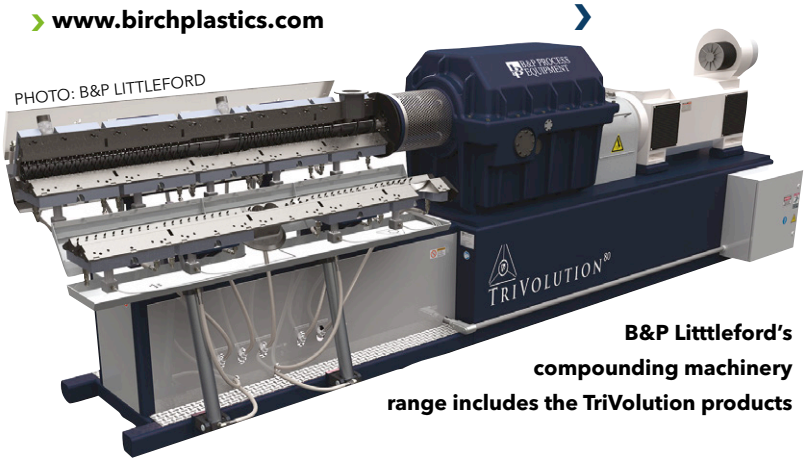
› **www.bergeninternational.com**

Birch Plastics

The Birch Plastics Recycling and Virgin Resin Divisions supply post-industrial regrind, reprocessed pellets and virgin resin including HDPE, LDPE, LLDPE, and all types of PP. The company also offers R&D scale up compounding, high-intensity powder mixing and lifecycle testing services.

› **www.birchplastics.com**

PHOTO: B&P LITTLEFORD



B&P Littleford's compounding machinery range includes the TriVolution products

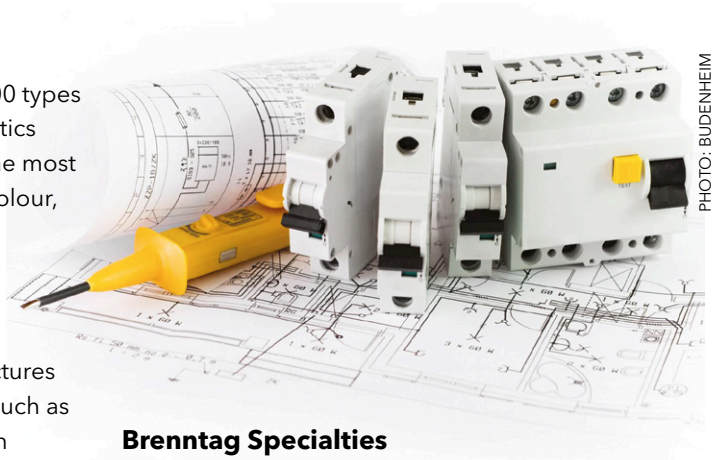


PHOTO: BUDENHEIM

Right: Budenheim's Budit halogen-free flame retardants are used in E&E applications

Birla Carbon USA

Birla Carbon has a portfolio of more than 100 types of carbon black. Its specialty brands for plastics applications, Raven and Conductex, meet the most demanding user requirements in terms of colour, conductivity, viscosity, and UV protection.

› **www.birlacarbon.com**

The Bonnot Company

The Bonnot Company designs and manufactures extruders as well as associated equipment such as bulk feeders and custom cutters. Its focus on manufacturing of top-of-the-line extruders is supported by a range of global consulting and equipment leasing services.

› **www.thebonnotco.com**

BPC Toll Compounding & Blending

BPC Toll Compounding & Blending is an independent toll compounder that specialises in polyolefins, TPOs, styrenics and a broad range of additives and fillers. The company also offers scale-up services.

› **www.bpctoll.com**

Brabender Technologie

Brabender Technologie manufactures feeding machinery for small to medium capacity, continuous or batch weigh applications requiring high reliability and precision. It offers equipment to handle a broad variety of powder, granular or flake ingredients, including FlexWall, internal/stirring agitated, single and twin screw, vibratory, fibre, micro rate and spreading spreading feeders.

› **www.brabender-technologie.com/en**

Brenntag Specialties

Brenntag Polymers offers a broad range of additive, mineral filler and pigment products for the thermoplastics compounding sector. Key markets include electrical & electronics, packaging, PVC processing and automotive.

› **www.brenntagspecialties.com**

Bronkhorst USA

Bronkhorst provides smart, low flow fluidics handling solutions for low flow liquid dosing. Its product range includes Coriolis meters and controllers (mini CORI-Flow), ultrasonic meters and controllers (ES-Flow), thermal mass flow meters and controllers (EL-Flow and Mass-Stream), and pressure meters and controllers.

› **www.bronkhorstusa.com**

Budenheim

Budenheim is a leading manufacturer of specialty phosphates. Its Budit halogen-free flame retardant systems are intumescent formulations used in E+E, building and construction, and transportation applications. Beyond flame retardants, it offers

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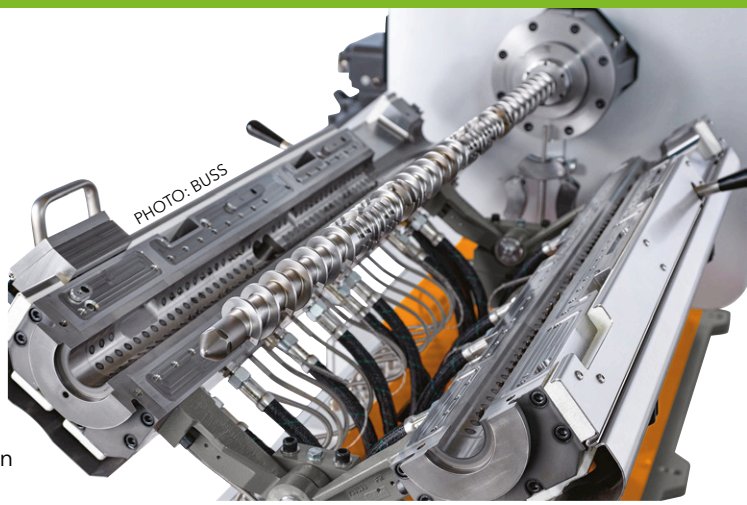
PHOTO: BUSS

Right: The modular Compeo series is the latest development of the Buss kneader extruder family

specialty grades for laser marking/welding, foaming and packaging applications.
› **www.budenheim.com/en**

Buss
Buss is a leading global supplier of high performance compounding systems. Its single screw kneader technology is a highly effective and versatile solution for heavily filled, shear or thermally sensitive compounds. The latest version of the technology is the modular Compeo machine.
› **www.busscorp.com**

CA Picard
CA Picard manufactures replacement elements, barrels and shafts for all twin-screw extruders and has production in the US, Germany, and China. Its latest US service offering includes barrel relining/retrofitting and FD hydraulic element stripping of elements from shafts.
› **www.capicard.de**

Cabot
Cabot Corporation is a global specialty chemical and performance additives company offering a wide range of black masterbatches and conductive formulations as well as specialty carbon blacks that provide conductive or electrostatic dissipative (ESD) performance in plastics.
› **www.cabotcorp.com**

Cathay Industrial Biotech
Cathay Industrial Biotech is an industrial biotechnology company providing commercial-scale production of long chain dibasic acids, biobutanol and bio-based DN5 (1,5-pentanediamine). It has an R&D centre in the Shanghai Zhangjiang Hi-Tech Park in China and production sites at Jinxiang and Wusu.
› **www.cathaybiotech.com**

Below: Cabot supplies carbon black materials and compounds for a wide range of applications


PHOTO: CABOT

Chemigon
Chemigon specialises in additives for plastics. Its current offering includes heat stabilisers, nucleating agents, flow modifiers, and viscosity reducers from Brueggemann; Compoline maleic anhydride graft copolymers from Auserpolimeri; and Alphalon reactor grade PA6 from Grupa Azoty.
› **www.chemigon.com**

Chemours
Viton FreeFlow process aids from Chemours can improve processing, increase output and reduce downtime. They can also help eliminate melt fracture and reduce die build-up in film, pipe and wire insulation production applications.
› **www.chemours.com**

Chengdu Silike
Silike is a manufacturer and supplier of silicone additives, including silicone masterbatch, silicone powder, silicone flame retardant synergist, silicone moulding, super-slip masterbatch and anti-wear agent for plastics and thermoplastics.
› **www.silike.cn/en-us**

Chris Machinery Engineering
Chris Machinery Engineering delivers turn-key solids handling project services, supplying customers in the compounding and concentrates industries with pneumatic conveyors, silos, batch weighing equipment, mixers and packaging machines.
› **www.chris-machinery.com**

Coperion
Coperion is an industry leader in compounding and extrusion, feeding and weighing, bulk material handling and services. Well known for its high end ZSK compounding machinery, the company can supply everything from a single rotary valve or twin screw extruder through to a complete turnkey plastics compounding plant.
› **www.coperion.com**

PHOTO: CPM CENTURY EXTRUSION

Left: A CXE series twin screw compounder from CPM Century Extrusion

CPM Century Extrusion

CPM Extrusion Group manufactures twin screw extrusion compounding systems, ring extruders and components through a global network of manufacturing facilities in the US, Germany and China. In addition to the manufacture of twin screw equipment, it also offers comprehensive engineering, training and consulting services.

› **www.centuryextrusion.com**

CTC Plastics

CTC Plastics specialises in compounding of commodity grade recycled and certified automotive and general purpose resins. The company also offers compression and injection moulding and manufactures plastic pallets from 100% recycled plastic.

› **www.CTCplastics.com**

Dalian FTZ Globe International

Dalian FTZ Globe International Trading offers a range of machines and additives for the compounding industry. Machinery includes lab compounders, mixing and conveying equipment, pulverisers, shredders and extruders; raw materials include impact modifiers, stabilisers and colour concentrates.

› **www.dlglobe.com**

Dotz

Dotz specialises in the development and marketing of end-to-end tagging, tracing, anti-counterfeiting and product-liability solutions. Products include the ValiDotz security markers, which are delivered as easily-mixed masterbatches.

› **www.dotz.tech**

Dover Chemical

Dover Chemical manufactures a full range of specialty chemical additives for the polymer compounding and formulating industries, including alkylphenols, chlorinated alkanes, polymer additives, liquid and solid antioxidants and flame retardants.

› **www.doverchem.com**

Dr Collin

Dr Collin Lab & Pilot Solutions develops modular pilot and laboratory lines for the plastics industry. Its Teach, Lab, Pilot and Medical Lines include extruders, compounders, and mono and co-extrusion lines, as well as equipment for quality control testing.

› **www.drcollin.de**

Dreytek

Dreytek Performance Products is a global distribution company offering specialty polymers and polymer additives including Dreycarb chopped carbon fibre, Fleka glass flake, Kitamura PTFE micropowder, Dreystat IDP, Krefine ESD special carbon, and Xeran SMA blend compatibilisers.

› **www.dreytek.com**

Durastream CPVC Compound

Sekisui's Durastream CPVC Compound displays high heat resistance, flame resistance, and mechanical strength. It is also NSF certified and has a proven track record as a high performance pipe material.

› **www.sekisui-sc.com/durastream**

Below: The EU10 is the smallest pelletiser in the Econ product line

PHOTO: ECON

Econ

Econ specialises in the development and production of innovative underwater pelletising technology and screen changers. Its pelletisers feature thermal separation and a specially designed die plate and are designed for easy operation and a high degree of process reliability and efficiency.

› **www.econ.eu**

A laboratory-scale compounding system from Dr Collin Lab & Pilot Solutions

PHOTO: DR COLLIN

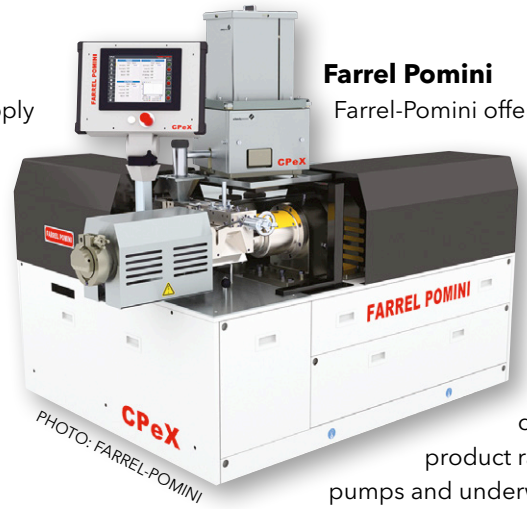

PHOTO: FARREL-POMINI

Right: Farrel-Pomini's CPeX laboratory sized compact processor

Entec Polymers

Entec has an international supply network covering the US, Canada, Mexico and beyond and supplies a broad range of polymer compounds and concentrates, including functional polymers, engineering thermoplastics, additive and colour masterbatches, and resin modifiers.

› **www.EntecPolymers.com**

Entek

Entek is a US-based manufacturer of turnkey production extrusion systems, twin-screw extruders, and components. It is a leading supplier of custom compounding, pelletising, and specialty sheet lines, offering twin-screw extruders and replacement wear parts for systems from 25mm to 250mm diameter.

› **www.entek.com**

Entex

Entex is a German manufacturer of planetary roller extruders for use as compounders, mixers, coolers, and devolatisers. Modular, multiple-zone designs are available for continuous processing applications, including reclaim/recycling, fibre processing, wood plastic composites.

› **www.entex.de**

Europiren/Gehring-Montgomery

Europiren is the exclusive sales and distribution partner of Russian Mining Chemical Company, which produces products based on natural magnesium hydroxide (MDH) for use in applications including flame retardants in plastics compounds. Distributed in the US by Gehring-Montgomery.

› **www.europiren.com**

Below: Feddem's compounding machinery product line is built on its MTS models

PHOTO: FEDDEM

Extreme Coatings

Extreme Coatings has protected more than 50,000 feed screws over the past 23 years with its wear-resistant treatments. Its advanced thermal spray technology and proprietary ceramic, metallic formulations allow full encapsulation of complex components such as screws with tungsten carbide.

› **www.extremecoatings.net**

Farrel Pomini

Farrel-Pomini offers a range of processing equipment for the plastics compounding industry including its CP-Series II Compact Processor for highly filled materials, CPeX laboratory machine, FCM continuous mixer and UMSD side discharge continuous mixer. The product range also includes melt pumps and underwater pelletisers.

› **www.farrel-pomini.com**

Feddem

Feddem has been designing and manufacturing co-rotating twin-screw extruders and ancillary equipment for more than 30 years. The company's range includes the FED MTS series of turn-key compounding systems and recently-introduced ready-to-use LFT-PT long fibre pultrusion technology.

› **www.feddem.com**

Fine-Blend

Fine-Blend is a leading producer of polymer compatibilisers. Its technology platform includes design and polymerisation of different compatibilisers as well evaluation of their performance. It can also provide practical compounding data to support customers.

› **www.fineblend.com.cn**

GreenMantra Technologies

Clean technology firm GreenMantra uses a proprietary catalyst and patented depolymerisation process to upcycle and transform recycled plastics into value-added specialty polymers. It currently offers PE and PP polymer additives under the Ceranovus A brand name with plans to introduce a new PS portfolio this year.

› **www.greenmantra.com**

Harwick Standard

Harwick Standard is a full-service supplier of raw materials and additives for the plastics, rubber, coatings and adhesives markets. Its product line-up includes colour concentrates, blowing agents, impact modifiers, ATH and process aids.

› **www.harwickstandard.com**

Helluva Container

Helluva Container is a leading supplier of FIBC bulk bags and new and used Gaylord boxes across

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THE RENEWABLE MATERIALS COMPANY

storaenso

Above: The TEX34αIII is one of a range of high performance twin screw compounders from JSW

the US. The company also buys used Gaylord boxes. Its product line extends to liners, tape, film and pallets.

› **www.helluva.com**

Heritage Plastics

Heritage Plastics develops and manufactures specialty calcium carbonate concentrates to improve performance of plastics compounds. Its Minapol Additive Technology products can be used to offset rising resin costs as well as achieving carbon footprint reductions compared to "resin only" systems.

› **www.heritage-plastics.com**

Heubach

Heubach is a leading manufacturer of pigments with a portfolio that encompasses organic and inorganic high performance types and preparations. It has three production facilities and service centres allowing it to provide a global service to customers.

› **www.heubachcolor.com**

High Dream Machinery

Guangdong High Dream has been manufacturing multi-head weighing equipment for more than 16 years. Its product portfolio includes computerised multi-head models, loss-in-weight feeders and metal detectors.

› **www.highdream.net**

Hongwei

Shanghai Hongwei focuses on production of custom colour and additive masterbatches for food packaging, cosmetic packaging materials and automotive applications.

› **www.hoowee.cn**

IMI Fabi

IMI Fabi is a specialist talc producer offering a wide range of high quality mineral products. Its product line includes grades optimised for reinforcement, nucleation and anti-blocking and suitable for use with commodity, engineering and recycled resins.

› **www.imifabi.com**

Inspection Technologies

The latest development from Inspection Technologies is its in-line vision inspection and sorting system for pellets. The compact and easy-to-use system is able to determine pellet size and identify tails, contaminations and discoloration.

› **www.sheetinspection.com**

Japan Steel Works

Japan Steel Works (JSW) offers a range of compounding equipment, including twin-screw extruders, feeders, pelletisers and control systems. The company also offers turnkey project management, service and support from its US facility near to Detroit.

› **www.jswamerica.com**

J-Tec Material Handling

J-Tec Material Handling designs, supplies, builds and maintains powder, pellet and liquid processing systems. It offers global installation of plastic compounding lines and turnkey projects from material reception, storage and conveying through to dosing, mixing, extruding and conditioning.

