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Compounding WORLD

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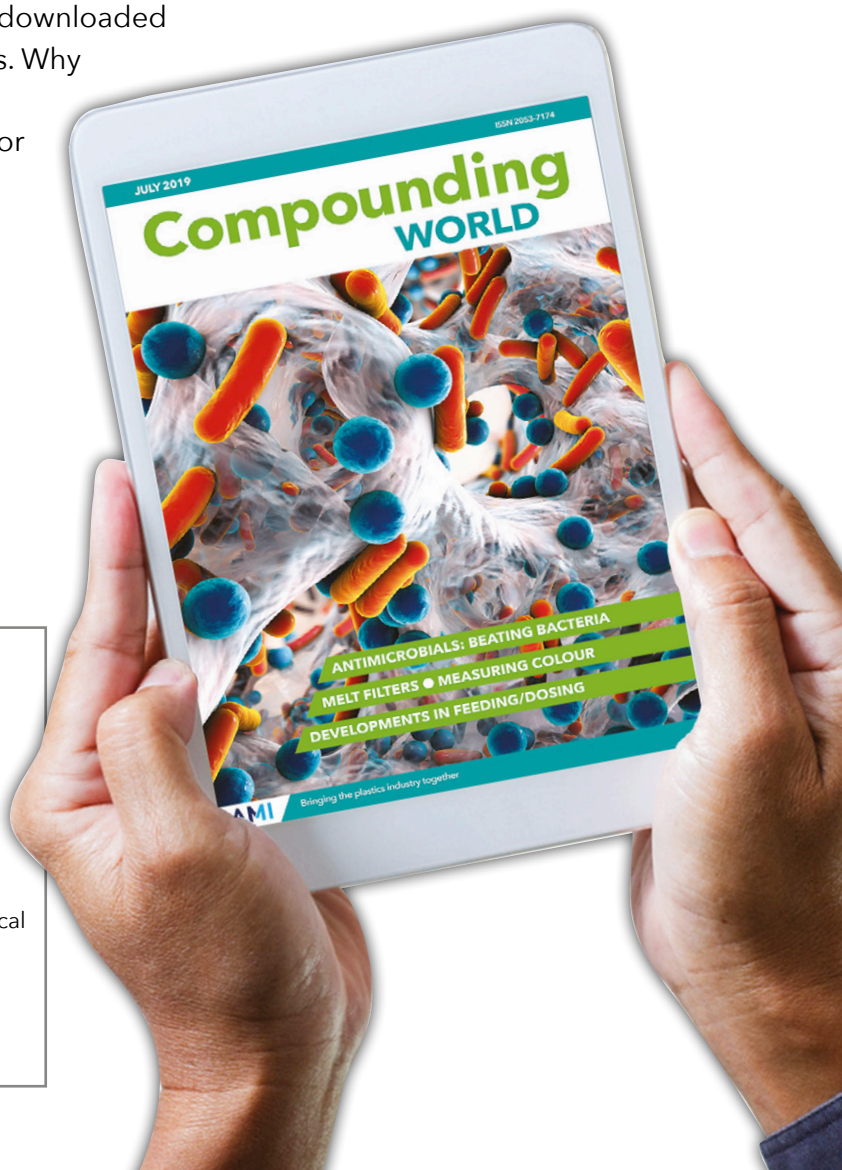

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extruders.leistritz.com

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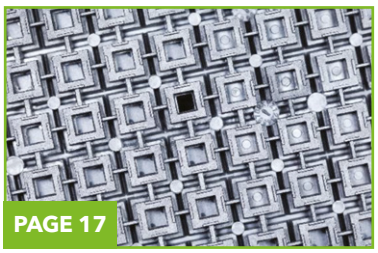
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COMING NEXT ISSUE

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How to get involved

Attend as a delegate
If you are a compounder, masterbatch maker, plastics processor (eg moulder or extruder) or an end-user (eg OEM or brand owner) you can attend as a free delegate.

Other ways to take part
For any other company types (eg suppliers of polymers, additives and machinery), please contact Levent Tounjer to discuss how you can get involved in this event as a speaker, exhibitor or sponsor.

Organised by: AMI

Sponsored by: HPF The Mineral Engineers, KMI, Evonik, Nabaltec

Media supporters: Compounding World, PolymerUpdate

New exclusive industry event

Functional Fillers 2021 is a new global online conference covering the latest developments in functional fillers applications, as well as advances in coupling agents, plus tips for increasing filler loadings and dispersion.

Speakers include:

Roger Rothon
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Rothon Research

Ted Dickson
Senior Consultant,
Tak Industrial Mineral Consultancy

Veronika Mayer
Senior Engineer,
Kärntner Montanindustrie

Péter Sebö
Head of Marketing & Market Development,
HPF The Mineral Engineers, a division of The Quarzwerke Group

Chris DeArmitt
President,
Phantom Plastics

Register your free* place today

**All applications for free places will be vetted by AMI to check that they meet our qualification criteria. AMI reserves the right to refuse access to individuals and companies*

Benvic buys Celanese compound unit in Italy

Italian PVC and biopolymer compounder Benvic Group is to acquire Celanese's compounding plant at Ferrara Marconi in Italy, together with certain assets dedicated to artificial grass infill and appliance PP and the European footwear business. It expects to conclude the acquisition in the coming months and start production by June.

Benvic has had a presence in Ferrara since its acquisition of the Vinyloop operations on the same site in 2018. The company said this new acquisition continues its plans to grow its presence in the non-PVC engineering polymer compounding sector.

"With this transaction, Benvic continues to invest significantly in the creation of a centre of excellence for PVC and non-PVC compounding – including biopolymers – in Italy and in the Ferrara Marconi site in particular," said Benvic CEO Luc Mertens.

IMAGE: BENVIC

Above: Benvic is to acquire the former Celanese compounding site at Ferrara Marconi

Benvic said a "significant" proportion of the plant's workforce will be taken on, adding that it plans to make Ferrara Marconi one of Italy's largest compounding sites.

The acquisition is Benvic's eighth since it was acquired by InvestIndustrial in 2018 and its fifth in Italy. Previous purchases include biopolymer manufacturer Plantura, medical compounds and tubing maker Modenplast, and medical components maker Luc & Bel, all based in Italy, and UK PVC compounder Dugdale Compounds.

For Celanese, the sale is part of a strategy announced in July 2020 of consolidating its European compounding operations at its plant at Forlì in Italy in line with its regional models in the Americas and Asia. As well as closing the Ferrara Marconi site, the plans included merging of its activities at Kaiserslautern and Wehr in Germany into Forlì, which it acquired through its 2016 purchase of TPE specialist So.F.TER.

› **www.benvic.com**

› **www.celanese.com**

Melos integrates Inhol

German cable compound specialist Melos merged the Netherlands-based Inhol business, which it acquired in January 2018, into its main activities at the end of last year.

"We are very pleased with the successful merger. The two business fields complement each other perfectly," said Marcus Hohlweck, Head of Cable Compounds at Melos.

"In particular, we will be able to expand our activities abroad, which will help us achieve a stronger and more competitive position on the global market for cable compounds," he said.

Inhol's operation at Soest has closed. The complete Inhol line of cable compounds, including its specialties for heat shrinkable tubing and thermally and moisture-resistant insulation compounds, will continue to be available through Melos.

› **www.melos-gmbh.com**

Researchers aim for antibiotic polymers

IMAGE: FRAUNHOFER

The University of Potsdam, in Berlin in Germany, has started a research project in cooperation with the nearby Fraunhofer Institute for Applied Polymer Research (IAP) to develop novel polymers capable of destroying antibiotic-resistant bacteria.

Part of the German Research Foundation's Emmy Noether Programme, the project addresses the huge health issue of growing resistance of microbes because of the misuse or overuse of antibiotics.

"The fight against antibiotic resistance is unfortunately becoming increasingly important. If we, as a society, lose the ability to fight bacterial infections we would be facing difficult times", said to Dr Matthias Hartlieb, who founded and heads the research group. "It is therefore essential to find new ways to effectively counter bacterial infections."

› **www.iap.fraunhofer.de**

Palsgaard adds pellet capacity

Denmark's Palsgaard has commissioned a 10,000 tonnes/year pellet line for its Einar brand of plant-based polymer additives at its site in Juelsminde in Denmark.

The Einar range includes plant-based anti-fogging, anti-static, slip and release additives for film, injection moulding, foam and coating processes. The investment in additional pellet capacity is said to be a response to a trend towards renewables among consumers, brand owners, packaging designers and plastics manufacturers.


IMAGE: PALSGAARD

Left: Palsgaard has expanded its additive pellet capacity

"Our expanded production capacity meets these requirements by boosting the availability of food-grade plant-based surfactants and modifiers for polymer manufacturers and compounders," said Ulrik Aunskjær, Global Industry Director of Non-Food Business Development.

The company said the particular pellet form addresses the need of compounders and processors who prefer to add Einar products to polymers directly rather than as part of a masterbatch formulation.

› **www.palsgaard.com**

ZSW opts for Coperion system

Coperion has supplied a ZSK 18 MEGAlab twin-screw extruder and two high-accuracy gravimetric Coperion K-Tron loss-in-weight feeders to the Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW) at Ulm in Germany.

ZSW, an international institute for research in energy technologies, is investigating the complete industrial process chain for battery electrodes, from component feeder to direct transmission of extrudate onto a collector film in a roll-to-roll process.

The Coperion machine is equipped with a number of features to allow for safe handling of the hazardous materials used in the manufacture of batteries, including an encased gearbox lantern and nitrogen purging system.

IMAGE: COPERION

The system, which offers throughput rates of up to 5kg/h depending on formulation, is designed to eliminate the use of toxic N-methyl-2-pyrrolidone from the process and to reduce drying time for the carrier films.

› **www.coperion.com**

Left: Energy technology institute ZSW has installed an 18mm Coperion compounding extruder

JNS-SmithChem buys CheMarCo

JNS-SmithChem, a US-based distributor of speciality chemicals and additives including many for plastics and rubber, has acquired CheMarCo, a speciality regional distributor located at Greenville, South Carolina.

New Jersey-based JNS-SmithChem said the move will significantly expand its scope and sales coverage while enabling it to offer a wider range of complementary product lines. The expanded distribution territory will cover 26 states, including the entire US East Coast and as far west as Ohio, Oklahoma and Texas.

› **www.jns-smithchem.com**

› **www.chemarco.com**

Plast 2021 exhibition postponed

Organisers of Italy's triennial Plast trade show announced this month that the 2021 show has been postponed due to the ongoing Covid pandemic and its likely limitations on travel.

A new date is yet to be set for the event, which was originally set to run at the Fiera-Milano fairground in Milan on 4-7 May and was then subsequently re-scheduled to 22-25 June. However, the organisers said in a statement it will be "certainly after the end of 2021."

The previous edition of the trade fair took place in 2018. It included 1,510 exhibitors across six halls at the Fiera Milano showground and attracted more than 50,000 visitors.

› **www.plastonline.org**

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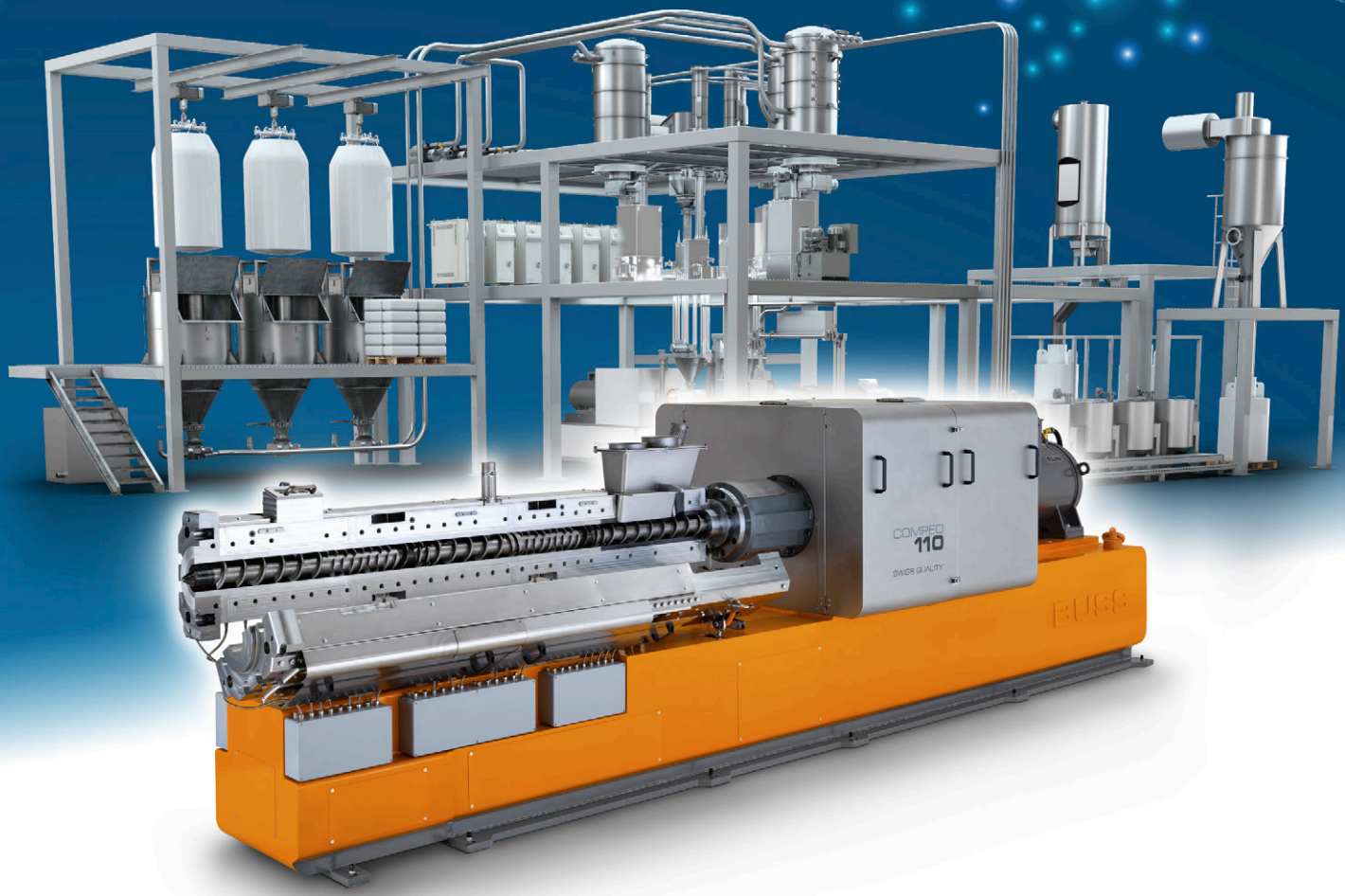

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www.busscorp.com

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IN BRIEF...

Lanxess is to buy Paris-based **Intace**, a manufacturer of speciality fungicides for packaging. It will become part of Lanxess's existing Material Protection Products business.
www.lanxess.com
www.intace.com

The High Performance Polymers division of **Radici Group** has joined CEFIC sub-group **PINFA**. PINFA brings together manufacturers and users of non-halogenated phosphorus, inorganic and nitrogen flame retardants, to share scientific findings, best practices and other knowledge in the field.
www.radicigroup.com
www.pinfa.eu

Plastics packaging firm **Corplex** has acquired **GeboPlast** a recycling company with two sites in France's Alsace region. GeboPlast has a combined capacity of more than 15,00tpa. The business will be renamed Corplex Recycling.
www.corplex.com

Nexeo Plastics owner to acquire Distrupol

One Rock Capital Partners, the US-based private equity firm which owns Nexeo Plastics, has entered into a definitive agreement to acquire UK-based distribution business Distrupol from Univar Solutions.

Distrupol distributes resins and provides application support for customers across Europe. The company claims to supply more than 4,000 different grades to around 1,300 customers in the consumer, medical, automotive, and electrical sectors, among others.

The deal is expected to close in the first half of this year. After that, Distrupol will form part of One Rock's GPD Companies holding group but will continue to operate as a standalone, independent entity under its current brand identity. Existing management and commercial teams will remain in place.

One Rock acquired Nexeo Plastics, the plastics distribution business of Nexeo Solutions, in 2019 when Univar acquired the rest of the company. Headquartered in Texas, Nexeo Plastics distributes polymers and prime engineering resins in more than 60 countries across North America, Europe and Asia.

› **www.gpdcompanies.com**
› **www.distrupol.com**

Borealis to exit fertilisers to focus on polyolefins and chemicals

Borealis is to sell most of its nitrogen business unit, which manufactures fertilisers and melamine products, to focus on its core activities in polyolefins and base chemicals.

The Nitro business, which accounted for around 15% of group sales in 2019, includes fertiliser production plants in Austria and France as well as 60 warehouses across Europe (the company's share in joint venture fertiliser operations in Belgium and the Netherlands are not included in the disposal plans). It also includes melamine production units in Austria and Germany.

The company announced the move alongside its 2020 results, which showed total group sales down by 13% to €8.5bn and net profit down by 32% to €589m due to weak Covid demand, reduced oil prices, and a deteriorating fertiliser market.

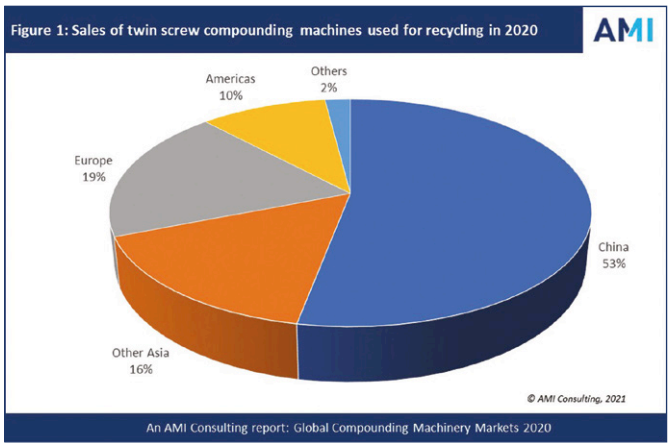
› **www.borealisgroup.com**

Recycling compounder demand to double

Demand for twin screw compounding equipment for recycling applications is forecast to more than double over the period from 2020 to 2024, according to AMI's Global Compounding Machinery Markets 2020 report.

Recycling is the fastest growing application sector for twin screw compounding equipment. More than half of all machines sold into this application in 2020 were sold into China, reflecting the opportunity within the country to 'upcycle' low value waste polymer. Measured by value, however, Europe was the largest market due to the preference for higher output equipment.

More details about the new AMI report can be found **here**.



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AMI postpones Essen compounding expo

Compounding World publisher AMI has announced that its four focused plastics industry exhibitions – including the Compounding World Expo – that were scheduled to take place at Messe Essen in Germany on 1-2 June of this year have been postponed to 29-30 September.

On-going uncertainty created by the Covid pandemic led to the decision to delay the Compounding World Expo, Plastics Recycling World Expo, Plastics Extrusion World Expo and Polymer Testing World Expo, the company said.

"We have been reviewing the on-going situation and consulting with exhibitors and visitors. Our primary concerns are for the health and safety of all attendees at our events and delivering the very best audience for our exhibitors. With these factors in mind, we have taken the decision to postpone the expos to 29-30 September 2021," said Rita Andrews, Head of Exhibitions at AMI.

"Exhibitor numbers are up substantially compared to our launch event in 2018, and we want to ensure visitors can feel confident and comfortable in attending the expanded exhibitions," she added.

The decision to reschedule the event was announced on 1 February. "We felt it was important to make and announce this decision now, in order to end the current uncertainty and to allow exhibitors, speakers and attendees to plan effectively for the new dates. We have had tremendous support and understanding from the industry during this process and are now all looking to forward to a successful return to Essen at the end of September," said Andy Beevers, AMI Events Director.

Admission to the four expos and their five conference theatres will continue to be free of charge. Registrations for the June dates will still be valid, while anyone wanting to register for free tickets for the September dates can do so **here**.

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

JM opens glass fibre recycling unit

Glass fibre producer Johns Manville (JM has started up a thermal recycling unit for waste glass fibres at its engineered products plant at Trnava in Slovakia.

The unit represents a total investment of just under €10m and consists of a warehousing area, feeding and transportation equipment, shredder, burning chamber and mill.

The plant has a capacity of over 3 tonne/h and will divert 10,000 tonnes/year from landfill.

› **www.jm.com**

Maguire buys into Newton

US-based Maguire Products has bought an unspecified minority stake in OA Newton, a supplier of storage, conveying and blending systems for industries including flexible and rigid PVC and WPC production

Maguire Products is best known for its gravimetric blenders, liquid colour pumps and vacuum dryers but also makes loading systems, auger feeders, granulators and software at six locations in Aston, Pennsylvania. "This investment broadens our offering to the plastics industry and allows us to serve markets that we would otherwise never reach with our current product line," said Steve Maguire, owner and president of Maguire.

Maguire is a also co-owner of US ancillary equipment maker. Newton, like Novatec, will continue to operate independently.

› **www.oanewton.com**

› **www.maguire.com**

Milliken extends nucleators

Milliken has launched Hyperform HPN 909ei, a new nucleator for thermoformed PP packaging applications that is said to simplify EU food contact approval.

The HPN 909ei grade is claimed to use a new chemistry that results in one Specific Migration Limit (SML) less than its predecessor, reducing the number of substances that must be monitored and tested in food approvals.

According to Milliken, the new additive delivers improved stiffness while maintaining impact performance. It also provides isotropic shrinkage and higher heat-deflection temperature, while helping to override the nucleation effects of pigments.

› **www.milliken.com**

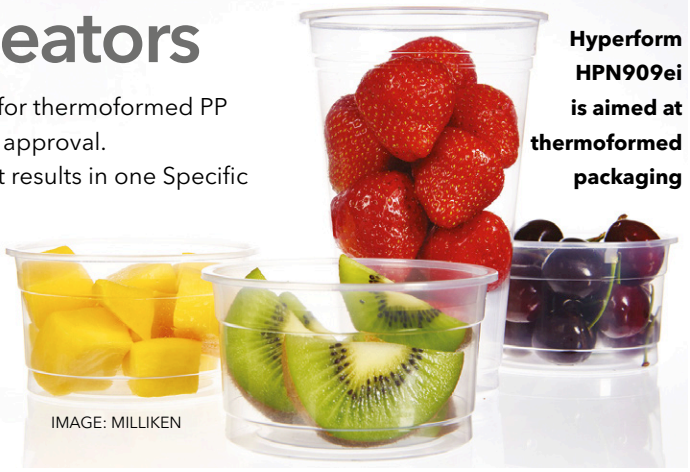

IMAGE: MILLIKEN

Hyperform HPN909ei is aimed at thermoformed packaging

JSW runs PMMA recycling trials

Researchers working on the EU Horizon 2020-supported MMAtwo project completed a week of trials at the JSW Technical Centre in Dusseldorf, Germany, late last year to depolymerise a variety of post-industrial and post-consumer PMMA waste to high quality MMA feedstock.

Thirteen European organisations – including Ghent University, Ecologic, Arkema, Delta Glass, Heathland, Comet Traitements, Speichem, Plados Telma and JSW – are involved in the €6.6m MMAtwo project, which aims to develop a process to regenerate waste PMMA by converting the polymer to liquid MMA monomer.

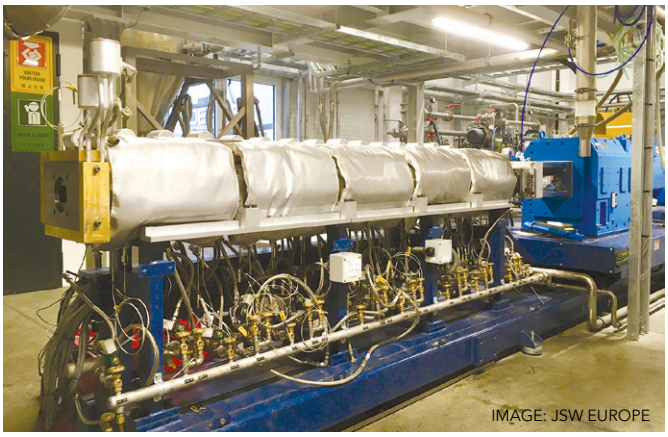

IMAGE: JSW EUROPE

Left: The modified MMAtwo TEX44αIII extruder at JSW's European technical centre

JSW has constructed a special version of its TEX44αIII twin-screw extruder for the task. Operating at temperatures between 400-600°C, it melts the polymer in the upstream section of the extruder, then decomposes it in the downstream section before capturing the decomposition gas at the tip of the extruder and condensing it to a liquid form.

Another series of tests are planned for the first quarter of this year to further refine the process. "We are getting closer and closer to the industrial, commercially highly interesting implementation of our PMMA depolymerisation project," said Makoto Tojo, Technical Manager of Japan Steel Works Europe.

› **www.jsw.de**

Normec acquires OWS

Normec Group, which is based in Ghent in the Netherlands and is active in testing, inspecting, certification and compliance mainly in the Netherlands, Belgium and Germany, has acquired Organic Waste Systems (OWS).

OWS is described as a "world leader for the determination of the biodegradability and compostability of plastic packaging materials and other applications of biodegradable polymers." The company, which generates sales of around €25m, has operations in the US, Germany and Japan.

› **www.ows.be**

Avient forecasts growth ahead

Avient – the polymer compounds group created from Polyone's acquisition last year of Clariant Masterbatches – posted sales of $3.24bn for 2020 and said it expects to see a revenue growth of 8% for 2021.

"As the COVID-19 vaccine brings hope for a recovery from the pandemic, we anticipate our businesses will continue to benefit from new product development requiring sustainable solutions as well as demand for consumer and healthcare applications," said Robert M Patterson, Chairman, President and Chief Executive Officer.

"We will also uniquely benefit from the Clariant Masterbatch acquisition and related synergy capture, which is well ahead of schedule." Avient has increased its total cost synergy estimates from the Clariant acquisition from $60m to $75m.

Patterson said that, looking ahead, the company's headline projection for 2021 is to grow revenues by approximately 8% pro forma.

Late last year Avient completed an expansion of its production capabilities for colour concentrates at Binh Duong, Vietnam, adding 30% more production space and some new machinery. The plastics industry is currently said to be growing at 16-18%/year in Vietnam, making it one of the fastest growing parts of the economy.

› **www.avient.com**

Maag set to deliver for Ravago

Switzerland's Maag Group is to supply a complete line for polyolefin waste recycling to Ravago for its site at Arendonk in Belgium. The new line will be commissioned this year.

The line includes an ERF 500 melt filter, FSC 300 hydraulic screen changer, and Pearlo underwater pelletising system.

"Our systems expertise, recently enhanced in relation to digitalisation and Industry 4.0 through the acquisition of Xantec, is a clear benefit for the customer," said Maag Group President Ueli Thuerig.

› **www.maag.com**

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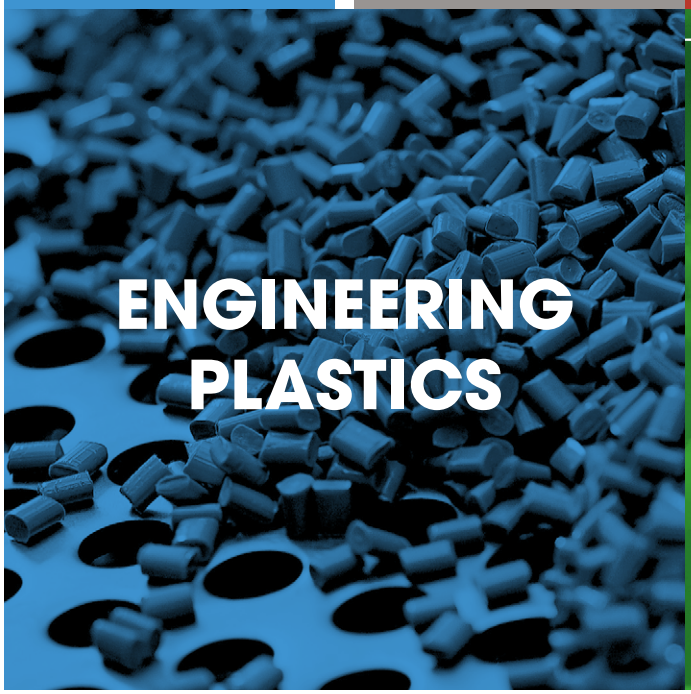


Plastics Engineer

www.tisan.com.tr

Bio-based polymer capacity to grow 8% a year to 2025

Production capacity for bio-based polymers will grow by CAGR 8% to 2025, according to the latest sector study from Germany's Nova Institute (Bio-based Building Blocks & Polymers – Global Capacities, Production & Trends, 2020–2025).

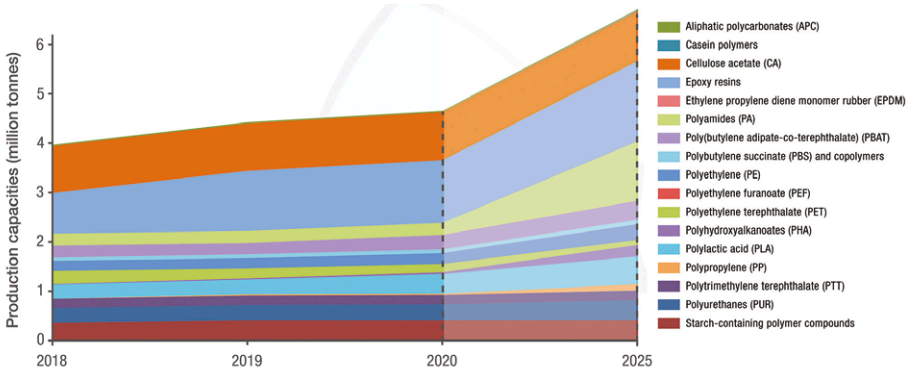
Total global production of biobased polymers amounted to 4.2m tonnes in 2020, equivalent to 1% of global polymer production, according to Nova data. It estimated total biopolymer production capacity at around 4.6m tonnes. The main biomass feedstock used for biobased polymer manufacturing is glycerol as a biogenic by-product, it said.

The study author's described 2020 as a "promising year" for the bio-based polymer sector. PLA capacity was sold out in 2019, leading to commitment to new capacity, and there was also significant investment in PE and PP produced from bio-based naphtha. Future expansion for bio-based PA, PBAT, PHA and casein polymers "is on the horizon", they said, though growth in bio-based PET has slowed.