› **www.j-tec.com**

Kaneka

Kaneka Americas offers a wide range of products for the plastics industry including PVC and CPVC, as well as impact modifiers, processing aids and impact modifiers.

› **www.kaneka.co.jp/en**

Keim Additec

Keim Additec's Euroceras division has developed a new range of synthetic Ceralene polyester waxes said to show similar properties to montan waxes. Its product range also includes Viscocer modified polyester waxes and reactive Addimer wax additives.

› **www.keim-additec.com**

Keller USA

Keller USA specialises in separation of air pollutants and reduction of emissions in industrial applications. It offers dust collectors, wet separators, oil/emulsion mist collectors, and safe (explosion and fire prevention) and energy efficiency technologies.

› **www.kellerusa.com**


PHOTO: LEISTRITZ

Left: One of the most recent additions to the Leistritz product family is this in-line rheometer

Kennametal
Kennametal' Conforma Clad provides wear protection solutions for twin-screw extruder barrels. Its novel cloth delivery system enables densely-packed tungsten carbide to be uniformly applied to provide a metallurgically-bonded protective barrier.
› **www.conformaclad.com**

Kisuma
Kisuma Americas provides a range of additives based on its magnesium technology, including Alcamizer heat stabilisers for PVC, Kisuma 5 halogen-free flame retardants, and DHT 4A/4V halogen scavengers.
› **www.kisuma.us**

KK Kompounding Tech Giant
KK Kompounding Tech Giant (formerly Technovinyl Polymers) manufactures polymer compounds including SEBS and SBS thermoplastic elastomers, TPU alloys, nano-engineered PP compounds, halogen-free flame retardant wire and cable compounds, TPVs and PVC compounds.
› **www.kkthelittlegiant.com**

Konica Minolta
Konica Minolta Sensing Americas provides advanced optical measurement technology that makes it easier to develop high quality products and to communicate colour standards internally and throughout the supply chain.
› **www.konicaminolta.us**

Krauss Maffei Berstorff
KraussMaffei Berstorff provides high-performance compounding extruders ranging from lab to high volume production units, including its energy optimised ZE BluePower and performance E-UTXi and ZE Ultra Torque models. The company also offers a range of feeders and PVC pelletising systems.
› **www.kraussmaffeiberstorff.com**


PHOTO: KRAUSSMAFFEI BERSTORFF

Left: KraussMaffei Berstorff's BluePower machines are optimised for energy-efficient production

Lanier Color
Lanier Color Company specialises in the production of custom colour concentrates for thermoplastics. It focuses on supplying high quality products with proven weather resistance for a wide range of end markets.
› **www.laniercolor.com**

Leistritz
Leistritz Extrusion manufactures co-rotating intermeshing twin screw compounding extruders with screw diameters from 18 to 260 mm. It also offers a full range of peripheral equipment, including die heads, degassing units, feeders and vacuum ports. Its most recent introduction is an in-line rheometry measurement system.
› **www.leistritz-extrusion.com**

Lubrizol Engineered Polymers
Lubrizol offers innovative polymer compounds for demanding applications, including flame-retardant solutions for wire and cable, a range of conductive polymers for protecting electronic devices, and structurally reinforced materials for lightweighting and metal replacement.
› **www.lubrizol.com**


PHOTO: MAAG

Above: A Primo 200e pelletiser from Maag Americas

Lushan
Guangzhou Lushan New Materials is one of the largest manufacturers of functional polymer compatibilisers and adhesive materials for engineering plastic compounds and the recycling industry. It has products suitable for PP, PA, PE, HFFR and WPC applications.
› **www.cnlushan.com**

Maag Americas
Maag Americas offers dry-cut and wet-cut strand pelletisers, underwater pelletisers, gear pumps, screen changers, pulverisers, colour mixing systems, centrifugal pellet dryers, and pellet production systems. Group brands include Maag Pump Systems, Automatik Plastics Machinery, Gala Industries, Reduction Engineering Scheer and Ettlinger.
› **www.maag.com**

Maris
Maris is a European leader in the production of extrusion lines for compounding of polymer materials including organic pigment masterbatch,

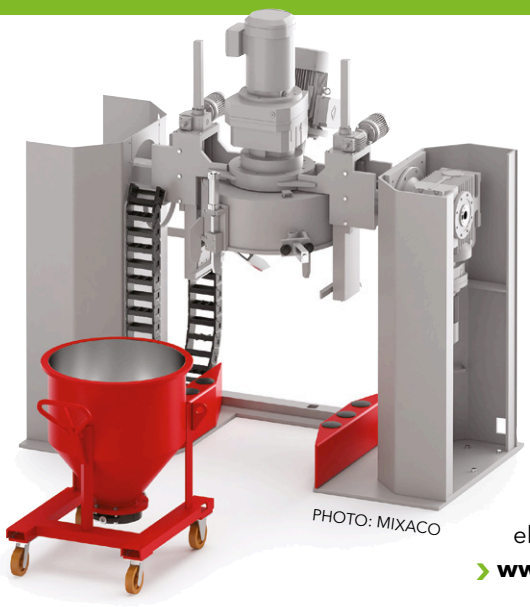
PHOTO: MIXACO

Right: A CM Multi Tool container mixer by Mixaco

inorganic pigment masterbatch and mineral fillers, additive masterbatch, polymeric alloys, reinforced polymers and reactive extrusion.
› **www.mariscorp.com**

Maroon Group
Maroon Group distributes specialty chemicals and ingredients across North America. Founded in 1977, it focuses on the CASE, plastics, specialty intermediates, CARE, and HI&I markets.
› **www.maroongroupllc.com**

McCann Plastics
McCann Plastics supplies custom thermoplastic compounds, including highly filled grades, on short lead times to a wide range of customers in the automotive, electrical and electronics, packaging, film production and consumer goods industries.
› **www.mccannplastics.com**

Microban
Microban's extensive portfolio of antimicrobial and odour control solutions are formulated to keep plastics cleaner and fresher for longer. The company offers additive solutions for the consumer, textile, industrial, and medical sectors.
› **www.microban.com**

Midwestern Industries
Midwestern Industries produces screening equipment, replacement screens and parts. Equipment is designed for simple integration into an existing process and is supported with engineering advice on maximising efficiency and resolving screening issues.
› **www.midwesternind.com**

Below: Milliken produces a range of nucleators and clarifiers for use in PP


PHOTO: MILLIKEN

Milliken
Milliken provides compounders with a range of specialty chemical products including its Hyperform nucleating agents and Millad clarifiers. It also offers a broad collection of antioxidants, antimicrobials, UV absorbers, colorants and electroconductive powders.
› **www.milliken.com**

Mitsui Chemicals America
Mitsui Chemicals America supplies chemicals and intermediates, engineering plastics, elastomers and functional materials including Admer tie layer resins; Mitsui EPT EPDM, and Tafmer elastomers for impact improvement.
› **www.mitsuichemicals.com**

Mixaco
Mixaco is a leader in mixing technology. The company manufactures a variety of container mixers, bag and drum mixers, heating and cooling mixing systems, high speed mixing units and universal mixers. It also offers loading and emptying units.
› **www.mixaco.com**

Modern Dispersions
Modern Dispersions Incorporated (MDI) is a thermoplastics compounder and producer of high quality carbon black masterbatches. The company specialises in conductive concentrates and compounds, wood polymer composites, and a wide variety of colour, specialty, and additive products.
› **www.moderndispersions.com**

Nanjing Lesun
Founded 15 years ago, Nanjing Lesun Screw manufactures parallel co-rotating modular screw elements, barrels and shafts. The company can provide parts for extruders between 20mm and 300mm diameter.
› **www.lesunscrew.com**

Nanjing Yongteng Chemical
Nanjing Yongteng Chemical Equipment designs and manufactures co-rotating parallel twin-screw extrusion equipment including its YT high torque high speed series. It also offers the SHJS series two-stage extruder and SJ series single screw extruder, plus pelletising and peripheral equipment.
› **www.yongtenggroup.com**

Right: Orion Engineered Carbons has a range of more than 40 carbon blacks

NanoXplore
NanoXplore is a producer of industrial volume graphene manufactured using its low cost proprietary technology. The company also makes thermoset and thermoplastic products for transportation, packaging, electronics, and other industrial sectors.
› **www.nanoxplore.ca**

NASCA Elastomers
NASCA Elastomers designs and develops custom-developed high-functional elastomer materials for various industries. These include TPEs, TPOs and highly-filled masterbatches, as well as high heat resistance infill materials for the synthetic turf sector.
› **www.nascatpe.com**

National Bulk Equipment
National Bulk Equipment designs and makes bulk material handling and product recovery equipment including bag dischargers, bag fillers, container dischargers and fillers, bulk material blending systems, agitator hoppers, storage bins, and pneumatic and screw conveying systems.
› **www.nbe-inc.com**

Netzsch Instruments North America
Netzsch Instruments provides thermal analysis instrumentation for material characterisation and study of properties including specific heat capacity, enthalpy, weight change, Young's modulus, conductivity, thermal diffusivity, and evolved gas analysis.
› **www.netzsch.com**

Omega Plasto Compounds
Omega Plasto Compounds been manufacturing processing aids and modifiers for more than a decade. The company's Polycom-P processing aid is designed for PVC and is claimed to provide technical and processing advantages together with reduced cost of production.
› **www.omegaplasto.com**

Omya
Omya is a leading global producer of calcium carbonate and a worldwide distributor of speciality chemicals. It offers a broad portfolio of calcium carbonate grades targeting compounds for all applications.
› **www.omya.com**

PHOTO: ORION ENGINEERED CARBONS

Onelead
Onelead supplies UV absorbers, light stabilisers, antioxidants, clarifying agents and optical brighteners. The company operates two factories and an R&D laboratory and artificial weathering test facility in China.
› **www.onelead.co**

OptiColor
OptiColor is a specialist custom colour compounder specialising in transparent and translucent effects. It offers concentrates and compounds for demanding application sectors such as eyewear, lighting, automotive and medical.
› **www.opticolorinc.com**

Orbetron
Established in 2011, Orbetron focuses on low rate bulk material feeding, producing precision equipment that will feed low rates below 1 g/h. The company will engineer and manufacture feeding systems for specific liquid or bulk material applications.
› **www.orbetron.com**

Orenda Pulverizers
Orenda Pulverizers manufactures the patented AirForce Technology pulverising machines. These rugged and reliable automatic machines are said to be energy efficient and use double-faced disposable cutting discs. Production rates range from 25 kg/h to 1,500 kg/h.
› **www.orenda-pulverizers.com**

Orion Engineered Carbons
Orion Engineered Carbons will showcase more than 40 grades of specialty carbon blacks which provide colouring, UV stabilisation and electrical conductivity to polymer systems. Carbon blacks are produced for the film, pipe, wire/cable,

PHOTO: NETZSCH

Left: Netzsch Instruments offers a full range of materials testing equipment

engineering plastics, fibre and automotive markets.
› **www.orioncarbons.com**

Otsuka Chemical America

Otsuka Chemical America offers a range of specialty compounds. Poticon, for example, uses Otsuka Chemical's Tismo ultrafine potassium titanate fibre and is employed in demanding micro-reinforced applications such as automotive friction and sliding parts, as well as LED reflectors and camera modules.
› **www.otsukachemicalamerica.com**

Paramount Colors

Paramount Colors offers an extensive portfolio of pigments, dyes, additives and other specialty products for the plastics industry. It has distribution centres across the US and partnerships with International manufacturers in India and China.
› **www.paramountcolors.com**

Plas Mec

Plas Mec designs and builds equipment for mixing of plastic materials such as PVC, PE, PP and ABS, as well as WPCs and technical polymers including PA, PC and PET. Its Combimix-HC is well suited for PVC or WPC dry blends while the Container Mixer TRR provides an alternative to turbomixers for masterbatch, pigments and technical compounds.
› **www.plasmec.it**

Plastic Systems

Plastic Systems manufactures plastics processing peripheral equipment covering raw material storage, centralised transport systems for granules and powder, individual and centralised drying, and gravimetric and loss-in-weight dosing units.
› **www.plasticsystems.it**

Polymers Technology Centre

Polymers Technology Centre was established in 2012 as a wholly-owned subsidiary of the Polymers Centre of Excellence. It supplies compounds to a variety of industries on a toll basis with volumes ranging from 250kg to truck load quantities.
› **www.polymers-tech-center.com**

Polyscope Polymers

Polyscope is a global leader in research, development, production and supply of styrene maleic anhydride (SMA) copolymers, compounds and aqueous solutions and styrene, maleic anhydride and N-phenylmaleimide (SMANPMI) terpolymers.
› **www.polyscope.eu**

Learn from experts at the free conferences

Visitors to the Compounding World Expo can attend its free conferences in two dedicate conference theatres. Business issues, market opportunities and updates on technology and materials will be presented by leading industry experts during the event.

Two keynote addresses will be given on 8 May in Theater One. Andrew Reynolds, Director of Advance Bidco and a founder of AMI, will analyse global trends in the plastics compounding market. And Chris Smith, Editor of *Compounding World* magazine, will speak about some key emerging compound technologies.

Theater One also hosts four industry debates across the two days, focusing on the future for technical compounds, concentrates, cable compounds and PVC compounds. The panelists include influential representatives from companies such as A Schulman, Alok Masterbatches, Americhem, Aurora Plastics, Champlain Cable, Chroma Color Corp, Clariant, Mexichem Speciality Chemicals, Primex Plastics, Prysmian, RTP Company, Southwire Company, Techmer PM, TPC Wire & Cable and Westlake Compounds.

VIEW THE FULL AGENDA FOR THEATER ONE

A number of special training seminars will take place across the two days in Theater Two. These will focus on challenges such as how to specify a twin screw compounder, designing for extension mixing, formulating compounds, optimising twin screw performance, evaluating and controlling colour, and understanding degradation and stabilisation. Speakers will be drawn from CPM Extrusion, Case Western Reserve University, Phantom Plastics, Leistritz Extrusion, Konica Minolta, and SI Group.

VIEW THE FULL AGENDA FOR THEATER TWO
DOWNLOAD THE FULL PROGRAMME

Right: Promixon's FX series container mixers offer fast mixing of colour pigment masterbatches

Precise New Material

Precise New Material Technology offers full-spectrum colours for production of synthetic fibres and plastics. Its product range extends to more than 200 pigments, dyestuffs, single pigment dispersions (SPC) and additives.

› **www.pro-color.cn**

Promixon

Promixon manufactures high quality mixing plant for the plastics compounding industry. Its XM High Speed Turbomixers combined with XC High Efficiency Coolers are well suited to production of rigid and plasticised PVC dry-blends, WPCs, colour masterbatch, additives and powders while its FX Container Mixer provides fast mixing of colour pigment masterbatch, engineering plastics and powder coatings.

› **www.promixon.com**

Quality Magnetite

Quality Magnetite has recently introduced the MicroMag product line for polymer compounding applications. MicroMag properties include high density, thermal conductivity and radiation shielding performance.

› **www.qmag.com**

Reliance Mixers

Reliance Mixers' mixing and compounding equipment is used to blend polymer compound components prior to processing. Applications range from PVC to colour concentrates and pigments.

› **www.reliancemixers.com**

Below: Mobile access is the latest addition to Schenck's materials handling control system

Provençale

Provençale has been transforming calcium carbonates extracted from its different quarries into industrial products since 1933. The company offers a number of grades for plastics applications under the Mikhart and Criscal brands.

› **www.provencale.com**

Q-Lab

Q-Lab Corporation's QUV accelerated weathering tester is a mainstay in the coatings and plastics industries. The Q-Sun xenon arc test chamber offers an accurate match to the full sunlight spectrum along with precise temperature and humidity control.

› **www.q-lab.com**

Schenck Process

Schenck Process is a leader in industrial weighing, feeding, conveying, mixing, blending, screening, automation and air filtration equipment. It specialises in dry bulk solids handling equipment for process industries, including difficult to feed dry materials such as TiO_2, carbon black, and wood flour.

› **www.schenckprocess.com**

Schwing Technologies

Schwing provides thermal cleaning services for the removal of all types of polymers and organic contaminations from metal tools and machine parts. The company claims to be able to offer all currently available cleaning technologies.

› **www.schwing-technologies.com**

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› **www.scconsultants.com**

SGL Carbon

SGL Carbon manufactures high-quality materials and composites from specialty graphites. Its portfolio includes graphite powders and chopped and milled carbon fibres. Sigratherm GFG graphite powders, for example, provide enhanced thermal conductivity for heat sinks.

› **www.sglcarbon.com**

Shamrock

Shamrock Technologies is a global leader in production of micronised polytetrafluoroethylene. It offers a broad line of specialty micronised powders, dispersions, emulsions, and compounds in PTFE, as well as PE, PP, custom wax alloys, and natural waxes.

› **www.shamrocktechnologies.com**

Below: The Purity Concept V from Sikora offers highly accurate pellet analysis

PHOTO: SIKORA

Sikora

Sikora supplies measuring, inspection, and sorting systems for the hose and tube, wire and cable, optical fibre and plastics industry. During the show it will present its Sikora Purity Concept V offline purity inspection and analysis system for pellets.

› **www.sikora.net**

Sonner

Sonner develops and manufactures weighing and feeding technology for polymer compounding applications. Products include UM series gravimetric blenders, SS and ST series loss-in-weight blenders and the Compact range of dosing and blending systems.