"Several global brands are already expanding their feedstock portfolio to include, next to fossil-based, sources of renewable carbon, CO_2, recycling and especially biomass, increasing the demand for bio-based as well as biodegradable polymers," Nova said. The major constraint is "a lack of support from politics, which still only promotes biofuels and bioenergy".

› **www.renewable-carbon.eu/publications**

Bio-based polymers: Evolution of worldwide production capacities 2018 to 2025



Architect's impression of the new Lifocolor plant at Lichtenfels

IMAGE: LIFOCOLOR GROUP

Lifocolor expansion on track

German masterbatch producer Lifocolor says it remains on track to move in to its new production building at Lichtenfels this summer.

The 14,000m² facility will expand the company's production capacity by 5,000tpa and is the final element in a 10-year investment programme that has seen it expand locations in the Czech Republic, France and Poland, as well as completely updating its second German plant at Straufhain.

Lifocolor Group CEO Dr Martin Fabian said the new facility, which will be 30% powered by its own photovoltaic installation, will "set new standards in the production of masterbatches."

› **www.lifocolor.com**

Waste-to-CNT idea wins funds

Researchers at Swansea University in Wales have secured £270,000 from the Welsh government to fund a project to create carbon nanotubes from waste plastics and apply them in non-metallic conductive cables.

The team at the university's Energy Safety Research Institute will use the funding to test the electrical and physical properties of the CNT wires and to advance required closed-loop chemical recycling processes.

› **www.swansea.ac.uk**

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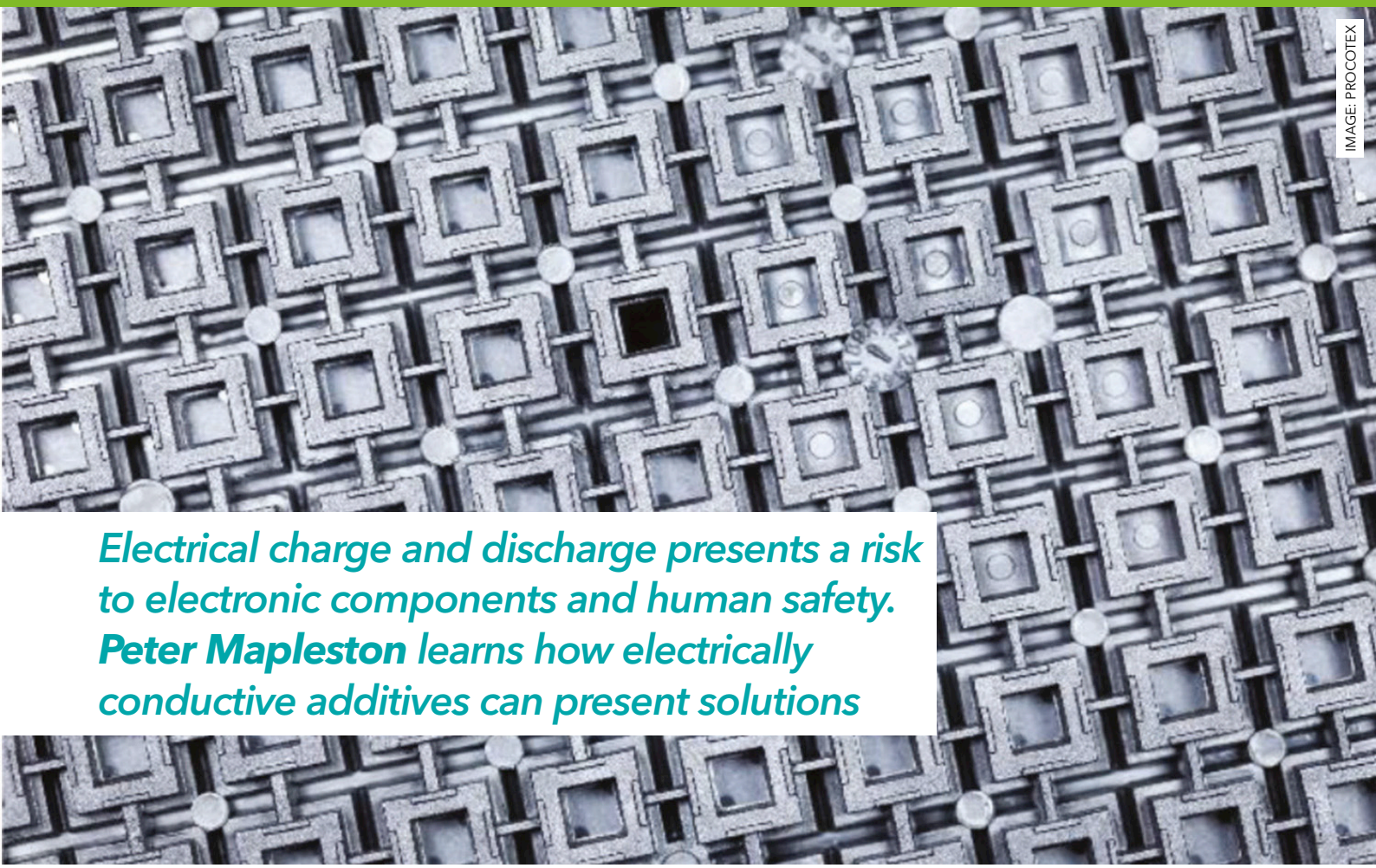

IMAGE: PROCOTEX

*Electrical charge and discharge presents a risk to electronic components and human safety. **Peter Mapleston** learns how electrically conductive additives can present solutions*

Innovative options to tackle static and ESD

Accumulation of electrical charge on plastic parts can lead to electrostatic discharge (ESD) that can damage or destroy sensitive electronic components or cause sparks that lead to explosion or fire. And, while insulating thermoplastics provide great mechanical and environmental protection, their transparency to electromagnetic radiation can negatively affect the performance of electronics they may be intended to protect. With electronics penetrating into more and more everyday equipment, there is a growing need for plastics containing electrically conductive additives.

This article takes a look at some of the most recent developments in electrically conductive additives and explores some examples of compounds that make use of them. Most development work relates to additives based on elementary carbon in different forms – carbon black, carbon nanotubes, and a novel porous carbon among them. But work is also ongoing, especially when it comes to static dissipation, in solutions based on other chemistries.

Netherlands-based **CarbonX** – which traces its roots back to the country's TU Delft – has been focusing its attention on the ability of its additives, marketed under the same name, to improve performance and sustainability across several polymer applications where both reinforcement and conductivity are required.

CarbonX is a porous carbon comprising chemically linked nano-fibres in a three-dimensional network. "In cases where conductivity is needed, carbon black has often been the go-to option. Unfortunately, compounds with carbon black become exceedingly viscous and their impact resistance is compromised, so there are limits to how much conductivity can be achieved before the compound becomes impossible to process," says company CTO Daniela Sordi."CarbonX materials have very good dispersibility. This leads to very homogenous compounds that provide the desired conductivity, reinforcement, light weight and impact resistance required by applications where physical and electrical safety are paramount," she

Main image: This injection-moulded IC chip tray is produced in a conductive compound containing recycled carbon fibre from Procotex

IMAGE: NANOCYL

Right: Fuel pumps are an example of automotive parts produced using electrically dissipative plastics

claims.Sordi says that these features are particularly applicable for products such as casings in electric vehicles (EVs), where the goal is not only to provide adequate EMI shielding around the EV battery and other under-the-hood components, but also ensure greater impact resistance and reduce the overall weight of the casings.

Recent results have confirmed the synergistic effect of the CarbonX material for EMI shielding and ESD applications.

"We found that when CarbonX is used as a polymer filler on its own, 60dB EMI shielding could be achieved," says Sordi. "Interestingly, when CarbonX was combined with other fillers, a synergistic effect resulting in greater EMI shielding effectiveness was observed."

The synergistic effect of CarbonX can also be observed in applications requiring electrostatic dissipation, such as crates and pallets used to transport electronics or flammable substances.

"Glass fibres can be partially replaced by CarbonX," says Sordi. "We tested the mechanical properties and the conductivity of a polyamide 6 reinforced with only glass fibres against PA6 reinforced with both glass fibres and CarbonX [grade X7]." The results showed a significant synergistic effect in terms of strength (Young's Modulus) and volume resistivity, while yield stress is only slightly reduced (Figure 1).

CNT application

Carbon nanotubes (CNTs) continue to demonstrate their effectiveness as conductive additives for plastics, according to **Nanocyl**, a leading producer of multiwall CNT variants (MWCNT) and formulated products based on them. "CNT's elongated structure is what makes it so special compared to other carbon-based additives," the company claims. "Nanocyl's thin, entangled and flexible nanotubes tend to form network-like structures when dispersed in a matrix. A small percentage of carbon nanotubes already endow electrically dissipative properties to the matrix while maintaining or even improving its other characteristics."

Nanocyl's formulated products include its Plasticyl range of polymer masterbatches, which are loaded with its NC 7000 MWCNT. The company says these materials are already used in automobile fuel pumps and fuel lines. "Chosen Plasticyl grades ally the stringent requirements of high heat resistance and chemical resistance to various fuels with the requested ESD properties," it says. Other current applications include parts that need to be painted, where the nanotubes provide conductivity for electrostatic painting and can obviate the need for conductive primers.

The Covid-pandemic had a huge impact on aircraft production. Consequently, demand for raw materials such as aerospace-grade carbon fibre has dropped and is expected to remain at a low level for some years. Carbon fibre demand is also being impacted by calls to cut CO_2 emissions. "These two elements are at the basis of the strongly growing interest for recycled carbon fibre today," says **Procotex**, a supplier of such fibres.

The company says that supply of virgin carbon fibre – especially aerospace-grade fibre – is currently low while most virgin industrial-grade carbon fibre is likely to be consumed by emerging

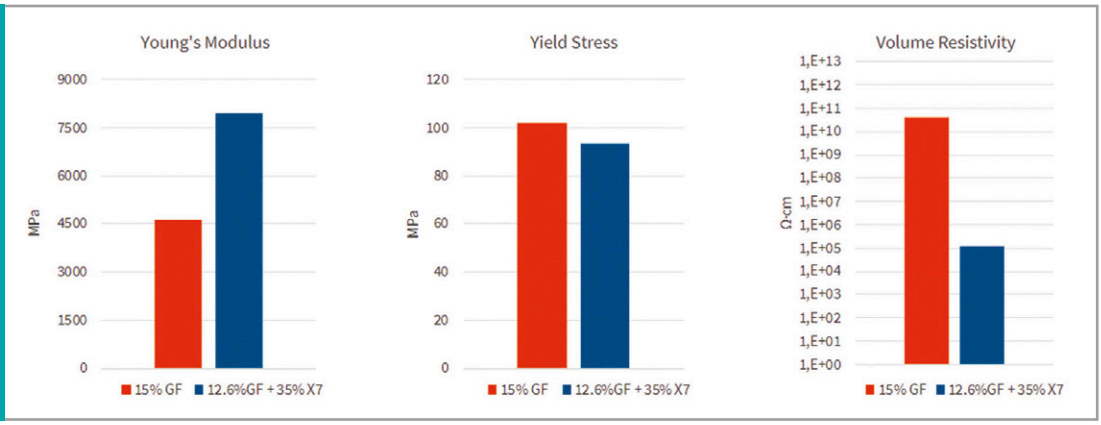

Figure 1: A comparison of strength (Young's Modulus), yield stress and volume resistivity of two PA6 compounds, one containing glass fibres and the other a combination of glass and CarbonX Grade X7, showing a synergistic effect

Source: CarbonX

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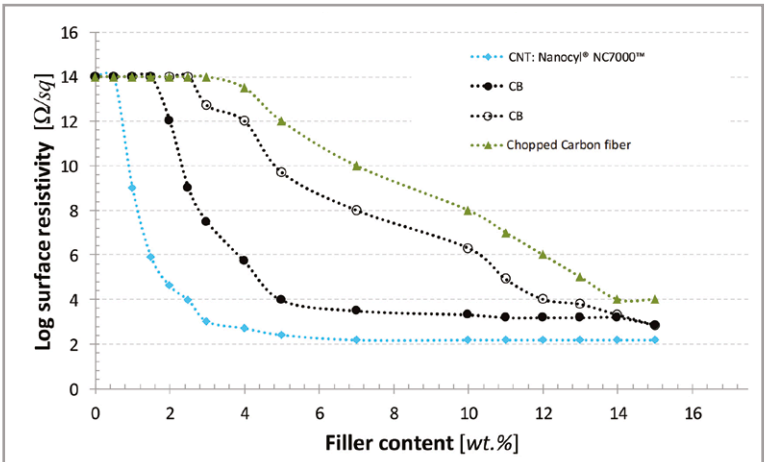


Figure 2: Surface resistivity of polycarbonate loaded with various carbon-based conductive additives
Source: Nanocyl

sectors such as wind energy, fuel cell technology or the hydrogen pressure vessel market." The resulting growing imbalance between supply and demand, further supported by the high price of virgin carbon fibre and its highly unfavourable inherent CO_2 footprint, offers tremendous opportunities for recycled carbon fibre – with comparable performance to virgin carbon fibre, but at only a fraction of its cost and CO_2 footprint. Availability of recycled feedstock – both post-industrial as well as end-of-life waste – by far exceeds current short carbon fibre demand, underlining the potential for the substitution of incumbent materials with recycled carbon fibre compounds," according to the company.Procotex, through its subsidiary Apply Carbon, sources high-quality, soft post-industrial waste from major producers and processers of carbon fibre. It says that to maximise product performance it puts considerable effort into development of new sizing chemistries suitable for the different matrix polymers, adding that it has made some recent advances in this area targeting non-polar polymers such as polypropylene.

Apply Carbon is also taking an innovative approach to the feedstock types it is using to produce its recycled products. A key target market for the company is IC chip trays, which are generally injection-moulded from polycarbonate or polyphenylene oxide/polystyrene compounds. "The dependency on continuous fibre carbon bobbin waste poses a challenge in view of the volumes required by this market," according to Dr Hans Miltner, who provides Technical Market & Business Development Services for Procotex.

"Apply Carbon has therefore developed a range of milled and granulated products that offer a comparable performance spectrum, at even more competitive cost. Mixed fabric waste is used as a feedstock for these granulates and is first milled, then compacted and compatibilised for more convenient handling and dosing and for more efficient dispersion in the polymer matrix," he says. Similar concerns from other emerging volume markets – especially automotive – have provided the incentive to extend this approach to other products more relevant to these industry segments, such as polypropylene and polyamide, Miltner says. Apply Carbon has, for example, put substantial effort into developing a range of recycled materials in granulate form. "These allow for dust-free handling and offer good flowability for easier dosing, but without compromising on the ease of dispersion within a polymer matrix," he says.

"This strategy is now being extended further with the development of pelletised long-fibre products based on recycled carbon fibres," Miltner says. "These products, that will have millimetre-long recycled fibres instead of the 300 µm fibres used so far, will offer the handling and processing benefits of the chopped and granulated short-fibre products, but with significant additional performance benefits owing to the higher fibre length, especially with regard to impact performance and electrical conductivity."