› **www.sonnerfeeder.com**

Southeast Machinery

Southeast Machinery aims to provide low cost new and used extrusion and recycling equipment, including twin screw extruders, single screw extruders, sheet lines and pelletisers. It can also supply shredders, granulators and wash lines.

› **www.semachinery.com**

Steer

Steer manufactures twin screw extruders and is the developer of the patented fractional lobe geometry screw element, claimed to provide unparalleled process control in shear and/or temperature-sensitive applications. It also supplies standard elements, barrels and shafts for all makes of twin screw extruders.

› **www.steeramerica.com**

Struktol

Struktol Company of America supplies lubricants and processing additives for all major polymers, including PE, PP, PVC, ABS, PC, PA and more. These are particularly useful in highly filled systems and in the processing of reclaimed/recycled plastics, where they can improve compatibility and melt flow and eliminate odours.

› **www.struktol.com**

Sukano

Sukano develops and produces additive and colour masterbatches and compounds for a wide range of applications. The company handles all base materials and has particular expertise with bio-based polymers.

› **www.sukano.com**

Superior Graphite

Superior Graphite developed its FormulaPT carbon and graphitic powders for plastics applications such as improving tribological or conductive performance. The product line includes synthetic and natural graphite powders, calcined petroleum coke and its own Resilient Graphitic Carbons.

› **www.superiorgraphite.com**

Technovel

Technovel developed the first co-rotating four and eight screw compounding extruders. Compared to standard twin screw designs, the WDR units are claimed to provide reduced heat generation, longer retention time, improved venting, better dispersion and lower energy consumption.

› **www.technovel.co.jp**

Right: Technovel's WDR four screw compounder is said to offer performance benefits over traditional designs

PHOTO: TECHNOVEL

PHOTO: THERMO FISHER

Left: Thermo Fisher's Process 11 is a laboratory compounding extruder for material development

Thermo Fisher

Thermo Fisher Scientific's laboratory twin screw compounding extruders and mixers support process modelling programmes by processing polymers under real-world conditions.

› **www.thermofisher.com**

TMI

TMI designs and manufactures bagging, palletising and stretch wrapping lines. The company specialises in formats from 5 to 50kg for FFS, open mouth bags and valve bags, and FIBCs.

› **www.tmipal.com**

Toyota Tsusho America

Toyota Tsusho America's Plastic and Performance Materials Unit supplies specialty additive materials from Sanyo Chemical Industries, including the Pelectron permanent polymeric antistatic agents, Umex high-acid maleated coupling agents, and Mel-Aqua hydrophilising agents for polyolefins.

› **www.toyota-tsusho.com**

TPEI

TPEI is a leading manufacturer of continuous mixer and single screw extruders for the plastics compounding industry. In addition to supplying compounding equipment, it can also undertake rotor repairs and restacking, machine alterations and rebuilds, and delivery of complete turnkey plant.

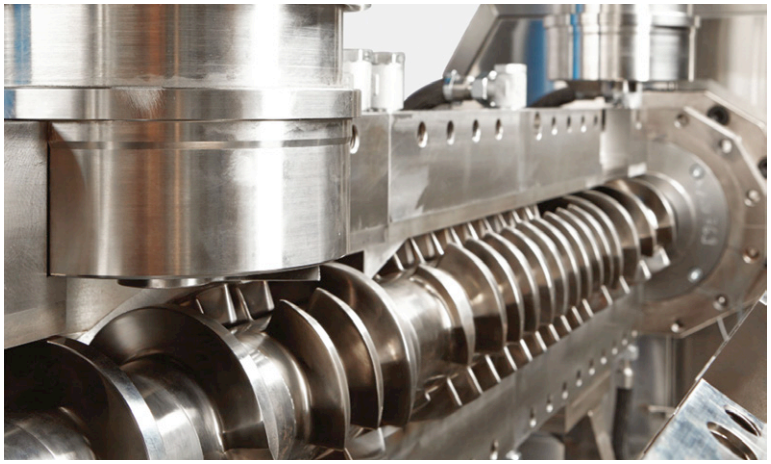
› **www.tpei.com**

Trendelkamp

Trendelkamp produces melt filtration screen changers, polymer start-up and diverter valves, pellet classifiers, extruder degassing systems, and custom processing solutions.

› **www.trendelkamp.com**

PHOTO: X-COMPOUND



Above: X-Compound manufactures a range of co-kneader compounding machines

Unibrom
Well established as a supplier of brominated flame retardants, Unibrom has recently extended its EcoFlame portfolio to include phosphate and sulphonate types. EcoFlame products are available in bulk form or as a masterbatch.
› **www.unibrom.com**

Unipetrol
Part of the Czech group PKN, Unipetrol is a refining and petrochemicals company with a strong position in polyolefins (Liten HDPE and Mosten PP) and carbon black (Chezacarb highly conductive grades). It also produces a range of colour and additive masterbatches.
› **www.unipetrol.cz**

United Feed Screws
United Feed Screws offers screw and barrel repair and replacement services for a range of plastics processing equipment. It also offers a laser alignment service for extruder barrels and can undertake complete system rebuilds.
› **www.unitedfeedscrews.com**

Vertellus
Vertellus is a leading provider of specialty chemicals to the plastics industry. Products for compounders include the Morflex and Citroflex plasticiser families, ZeMac compatibilising copolymers, Vitride reducing agents and Toponal antioxidants.
› **www.vertellus.com**

Wacker
Wacker offers an extensive portfolio of silicones and silanes. The product range includes silicone-based performance additives and modifiers for improved processing and compound properties and vinyl silanes for polyethylene crosslinking.
› **www.wacker.com**

Welset Americas
Welset Plast Extrusions offers single pigment dispersions (SPD) for plastics compounding and masterbatch applications. Its Welset Amethylen SPD portfolio extends to 4,000 colours plus white, black and additive concentrates.
› **www.welset.com**

Witte Pumps & Technology
Witte Pumps & Technology manufactures precision gear pumps in standard and customised designs. Its products for the compounding and extrusion industry include melt and pressure increasing pumps.
› **www.witte-pumps.com**

X-Compound
X-Compound designs, develops and manufactures continuous kneader extruders for processing of temperature and shear sensitive formulations as well as highly filled compounds. It can supply standalone extruders or complete compounding plants.
› **www.x-compound.ch**

Xinda
Xinda manufactures co-kneader and clamshell barrel co-rotating twin screw extruders for cable, masterbatch and engineering compound production. It has more than 1,800 compounding lines running in 48 countries worldwide.
› **www.xindacorp.com**

Zenith/Circo International
Zenith's precision gear metering pumps provide accurate, reliable, pulse-free performance over a wide range of process and fluid conditions. Typical applications include dosing, filling, injection, coating, extruding, spraying and fibre spinning.
› **www.zenithpumps.com**

Zeppelin Systems
Zeppelin Systems is a global plant engineering company that specialises in development and manufacturing of components and plant for storage, conveying, mixing, dosing and weighing of bulk materials.
› **www.zeppelin-systems.com**

Zoltek
Zoltek is a leader in the production of industrial grade carbon fibre. Its products include general grades sized for use with PP, PA or PC as well as types suitable for use with ultra-performance thermoplastics.
› **www.zoltek.com**

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Comparison of Strain Hardening Modulus and Crack Round Bar testing for new generation pipe materials

Testing long term performance of PE 100 and PE 100 RC pipe grades can be time consuming. Unipetrol researchers have compared the two most common ISO test methodologies

The Pennsylvania notched test (PENT) was developed two decades ago to enable fast testing of slow crack growth in polyethylene pipe materials. The method was developed especially for testing PE 63 and PE 80 resins and for these grades gave a good determination of the quality of the prepared materials in a short-time period. Today, however, PE 63 and PE 80 resins have been replaced by PE 100 and PE 100 RC materials, which offer far superior resistance to slow crack growth. For these new materials PENT testing times can take several years.

The need for a faster test method led to creation of two new techniques that have been transformed into the ISO 18488 and 18489.

ISO 18488: *Polyethylene (PE) materials for piping systems. Determination of strain hardening modulus (SHM) in relation to slow crack growth*. In this method test specimens cut from compression moulded sheet are subjected to a tensile test at 80°C. The stress-strain curve is obtained sufficiently beyond the natural draw ratio and SHM determined from the slope of this curve in the area after the natural draw ratio.

ISO 18489: *Polyethylene (PE) materials for piping systems. Determination of resistance to slow crack growth under cyclic loading – Crack Round Bar Test (CRB)*. This method uses a cyclic tensile test with constant load range on a cylindrical specimen under suitable test conditions within the stress range where slow crack growth is achieved. A test specimen with circumferential notch is tested. The number of cycles until final failure is recorded as a function of the stress.

To assess the validity of these tests five materials were selected; one extrusion HDPE, two PE 80, one PE 100 and one PE 100 RC. Comparison of both techniques was based on the time required for specimen preparation, the need for laboratory equipment, test specimen measurement and measured data evaluation. Results are shown in Tables 1 to 4.

The study shows that the SHM allows test specimens to be prepared easily and two tensile tests can be completed in one hour. However, evaluation of the measured data is complicated and time consuming and testing without appropriate equipment is not possible. This test is associated with crazing, fibril creation and fibril deformation.

Specimen preparation for the CRB test is more complicated. Testing without appropriate equipment is not possible and testing is time consuming. However, the test is associated with slow crack growth and final evaluation is easier.

Table 1: Time required for test specimen preparation

Strain Hardening Modulus	Cracked Round Bar Test
• preparation via compression moulding • punching of 10 test specimens • additional annealing	• preparation via compression moulding • machining of 14 test specimens • test specimen notching • conditioning
Procedures takes a maximum of 2 days	Procedures take 5 days

Table 2: Laboratory equipment

Strain Hardening Modulus	Cracked Round Bar Test
• tensile-testing machine • load cell • extensometer up to 1,100% • temperature chamber • grips • micrometer	• fatigue-testing machine • load cell • special grips • microscope
Both test methods require specific and expensive laboratory equipment	

Table 3: Test specimen measurement

Strain Hardening Modulus	Cracked Round Bar Test
• temperature 80°C • test specimen put into grips • temperature equilibrium • speed of testing = 20 mm/min • deformation = 1,100%	• temperature 23°C • test specimen put into grips • temperature equilibrium • testing frequency = 10 Hz • breakage = end of test
Two or three test specimens can be tested in one hour	Poorer materials require 100,000 cycles (170 minutes equivalent to one test specimen in 3 hours) Better materials may require 1,000,000 cycles (1,700 minutes equivalent to one test specimen in 28 hours)

Table 4: Measured data evaluation

Strain Hardening Modulus	Cracked Round Bar Test
• measured data exported to EXCEL file • recalculation and application of mathematical model • evaluation of SHM	• number of cycles automatically evaluated • microscopy for fracture surface evaluation • calculation of stress intensity factor
Measured data evaluation is faster for CRB testing	

Authors: Jiří Sadílek[1], Jaroslav Kučera[1], Martin Chytil1, Pavel Hutař[2], Jan Poduška[2]
[1]UNIPETROL RPA, s.r.o. - POLYMER INSTITUTE BRNO, odštěpný závod
[2]Institute of Physics of Materials of the Czech Academy of Sciences

PHOTO: SHUTTERSTOCK

Processing aids - users seek improved functionality

Lubricants and processing aids are vital for efficient polymer processing. However, compound producers are increasingly demanding additional functionality as well, writes ***Mark Holmes***

Making raw materials go further and delivering more efficient end-use processing – whether that be faster and thinner extrusions or shorter injection moulding cycles – are key roles of processing aids in the formulation of polymer compounds. A wide variety of chemicals, waxes and lubricants can be employed to this end but increasingly these additives are being required to be multi-functional. And as the Circular Economy moves up the agenda, lubricants and processing aids that can work effectively with recycled polymers are also finding important roles in the market.

German wax additive blend and montan wax supplier to the compounding industry **Völpker Spezialprodukte** highlights a number of significant factors in the current lubricant and wax market sector. "Polyethylene wax – mainly oxidised – is still in short supply," says Dr Lutz Matthies, Head of Business Development. "The recent global shortage of oxidised polyethylene waxes has caused users to search actively for adequate replacements. However, montan wax is in good demand, mainly for high-quality applications and is readily available. The market is open for new developments with montan wax. The demand problem for Fischer-Tropsch (FT) wax is now relaxing because of new Asian producers and new plants introduced by established players in the market. In addition, the biopolymers market now deserves effective bio-based lubricants."

Matthies identifies a number of key trends driving new developments in waxes and lubricants. ❯

Main image: Processing aids and lubricants are key elements in the preparation and processing of polymer compounds for performance applications

"Multi-functionality of wax additives – one additive with several functions – is an asset," he says. "In addition, plant-based chemically functionalised wax additives, available on a sustainable basis, are a growing requirement of the biopolymer market. There is also a need for special wax additive packages for recycled plastics: The multi-functionality of montan waxes in synergy with other additives, such as stabilisers and lubricants, can be used to produce compounds with property profiles that are very close to those of new products. These include the Voelkper plastic recycling series of wax additive blends and montan waxes – Cevo and Waradur. The products of the Voelpker plastic recycling series are also adapted to the processing conditions of specific recyclates."

Monitoring wax performance is also a key consideration, according to Matthies. "Many of the products that have been advertised in the past as 'drop in alternatives' to proven montan wax esters give sub-optimal results in practical applications because they do not provide the same properties and use characteristics," he says. "Un-derivatised vegetable ester waxes, for example rice bran wax, and also polyester waxes from polymer degradation do not provide the equivalent processing and performance characteristics such as those of montan esters. Their chemical characteristics do not fully meet most current specifications for montan waxes and they also show differing performance in volatility [Figure 1] and colour stability [Figure 2]."

Matthies adds that low priced standard commodity lubricants can often cause unwanted side effects such as 'blooming out', for example with EBS wax in TPU. He says that the solution in many cases is new montan wax derivatives that close the gap between oleo-based and montan-based structures and application properties, such as Waradur GSM and ESM. In addition, the company offers the Waradur OP*plus*, a saponified montan wax with a high calcium montanate content and further improved volatility. Its structure and chemical characteristics are shown in Figure 3.

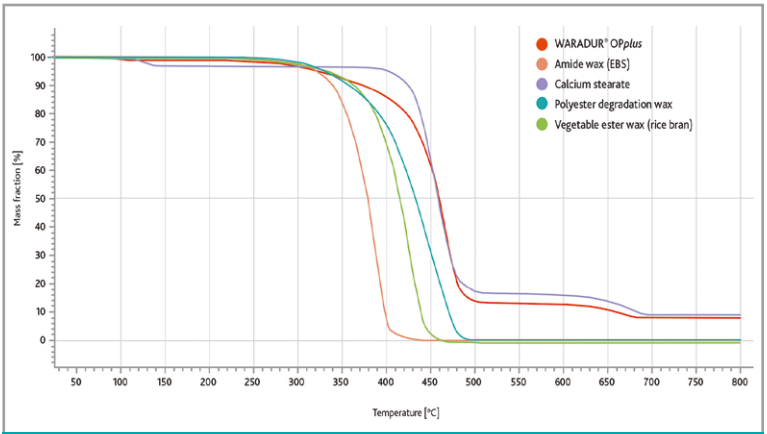

Figure 1: Volatility of Waradur OPplus high calcium saponified montan wax compared to some typical alternatives determined by Thermogravimetric analysis (Fraunhofer-Institut WKI, Braunschweig; Mettler, 10.00 K/min)
Source: Voelkper

Recycling challenges

The company says that its Voelpker plastic and plastic recycling series of wax additive blends and montan waxes are designed to overcome processing challenges and allow compounders to develop formulations offering optimised characteristic value profiles. "One goal is to complement the specific 'DNA' of the montan esters to the properties of oleo-based esters," says Matthies. "Waradur GSM and Waradur ESM are hybrid ester waxes consisting of a mixture of long chain (mainly C28-32) wax acids and fatty acids esterified with multihydroxyl alcohols. They

Figure 2: Colour stability under stress of Waradur E hard ester montan wax compared to some current alternatives (Heraeus UT 6120 laboratory air circulation oven; 250°C/ 30 min)
Source: Voelpker

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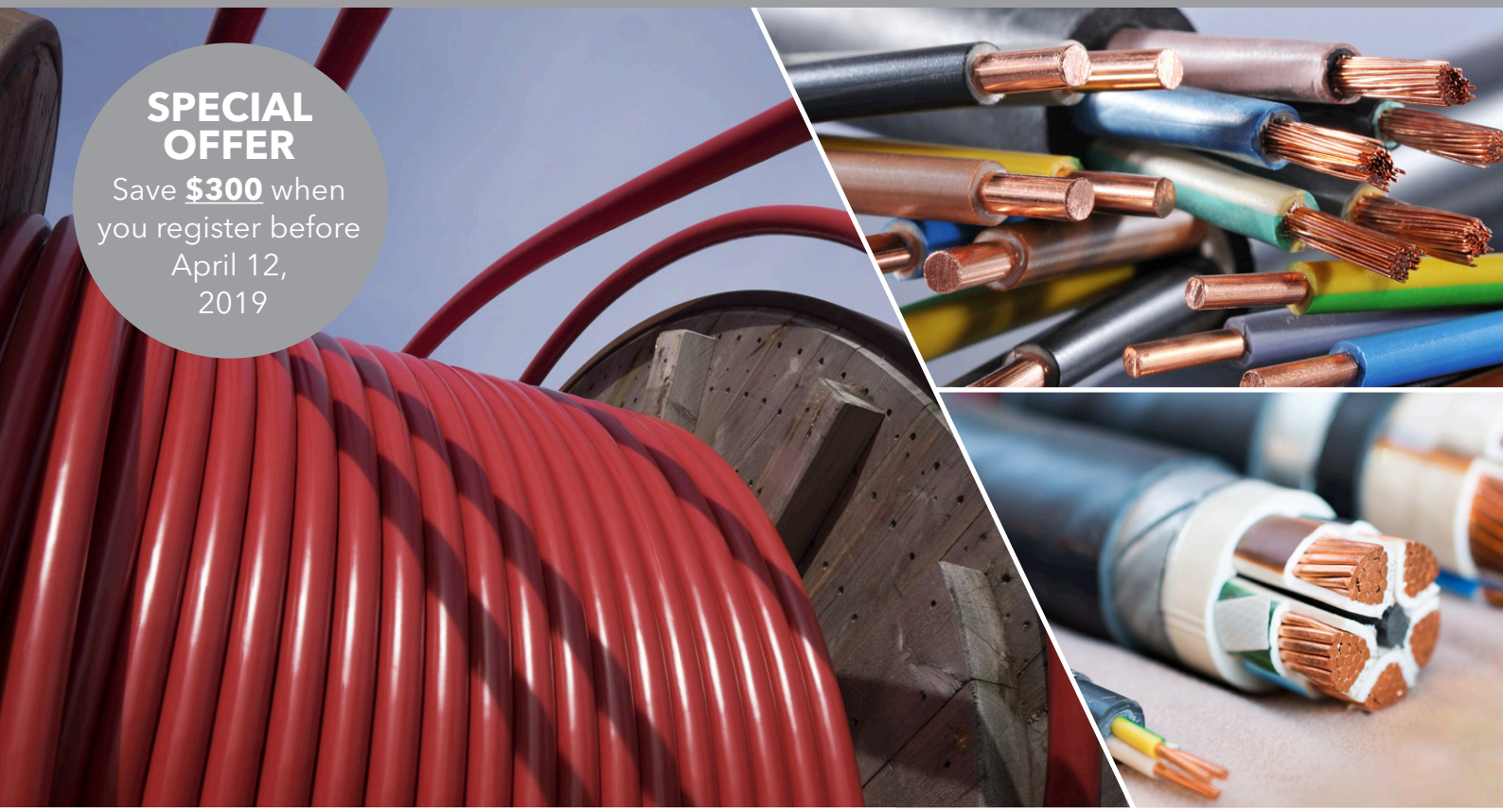

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combine the chemical properties of montan esters and classical oleo esters on a molecular level. They also combine in an ideal manner the application properties of montan esters including high thermal stability, low volatility, no blooming out and excellent release/anti-sticking, with those of oleo esters such as improved mould release."

The Voelpker bio-based series includes the processing aid Cevo-process J-4418. This wax additive is 95% bio-based and is designed to provide flow improvement, faster part production, reduced injection moulding ejection force and improved dispersion. It is an organic ester wax based on renewable plant material (it is predominantly derived from acids and alcohols in the C26–C30 range) making it suitable for formulation of bio-based thermoplastic compounds.

A particular advantage of Cevo-process J-4418 is its high effectiveness at low concentrations. Voelpker says that it is suitable for use as an additive in a wide range of plastics applications, including release agent, flow improver, dispersing agent and cycle time reducer. Typical results achieved in injection moulding applications are said to include a 46% reduction in cycle time, 15% improvement in flow and up to 49% reduction in ejection force. Cevo-process J-4418 can be used in thermoplastics such as PA, TPU, PLA, PBT, PC, PVC and PS. Thermoset applications include epoxy resins, phenolic resins and polyurethane. It can also be used as a dispersing agent for colour masterbatches and mineral or glass fibre-reinforced plastics.

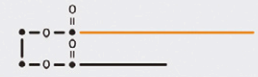
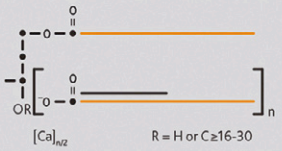
Name	Chemical Characteristics	Drop point [°C]	Acid value [mg KOH/g]	Visco-sity at 120°C [°C]
WARADUR® GSM		79	14	16
WARADUR® ESM		82	36	12
WARADUR® OP*plus*		n.a.	5	n.a.

Figure 3: Structural elements and typical chemical characteristics of Waradur montan derivatives
Source: Voelkper

Moulding trials

Voelpker says in a recent injection moulding study designed to demonstrate reduced cycle times and enhanced flow improvement, a number of PA6 matrices were investigated. Unmodified Durethan B 29 (Lanxess) was stabilised with Irgafos 168 (BASF) and Microtalc IT extra (from Mondo) added as a nucleating agent. Blank 1 (without nucleating agent) was tested as a control while the effect of adding Cevo-process J-4418 was compared against Waradur E, amide wax and calcium stearate.

In the applied experimental set-up, using standard tools and test specimens, the nucleating agent alone reduced cycle time by 7%. The 56% reduced cycle time compared to the Blank 1 control for the Waradur E sample is attributed to the proven dispersing effect of the wax, which leads to better distribution and effictiveness of the nucleating agent. Cevo-process J-4418 produced a similar cycle time reduction – 46% – and significantly outperformed both the amide wax and calcium stearate samples.

Spiral Flow Number, defined as the flow length, was determined by injecting the molten resin into a

Table 1. Spiral flow injection moulding analysis of CEVO-process J-4418 processing aid compared to alternatives in PA6 resin. Test formulations.

Matrix	Additives	%	Comments
PA 6 Durethan B 29-Irgafos 168 [0.2 wt.%]	–	–	Blank 1
PA 6 Durethan B 29-Irgafos 168 [0.2 wt.%]	Microtalc IT extra	0.2	Blank 2, with nucleating agent
PA 6 Durethan B 29-Irgafos 168 [0.2 wt.%]	Microtalc IT extra CEVO-process J-4418	0.2 0.5	Renewable long-chain ester wax
PA 6 Durethan B 29-Irgafos 168 [0.2 wt.%]	Microtalc IT extra WARADUR E	0.2 0.5	Montan ester wax
PA 6 Durethan B 29-Irgafos 168 [0.2 wt.%]	Microtalc IT extra Amide wax	0.2 0.5	Ethylenebisstearamide (EBS)
PA 6 Durethan B 29-Irgafos 168 [0.2 wt.%]	Microtalc IT extra Ca-stearate	0.2 0.5	Calcium saponified fatty acid

Source: Voelkper

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spiral channel testing mould. The results demonstrated that flow can be significantly increased by using wax additives, with the best result of 15% longer than the control Blank 1 achieved with Cevo- process J-4418. The flow extension with Waradur E was around 8% and for both calcium stearate and amide wax between 5.0 and 5.5%. The results are shown in Table 1.

Ejection gains

In another study, ejection force reduction enabled by the use of montan waxes in PBT (polybutylene terephthalate) was examined. Montan wax Waradur E acts as a thermally stable and low volatile release agent in PBT, with typical additions of 0.3-0.5% recommended for unfilled PBT resins and up to 1.0% for filled or reinforced formulations. The PBT formulations (Table 2) were compounded using a Brabender twin screw extruder and pre-dried at 110°C to a residual moisture content of 0.03%. The moulding trials were carried out on an Arburg Allrounder 420C 1000 at a melt temperature of 240°C and the ejection forces calculated from 20 measured injection mould cycles once the process had stabilised.

The force required for ejection was measured using a 5kN load cell from Hottinger Baldwin Messtechnik that was axially integrated into the ejector rod. An injection moulding tool with a particularly high shell surface was selected and the precise ejection force calculated using Katman software. The results showed that ejection forces were reduced by approximately 20% using Waradur E. PETS and calcium stearate only reduced the ejection forces by 8% and 11% respectively.

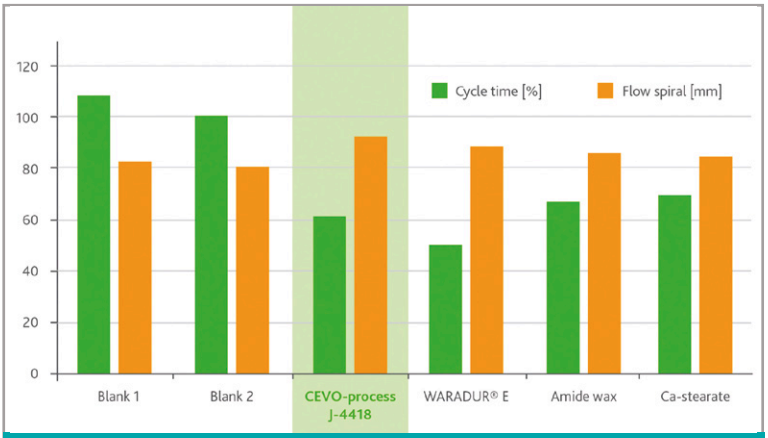

Figure 4: Cycle time reduction and flow improvement – spiral flow injection moulding trials
Source: Voelpker

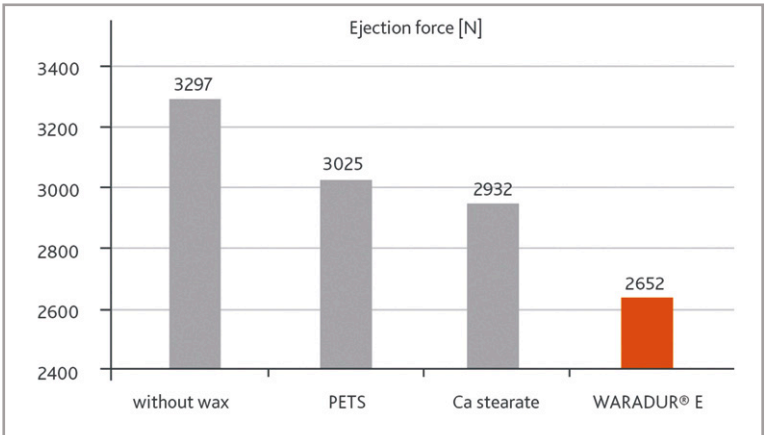

Figure 5: Ejection force results comparing Waradur E montan wax with alternatives
Source: Voelpker

Beyond lubrication

With a customer base focused on either innovation, performance or adapting to regulatory change, US-based **Hybrid Plastics** says that it is seeing a demand for processing aids that offer value beyond traditional lubrication. "For example, processing additives that provide desirable rheological effects in conjunction with modulus enhancement, nucleation capability or dispersion capability are common requests," says Joe Lichtenhan, Vice-President, New Business Development. "These innovation-based customers are focused on using smart or multi-effect additives to achieve new material performance levels and manufacturing simplifications that improve bottom-line economics. We are also see growing interest in processing aids that do migrate and that do not contain low molecular weight volatiles. Customers in this area most often are seeking regulatory compliance or aesthetics."

There is a real and growing demand for low addition level products. **"**Additives that can be utilised at low percentages to expand the

Table 2: Ejection force analysis of montan wax and alternatives in PBT. Test formulations

Matrix	Additive	Additive [phr]	Comments
SHINITE	None	0.0	Reference/blank
D201NA	WARADUR E	0.4	Montan ester wax
(PBT Base polymer grade)	PETS	0.4	Pentaerythritolester
+ Irganox 1010 [0.5 wt.%]	Calcium stearate	0.4	

Source: Voelpker

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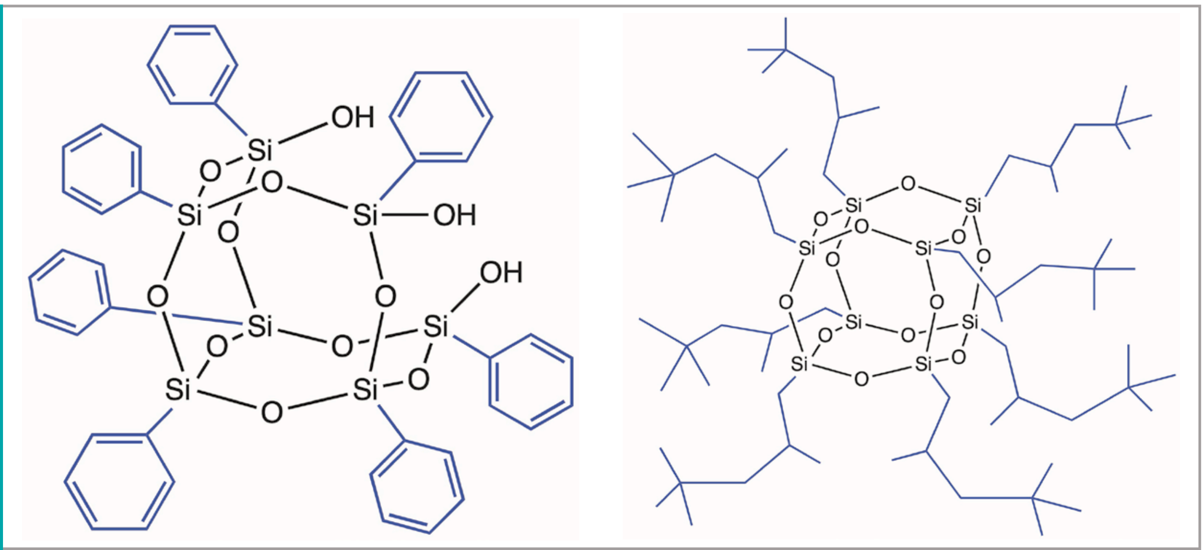
Figure 6: Schematic showing (left) i-Octyl POSS plasticising lubricant and (right) high temperature phenyl trisilanol surfactant processing additive

Source: Hybrid Plastics



performance of existing polymer formulations has become a growth area within the speciality chemicals industry. This trend is now extending to processing, lubricant and surfactant additives. Our customers always want more performance from their additives and this means they ask for a single additive that can provide a combination of desirable effects that were previously only achievable through careful formulation from multiple different ingredients," Lichtenhan says.

Formulation challenges

One of the longstanding problems has been that polymers often remain plasticised from processing aids and die lubricants, he says. "This creates a challenge for formulators and material engineers because the residual effect must be accommodated for. The time dependent plasticiser migration and volatility further complicates the performance assurance of final parts. In several cases we have had customers replace traditional processing aids and lubricants because they negatively impacted the high temperature durability of moulded parts. The replacement of these additives with advanced additive technologies enabled more competitive and upgraded product to enter the market. In some cases, even new performance standards were achieved."

Additives that afford rheological control, colour dispersion and nucleation control of high performance aromatic thermoplastics is the focus for Hybrid Plastics. A particular growth area is in the use of polymers such as PPS, PEEK, PEI and PPE for 3D filament printing. Such polymers are challenging to mould using traditional methods. However, the absence of injection pressure and layer deposition limitations in 3D print systems provides additional hurdles for high molecular weight grades of these polymers.

Hybrid Plastics says that its POSS processing additives and compatibilisers based on silesquioxanes provide the basis for its solution platforms. "The precisely defined composition and topological features of this chemical family are unique from traditional chemical additives by providing an envelope of desirable effects. The effects are derived from the rigidity of the inorganic central core, which enables large molecular surface area and volume contributions to formulations. Externally, each core silicon atom contains an organic group for compatibility, plasticisation, reinforcement or reactivity. POSS additives are also well suited for masterbatching. Typical let-down dosing levels range from about 0.1% to about 5% relative to resin," says Lichtenhan.

"The high processing temperatures of aromatic thermoplastics also limits the use of traditional plasticisers due to their propensity to degrade and volatilise during compounding. In such instances the phenyl POSS trisilanol provides an envelope of effects. The phenyl groups strongly interact with the aromatic of the polymer backbone and the silanols afford interfacial compatibility with other ingredients such as colour additives. In this respect, POSS silanols are similar to a surfactant molecule," he says.

Engineering options

Processing aids for engineering thermoplastics (PE/PP) and elastomers are often sought from Hybrid Plastics. "Low migration additives are highly desired in these systems and in some cases a secondary process of crosslinking is also utilised," Lichtenhan adds. "POSS additives containing reactive groups, such as vinyl, can be utilised. The crosslinking capability of olefinic POSS greatly aids

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in the reduction of migration. When plasticising lubrication is sought, POSS additives bearing long groups like i-octyl or i-butyl are desirable. These POSS are highly thermally stable and not subject to depolymerisation and volatilisation."

Lichtenhan says a number of mechanisms have been put forward to explain the effect of the POSS additives on flow, based on Einstein sub-rheology and the effect of weak forces – Van der Waals or London forces - between the POSS cages and polymer chain "Perhaps a simpler explanation is that POSS cages melt during compounding. In the molten state the cages act as low viscosity liquids and thus provide a reduction in extrusion torque and viscosity during processing. Upon cooling the POSS cages and the polymer re-solidify. The solidification of POSS is highly advantageous as it does not result in post processing plasticisation," he says.

Future POSS developments will exploit the effects from combining chemical compatibility with surface area and volume control, resulting in significant viscosity reductions and enhanced dispersion effects for particle loaded polymer formulations, according to Lichtenhan.