Carbon black moves

Carbon black specialist **Cabot Corporation** has introduced a number of new conductive formulations, compounds and concentrates for the styrenics market, including solutions tailored for carrier trays and industrial packaging. "We continue to see the electrification trend increase in many critical applications, and as a result, demand for products that enable a safe and hazard free production environment is critical for many conductive applications," says Global Market Segment Manager Sebastian Heitkamp.

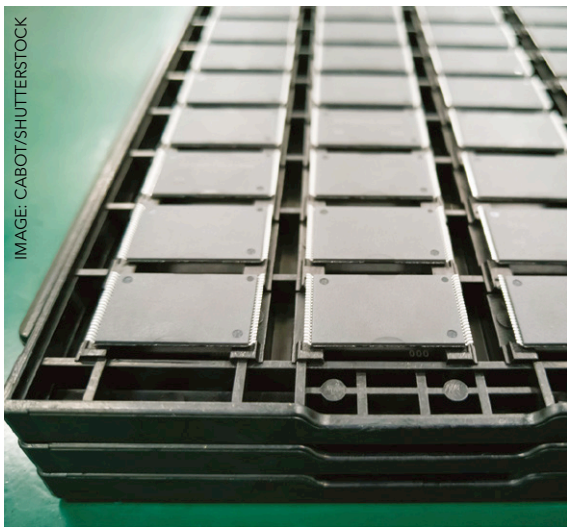


IMAGE: CABOT/SHUTTERSTOCK

Right: Semi-conductor carrier trays are moulded in conductive formulations

The company has launched Cabelec CA6483 conductive compound, as well as the Cabelec CC6532 conductive concentrate for ABS sheet extrusion and thermoforming. "With the increasing use of recycled materials in packaging applications, our conductive concentrates provide versatile application benefits as they can be diluted in different polymer types and even combined with recycled polymers," says Heitkamp.

Cabot has also introduced carbon nanostructure (CNS) concentrates that provide high conductivity at low dosage together with low dust generation during processing and use. The company says this helps producers meet the cleanliness requirements of clean room environments. "CNS particles have shown significant benefits so far in applications that require high conductivity, such as in EMI shielding applications for sensors," Heitkamp notes.

UK-based **Colloids** is continuing the development of its E-TEC range of permanent electrically conductive compounds and concentrates. It says this effort is centred on improving its scientific understanding of conductivity in polymeric matrices, enhancing formulation design for maintaining good mechanical properties, and developing manufacturing technology.

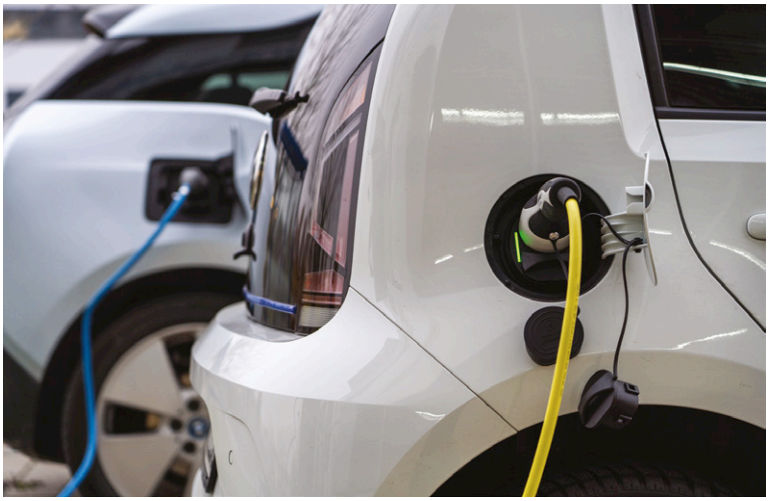


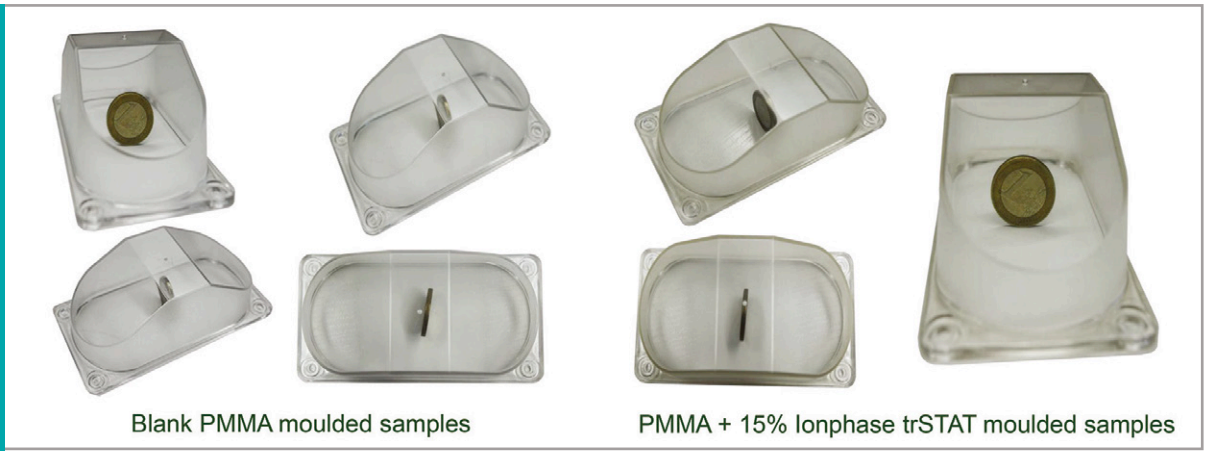
IMAGE: SKZ

Above: The aim of the TECMAT project is to develop conductive polymer compounds with improved processability

In addition to the existing E-TEC standards, the company now has a product portfolio that includes bespoke formulations developed together with customers. This collaboration process has been extended to include academic institutions, researchers, raw material suppliers and customers to develop a new family of graphene-based compounds and concentrates. Colloids says it is aiming to use graphene material technology, not only to

Ionphase trSTAT does not affect transparency of PMMA

Image: Croda Polymer Additives



provide electrical conductivity but also to produce novel polymer composites for various markets.

"Colloids' E-TEC formulations have been designed to meet extremely demanding specifications for electrical conductivity whilst maintaining requisite mechanical property characteristics. The formulations involve various carbon-based hybrid conductive additives chosen for specific conductivity requirements, specific polymers, and end applications," says R&D Senior Technologist Shazia Akhtar.

"Electrical conductivity is achieved in these materials by combining electron tunnelling and a percolation process, where the conductive additive develops an internal network structure. This is concentration and material dependent. The additive level required to reach the percolation threshold depends on the type of conductive additive and its level of dispersion. Optimising processing to achieve maximum dispersion whilst not destroying the additive's structure and conductivity is a complex balance of formulation and processing technology," Akhtar explains.

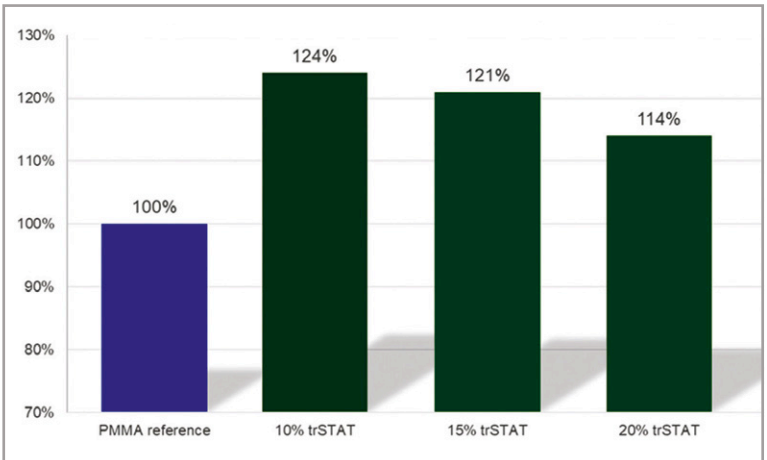


Figure 3: Effect of Ionphase trSTAT on impact strength of PMMA. Reference material (Plexiglas zk5BR) has an impact strength of 2.9 kJ/m² (Charpy notch type A, ISO 179)
Source: Croda Polymer Additives

Conducting research

Production of thin-walled, highly conductive plastic components, especially for lightweight applications, can be challenging because high filler loadings are often required. A collaborative project formed last summer involving researchers in Germany and Belgium aims to change this situation.

Partners in the two-year government-funded TECMAT (Thermally and electrically conductive fibre and plastic materials) project include the German Plastics Centre SKZ, Fraunhofer ICT, and the Belgian Institute for Textile Research Centexbel. They aim to developing novel conductive compounds with a low filler content and improved processability using blends of immiscible polymers in which islands of a conductive material are distributed in a low-viscosity matrix polymer. When the blends are processed into parts, these islands can be deformed to create a conductive micro- and nanostructured network within the surrounding non-conductive matrix.

"With the help of this 'coalescence approach' it is possible to produce easy flowing compounds that can be used for fibre spinning, injection moulding of thin-walled parts and thermoforming with high degrees of deformation while still maintaining a high conductivity in the final part," the partners say.

New antistats

According to additives specialist **Croda Polymer Additives**, the global anti-static market will grow at an average rate of 6.3% annually from 2019 to 2024. It says it has identified a specific need for static control in transparent polymers to control static to reduce issues such as dust build-up. Its latest permanent anti-static additive, Ionphase trSTAT, was launched in April last year.

Ionphase products are permanent anti-static additives based on inherently dissipative polymers (IDPs) that can be added to plastics during compounding, extrusion, or injection moulding. ❯

Right: Adeka's ADK Stab AS-301E is supplied in an easy-to-handle pellet form

"Ionphase trSTAT has been specifically designed to meet the market's needs for an anti-static agent which can be used in transparent, PMMA end applications such as ESD protection for covers and housings in electronics, dust prevention for automotive interior parts and dust prevention in consumer appliances," says Croda.

"Inclusion of Ionphase trSTAT can provide surface resistance values between e^9 – e^{11} Ω depending on the host polymer type and addition levels; therefore, although designed for anti-dust applications, Ionphase trSTAT is also suitable for EX or EPA applications," it claims.

Croda goes onto say that Ionphase trSTAT can also have a positive influence on the mechanical properties, maintaining them or slightly increasing them (Figure 3).

Electronic demand

Increase in demand for electric and electronic components has been given an extra boost in recent years with the introduction of 5G and IoT (Internet of Things) technologies. "With it, the requirements for parts with both anti-dust and electrostatic dissipative properties is also increasing," according to additives producer **Adeka**. "Permanent antistatic agents are already used for automotive parts, home appliance and packaging/containers for electrical and electronic components, etc, and these markets are also growing."

Adeka has developed a new permanent antistatic agent, ADKStab AS-302, to cover these applications. It can provide levels of antistatic performance from anti-dust to ESD through control of loading levels; it has a surface resistivity of 10^6 Ohms/sq. Typical loadings are 5-10wt% for anti-dust applications and 10-20wt% for ESD. The additive is supplied in pellet form and can, if necessary, be added directly at the injection moulding machine.

"The heat stability of ADK Stab AS-302 is sufficient to be considered suitable for a whole range of engineering plastics processing temperatures," the company says. "Furthermore, ADK Stab AS-302 has high recyclability. Our results show that antistatic performance of ABS with ADK Stab AS-302 does not change after multiple extrusion passes." The additive is said to show good antistatic performance in styrenic resins and alloys, as well as polyesters, POM, PA and PP.

Meanwhile, the company's existing ADK Stab AS-301E, already used as an anti-stat for polyolefins, is finding new potential opportunities. "It was recently discovered that ADK Stab AS-301E can also be applied for PC film and sheet, which are used for packaging of electronic parts and components. It was found that it can provide good antistatic performance with much less impact on transparency of PC than alternative product offerings," the company says.

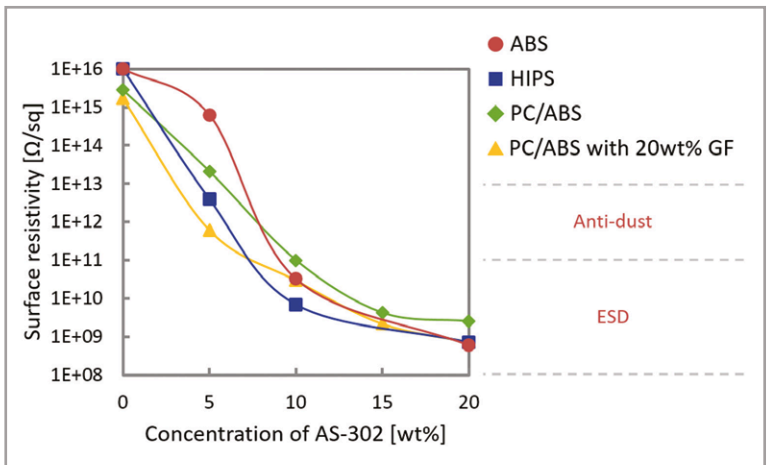
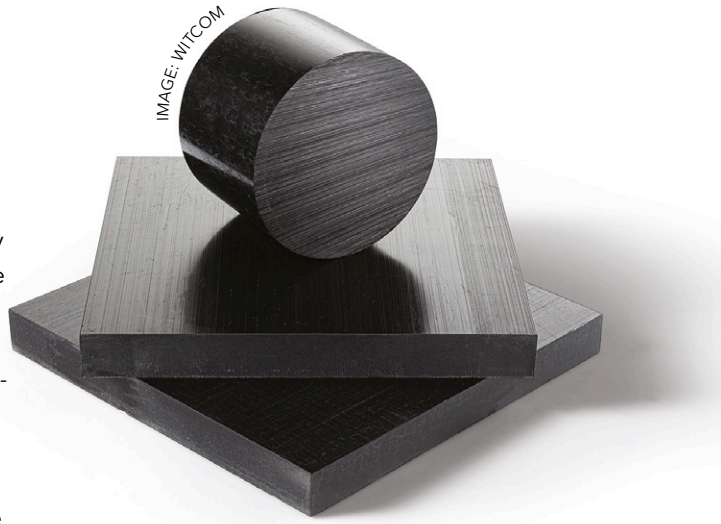


Figure 4: Effect of ADK Stab AS-302 on surface resistivity of different compounds
Source: Adeka

Conductive compounds

Wittenburg Group company **Witcom Engineering Plastics** specialises in development and production of electrically conductive compounds based on a wide range of polymers. It says conductive POM (acetal) is gaining a lot of attention for semi-finished materials used during manufacturing and assembly of electronic components.

"We can produce conductive POM that our customers can extrude safely up to more than 200 mm thick slabs and rod stocks without any stress cracking or gas bubbles on cross sections during further machining," says Christine Van Bellingen,



Right: Semi-finished products in conductive POM

Business Development Manager for Conductive Materials at the company.

"In another direction, motivated by the corona pandemic, our conductive TPE grades offer touch-free solutions as well as tight profiles and sealing solutions," she says.

Witcom has customers in the automotive industry already using its radar absorption compounds in the latest radar systems for blind spot detection, cross-traffic alert and more. Opportunities are also seen across the broader EV sector. "While electrification and digitalisation of cars generate more electro-magnetic interferences, the trend for lower energy consumption and light weighting calls for more plastics. Our latest generation of cost-effective EMI shielding plastics compounds clearly opens new perspectives for metal replacement as well as for metal coating alternatives," says Udo Schwestka, Business Development Manager for Radar Absorbing Materials.

Turkish compounder **Tisan Engineering Plastics** is also providing a wide range of products with specific ESD protective or conductive characteristics. It is working with additives such as carbon black, carbon fibre and other anti-static additives.

Tisan cites compounds based on polyethylene, polypropylene, polystyrene, and PET with surface resistivity ranging from 10^3 to 10^{12}ohms/sq for extrusion and injection moulding. All carbon-based solutions are necessarily black; where light coloured products are required it can produce compounds with a surface resistivity of 10^8 to 10^{12} ohm/Sq.

European PVC compounds group **Benvic** says it will launch a range of polymer grades this year aimed at static and electrical discharge applications. The ProVinyl KCC conductive polymers will target applications as diverse as cables, packaging, tubing and flooring.

'Speed to market and ease of polymer processing have been key to us in designing these specialty materials,' says Benvic Product Manager, Philippe Gressier. He says ProVinyl KCC grades are primarily formulated with plasticised PVC and provide electrical performance along with the normally-expected durability, cost effectiveness and ease of processing of PVC.

Benvic says the first ProVinyl KCC products will target specialty cable applications such as low voltage sensors in medical monitoring or automotive. In these senstive applications, integrating an "anti-static drain" in the cable sheathing can protect against signal fluctuation and disturbance.

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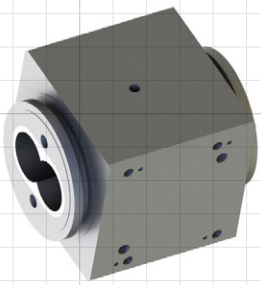

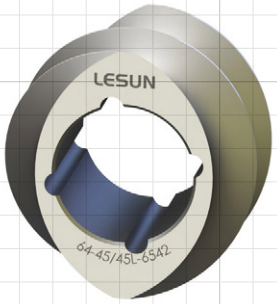

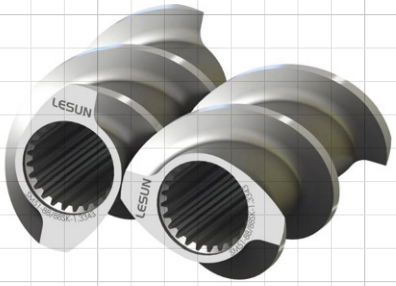

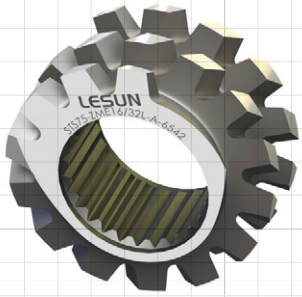

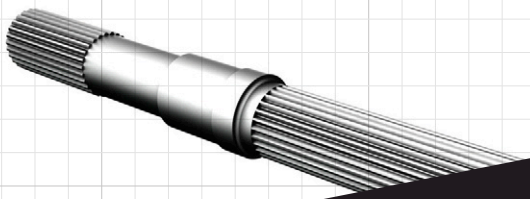

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Make more from less

Energy is a major cost in any compounding plant but it is not a fixed one. Mark Holmes talks to some leading energy and equipment specialists to find out how to cut energy bills

IMAGE: SHUTTERSTOCK

There are plenty of steps that can be taken in the compounding plant to minimise and manage energy usage but the compounding extruder motor is a good place to start. Motors typically use around two-thirds of the energy at a compounding plant so it is really important to implement a motor management programme, according to Dr Robin Kent, Managing Director of UK-based **Tangram Technology**, a consulting engineer for energy management in plastics processing. He has developed a simple step-by-step programme (outlined in Figure 1) that is designed to reduce motor energy costs throughout the motor system, not just in the motor itself.

The first stage of the programme is focused on demand. "Minimising the demand is not about removing services that are necessary for operation," says Kent. "It is about providing the appropriate service when needed."

He says the best method – and the first step in his programme – to reduce the cost of motor energy is to stop motors operating when not required or when not producing valuable output. The second step is to reduce transmission losses, which he says are often a major component of the losses in the motor system and can easily exceed losses in the motor itself. Step three is to reduce the driven load. This can be achieved through measures such as improving the control system, better maintenance, and examining the load to identify methods of reduction.

The second stage in Kent's programme is to optimise the supply, which means getting the right size motor. "Motors are often too large for the application. This can lead to higher-than-needed operational costs if the motor is operating at full load. If a large motor is operating at low loads, then the efficiency will drop dramatically and again add to operational costs. Getting the right size motor for the application is a key issue," he says.

"The next step is to improve the motor efficiency. The efficiency of a motor will vary with the motor type, the load and the demand profile but new high-efficiency motors are available to save energy." Kent says that installation of high-efficiency motors is now required by EU and US law for new installations but many old and hidden motors will be IE 1 rated or less. These motors can easily be upgraded to IE 3 (equivalent to NEMA Premium efficiency in the US) to give energy savings across the loading range and the payback will generally be less than a year.

The sixth and final step is to slow the motor

Main image: The route to improved energy efficiency moves through simple management strategies as well as plant upgrade and equipment investment

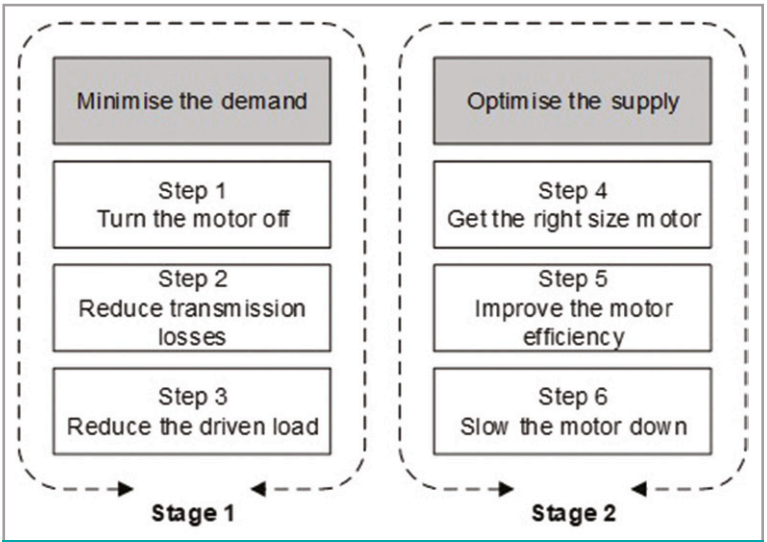

Figure 1. A motor management programme can be used to reduce motor energy costs throughout the motor system and not simply in the motor itself.
Source: Tangram Technology

down. "The majority of motors used in compounding are AC induction motors. These are low-cost and reliable but operate at a fixed rotational speed. Variable Speed Drives (VSDs) allow AC motors to operate at variable speeds to match the process demands," Kent explains.

Informed choice

Compounders have a number of options available when selecting an extruder motor so it is important to make an informed choice. "The motor uses more than 65% of the power input to the extruder and it is essential to get the motor choice right," says Kent. "The traditional choice was a DC drive to give the variable speed needed for extrusion, but the range of options has now increased, and DC motors are old technology. For new machines, most manufacturers have removed DC motors from their product range to only offer AC motors plus VSDs."

VSDs can be used to adjust motors to run at the lowest possible speed – within the allowable torque values – to reduce the energy used to a minimum. Reported achieved savings vary widely. Kent says that in Tangram's validated tests savings amount to around 7–10%, but savings of 5–20% are widely reported. "The exact savings depend on the machine type and speed and, as a general rule, the savings decrease with increasing screw speed. Some tests report even greater savings of more than 30%, but this depends on the load and speed," he says.

Kent says AC motors plus VSDs can easily be retrofitted to most extruders and this is his recommended action. Energy savings will generally be around 5–20% but reductions in maintenance costs are also significant so payback will be achieved in one to two years. Whether specifying a new installation or retrofit, he recommends an IE3 rated motor – or better – especially if it is not going to be run at full load.

"For those who want to be at the forefront of technology, the introduction of direct drive, permanent magnet [PM] synchronous motors presents even more opportunities. This is a new motor technology to connect the motor directly to the screw - often with no need for a gearbox at all," he says. "These are advanced systems but offer advantages over existing systems, for example, they are more energy-efficient – around 12–15% compared to AC motor plus VSDs. They are also quieter than DC or AC motor plus VSDs, smaller and less complex."

Kent also offers a couple of extra tips for energy saving. He says that one of the biggest savings to be made through the use of AC motors with VSDs or PM motors is the greatly reduced maintenance load. And, where belts are used to connect the motor to the load, it is a simple and inexpensive task to replace standard V-belts with more efficient cogged belts. Energy savings of up to 5% are achievable by making that change.

In addition to appropriate motor and drive selection, managing extruder and motor energy costs also requires a good maintenance programme. AC motors are the workhorse of modern industry and will give continuous operation for many years, but they do need some basic maintenance to ensure that they continue to operate efficiently, says Kent. This includes:

- Checking the motor is well ventilated and that air flow to the cooling fan is unobstructed (allowing the fan inlet to become blocked will cause overheating);
- Checking the condition of bearings using a vibration meter;
- Checking electrical connections are correctly torqued;
- Checking electrical integrity of cables and motor insulation;
- Checking the overall cleanliness of the casing, fan, terminal box and associated electronics such as soft starters and VSDs;
- Checking the load transmission and alignment of motor to load.

The first check on the list is particularly important as the worst action for reliability is to allow an AC motor to run hot, Kent says. Motors are certified for a specified temperature increase while running. Running them above that temperature reduces their efficiency due to increased winding resist-

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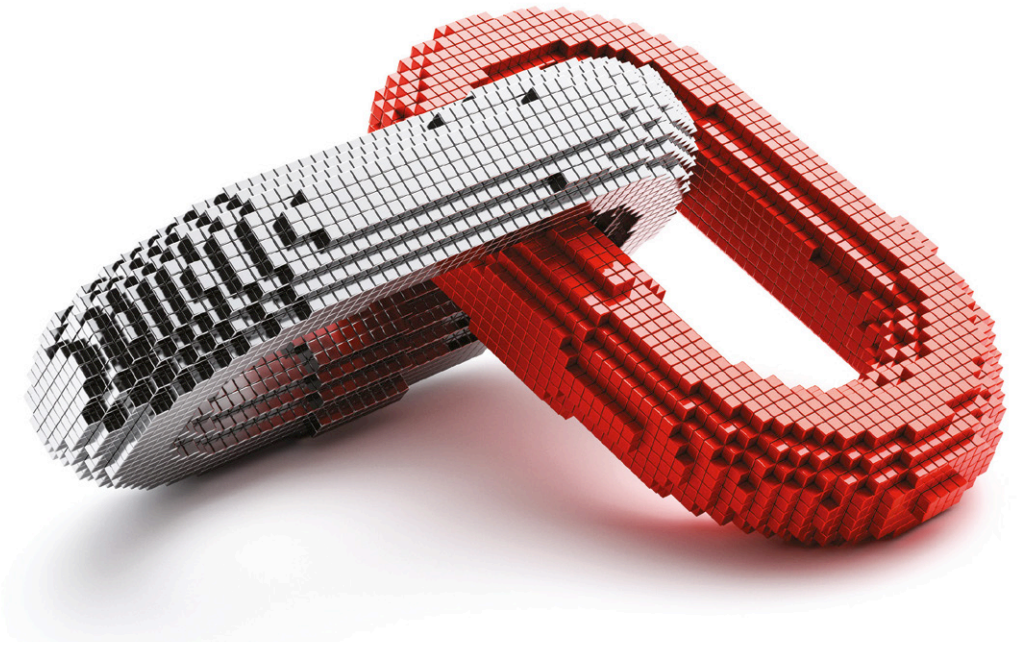

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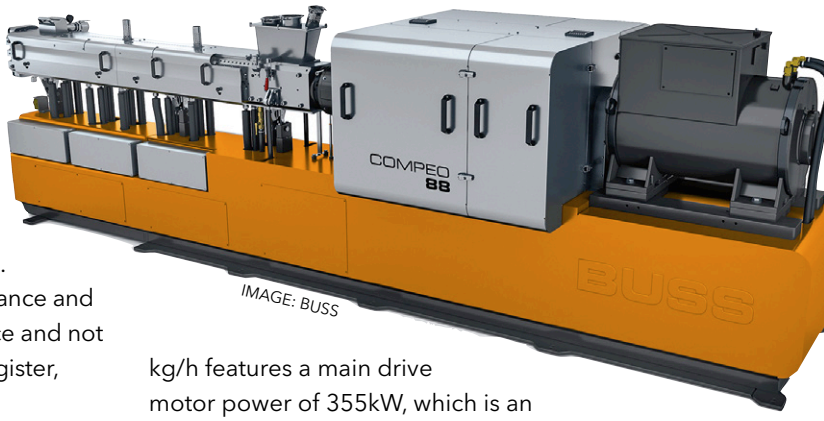

IMAGE: BUSS

Right: Buss claims its Compeo co-kneaders, shown here in an 88m 25LD version, avoid energy-consuming shear peaks

ance. This means more electrical power is dissipated as heat, which in turn pushes the winding temperature even higher.

Motor management

A motor management programme also needs a motor management policy (MMP). This can be used to define motor maintenance and inform the replace/repair decision – replace and not rewind. Kent suggests creating a motor register, which is a simple spreadsheet that lists:

- The motor application;
- The nameplate details;
- The frame size;
- The approximate running hours;
- The repair history;
- The spares held for the motor;
- And the action to be taken in the event of failure – replace or repair.

Dino Kudrass, Head of Design and Development at **Buss,** agrees with Kent that the dominant contributor to the energy consumption of a plastics compounding plant is the machine's main drive motor. "Here, electric energy is converted into kinetic energy, which is then used to melt, mix, convey and pressurise the polymer through shear forces present in the process chamber," he says. "A large proportion of this energy input exits the compounder's control volume through the elevated thermal heat energy of the polymer melt."

He explains that considerable energy is required to melt the polymer due to the high specific heat capacity of polymeric materials. "To put this into perspective, a typical polyolefin compounding machine with a throughput of approximately 1000 kg/h features a main drive motor power of 355kW, which is an order of magnitude more than the machine's heating system. Therefore, even small improvements to the energy efficiency of the main drive and mixing process can yield comparatively significant savings," Kudrass says.

"One core issue in good energy management is including related considerations as early as possible. Too often new plants are planned and commissioned before the first serious considerations towards a suitable energy management strategy are made. Reducing overall energy consumption should be an important constraint from the early concept design, right through to the final implementation and operator training phase," he says.

Kudrass also agrees with Kent that one important practical step towards using compounding energy efficiently is the correct drive line specification. "Electric motors are often operated far below their nominal speeds during production, which greatly increases thermal losses and decreases efficiency," he says. "In this case, machines are specified with a reduction ratio and nominal speed to match the maximum required compounding speeds, although these are relative outliers and do not match the intended operating speeds.

Another practical step that can be taken is to recycle thermal energy, according to Kudrass. "In many cases waste heat from pellet conveying, H/C units or other cooling circuits can be easily used to pre-heat the polymer before entering the compounder. This in turn reduces the energy requirement for melting the polymer inside the compounder," he says. Compounding energy inputs for PVC material fed at room temperature and pre-heated are compared in Figure 2.