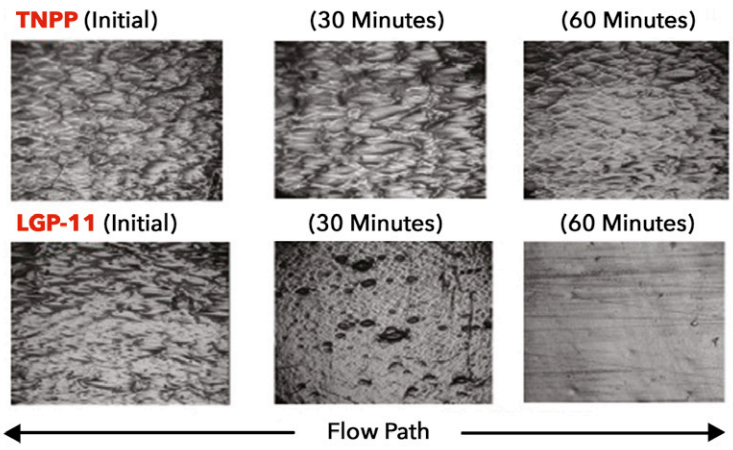

Figure 7: Improvement in time to clear melt fracture for LLDPE containing TNPP compared with Doverphos LGP-11 stabiliser and processing aid
Source: Dover Chemical

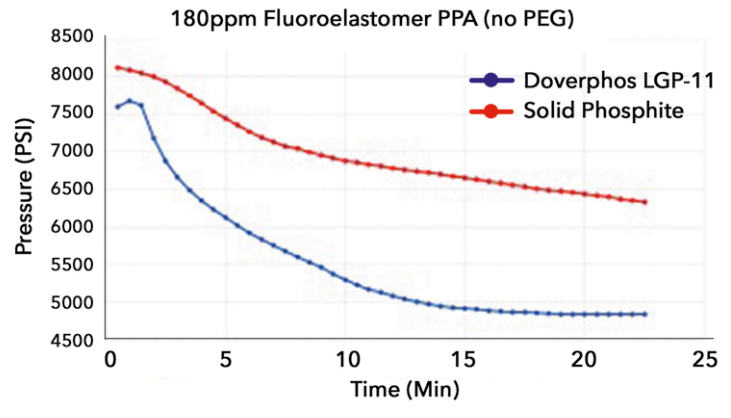

Figure 8: Pressure reduction effect of Doverphos LGP-11 compared to solid phosphite stabiliser in metallocene LLDPE
Source: Dover Chemical

Alternative approach

Meanwhile, **Dover Chemical Corporation** has developed a new approach for polymer processing improvement with the introduction of its new polymeric liquid phosphite stabiliser, Doverphos LGP-11. The company says that it offers a variety of advantages compared to other phosphites, such as trisnonylphenyl phosphite (TNPP). [Within the EU, TNPP is under consideration for addition to the REACH SVHC list over concerns that it may display endocrine disrupting properties.]

Doverphos LGP-11 is claimed to improve colour stability during processing and NO_x gas fading. It also offers a reduction of plate-out on processing equipment and elimination of surface bloom or exudation in the final product, does not contain any alkylphenols and is said to greatly reduce migration into food from plastic containers.

Dover says fluoroelastomers are commonly used as polymeric process aids (PPAs) in polyolefin applications. "They offer several benefits, such as the reduction of melt fracture during blown film processing. Many of the common commercially available PPAs also include an interfacial agent or synergist that improves the general performance. These are often low molecular weight polymers, such as polyethylene glycol [PEG]," according to Trisha McNutt, Product Manager at the company.

"Due to the polymeric nature of Doverphos LGP-11, it can also replace PEG as a synergist in PPAs and offers enhanced benefits such as reduced pressure during melt extrusion. In various LLDPE studies, Doverphos LGP-11 has shown the potential to reduce melt fracture using lower levels of PPA, improve processing throughput, allow lower processing temperature and improve overall thermal stability. These benefits can be realised by simply replacing commonly used solid or liquid phosphites with Doverphos LGP-11. In addition, Doverphos LGP-11 can also be added separately to the formulation through the use of an antioxidant or PPA solid masterbatch," McNutt says. Doverphos LGP-11 also has FDA clearance for use in indirect food contact applications such as LLDPE, HDPE, PP, HIPS and adhesives.

Targeting friction

Recent developments from **Axel Plastics Research Laboratories** include a process aid additive with reduced coefficient of friction. TD INT-33LSER is a

100% active additive designed for incorporation directly into resins. It is available in powder or pellet form and offers improved resin flow and better dispersion of other resin additives. In injection moulding it allows for shorter cycle times, reduced processing temperatures and lower injection pressures. It is also said to help reduce or eliminate weld/knit lines.

TD INT-33LSER is recommended for use with all PE and PP materials, including TPO, TPE, TPV, and TPU. The company says that benefits include a greatly reduced coefficient of friction compared to its earlier additive options, such as Axel MoldWiz INT-33LCA and INT-33CFW. In addition, it delivers lower torque values compared with additives such as AXEL MoldWiz INT-33CFW and INT-34KF. The new product carries FDA Compliance 21 CFR 175.300. The company says that its synergistic blend of modified polymers and organic components will not interfere with any secondary options such as pad printing or labelling.

Axel has also developed a new process aid with anti-static properties. MoldWiz INT-34KF is a 100% active additive again available in powder or pellet form and is said to offer improved release, lubricity and resin flow without discolouration or loss of clarity. It is also recommended for use with PE and PP, TPO, TPE, TPV, and TPU, as well as PA, styrenics, PET and many engineering plastics, including PPA. The minimal impact on clarity and colour makes it a particularly good choice for clarified PP, the company claims.

The company says the new additive offers improved release over older alternatives, such as its Axel MoldWiz INT-33 series and INT-38HM and better flow compared with older Axel MoldWiz INT-34DLK and INT-55PV. It typically eliminates the need for any external mould release agents and can also reduce cycle times, temperatures and pressures during moulding and potentially reduce or eliminate weld/knit lines. As it contains no silicones, stearates or waxes it will not interfere with downstream bonding, painting, printing or plating processes.

CLICK ON THE LINKS FOR MORE INFORMATION:

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A series of six free training seminars will provide practical tips on vitally important topics such as: specifying and optimizing compounding lines; measuring and controlling color; ensuring regulatory compliance; formulating better compounds; and understanding polymer degradation and stabilization.

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The 2,000+ visitors who have already registered to attend include representatives from Abbott, Ampacet, Azek Building Products, Berry Global, Colgate-Palmolive, Dell, Ford Motor Company, HP, Nestle, PolyOne, Reynolds Consumer Products, Royal Building Products, Tekni-Plex, Teknor Apex, TE, Whirlpool and many more.

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The focused exhibition will feature more than 20 suppliers of compounding lines, including B&P Littleford, Buss, Coperion, CPM, Entek, Farrel Pomini, JSW, KraussMaffei, Leistritz, Maris, NFM and Steer. In addition, it will include the leading suppliers of pelletizers, feeding equipment and replacement parts.

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There will be two focused conference theaters at the Compounding World Expo with presentations on: market trends; conductive compounds; wear-resistant plastics; computer modelling; fire retardants; highly-filled compounds; recycled materials; TPEs; nanocomposites; automotive TPOs; and many more hot topics.

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Visitors to the Compounding World Expo will have free access to the adjacent Plastics Recycling World Expo and Plastics Extrusion World Expo plus their three conference theaters. In total, there will be more than 250 exhibitors and 130 speakers to choose from.

Get your free ticket

The Compounding World Expo will take place at the Huntington Convention Center in Cleveland, Ohio, USA on May 8-9, 2019. Admission to the trade shows and its conference theaters will be free of charge to visitors who register in advance **HERE**. Your free ticket is valid for both days of the event.

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Adding value to PP compounds

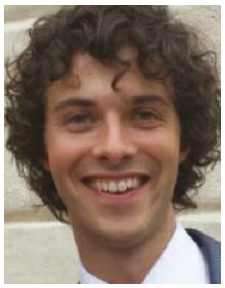
AMI's second Performance Polypropylene conference takes place in Cologne in Germany next month, providing an opportunity to learn more about the latest PP formulation and compounding developments

Following its successful launch last year, AMI's Performance Polypropylene conference returns to Cologne in Germany on 14-15 May for its second edition. Demand for engineered PP compounds is growing fast, especially from the automotive industry, but also in areas such as appliances, E&E and construction. And the requirements are set high – while the pressure is on to find lightweight metal replacements that is not at the price of mechanical performance, durablility, processing and, of course, cost.

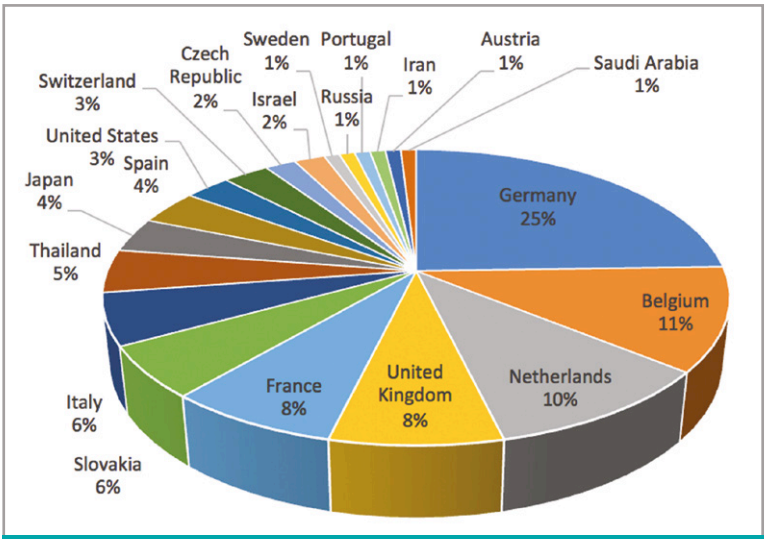
Performance Polypropylene 2019 will provide a timely technical forum that will bring together key players to analyse and discuss the latest formulations and applications for these high-performance PP products. It is expected to bring together a global audience – last year's launch event attracted attendees from more than 20 different countries and across the entire supply chain. The 2019 conference will provide a further opportunity to examine the latest advances in polypropylene resins and compounds for demanding technical applications across all markets. This article previews the event and takes a closer look at the international line-up of expert speakers and the topics that will be covered.

The opening session of the conference focuses on automotive applications. **Matt Defosse**, Market Development Manager at **PolyOne** in Luxembourg, kicks off day one with an opening presentation looking at the effects of distracted drivers and rapid automotive industry change on creation of polypropylene parts for high quality car interiors. He will be followed by **Dr Nuria Garcia Batista**, Technical Researcher (Chemical Laboratory – Identification) at **AIMPLAS** in Spain, who will delve further into polypropylene inside the vehicle and discus how to guarantee air quality in the passenger compartment. The session will be closed by **Dr Michele Grazzi**, Senior Scientist at **LyondellBasell** in Italy, who will look at the development of the

Main image: Demand for high performance PP compounds is growing fast but there are many technical challenges to overcome



Industry experts sharing their views at Performance Polypropylene 2019 include (from left) PolyOne Market Development Manager Matt Defosse, Honda Senior Project Engineer Paul Vickers, and Electrolux Resins Commodity Manager Daniele Gallo



Attendees at Performance Polypropylene 2018 were drawn from 20 countries, making it a truly international event.
Source: AMI

polypropylene building blocks that will serve technical compounders in the automotive industry.

The next session moves the focus on to modifying and enhancing the mechanical properties of polypropylene. **Dr Warren Ebenezer**, Research Manager for Polymer Applications at **SI Group**, will start the session with a presentation investigating novel antioxidant solutions for polypropylene requiring enhanced colour performance**. Dr Dimitrios G Papageorgiou**, Research Associate at the National Graphene Institute at the **University of Manchester,** then follows with an examination of hybrid, graphene-reinforced multifunctional polypropylene nanocomposites. Then **Dr Camillo Cardelli**, Chemist in the Materials Division at **IPOOL** in Italy, will present a new solution for halogen-free flame-retardant polypropylene compounds.

The flame retardant theme continues with a presentation on development of environmentally-friendly flame retardants for polyolefins by **Morteza Zare**, Senior Polymer Researcher in the Compounding Section at **Marun Petrochemical Company** in Iran. And this session will be brought to a close with a look at the use of polypropylene and polyethylene as engineering materials by **Oscar Brocades Zaalberg**, Managing Director at **BPO BV** in the Netherlands.

Open discussion

Day One will be rounded off with an interactive panel discussion that will focus on the future of polypropylene and the latest developments and trends. Panellists include: **Dr Adam Galambos**, Director of Technology at **Washington Penn** in Slovakia; **Paul Vickers**, Senior Project Engineer at **Honda** in the UK; and **Daniele Gallo**, EU Chemicals and Resins Commodity Manager at **Electrolux** in Italy. Attendees will have the opportunity to join in the discussion by posing questions and engaging with panellists. The day will close with some informal networking over drinks and canapés.

Day Two opens with an insight into new applications. **Manfred Bachtrod**, Application Development Engineer at **Borealis** in Austria, will pose a highly topical challenge for the industry: How can we make appliances more sustainable? He will be followed by **Tim Vroman**, Technology Manager at **Beaulieu Fibres International** in Belgium, who will present details of a new generation of high tenacity polypropylene fibres for lightweight geotextiles.

Dr Robert Brüll, Group Manager, Material Analytics at **Fraunhofer LBF** in Germany opens the final session of the conference with an examination of how analytics can be used as a tool for development of high-performance polypropylene. He will be followed by **Dr Cornelia Tranninger**, Group Leader Flexible Polymers at **Borealis Polyolefin** in Austria, who will present an insight into some innovative polypropylene polymer developments based on non-phthalate Ziegler-Natta catalysts. And the conference will be brought to a close by **Marco Bernsdorf**, Business Development Manager of **Lotte Chemical**, who will detail some of the company's latest polypropylene projects.

About Performance Polypropylene 2019

AMI's second Performance Polypropylene will take place in Cologne in Germany on 14-15 May 2019. The event will provide insight into the latest developments across the PP compounds supply chain, addressing key technical challenges and identifying technological solutions to overcome them.

The conference will bring together expert speakers from across the globe with key technical and marketing personnel from the compounding industry and end user market sectors including automotive, appliances, electrical & electronic, and building and construction. Beyond the formal conference sessions, the event will provide plenty of informal networking breaks and complimentary cocktail reception.

To find out more about Performance Polypropylene 2019, visit the **conference website** or contact Conference Organiser Jasmine Coles. Tel: +44 (0) 117 314 8111; Email: **Jasmine.Coles@ami.international**

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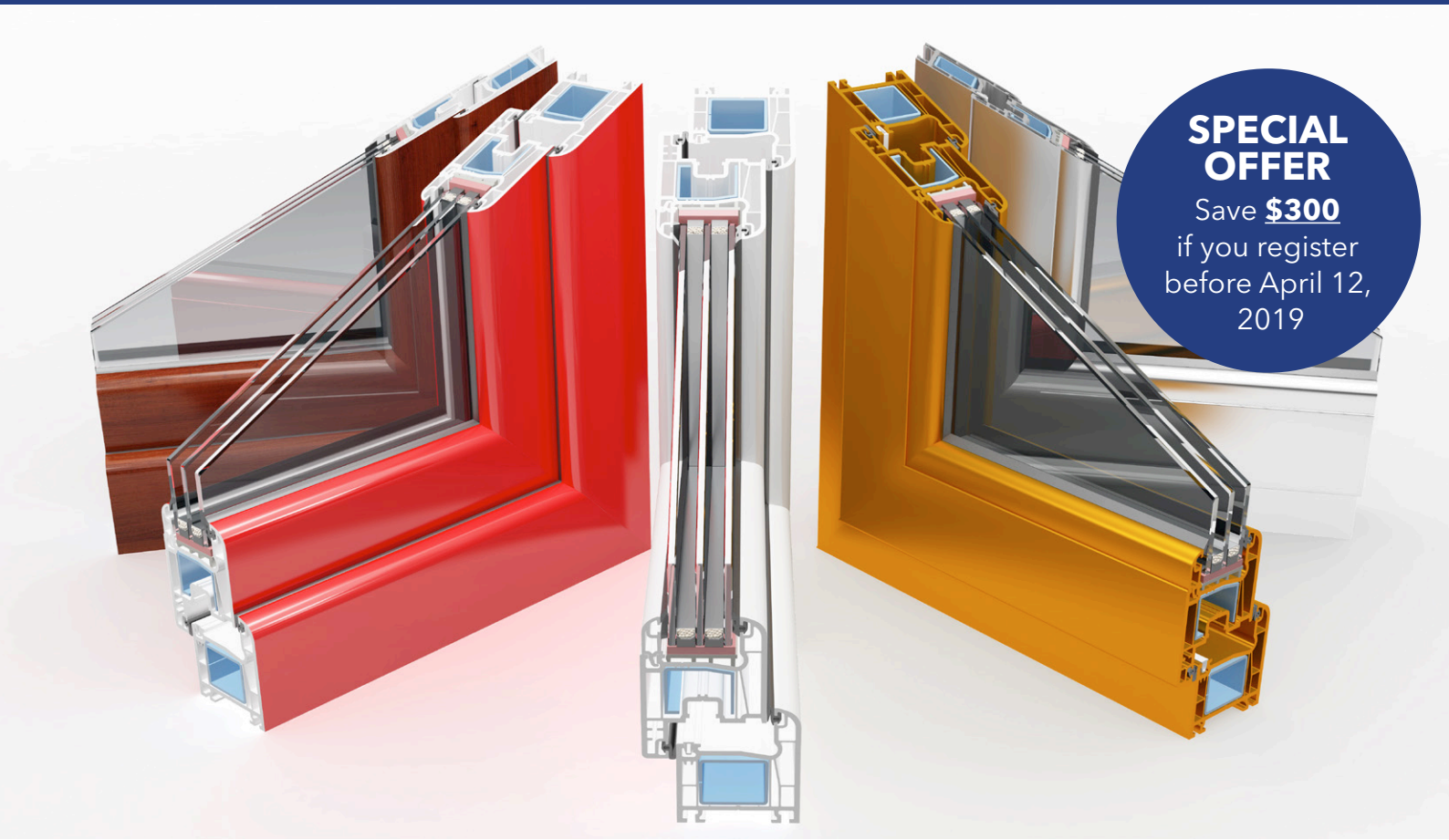

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*The goal of test equipment makers is to offer easier-to-use equipment that offers higher precision at lower cost. **Peter Mapleston** looks at the latest developments*

Hardware innovations will simplify materials testing

From the simplest manual tensile testers through to the most sophisticated FTIR and X-ray fluorescence systems, equipment for analysing polymers, compounds and parts is increasingly accurate, user-friendly, and affordable. This article will explore some of the most recent developments.

Some years ago, **Lacerta Technology**, which specialises in thermal analytical technologies, developed its IdentiPol range of instruments specifically for plastics. The company, together with its exclusive IdentiPol distributor FTT, now says a "next generation" QA2 identiPol is available to bridge the gap between the basic plastic tests found in traditional quality assurance facilities and the complex instruments used in scientific laboratories. FTT says the compact QA2 IdentiPol system is both simple to use and affordable, while still delivering on the same physical parameters as the research and development instrumentation (DMA and DSC) on which its technology is based.

The QA2 is said to help users prevent incorrect material entering production and ensures availability of a quick "go/no go" decision regarding material quality assurance. No knowledge of materials properties or testing is said to be required to use it. "This quick assessment of incoming materials ensures production is running at full capacity and that quality control targets are being met," says FTT. "It also offers the flexibility in exploring cheaper material suppliers to reduce costs, but at the same time allowing product quality to be maintained and proof of material conformance demonstrated."

The company says the operator simply enters supplier, material and batch information into the software to run a test. Built-in diagnostics ensures that samples always run under optimum conditions, without intervention.

In the first stage of the test, samples are moulded within the unit to produce a consistent sample for measurement. The moulded sample is then cooled and transferred to the test station where it is rapidly heated. At this point, several thermal properties are measured and used to determine a fingerprint of the material, which is

Main image: Automation is a key theme in today's materials testing systems. Sikora's Purity Concept V light table, for example automates optical pellet inspection

Right: IdentiPol QA2 by Lacerta Technology is claimed to bridge the gap between QA and scientific DMA/DSC instruments

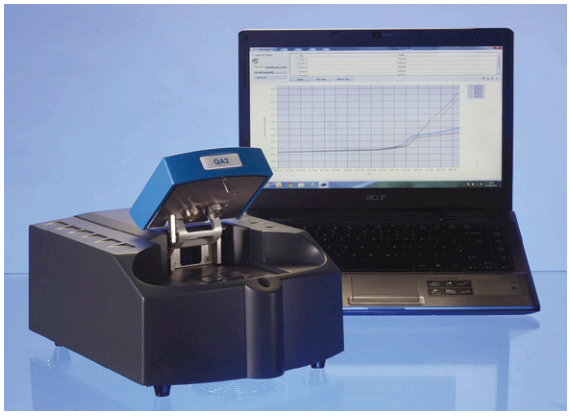

PHOTO: LACERTA TECHNOLOGY

then stored for comparison. This fingerprint is then automatically compared to previous results and a QIS value calculated. This is used to indicate the similarity of the test sample to a reference set.

Also emphasising cost-effectiveness, **Ametek** says its CS2 Series force testers present a good option where accuracy, repeatability and documentation of results are important. "They make plastic testing easy and offer a low-cost alternative when advanced material testing functionality is not required," the company says.

The CS2 Series instruments can perform most commonly used routines, ranging from basic static force testing to multi-stage, cyclic testing and more at what the company says is "a fraction of the cost of an advanced materials tester." The machines can apply force in tension, compression, shear and flex, including multi-stage testing routines that comply with ISO and ASTM testing procedures. They feature a laptop console with a 9-inch touch-screen that displays graphical and tabular results; the user interface is said to be highly intuitive. Set-up parameters include limit testing (load, distance and time), break testing, cyclic and loop testing, multi-stage/user-defined testing, spring rate calculation and height measurement.

CS2 Series models are available in a 1kN and a 5kN frame. The 1kN CS2-225 offers a large work area with a 180mm throat depth and 500mm of crosshead travel. The larger CS2-1100 offers a 150mm throat depth and an 800mm crosshead travel.

Below: Ametek's CS2 Series force testers provide a low cost option for basic testing routines

PHOTO: AMETEK

Tensile add-on

Earlier this year, **Instron** debuted an enhanced version of its Torsion Add-On 2.0 for its universal testing machines. The new product converts axial-only testing machines into biaxial testing systems that the company says are capable of simulation of real-world use of products subjected to multi-axis loading. It can be fitted to any new or existing Instron 5940 or 5960 Series table-top universal testing machine and is said to meet the axial and torsional control requirements of common standards such as ISO 11040-4, ISO 80369, and ASTM F543.

The new hardware is controlled by two TestProfiler method types in Bluehill Universal testing software. Instron says TestProfiler provides simplified method development and intuitive control of the axial and torsional drives. Bluehill Universal is controlled with a touchscreen operator dashboard that mounts directly onto the test machine. Calculations in Bluehill Universal now incorporate force, torque, displacement, and rotation measurements.

X-ray fluorescence

Energy dispersive X-ray fluorescence (ED-XRF) systems are now offered by several companies, including Ametek, Malvern Panalytical, and Thermo Fisher Scientific. Speaking at the Polymer Testing & Analysis 2018 conference organised last September by *Compounding World* publisher AMI in Berlin, Germany, Dirk Wissmann from **Spectro Analytical Instruments** (part of Ametek's Material Analysis Division), said the company's ED-XRF instruments are now available as handheld, portable and laboratory units.

Depending on the particular configuration, they can be used for bulk or small spot applications. These include process control applications (bulk analysis of stabilisers, fillers, pigments, flame retardants, and so on); compliance screenings; and analysis of inclusions. Wissmann said examples of process control applications include measurement of trace element content of titanium; medium content of TiO_2 in ABS; content of copper iodide stabiliser in polyamide (where he said that even at high concentrations of copper a good correlation can be achieved with good precision – Figure 1); medium content of $CaCO_3$ in powders (with simultaneous analysis of other fillers, pigments or flame retardants); and medium content of bromine in polystyrene.

The equipment can be particularly useful for RoHS compliance testing of recycled materials under the IEC 62321 standard, which provides test methods for determining levels of certain substances of concern in electrotechnical products.

Also at the AMI conference, Michael Galla from **Sikora** discussed the company's Purity Concept systems, which can combine the advantages of an X-ray measuring system (Purity Concept X) with those of an optical light-table system (Purity

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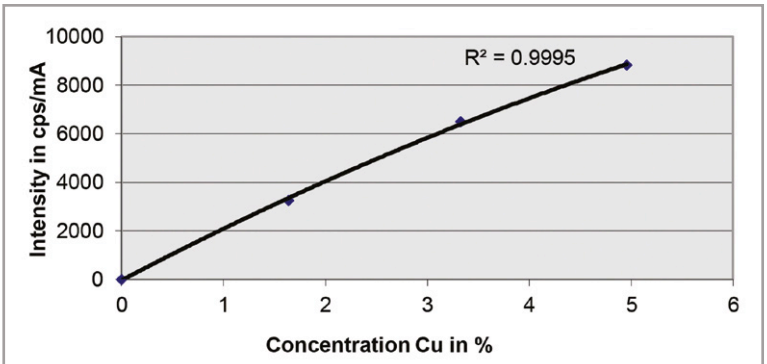
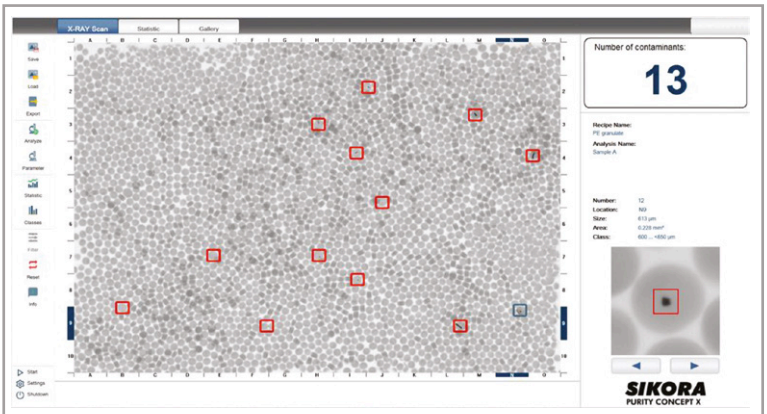


Figure 1: ED-XRF measurements of the level of copper in a polyamide correlate well with actual values across a broad level of concentrations
Source: Spectro Analytical Instruments



An X-ray image of pellets inspected using a Purity Concept X system from Sikora
Image: Sikora

Concept V) for detecting impurities on and in a pellet. The Purity Concept X uses specially developed X-ray technology that enables it to inspect both natural and coloured pellets for impurities.

The Concept X comes with the company's Professional Data Analysis Management (PDAM), software tool, which provides a statistical evaluation of detected contamination, sorted by size and frequency, as well as an image gallery of the pellets that have been detected by the optical and colour cameras as well as the X-ray camera. All data is automatically saved and available in MS Excel format, as well as an image file compiled together with information such as time and batch number.

Mechanical moves

TA Instruments says its recently introduced Discovery TMA 450 Thermomechanical Analyzer precisely measures dimensional changes of materials from -150 to +1,000°C "with unparalleled sensitivity and reproducibility." Usable with a wide range of fixtures and options, it handles sample configurations for testing in expansion, compression, flexure and tension modes.

According to Kadine Mohomed, Thermal Product Manager at the firm, the Discovery TMA 450 provides information about the material's coefficient of linear thermal expansion (CTE), as well as its shrinkage, softening, and glass transition temperatures. Advanced options can be used to obtain viscoelastic properties such as the material's stiffness, damping properties (tan delta), creep and stress relaxation over extended experimental time. He says the unit is particularly useful for measuring these material properties locally, which is especially useful in manufactured components or assemblies where compatibility of materials is paramount.

TA Instruments has also introduced a Rheo-Raman Accessory for its Discovery Hybrid Rheometer (DHR) product line. This new addition combines a Raman spectrometer with the DHR to enable simultaneous collection of rheology and Raman spectroscopy data. "This combination allows for direct correlation between flow characteristics and the unique spectroscopic fingerprints of each material, including information about its chemical and morphological structure," the company says. The accessory integrates with an iXRTM Raman Spectrometer from Thermo Fisher Scientific to provide a turnkey system for spectroscopic investigation of materials.

Compounding demands

At **PerkinElmer**, Aniket PhD, Product Line Leader for Material Characterisation, says advanced testing and analysis solutions for traditional, as well as emerging, materials will play a key part in plastic compounders' ability to meet increasing requirements and demands for better and more recyclable materials. The company's FTIR (Fourier Transform Infrared Spectroscopy) instrument and software solutions (including its Spectrum Two and Frontier Spotlight offerings) are well suited for qualitative and quantitative analysis of polymer starting materials, blended compositions, and finished products, he says. Typical applications include identification and characterisation of fillers and additives, understanding of chemical and physical composition of laminates and adhesives, troubleshooting the chemical origin of inclusions, and identifying the orientation of molecules.

"Moreover, our thermal instruments such as DSC (differential scanning calorimetry), TGA (thermogravimetry analysis), and DMA (dynamic mechanical analysis) complement FTIR data by providing comprehensive analysis of melting temperature, crystallinity, stability and purity, as well as analysis of thermo-mechanical properties and viscoelastic behaviour." Aniket also highlights

the company's services for labs and manufacturing plants to get the most out of their testing and analysis efforts and investments.

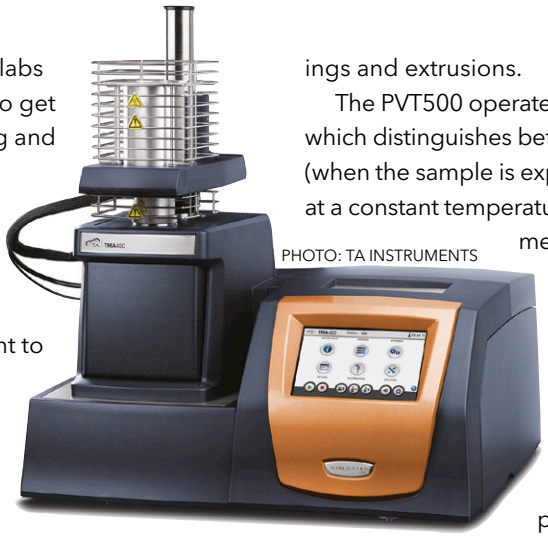


PHOTO: TA INSTRUMENTS

Left: The benchtop Discovery TMA 450 Thermomechanical Analyzer from TA Instruments

Measured flow

There are numerous developments in equipment to measure flow properties of materials, in both the melt and the solid phase. **ZwickRoell**'s marketing team member Wolfgang Mörsch says the company's portfolio of melt flow testing instruments ranges from the Cflow compact manually operated tester, through the modular Mflow with classical load weights, to the fully automatic Aflow with electromechanical force control. The latter system was developed for particularly high specimen testing rates and is designed for determination of volume and melt flow rates to Methods A, B, C and D. All established standards and methods are supported, including ISO 1133, ASTM D1238 and ASTM D3364.

Mörsch says functions of the Mflow and Aflow instruments include detection of any air bubbles in the plastic melt (air bubbles temporarily increase piston speed, causing distortion of the flow rate). "ZwickRoell testing instruments feature high-resolution time and travel measurement, enabling changes in piston speed to be detected automatically," he says. "This allows certain extrudates to be excluded from measurement to avoid errors in flow-rate calculation."

The operator is also assisted by a function called APC (Adaptive Process Control), which measures the speed of the piston shortly before the start of the actual measurement. The system uses this data to select the most appropriate type of control, travel or time-controlled.

Thermodynamic systems

Also at the AMI Polymer Testing and Analysis conference, Moritz Göttfert, Technical Sales Manager at **Göttfert Werkstoff-Prüfmaschinen** discussed different systems for measuring PVT (pressure, volume, temperature) characteristics in materials. This included the company's PVT500, which he described as a self-sufficient system for determining the thermodynamic behaviour of various materials. In the PVT500 specific volume is determined as a function of variations in pressure and temperature, with resulting data being used for such things as shrinkage prediction in moulding and extrusions.

The PVT500 operates according to ISO17744, which distinguishes between isothermal measuring (when the sample is exposed to different pressures at a constant temperature) and isobaric measurement (carried out at constant pressure, with the sample being cooled at a defined rate). The isothermal measuring method is still one of the most common applications, but the isobaric measuring method describes the process significantly better, says Göttfert. "This is especially the case in injection moulding because the moulding cools down at constant pressures until the freezing point of the sprue system," he explains.

Göttfert says the new PVT500 offers several advantages over one of its Rheograph capillary rheometers fitted with an add-on for PVT measurement. Firstly, it is more accurate. In addition, the test barrel, with a diameter of just 9.5mm, allows faster cooling of the sample with better temperature homogeneity. And less amount of sample material is necessary, providing more homogeneous stress state in solid state range (especially with amorphous plastics), Figure 2.

Online rheometry

Speaking at last year's ANTEC in Orlando in the US, **Dynisco** Rheological Scientist Azadeh Farahanchi said online rheometers are being increasingly used in order to capture a continuous data stream of rheological properties and real-time information on the extrusion process without any delay for the offline laboratory testing. "Online rheometers have extensive applications in automatic processing, product development, and quality control," he said. "Online rheometers can monitor the effect of different operating conditions or different formula-

Right: ZwickRoell equipment for measuring flow properties of plastic materials ranges from manual to fully automatic

PHOTO: ZWICKROELL

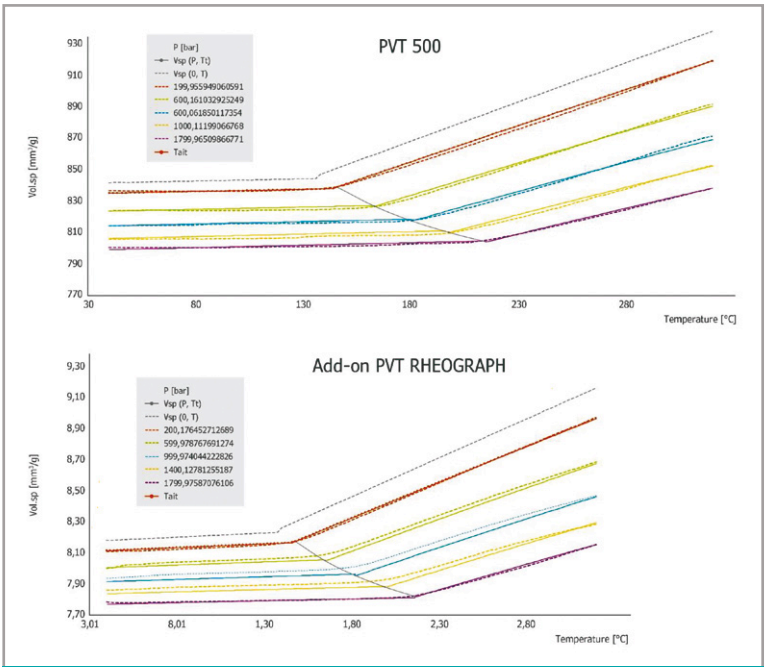


Figure 2: Comparison of readings from Göttfert's PVT 500 (top) and its Rheograph 75 with Add-on. Both show the same course, but the isobars are more linear with the PVT 500 so the data can be better approximated with the Tait Model (used to determine the density of the material as a function of the temperature and pressure)
Source: Göttfert Werkstoff-Prüfmaschinen

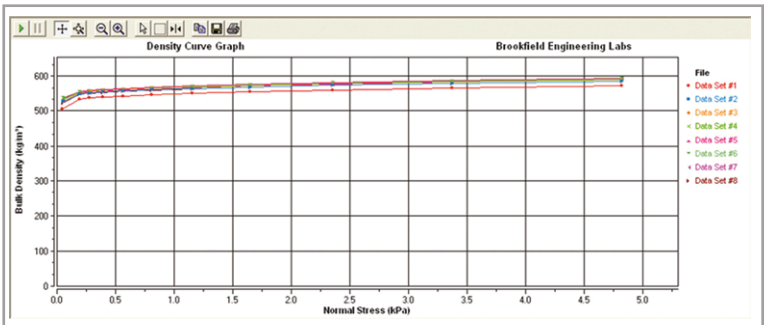


Figure 3: Results from this wall friction test show bulk density of a powder increasing only modestly with increasing normal (compressive) stress. It suggests that the powder is free flowing
Source: Ametek Brookfield

tions on the rheological properties of the final products. This would be beneficial for having a window into the process. Also, it helps to realise the optimised percentage of regrind while maintaining the quality in a recycling process."