Buss believes that the operating principle of its Co-Kneader machines allows for an energy efficient mixing process due to the inherently homogenous shear rate distribution. Avoiding unnecessary shear peaks and stagnation zones not only reduces compound degradation, but also avoids the ineffective use of kinetic energy, according to Kudrass.

"Our recently developed machine series

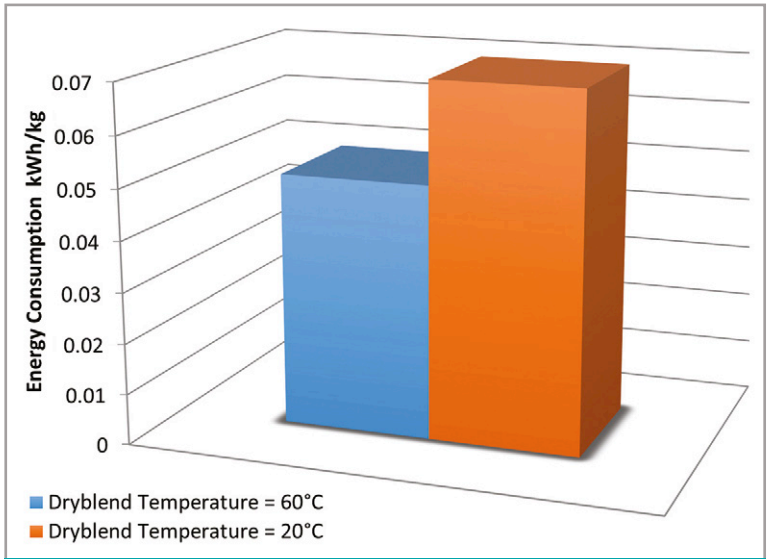

Figure 2: Specific energy due to different inlet temperatures of PVC Rigid Dryblend *Source: Buss*

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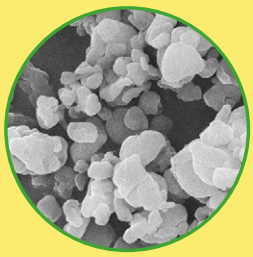

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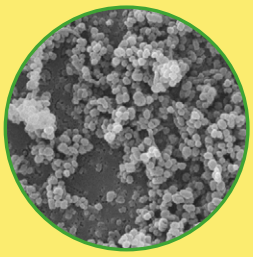

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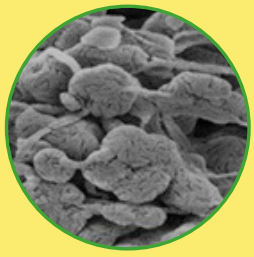

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IMAGE: FARREL POMINI

Above: Farrel Pomini's Compact Processor continuous mixers are claimed to offer reduced energy consumption and operating cost

Compeo features a unique process chamber where elements of very different geometry and shape can be combined," he says. "The combination of two, three and four flight elements in the primary melting and mixing zones, for instance, can significantly improve the processing effectiveness and thus reduce losses. Another development of the Compeo series is a high energy density electric heating system with a water evaporation cooling system. Particularly for high temperature compounding applications like filled engineering plastics, such a system can drastically reduce thermal losses when compared to a liquid oil heating system."

Energy incentives

Kudrass sees energy efficiency playing an increasingly important role in compounding plant decisions. "As the unit cost of energy increases, the economic incentive for optimising energy efficiency in polymer compounding will also increase. As a result of this, energy management considerations are playing a growing role in the development of processing aids, in the design of processing machinery and in layout of compounding plants," he says.

Right: Farrel Pomini says its latest Synergy control system is helping customers optimise their operations

And with energy costs likely to rise, he advises that cost-versus-benefit calculations for energy efficiency optimisation are not made based on present energy costs, but on the basis of likely future expenses. "Such predictions can be difficult to make, but even benefit calculations with conservative future cost estimates usually yield much higher return on investments than those using current energy prices."

According to Paul Lloyd, President & Business Unit Director at **Farrel Pomini**, the big energy user in any compounding plant is the compounding process itself. "A good energy management strategy in the plastics compounding plant starts with the equipment choice," he says. "Different types of compounding equipment have distinct levels of heat generation and energy efficiency. Selecting an energy efficient compounder, such as a Compact Processor [the type of machine manufactured by the company], can result in 10-15% lower energy consumption during the primary mixing process."

In addition to equipment selection, plant layout and philosophy are important, he says, pointing out that good design can save space, reduce distances for the material to travel throughout the process, and significantly reduce power needs.

According to Lloyd, there are a number of points to consider for efficient energy use. These include:

- Selecting the most appropriate equipment and making sure it is maintained properly and running efficiently;
- Seeking out opportunities for upgrades. A more energy efficient motor, for example, can provide a rapid return on investment and have a significant impact on energy consumption;
- Training staff to a high level to ensure equipment is run correctly, without waste or unnecessary consumption;
- Consulting with equipment specialists to ensure process parameters are optimised to achieve better energy efficiency.

"One of our more recent developments that has a large impact on a customer's compounding operation is the Farrel Pomini Synergy control system. This is a very user-friendly, visually driven platform and provides integrated control of the mixer, feeder, upstream and downstream equipment," says Lloyd.

"We also conduct a significant amount of development work on the coatings we use on major wear components, such as rotors and the mixing chamber. One special wear coating for the mixing chamber liner has the potential to increase the throughput rate without any increase in power.

›

IMAGE: FARREL POMINI

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Right: CPM's RE Ring Extruder has been shown to significantly reduce specific energy via elongational mixing

Effectively, a production increase is realised without any additional energy consumption," he says.

Farrel Pomini's continuous mixing technology is claimed to offer low energy consumption and low processing temperatures. In part for those reasons, it is widely used in sensitive applications such processing virgin and recycled PVC, other recyclates, biodegradables and flame retardants, as well as highly filled and white masterbatch production. Features contributing to its energy efficiency include short overall length of its two counter-rotating mixing rotors, efficient flow of material over the feed flights, and high free volume in the mixing chamber.

"I feel the current energy management trends will continue; however, they will become increasingly more critical," Lloyd says. "Consumption and waste will become less tolerable to the entire supply chain, therefore energy conservation at all points will be essential. Increases in process feedback from intelligent machines – Industry 4.0 – will both highlight and assist the pursuit of lower energy processes."

Low hanging fruit

One reason that energy efficiency has not been a top priority in the development of compounding equipment and processes is that industry has become accustomed to relatively low energy costs, according to Adam Dreiblatt, Director of Process Technology at **CPM Extrusion Group**. "With the advent of higher energy costs in the future, there is some 'low hanging fruit' that has been promoted for many years but never given any serious attention," he says.

"For example, insulation of the compounding extruder barrel can have a return on investment payback within weeks or months, yet most compounding extruders are not equipped with insulation covers. When they are provided, the insulated covers get removed once for maintenance, then put into storage. When asked about this, production managers say because the insulating covers make access to the heating/cooling system cumbersome. As a result, the energy radiating from the barrel heaters goes to heating the plant because it is more 'convenient' when maintenance is needed," he says.

This type of thinking has to change, Dreiblatt says, and that change starts with corporate management making energy efficiency a high priority. "We see this type of philosophy taking place already in China, where new compounding lines are evaluated in terms of energy efficiency," he says.

Dreiblatt says good energy management should begin with an audit. "This is the only way to develop strategies to minimise waste and reduce energy consumption wherever possible," he says.

"Managing the peak electrical loads is possible, but perhaps not practical. When the extruder is first heated to operating temperature from ambient conditions, the electrical heaters on the extruder barrel draw 100% amperage until the barrel reaches near the setpoint – during this time the extruder is not yet running – at which time the heating demand is dramatically reduced. If you have multiple lines starting-up on a Monday morning, for example, they will all draw 100% amperage at the same time. If the heat-up period for each line was sequenced using timers, the peak electrical demand can be reduced," Dreiblatt says.

Some steps towards energy efficient production require little more than a change in mindset, Dreiblatt says. "In most plants today, companies leave idle machines at operating temperature for extended periods of time - sometimes for days – rather than turn off the heaters until the line is ready to run. These are simply bad habits we have all developed over time."

As energy use becomes an ever more important element in business planning, some decision

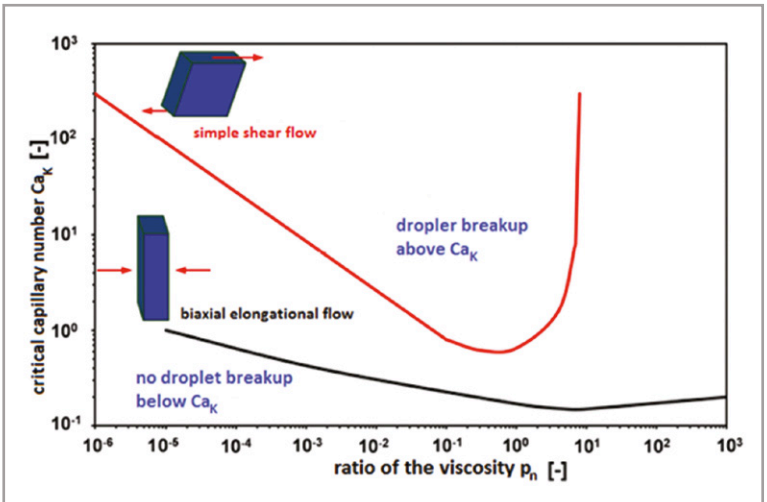

Figure 3: Grace curve comparing the lower dispersive energy requirement for elongational flow (in RE RingExtruder) with dispersive energy requirements in simple shear flow (in a twin-screw extruder) over a wide range of viscosity ratios
Source: CPM Extrusion

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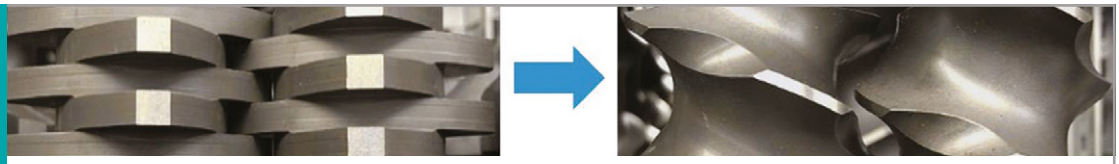

Images show the difference between a traditional kneading block (left) and Feddem's FME mixing elements
Image: Feddem

making processes could change, Dreiblatt points out. "In today's business environment, twin-screw extruders are favoured where initial capital cost is the primary criteria for evaluating new equipment. With the new green economy, we may see energy consumption become more important," he says.

"For resin producers operating twin-screw extruders above five tonnes per hour, a small decrease in specific energy can represent significant cost savings over the life of the extruder. In such cases, a larger diameter extruder operating at a lower screw speed will result in lower specific energy as compared to smaller diameter machines operating at high screw speed. The motor size is the same for both machines, but the higher initial capital cost of the larger diameter machine is not favourable in today's economy," he explains.

New opportunities

An increased focus on energy efficiency could also open up opportunities for alternative machinery solutions, such as the multiple screw Ring Extruder technology that CPM acquired with its 2017 purchase of German company Extricom. "CPM Extrusion Group has demonstrated use of the RE RingExtruder in significantly reducing specific energy via elongational mixing as compared to twin-screw extruders [Figure 3]. As energy costs becomes increasingly important, RingExtruder technology will be seen as lower cost over the lifecycle of the equipment," Dreiblatt predicts. He claims that elongational mixing is the only way to achieve a significant reduction in specific energy.

However, Dreiblattt also sees potential to further improve the efficiency of twin screw compounding technology. "Twin-screw extruders are highly efficient friction-energy generating machines; the average efficiency in converting 1kWh of electricity into melting of polymers is approximately 97%. Electrical energy is applied to increase the temperature of the solid polymer and then we use additional energy, for example from chillers or cooling towers, to remove the heat for pelletising," he explains.

"The electrical energy from the main drive motor is dissipated as waste heat through the cooling water for gearbox lubrication and extruder barrel temperature control and the water used to quench and solidify the molten polymer, for example in a water bath. All of this waste heat is currently diverted to the environment via cooling towers or chillers. In the future, this waste heat should be recoverable and presents tremendous opportunities for innovation," he says.

German extruder manufacturer **Feddem** says that screw configurations and barrel temperatures have a significant influence on compounding efficiency in terms of energy consumption. "With our kneading-block-free melting and mixing zones we can achieve energy savings of up to 10% in these sections of the compounding process compared to conventional screw configurations," says Klaus Hojer, Business Development Manager. "Heat insulation of the processing section of the extruder is also vital - not only for protecting the operator against accidental contact with hot surfaces, but also for heat conservation purposes."

Other practical steps that a compounder should consider to manage energy use efficiently include optimising the process and plant operation itself, including sequencing of compounds with respect to barrel temperature changes and the like. "Production capacity should be planned with a weekly yield of the lines in mind and not on the basis of the highest throughput rate for an individual line, Hojer says. "It is also necessary to take into consideration on what line the job can be processed on, without requiring a change of processing screws."

Hojer says Feddem is currently working on optimising particular screw configurations that can process a wide range of compounds without requiring a screw change. "The developmental targets are optimised screw elements and screw configurations. In the future, Feddem also sees more focus on the optimisation of compounding line sizes, which are adapted to new formulations and lot sizes for future demands," he says.

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Careful selection is the key to defeating wear

Successfully managing wear in plastics compounds requires careful selection of base polymers and lubricating additives. Peter Mapleston finds out more

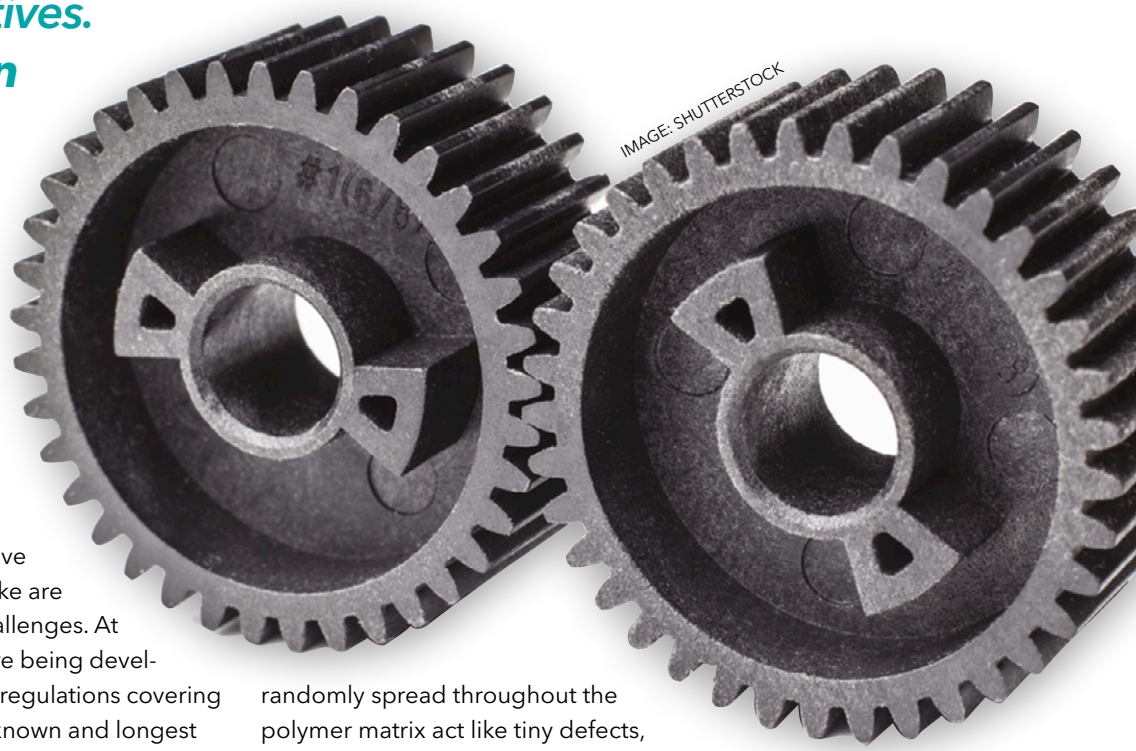

IMAGE: SHUTTERSTOCK

Use of compounds with enhanced wear and friction properties requires sensitivity in the selection of appropriate polymers and suitable fillers. Additive and filler systems play a significant role in meeting demanding requirements on sliding friction properties and long service life of plastics in tribological applications; Additive suppliers and compounders alike are working hard to meet those challenges. At the same time, new solutions are being developed to conform with evolving regulations covering PTFE, which is one of the best-known and longest established lubricating additives.