Dynisco's ViscoIndicator online rheometer was designed to duplicate the test conditions of a standard melt flow rate tester and monitor the rheological properties – particularly melt flow rate (MFR) and intrinsic viscosity (IV) – of the plastics materials while processing in an extrusion line, Farahanchi said. "Also, the temperature dependency of the flow parameters was correlated by calculating the activation energy of the samples. By considering the value of activation energy, ViscoIndicator is able to calculate the MFR value of the extruded materials at the standard temperature regardless of the temperature that extrusion is running at. This helps compounders to have a real-time quality control on their products and reduce the failure rates or scraps."

Powder testing

At **Ametek Brookfield** (Ametek acquired Brookfield Engineering three years ago), Quality Engineer – Rheologist David J Moonay says that with many compounders incorporating a wide variety of solid additives, one concern is how well those powders flow from the hoppers. "A related concern is that some simple tests don't produce data correlating with flow properties on an industrial scale in the manufacturing plant," he says. "Mass flow is desired, but most powders flow in a core flow manner. Material flows out through a central channel first, then material along the hopper inner wall."

The shear cell test for powder flowability is based upon sound, fundamental principles, Moonay says. Using that method, Brookfield's PFT Powder Flow Tester produces meaningful data within a reasonable experimental time, Figure 3. The sample is simply loaded into a circular cell called a sample trough. The system then places successively greater compressive stresses on the sample and shears it in torsion at each stress level to measure inter-particle strength. Various parameters are then automatically calculated and graphed with PC-based software. A complete test takes just 25 minutes. Vaned and smooth lids may be used for flow function and wall friction tests, respectively. Bulk density may also be calculated from the results.

The Standard Flow Function test and Wall Friction test results may be combined and used to calculate hopper design parameters, such as the hopper half-angle and minimum exit diameter to prevent "rat-holing" or arching.

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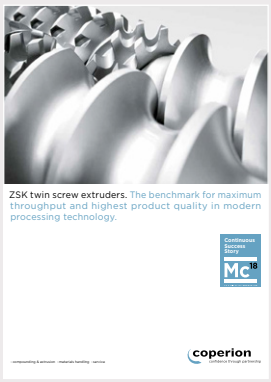

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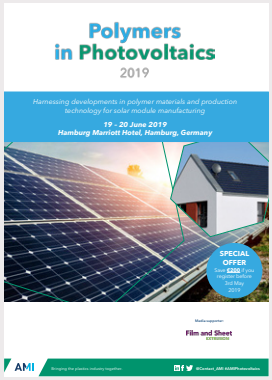

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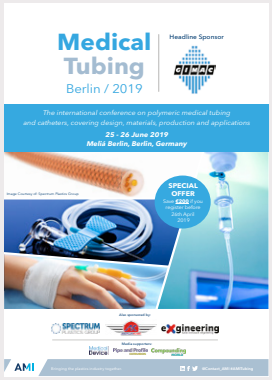

The vital role of polymers in the healthcare sector will be examined at AMI's third Medical Tubing conference in Berlin in Germany on 25-26 June 2019. Learn about the latest industry demands, regulations, materials and processing innovations.

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Head office location:	Barcelona, Spain
Date founded:	1983
Managing Director:	Lluis Pérez
Ownership:	Privately owned
No. of employees:	69
Sales 2017:	€24m
Production 2017:	70,000 tonnes capacity
Plant locations:	Barcelona, Spain
Profile:	Plasper was established in 1983, initially focused on supply of recycled plastics for the domestic Spanish market. In 1992 it installed its first extrusion line for manufacturing recycled PVC compounds. In 2000 it installed a micro-compound line and in 2002 moved to its current 13,000m^2 facility. It has since expanded to 23,000m^2 and added further recycling and compounded products, with the latest being a white masterbatch in 2016.
Product line:	Plasper producers a range of mineral-filled and additive masterbatches and recycled compounds. It also offers a variety of recycling services. The company's masterbatch portfolio includes calcium carbonate, desiccant and white. Compounds produced include recycled flexible PVC, PE, PP and TPO, as well as halogen free flame retardant wire and cable grades. Plasper also offers toll compounding services.
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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:

May

Wire and cable
Compatibilisers/coupling agents
Industry 4.0/plant management
High density compounds

June

PVC additives ● Functional fillers
Cleanroom compounding
Clarifiers and nucleators
Review: Compounding World Expo

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

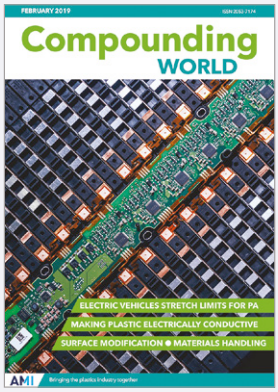
For information on advertising in these issues, please contact:
Claire Bishop: claire.bishop@ami.international Tel: +44 (0)1732 682948
Levent Tounjer: levent.tounjer@ami.international Tel: +44 (0)117 314 8183

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 March 2019
The March issue of Compounding World magazine has features on special effect pigments, reinforcement with natural fibres and twin-screw extruders. Plus a preview of the conference at Compounding World Expo in Cleveland, US

› CLICK HERE TO VIEW



Compounding World February 2019
The February issue of Compounding World looks at the use of polyamide materials in the developing market for electric vehicles. The features also focus on Improving wear and reducing friction, electrically conductive compounds and materials handling solutions.

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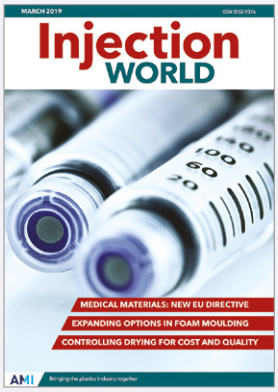

Injection World March 2019
The March edition of Injection World takes a close-up look at the latest medical materials and the new EU Medical Device Regulation. It also reviews developments in bioplastics, foam moulding and drying technology.

› CLICK HERE TO VIEW

Plastics Recycling World January/February 2019
The January/February 2019 edition of Plastics Recycling World looks at barriers to recycling flexible packaging and how they can be overcome. Plus, this edition reviews IV enhancement options for PET and the latest pelletising developments.

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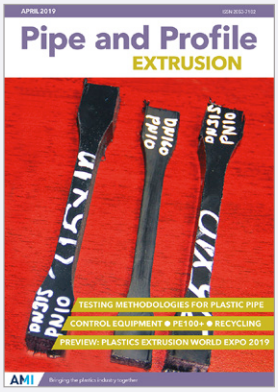

Pipe and Profile April 2019
The April edition of Pipe and Profile Extrusion magazine looks at developments in pipe testing and regulation. It also explores the latest innovations in process control and material recycling and highlights some new PE100 resin applications.

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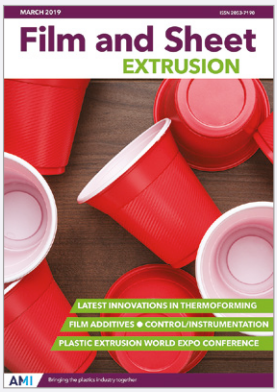


Film and Sheet March 2019
The March issue of Film and Sheet Extrusion magazine takes a look at the latest in thermoforming, additives for films and innovations in film extrusion technology. Plus regular updates on machinery and materials.

› CLICK HERE TO VIEW

Take out your own FREE subscriptions to any of the magazines. Click on the logos below to simply register on-line.

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

GLOBAL EXHIBITION GUIDE

2019	**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
	28-31 May	Plastpol 2019, Kielce, Poland	www.targikielce.pl
	19-22 June	Interplas Thailand, Bangkok	www.interplasthailand.com
	5-7 September	Utech Asia, Guangzhou, China	www.puchina.eu
	18-21 September	T-Plas / Tiprex, Bangkok, Thailand	www.tplas.com
	16-23 October	K 2019, Dusseldorf, Germany	www.k-online.com
	25-28 November	Plastivision Arabia, Sharjah	www.plastivision.ae
	27-29 November	Plastics & Rubber Vietnam	www.plasticsvietnam.com
2020-2021	**16-20 January**	Plastivision India, Mumbai, India	www.plastivision.org
	21-23 January	Swiss Plastics, Lucerne, Switzerland	www.swissplastics-expo.ch
	7-13 May	Interpack, Dusseldorf, Germany	www.interpack.com
	13-17 October	Fakuma, Friedrichshafen, Germany	www.fakuma-messe.de
	4-7 May 2021	Plast 2021, Milan, Italy	www.plastonline.org/en

AMI CONFERENCES

13-15 May 2019	Polymer Sourcing & Distribution, Barcelona, Spain
14-15 May 2019	Performance Polypropylene, Cologne, Germany
4-5 June 2019	Profiles 2019 USA, Pittsburgh, PA, USA
4-5 June 2019	Compounding World Congress, Cologne, Germany
18-19 June 2019	Performance Polyamides USA, Troy, MI, USA
18-19 June 2019	Polymers in Cables 2019 USA, Philadelphia, PA, USA

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

www.ami.international

APRIL 2019 EDITION

Extrusion Solutions

THE LATEST EXTRUDING NEWS FROM ENTEK

plastics color® corporation
Advancing Plastics. *Advancing Life.*™

CHOOSES ENTEK

Leading Compounder for Critical Medical, Pharmaceutical and Food Applications Chooses ENTEK for High-Output Masterbatch, Concentrates

With more than 50 years in the plastics industry, Plastics Color Corporation (PCC), based in Chicago, IL and Asheboro, NC, is a global leader in color concentrates, functional additives and custom polymer masterbatches for a variety of markets. A PMC Global company, PCC specializes in compounding custom formulations for the medical device market, pharmaceutical and food packaging as well as personal care packaging.

With many of their materials requiring FDA compliance, quality is job 1 at PCC. "Customers look to us to mitigate risks in their applications," said Dave Minor, PCC's Vice President of Sales. "We compound materials for critical applications, and there is no room for variance."

Business is strong at PCC. When the company recently set out to purchase a new high-output compounding line, they researched numerous suppliers of twin-screw extruders and complete extrusion systems. "We did our homework, and in the end, we chose ENTEK," said Joe Byrne, President of PCC. "Not only did their machinery and equipment fit the bill, but their design and processing expertise was second to none. They understood what we were trying to achieve, and delivered on their promises."

Increasing Capacity

The new compounding line purchased by PCC was installed and commissioned at the company's plant in Asheboro, NC in January 2019. ENTEK took complete responsibility for the design and installation of the entire line, which includes a high-output ENTEK HR^3-73mm twin-screw extruder and controls, a mezzanine, feeders, and pelletizers.

(continued on page 3)

Who We Are

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

Dr. Kirk Hanawalt

> *"We have built our reputation over the years as a people-first company that is focused on customer support. All ENTEK employees know this, and so do our customers. It's 'Who We Are'"*

Helping Customers Succeed

Our cover story in this issue of *Extrusion Solutions* provides an excellent example of how ENTEK helps its customers succeed.

Plastics Color Corporation (PCC), a leading materials compounder to the medical device market, pharmaceutical and food packaging, and personal care packaging markets, approached us to bid on a project back in 2017, and we were happy to win that business. After they placed the order in 2018, ENTEK went to work designing an all-new, high-output compounding line that would help PCC keep up with its current business, and provide the capacity they needed to fulfill their customers' future needs as well.

ENTEK stands apart from many in this industry because we don't just sell our customers machinery and equipment; we have the expertise on staff to take on entire projects, providing complete extrusion systems and even turnkey manufacturing plants. We know what it takes to act as the general contractor for these types of projects.

At the same time, we have the extrusion and compounding expertise to not only help our customers get the best machinery and equipment for their specific needs, but to help them get the best performance possible out of that machinery. From the earliest stages of a project we design the best solution for our customers, oversee installation and start-up, and stay on-site until everything is running properly to meet and exceed customer expectations.

A New Ad Campaign

While we're on the topic of helping customers succeed, take a look at the first ad in our new campaign (see story on p. 6). In this first of what will be several ads showing our employees talking about ENTEK's attributes, I answer in three short statements what I think is important about 'Who We Are'.

There are a lot of things I could say to answer that question, but space is limited in a one-page ad, and it wasn't easy to narrow it down to three short bullet-points. The second bullet-point in the ad says it all when it comes to customer support: 'ENTEK supports all of its customers – all of the time.'

We have built our reputation over the years as a people-first company that is focused on customer support. All ENTEK employees know this, and so do our customers. It's 'Who We Are'!

Our Pilot Plant – and Customer Training

Finally, please read the article from Dean Elliott, our Technical Processing Manager (see article on p. 5) , on our Pilot Plant Services and Customer Training. Our Pilot Plant is a tremendous resource for our customers, a place they can run trials on their material formulations, and put ENTEK's support and technical expertise to work to get the results they want to achieve.

As for training, ENTEK is happy to support its customers with operator training and can customize the courses to include both classroom-style learning and hands-on processing. Contact Dean anytime to learn more.

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

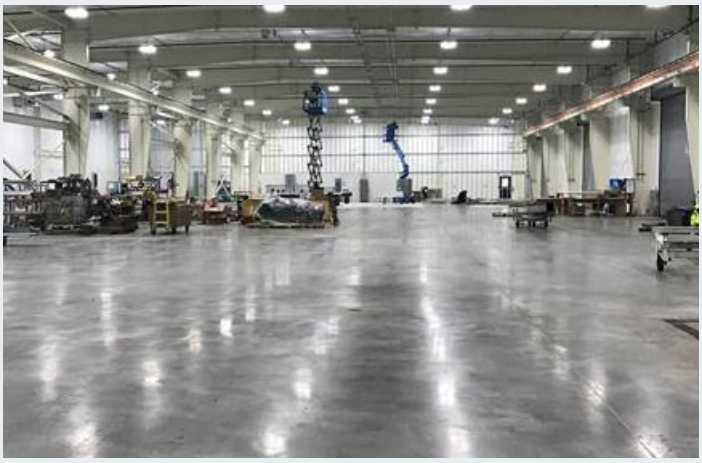
As always, I encourage you to contact me anytime at khanawalt@entek.com.

Sincerely,

Kirk R. Hanawalt

Dr. Kirk Hanawalt
President, ENTEK Extruders

Update on Shop Expansion



The new building/shop expansion at ENTEK Extruders is filling up fast! We have moved shipping and receiving in and the team has organized the new area. Two new overhead cranes have been commissioned and are now in use.

The new 30,000 ft^2 addition is providing much-needed space for ENTEK to keep up with its continued growth. The new space is being used for fabrication, assembly, testing and shipping/receiving. Several machines have already been moved in and are up and running.

John Burke, ENTEK's Director of Manufacturing, said "this additional space will help us work more efficiently, as we continue to apply lean manufacturing principles to our shop. We are already seeing improvements in our productivity."

PCC Chooses ENTEK

(continued from page 1)

PCC chose the HR^3-73mm twin-screw extruder to increase their capacity both now and in the future. It has already helped the company add substantial output and keep up with increasing demand. "Medical, pharma and food are all strong markets and to keep up with the needs of these markets, we had to ramp up our production," said Dave Minor.

ENTEK put their turnkey plant expertise to work for PCC, taking responsibility for the entire project from design to installation. After start-up, ENTEK personnel stayed on-site at PCC to help train their operators. "Robbie Stevens, our Production Manager in Asheboro, can't say enough good things about ENTEK," said Dave Minor. "They are a service-oriented company that is responsive to its customers. They stayed on-site until the new system was operating to everyone's satisfaction, and made sure our operators were comfortable as well."

Smart Extrusion

In addition to increasing PCC's capacity, another attribute of the ENTEK system was the technology available with ENTEK's PLC controls. These controls help PCC collect data, monitor performance, and remotely view and adjust all parameters.

"PCC runs a lot of complex compounds that can be challenging to process," said Bill Petrozelli, ENTEK Regional Sales Manager. "That, plus the fact that there is no room for error when producing materials for medical, food and pharma applications, makes the data-gathering and monitoring functions of our controls even more important."

Future Plans

PCC's Quality statement includes 'remain committed to continuous improvement in everything we do.' ENTEK is proud that PCC chose them to help on this journey and looks forward to helping PCC succeed, both now and in the future. "We have been thrilled with the new ENTEK system but even more so with the company's can-do attitude," said Joe Byrne. "They have met and exceeded our expectations, and we will look to ENTEK for additional support in the future."

See Us at the Compounding World Expo

Booth A720, May 8-9, 2019 – Huntington Convention Center, Cleveland, OH

ENTEK is proud to be a sponsor and exhibitor at the new Compounding World Expo. This show, being held for the first time in North America, takes place May 8-9 at the Huntington Convention Center in Cleveland, OH. It is free to attend and is co-located with the Plastics Extrusion World Expo and the Plastics Recycling World Expo. Click here to register for free: ami.ltd/CWExpo_ENTEK

If you're coming to the show please make a point to stop by to visit ENTEK at Booth A720, to learn more about our latest machinery, equipment and technology offerings for the compounding market. If you're attending the conferences, be sure to sit in on our own Melissa Jensen-Morgan's presentation on 'Tips for Faster Product Changeovers' (see story below).

On the evening of Wednesday May 8th, ENTEK is sponsoring the after-hours networking party at the Rock and Roll Hall of Fame. The party starts at 7 p.m. and is a short walk from the expo venue. We hope to see you there!

Top Tips for Faster Product Changeovers

At the Compounding World Expo in Cleveland, OH, ENTEK's Melissa Jensen-Morgan will present on 'Top Tips for Faster Product Changeovers'. This is a topic that ENTEK has been passionate about for several years, and led to the company's development of many of the technologies incorporated in its QC^{3TM} (Quick-Change, Quick-Clean, Quality Control) line of twin-screw extruders.

Melissa is a 2008 graduate of Oregon State University, where she earned her Bachelor of Science in Mechanical Engineering, with Honors. A Design Engineer at ENTEK, she has been with the company since 2010. Her name is on a patent awarded in 2017 for 'Extruder Screw Shaft Alignment Apparatus and Method', one of the key features on the QC^{3TM} line of twin-screw extruders. This invention allows for a much faster and easier method of installing extruder shafts by creating an automatic way to mate shafts and couplings, which was traditionally a time-consuming task.

If you're coming to the show, mark your calendar to attend Melissa's presentation which will take place on Thursday, May 9th at 11:40 a.m. in Theater 1.

Pilot Plant News

By Dean Elliott, Technical Processing Manager

In the October 2018 issue of *Extrusion Solutions*, I discussed the recent investments including safety and efficiency improvements we have made to our Pilot Plant. I am pleased to report that for the 4th quarter 2018 and 1st quarter 2019, these were the busiest 2 quarters for our Pilot Plant in the last 5 years!

Over the last 6 months our Pilot Plant was utilized approximately 40% by prospective customers, 40% by existing customers and 20% for internal R&D. We are seeing a growing interest from our existing and prospective customers in new technology we have developed in our Pilot Plant from our R&D efforts.

Let Us Do Your Training!

One customer use of our Pilot Plant that is gaining more traction is for training newly hired operators and for improving the efficacy/ability of experienced operators. ENTEK's pilot plant is available for operator training, process training, or any other type of twin-screw extrusion training you may need. A combination of a classroom setting and hands-on practice will insure your operator receives answers to all of their questions while not affecting production in your plant.

Process training can also be conducted at your plant if you prefer, and the training is fully customizable. For example, the week could be split between entry level operator extrusion training and more advanced processing information. It could include screw layout review and optimization if requested. We are flexible and willing to work with you to address your specific needs.

Schedule Your Trial Today!

Our Pilot Plant and our experienced technical staff is available to help current 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**.

Watch For Our New Ad Campaign!

Introducing - the first ad in our new campaign, being launched this month in leading industry trade journals! The new ad features ENTEK President, Dr. Kirk Hanawalt, explaining in his own words 'Who We Are'.

Going forward, the new campaign will feature other ENTEK employees talking about additional key attributes of ENTEK including product range, technical expertise, market reach, and more.

"We're excited about our new ad campaign," said Tammy Straw, ENTEK's Marketing and Business Development Manager. "It combines the 'people' aspect of our previous campaigns with fresh new messaging that tells the reader who ENTEK is, and what sets us apart from the competition."

Upcoming Events

See ENTEK at the following upcoming events in 2019

May 8-9, 2019 – Compounding World Expo
Huntington Convention Center
Cleveland Ohio – Booth A270
Sponsorship of Rock 'n Roll Hall of Fame party, May 8th, 7 p.m.

COMPOUNDING WORLD EXPO

September 17-19, 2019 - Extrusion 2019
Stephens Convention Center, Rosemont, IL

Extrusion2019

Who to Contact

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ENTEK
RAISING EXPECTATIONS. KEEPING THEM THERE.

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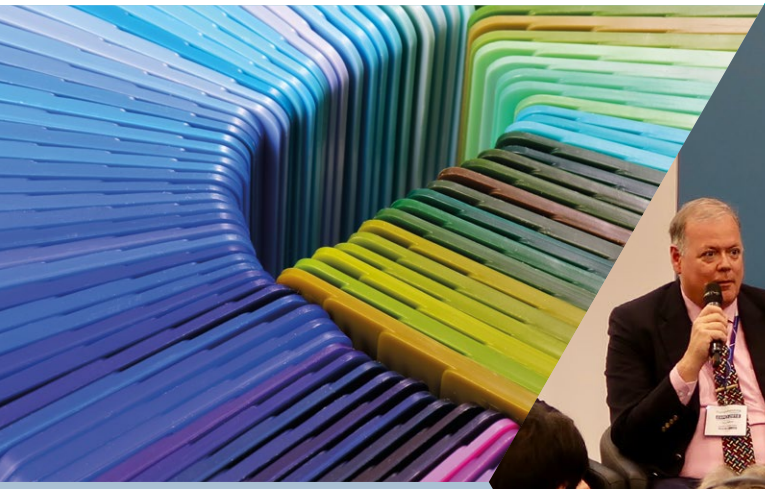
@ENTEK_Extruders

COMPOUNDING WORLD EXPO

MAY 8 - 9, 2019

HUNTINGTON CONVENTION CENTER, CLEVELAND, OHIO, USA



Focused conference programs for the plastics compounding and additives industries

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PLASTICS RECYCLING WORLD EXPO

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Compounding WORLD

AMI

Bringing the global plastics industry together

THEATER 1 - DAY 1

9:30 - 10:00 **KEYNOTE PRESENTATION: Analyzing global trends in plastics compounding markets**
Andrew Reynolds, Director
ADVANCE BIDCO (owner of AMI)

10:15 - 11:00 **BUSINESS DEBATE: Discussing the future of technical compounding. Chaired by Chris Smith, Editor, *Compounding World,* AMI**
Tom Drye, Vice President Emerging Markets & Innovation, TECHMER PM • Jean Sirois, MD of Strategic Planning and Acquisitions/GM Canada, RTP COMPANY • Frank Roederer, Senior Vice President Engineering Composites, A. SCHULMAN

11:10 - 11:30 **Useful tips for the production of thermoplastic elastomers on twin-screw compounders**
Sabine Schönfeld, Director Process Technology
COPERION

11:40 - 12:00 **Surface chemistry modification to improve the performance of polyamide compounds reinforced with glass fibers and other functional additives**
Dr. Ashok M. Adur, Global Commercial Development Director, Plastics
VERTELLUS

12:10 - 12:30 **Optimizing the production of highly-filled compounds and concentrates using co-rotating twin-screw extruders**
Ivano Lanzetta, Area Sales Manager
F.LLI MARIS

12:40 - 1:00 **Innovative feeding solutions for the future of polymer compounding**
Ed Ford, Sales Manager – Plastic Plants, North America
ZEPPELIN SYSTEMS USA

1:40 - 2:00 **Characterization of recycled polymer compound by thermal analysis**
Dr. Yanxi Zhang, Technical Sales Support
NETZSCH INSTRUMENTS NORTH AMERICA

2:10 - 2:30 **The global compounding market and perspectives for PP compounds**
Sylvia Tabero, Senior Project Consultant
AMI CONSULTING

2:45 - 3:30 **BUSINESS DEBATE: Discussing the future for cable compounds. Chaired by Chris Smith, Editor, *Compounding World,* AMI**
Tariq Quadir, Chief Technologist and Senior Scientist, CHAMPLAIN CABLE • Dave Camillo, Chief Engineer Formulations, SOUTHWIRE COMPANY • Eric Bates, Principal Engineer, PRYSMIAN GROUP • Tim Hannigan, Engineered Cable Innovation Manager, TPC WIRE & CABLE CORP.

3:40 - 4:00 **Developments in resilient carbon fillers to improve wear resistance and thermal conductivity**
Rijo Jacob Robin, Technical Product Manager
SUPERIOR GRAPHITE

4:10 - 4:30 **Compounding case studies - using continuous mixers for the efficient processing of PVC, HFFR and PLA compounds**
Patrick Lahmann, Sales Engineer
FARREL CORPORATION

THEATER 1 – DAY 2

9:30 - 10:00 **KEYNOTE PRESENTATION: Five compounding innovations to watch**
Chris Smith, Editor, *Compounding World*
AMI

10:15 - 11:00 **BUSINESS DEBATE: Discussing the future for the concentrates industry. Chaired by Andrew Reynolds, Director, ADVANCE BIDCO (owner of AMI)**
Matthew Hellstern, CEO, AMERICHEM • Deepak Parikh, Region President & CEO - USA and Canada, CLARIANT CORPORATION • Amit Puri, Owner & Director Marketing, ALOK MASTERBATCHES • Doug Borgsdorf, Business Director, PRIMEX PLASTICS • Tom Bolger, President and CEO, CHROMA CORPORATION

11:10 - 11:30 **Discussing carbon-fiber-reinforced plastics for automotive applications – current use and future methods**
Alex Walk, Product and Technology Development Manager
SGL CARBON

11:40 - 12:00 **Top tips for faster product changeovers**
Melissa Jensen-Morgan, Design Engineer
ENTEK EXTRUDERS

12:10 - 12:30 **Optimizing natural magnesium hydroxide flame retardants to deliver new opportunities for the building and construction industry**
Alexander Kulichenko, Technical Director
EUROPIREN

12:40 - 1:00 **Exploring advances in metal fibers for enhancing the conductivity of plastic compounds**
Tom Daniëls, Global Market Manager Conductive Plastics
BEKAERT FIBER TECHNOLOGIES

2:10 - 2:30 **Innovations in high-performance thermal stabilization and VOC-scavenging solutions for polyolefins and engineering resins**
Dr. Rob Lorenzini, Technology Manager
MAROON GROUP

2:45 - 3:30 **BUSINESS DEBATE: Discussing the future for PVC compounding. Chaired by Sylvia Tabero, Senior Project Consultant, AMI CONSULTING**
Darrell Hughes, CEO, AURORA PLASTICS • Donald R. Williamson Jr., Director- Compounds, North America, WESTLAKE COMPOUNDS LLC, A WESTLAKE COMPANY • Gautam Nivarthy, Vice President and General Manager Compounds Business Group, MEXICHEM SPECIALTY COMPOUNDS

3:40 - 4:00 **New trends in compounding - examining how computer simulation can help**
Laurent Ratte, Sales Manager
SCIENCES COMPUTERS CONSULTANTS

4:10 - 4:30 **Using continuous mixers for producing highly-filled compounds - increasing versatility and reducing costs**
Slayton Altenburg, Application Specialist
TPEI

Information correct at time of publishing. Speaker line up and titles subject to change .

THEATER 2 - DAY 1

9:30 - 10:15 **TRAINING SEMINAR: How to specify twin-screw extruders for polymer compounding applications**
Adam Dreiblatt, Director of Process Technology
CPM EXTRUSION GROUP

10:30 - 10:50 **Exploring progress in the optimization of engineering plastics blends**
Ardy Doelen, Sales and Business Development Manager
POLYSCOPE POLYMERS

11:00 - 11:20 **Enhancing the properties of recycled polypropylene resins to uncover new applications and market opportunities**
Emily Blair, Business Development Manager
MILLIKEN

11:30 - 11:50 **Monitoring and controlling plastic pellet quality: applying a novel optical inspection and automated analysis system**
Brian Birmingham, Business Development Engineer
SIKORA

12:00 - 12:20 **Exploring the latest developments in process technology for challenging compounding applications**
Dana Pulvino, National Sales Manager
BUSS USA

12:30 - 1:15 **TRAINING SEMINAR: Designing extensional mixing in extrusion**
João Maia, Professor, Macromolecular Science & Engineering
CASE WESTERN RESERVE UNIVERSITY

2:00 - 2:20 **Assessing the process-induced properties of graphene-polyethylene nanocomposites**
Dr. Nima Moghimian, Product Development Manager
NANOXPLORE

2:30 - 2:50 **Sustainable polymer additives from recycled feedstocks: novel tools to drive performance and enhance value while contributing to the circular economy**
Domenic DiMondo, Vice President Technology & Business Development
GREENMANTRA TECHNOLOGIES

3:00 - 3:20 **Studying the mixing performance of low-shear screw elements on high-speed compounding processes to improve output rates and polymer properties**
Dr. Haikun Xu, Process Engineer
KRAUSSMAFFEI CORPORATION

3:30 - 4:15 **TRAINING SEMINAR: Understanding and formulating plastic compounds**
Chris DeArmitt, President
PHANTOM PLASTICS

THEATER 2 - DAY 2

9:30 - 10:15 **TRAINING SEMINAR: Top tips for optimizing twin-screw extrusion**
Bert Elliott, Engineering Manager
LEISTRITZ EXTRUSION

10:30 - 10:50 **Lightweighting strategies with Talc in automotive TPOs**
Piergiovanni Ercoli Malacari, Product and Application Development
IMI FABI

11:00 - 11:20 **Silicones as high-performance additives**
Dr. Daniel Calimente, Technical Manager
WACKER CHEMICAL CORPORATION

11:30 - 11:50 **Examining flexible compounding technologies for the production of long-fiber thermoplastics (LFTs)**
Sebastian Jost, Manager Design & Engineering
FEDDEM

12:00 - 12:20 **Improving the wear-resistance of plastics: Advances in PTFE micropowders and new developments in non-halogen additives**
Dr. HyunSeog Kim, R&D Manager
SHAMROCK TECHNOLOGIES

12:30 - 1:15 **TRAINING SEMINAR: How to evaluate and control the color of plastics**
Frank Koger, Technical Sales Engineer
KONICA MINOLTA SENSING AMERICAS

2:30 - 2:50 **Tailoring the electrical conductivity of thermoplastics using carbon black masterbatches**
Jakub Olšan, Researcher
UNIPETROL RPA – POLYMER INSTITUTE BRNO

3:00 - 3:20 **Using an innovative chain extender to improve the performance of recycled polyester**
Duan Hao, R&D Market Development Manager
FINE-BLEND COMPATIBILIZER

3:30 - 4:15 **TRAINING SEMINAR: Understanding the basics of polymer degradation and stabilization**
Ronald Becker, New Business Development Manager - Americas
SI GROUP

REGISTER FOR FREE NOW!

Speakers over the two days include representatives from:

CLARIANT, ATP Engineering Plastics, A. Schulman, TECHMER PM Polymer Modifiers, americhem Performance | Solutions | Trust, Westlake Chemical

Information correct at time of publishing. Speaker line up and titles subject to change .

COMPOUNDING WORLD EXPO

MAY 8 - 9, 2019
HUNTINGTON CONVENTION CENTER, CLEVELAND, OHIO, USA
Focused conference programs for the plastics compounding and additives industries

TYPES OF PRESENTATIONS

Business Debates

Business debates will run for 45 minutes and feature influential industry leaders discussing strategic issues facing the global compounding industry. They will be focused on specific sectors of the compounding market including engineering plastics, masterbatch, PVC, and cable compounds.

Training Seminars

A series of six practical training seminars will be delivered by experts on a range of topics, such as specifying and optimizing compounding lines, meeting regulatory requirements, and monitoring and controlling color.

Industry Presentations

There will also be more than 30 presentations covering the latest technology developments and industry trends. Topics being covered include market analysis, process optimization, conductive compounds, material characterization, flame retardants, polymer stabilization, carbon fibers, computer simulation, compatibilizers, quality control, long-fiber thermoplastics, sustainability, wear-resistant plastics, and nanocomposites.

LOCATION AND VENUE

The Compounding World Expo, will be held at the Huntington Convention Center in Cleveland, Ohio, USA. This state-of-the-art exhibition facility is located right in the heart of Cleveland's revitalized downtown boasting plentiful parking, free public transport and surrounded by an excellent selection of hotels.

LAST EXHIBITION STANDS AVAILABLE

The two-day event will provide a cost-effective and time-efficient way to promote your company, and its products and services to a large international audience focused on your core markets.

A range of shell-scheme and space-only stands are on offer from 100 to 400 sqft, along with a special exhibition package including furniture to make exhibiting at the Compounding World Expo 2019 as simple and as cost-effective as possible.

BOOK YOUR BOOTH TODAY!

Contact our exhibitions sales team
exhibition_sales@ami.international +1 610 478 0800

Networking Party
Rock & Roll Hall of Fame

REGISTER HERE
TO GET YOUR TICKETS NOW!*

ROCK AND ROLL HALL OF FAME

From the ground up, the Rock Hall delivers a legendary music experience like no other. Feel like a rock and roll music inductee and be one of the first to see the Class of 2019 exhibit, showcasing iconic items representing this years' inductees; The Cure, Def Leppard, Janet Jackson, Stevie Nicks, Radiohead, Roxy Music and The Zombies.

The party ticket is $20 per person and will give you full access to this iconic venue with drinks and nibbles. Doors open at 7pm.

Click here to find out more

*Tickets are available to registered attendees of the exhibitions only.