At **Mocom** (previously the compounding division of Albis Plastic but since last year a standalone operation), Product Specialist Karolina Smrczkova says sensitivity in the choice of polymer and fillers is required when developing tribologically modified compounds. She notes, for example, that in general semi-crystalline polymers have better tribological properties than amorphous ones. "The crystalline structure increases the surface hardness and thus improves sliding and wear behaviour," she says.

The operation temperature and required stiffness and strength are the most important criteria when selecting suitable polymers for a specific sliding friction application, she advises. As far as fillers are concerned, attention needs to be paid not only to their effect on tribological properties, but also on mechanicals (Figure 1). "For example, PTFE significantly decreases the elongation and impact strength of a compound. Particles randomly spread throughout the polymer matrix act like tiny defects, which result in micro cracks, causing the embrittlement of the compound," says Smrczkova.

Silicones on the other hand soften the compound and significantly increase elongation and this softening effect can be used to reduce brittleness caused by PTFE addition, she says.

"This enables Alcom POM 770/1 PTFE SI2 NC to be used as a sliding block in a gearbox. In this application, it has two sliding partners: a PBT/PET blend and steel. From the first gearshift, the silicone used on both sliding partners ensures a perfect sliding action. The silicone is transferred directly to the surface, creating a smooth sliding film without any inflow. PTFE re-applies the sliding film again after inflow with each gearshift, even in long operation," Smrczkova explains. The different modes of action are shown in Figure 2.

Smrczkova also points to the importance of processing parameters when moulding parts. An injection mould that is too cold, for example, can significantly impair the tribological properties of a

Main image: Gear wheels are a prime application for wear resistant, low friction plastics, reducing cost and frequently improving NVH performance over metal

semi-crystalline compound. "Due to the frozen amorphous coating, the tribological properties can be halved compared to a well-formed semi-crystalline coating," she says.

Ongoing innovation

At Italian compounding company **Lati**, which includes a number of self-lubricating materials in its portfolio, Technical Assistance & Marketing Director Luca Posca says there has been no let-up in its development of new special compounds, "even during a very difficult period like 2020." He says the company has expanded its product range with numerous innovative formulations. "In particular, the LatiLub family of self-lubricating compounds has been enriched by the addition of new solutions designed to leave a lower environmental footprint compared with traditional ones."

Efforts have focused on the replacement of PTFE, which although it has exceptional tribological properties, is not suitable for halogen-free applications and presents end-of-life disposal problems, Posca says. The company has developed a full range of alternatives based on ultra-high molecular weight polyethylene, UHMWPE, also well-known for its low friction coefficient and good wear resistance (one high-profile use is skating surfaces). Its thermal characteristics allow it to be used in many semi-crystalline and amorphous thermoplastic matrices, including high-melting polymers such as PPS.

"Added to its superior excellent friction, abrasion and wear resistance compared to PTFE, the nature of the polymer is such that it is completely risk-free in terms of moulding equipment corrosion, and also presents no risk to human health or the environment," Posca says.

The elimination of PTFE, silicone and carbon-based additives is also the founding principle of a second new Lati development. It aimed not only to cut halogen content but also to limit the risks associated with particulate formation and hazardous migration which may threaten the smooth running of electrical machines. According to Posca, the new formulae, identified by the extension LU2, are based on mixtures of metal sulphides, whose ceramic structure reduces friction and wear without compromising either the safety or the reliability of the devices in which they are used over time.

Posca also highlights a range of self-lubricating compounds designed for 3D printing using the FDM (Fused Deposition Modelling or Fused Filament Fabrication) technology. Filaments developed within the company's 3DLab R&D unit include PTFE and aramid fibre-filled products based on PLA, ABS, PA, PC and PETG. The compounds are designed for use in the manufacture of functional items.

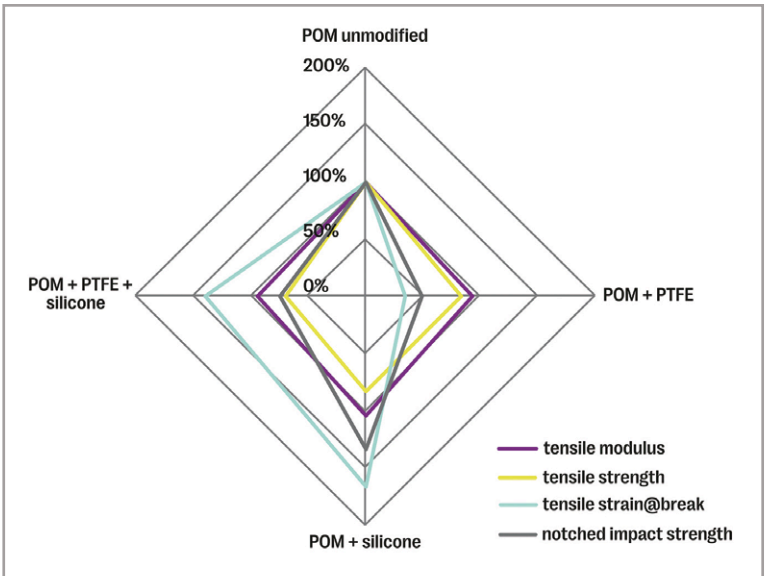

Figure 1: Chart showing the effect of different lubricant combinations on the tensile and impact properties of a POM compound
Source: Mocom

Functional options

UK-based **Colloids** offers a number of masterbatch products that are formulated to increase wear resistance characteristics in polymer compounds. The company uses numerous functional additives

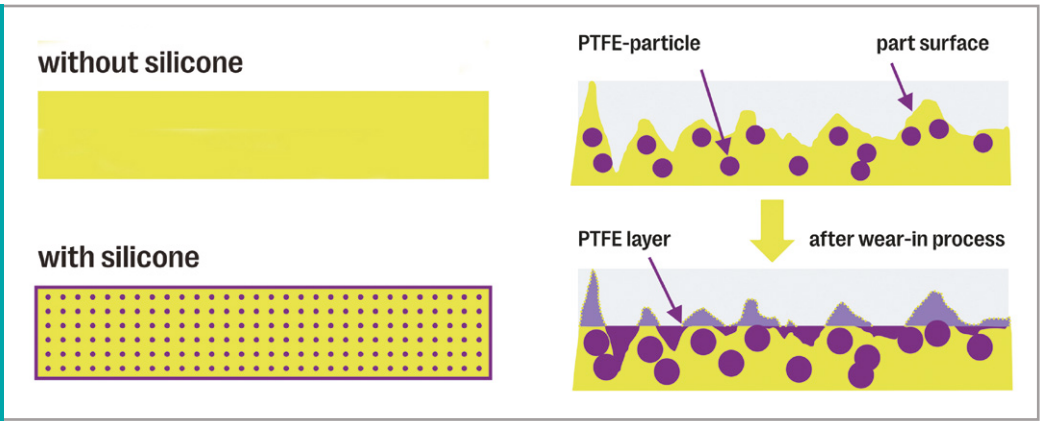

Figure 2: Schematic illustration showing the different modes of action of silicone and PTFE lubricants. Silicone (left images) functions through migration of silicone, which continually renews the lubricating surface layer. PTFE (right images) is embedded in the bulk material, with fresh particles exposed as the surface wear
Source: Mocom

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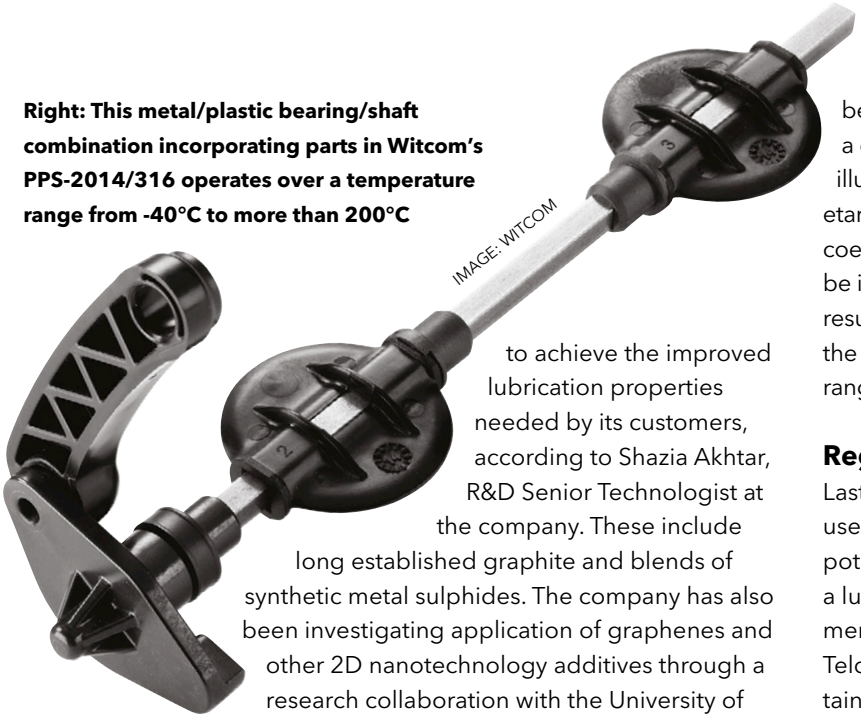

IMAGE: WITCOM

Right: This metal/plastic bearing/shaft combination incorporating parts in Witcom's PPS-2014/316 operates over a temperature range from -40°C to more than 200°C

to achieve the improved lubrication properties needed by its customers, according to Shazia Akhtar, R&D Senior Technologist at the company. These include long established graphite and blends of synthetic metal sulphides. The company has also been investigating application of graphenes and other 2D nanotechnology additives through a research collaboration with the University of Manchester, where graphene was first isolated and characterised in 2004.

Electro-mechanical devices are an important part of everyday life, whether they raise sun blinds, open the tailgates of cars, or drive the robots that assemble washing machines. All depend on problem-free operation of gears, bearings, guides, and slides working over long periods of time and a broad range of environmental conditions.

Witcom Engineering Plastics has developed a broad range of lubricated engineering plastic compounds for such applications with what it describes as outstanding wear and friction properties. "We see an increasing demand of low wear and friction compounds. In automobiles, buzzing, squeaks and rattles need to be kept to a minimum, as nowadays they are very noticeable, especially in electric vehicles," says Bram Willemen, the company's Business Development Manager for Lubricated Compounds.

Wear resistance has to be considered alongside other mechanical requirements, according to the company. A recent project for a metal/plastic bearing/shaft combination assembly incorporating a component in its Witcom PPS-2014/316 grade illustrates this. The compound contains a proprietary high performance lubricant system in which the coefficient of linear thermal expansion is adjusted to be in the same range as the metal elements. As a result, the bearing/shaft combination remains within the required tight tolerance field over a temperature range from -40°C to over +200°C.

Regulatory compliance

Last year, the EU toughened REACH restrictions on use of perfluorooctanoic acid (PFOA), which potentially affects compounds containing PTFE as a lubricant, according to Witcom Product Development Engineer for Lubricated Compounds Rudi de Telder. "We had to adjust some of our PTFE-containing formulations and started a lot of validation projects with our suppliers and customers and have successfully fulfilled all requirements with the new regulations," he says. "We also initiated the development of more non-halogenated lubricated solutions to provide more eco-conscious options as there will be more environmental pressure on PTFE and PFOA."

The EU 2020/784 regulation was originally intended to limit the amount of PFOA in PTFE micro-powder to 25 parts per billion (ppb) and was due to take effect on 4 July 2020. However, on 8 April 2020 it was superseded by an amendment to another regulation (EU 2019/1021) covering persistent organic pollutants (POPs), which allows for the use of PTFE micro-powders with PFOA at up to 1,000 ppb until 4 July 2022. After that date the limit is expected to revert to the originally proposed 25ppb limit.

US-based **Shamrock Technologies** is a global leader in PTFE micro-powder additives for lubrication and wear resistance modification across a variety of industries. It says it is committed to ensuring conformance with the more stringent <25 ppb

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REACH regulation with the launch of its new RC PTFE micro-powder product line.

"There is currently no globally accepted standard test method for measuring PFOA content in PTFE micro-powders, nor is there any indication as to how the regulation will be enforced," says company vice president Joon Choo. "Shamrock has pro-actively adopted a method similar to 3M's Standard Test Method (Edition 1.0, Nov 2016), based on extraction of PTFE powders with methanol and the use of liquid chromatography-mass spectrometry (LC-MS) to determine the concentration of PFOA. Shamrock's method has correlated well with test data from external test centres to validate accuracy and precision.

Compliance database

"With a validated test method, Shamrock established a fully dedicated PFOA test centre with 2 LC-MS systems and started building the database of PFOA in its portfolio of PTFE-containing products. With statistically significant lot-verified data, Shamrock mapped out pathways to ensuring that its product lines are fully regulatory-compliant (RC) to the level of <25 ppb, on an industrial scale, product by product, lot by lot."

PTFE micro-powder products based on controlled degradation process may be made with virgin or post-industrial recycled based PTFE, Choo says. "In some applications, the recycled based PTFE micro-powder products out-perform virgin based products. Different degrees of degradation seem to work better in some specific applications. Combinations of raw material type and varying degrees of degradation result in different pathways to achieve the desired RC product with specific performance in a variety of resins."

Shamrock's intention is to continue further improvement approaching non-detectable limits, as well as potentially offering alternative PTFE-free polymers that may perform the same functions, Choo says.

Austrian company **Tribotecc** specialises in additives that improve the tribological properties of high performance polymers and promotes itself as the world leader in synthetic metal sulphides. "Synthetic sulphides can be tailor made to the application, they are cleaner, give more reproducible results, and in many cases are more economical than traditional solutions," says Clemens Kappl, Head of Market & Technologies. "Synthetic sulphides contribute to our customers developing novel polymer formulations successfully competing against established formulations, and also against parts made of metal." ›

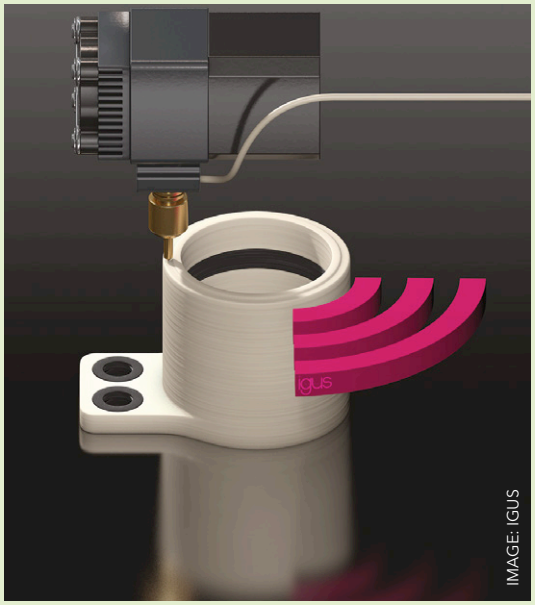

IMAGE: IGUS

3D print route to 'smart' bearings

German polymer bearing technology firm Igus has combined its tribogically-modified polymer formulation expertise with 3D print and Industry 4.0 concepts to provide a fast turnaround custom system for production of 'smart' bearings that integrate real-time performance monitoring.

Using a multi-material 3D print production process, the company can produce custom bearings with integrated wear sensing by combining tribologially-optimised and electrically conductive compounds.

The company says monitoring options are determined by the construction of the bearing. By sandwiching the conductive layer between the two wear layers, it says it can monitor the load on the bearing. By embedding a conductive track into the wear layer, it can monitor wear of the load-bearing layer.

According to Igus's Head of Additive Production, Tom Krause, the new process represents a significant breakthrough in smart 3D printed bearing production. ""In this way, predictive maintenance is also possible for special parts in a cost-saving manner," he says.

The components are manufactured from the company's Iglidur I150 or Iglidur I180 triboligically-optimised 3D print filaments and a specially developed electrically conductive 3D printing material. Igus claims a typical turnaround time of five working days.

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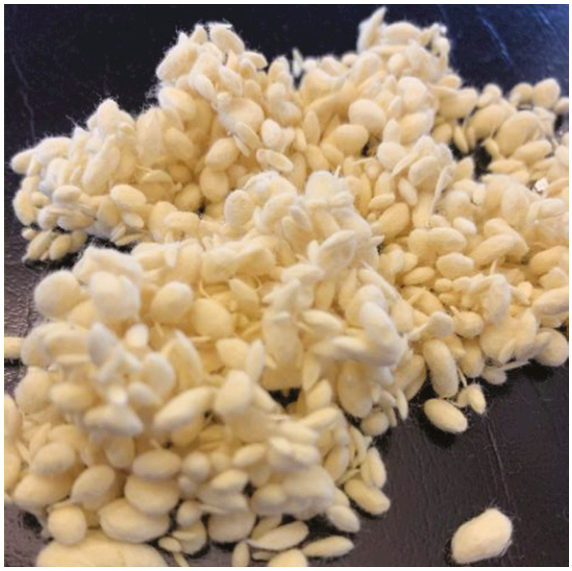

IMAGE: APPLY CARBON/PROCOTEX

Right: Granules of millimetre-long recycled para-aramid fibres for use in thermoplastics compounding

Aramid solutions

Short aramid fibres can be used in a variety of polymers in sealing and friction and wear applications. "The use of primary aramid fibre, however, also comes with a number of key challenges," says Dr Hans Miltner, who provides technical market and business development services for **Procotex**, a supplier of recycled fibres.

"First, primary aramid fibre is an expensive material, comparable to carbon fibre, which restricts its use mainly to high-performance application domains," he says. "Secondly, even though aramid fibre can be beneficial from a sustainability standpoint to many of the applications it enables (for example by reducing component weight, wear, or corrosion), the spinning of primary aramid fibre comes with an elevated CO_2 footprint and requires the use of sulphuric acid. And, finally, the outstanding thermal and chemical stability of aramid fibre imply that it cannot easily be eliminated – or disposed of."

On the other hand, he says aramid fibre lends itself to recycling, since it can be reused without any performance loss. Procotex, through its subsidiary Apply Carbon, sources high-quality post-industrial waste from major aramid fibre producers and processers, and converts it into various products. Binders are applied to ensure full compatibility with the matrix polymer in the targeted final compound.

Below: Plastic gears could benefit from the performance attributes provided by recycled aramid fibre, according to Apply Carbon

Apply Carbon typically produces pulled aramid fibre, supplied in 300kg bales. For applications demanding fibres with a well-defined length, it can supply precision-cut yarns in a range from 250µm to 120mm.

"Significant demand nowadays comes from the compounding industry, where short aramid fibre is chosen as a low-density additive to impart strength, toughness, durability and friction and wear performance," says Miltner.

Aramid fibre is substantially less abrasive than glass or carbon fibre and is, for this reason, often used in friction and wear applications such as bearings, clutch linings, or brake pads, he says. Synergistic effects can also result from the combined use of aramid fibre and PTFE in friction and wear formulations based on PEEK or POM, or acetal, where dramatically reduced coefficient of friction and wear rate has been seen in components in contact with moving metal surfaces.

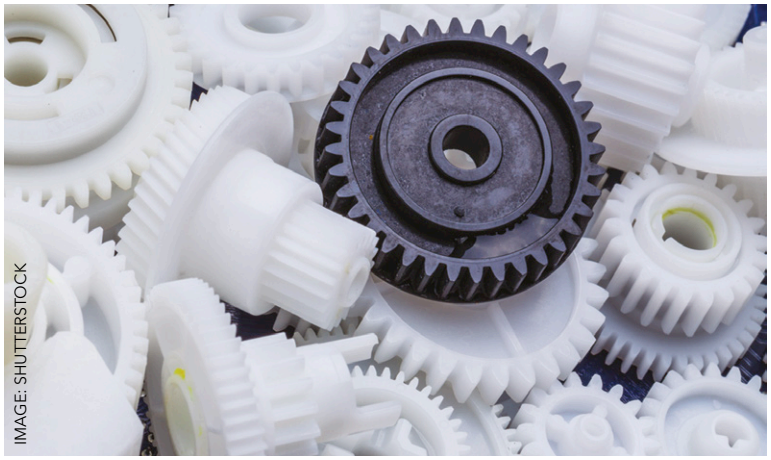

IMAGE: SHUTTERSTOCK

Miltner says e-mobility could significantly drive demand for recycled aramid fibre over the coming years. "Aramid fibre offers a set of highly desirable performance attributes that enable metal-to-plastic conversion in electric drivetrains and especially in gears," he says. These include lightweight and absence of corrosion, long term dimensional stability and resistance to creep and fatigue, and good damping properties. The latter can reduce gearbox vibration and improve the noise, vibration and harshness (NVH) characteristics of a vehicle.

The performance spectrum of Apply Carbon recycled fibres, which is claimed to be close to the level of primary fibre, enables development of innovative friction and wear compounds while exploiting an estimated 30-50 % lower cost versus primary aramid fibre and generating a fraction of its CO_2 footprint, according to Miltner. "There is more than sufficient recyclable aramid fibre feedstock available in the market to ensure security of supply," he says.

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IMAGE: SHUTTERSTOCK

***Increasing end user demands, in part a result of the global move to electric vehicles, are driving development of higher performing PA compounds, writes* Mark Holmes**

Automotive switch to EVs drives PA developments

Polyamides provide the mainstay of plastics growth in markets such as automotive, electrical and electronic (E&E), and others. To a great extent, this is down to the use of additives and fillers that enhance performance in areas such as flame retardancy, mechanical strength and toughness, and high temperature and chemical resistance. These performance gains are making PA compounds a 'go-to' solution for an ever broader range of applications.

Automotive and E&E remain key growth leaders in the PA market, according to **Brüggemann**. "There is currently an increase in global PA6 and PA66 compounding capacity, coupled with a measure of industry consolidation. There is also some ongoing inter-polymer competition, especially with PBT in E&E applications," says Dr Klaus Bergmann, Business Unit Manager Polymer Additives at the specialty additive maker.

"Long term security of supply is an issue in PA66 due to a continuing threat of supply bottlenecks. As a result, partial substitution of PA66 by PA6 is therefore ongoing. China has grown into the largest PA compound market worldwide and its significance will become even more pronounced due to continuing strong growth and resilience during the Covid pandemic," he says.

Brüggemann sees several key drivers for new developments in PA. The first relates to automotive industry efforts to meet more severe CO_2 emission standards through lightweighting, which requires polymers with higher strength and impact resistance. There is also a need for polymer compounds able to withstand higher temperature loads in smaller yet more powerful and energy-saving drivetrains.

The shift to e-mobility is also seeing increased focus on lightweighting approaches to combat the heavy batteries and to extend range between charges. And, across all end-use markets, the shift towards a circular economy means reducing environmental impact over the entire life cycle of a component, according to Brüggemann. ›

Main image: Intensifying demands from industries such as automotive are driving developments in PA compounds

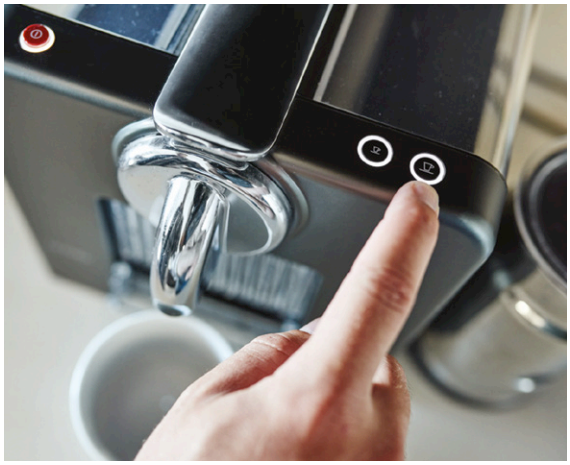

IMAGE: SHUTTERSTOCK

Right: Kitchen appliances such as coffee machines require PA compounds providing performance at elevated temperatures

Lightweight demands

"Lightweighting requires more intricate part design with ever thinner thin-walled components, increased glass fibre reinforcement to strengthen these components and advanced polymer additives to allow resultant compounds to be efficiently moulded and to perform as finished components," says Bergmann. "In addition, higher heat loads due to increasing under-the-hood temperatures require tailored heat stability of the multitude of polyamide components placed there. The broad spread of temperatures found there has highlighted the need for a more differentiated and sophisticated range of heat stabilisers."

Bergmann adds that in some food packaging and appliances, such as coffee machines or kitchen utensils, there is also a need to satisfy both high mechanical performance at elevated temperatures and food contact requirements. This can be met through use of appropriately modified PA compounds.

In the automotive sector, E-mobility means more electrical and electronic functional parts, which places new demands on polymeric materials. "Especially in sensitive E&E applications, there is a trend towards additive packages that are free of metal and halides," says Bergmann. "These are additives that do not trigger electrochemical corrosion while at the same time combine good stabilisation of mechanical properties at elevated temperatures and excellent electric properties."

Sustainable targets

Bergmann says sustainability is also high on most end-user agenda. "Sustainability as a central target for the future drives OEMs to increasingly focus on recycling and to include sustainability as an important part of their identity. Legislation and European directives will provide further incentives. Recycling of polyamide components is integral to automotive sustainability and is aided by the use of performance additives," he says.

Brüggemann has developed a number of additives to ease production of lightweight and thin wall parts in highly filled PA compounds. These include its Bruggolen TP-P1507 flow enhancer for standard polyamides and Bruggolen TP-P1810 flow enhancer for high temperature polyamides. In addition, nucleating agents such as Bruggolen P22 and TP-P1401 are offered to help optimise dimensional stability.

For application-specific heat resistance – which equates to extended mechanical performance at different temperature levels and ranges – the company's Bruggolen TP-H1607 and Bruggolen TP-H1803 heat stabilisers allow for tailor-made cost-performance solutions. Bruggolen TP-H1805 has been developed for high temperature environments of 200°C and beyond, for example in turbocharged engine environments.

Bruggolen TP-H2018 is a new heat stabiliser masterbatch for PA films and components contacting food, which helps to meet high mechanical performance demands. And for sensitive E&E applications, Brüggemann is launching Bruggolen TP-H2062, a metal and halogen free stabiliser system for e-mobility and other E&E applications (Figure 1).

In the area of polyamide recycling, Brüggemann's offering includes Bruggolen TP-M1417 and Bruggolen M1251/1253, both reactive chain modifiers that are said to allow for precise and reproducible adjustment of the relative viscosities of PA waste to the level of high-quality injection moulding grades. Other recycling-focused products include long-term heat stabilisers, processing stabilisers, flow enhancers, nucleating agents and other auxiliaries. The company says upcycling frequently requires a targeted selection and

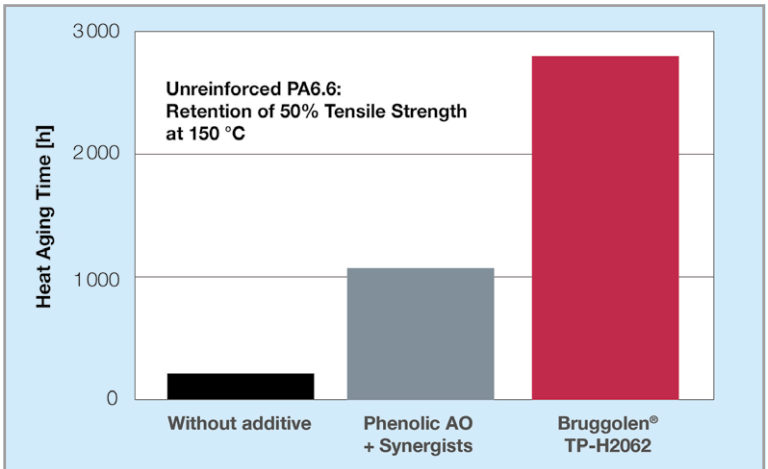

Figure 1: Tensile strength retention of unreinforced PA66 at 150°C comparing compounds with different stabilisation technologies, including Brüggemann's Bruggolen TP-H2062
Source: Brüggemann

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IMAGE: SHUTTERSTOCK

Above: Many automotive EV applications require combinations of thermal endurance, flame retardance and colour stability

combination of additives, such as its Bruggolen P31 powerful one-pack.

Looking ahead, Bruggolen TP-H1804 is a close-to-launch copper-based stabiliser system intended to close the heat stabilisation gap between 180-200°C. Brüggemann says it will outperform current stabilisers with significantly enhanced efficiency in this high to very high temperature range. Other new additives planned for the near future include halogen-free flame retardants for E&E that will tackle some of the drawbacks of currently available products, as well as a new additive solution for maintaining the orange colour (RAL 2003) for high voltage connectors and battery terminals.

Driven by automotive

The market for polyamides, while recuperating after the automotive downturn, will continue to be driven by developments in transportation whether for internal combustion, electric or hybrid vehicles, according to the Polymer Additives Team at **Clariant**. In addition, it is expected that the use of polyamides in household appliances will continue to increase because of the technical performance such compounds can offer over other polymer materials and due to their versatility and high performance, which will see PA compounds replace other polymer-materials such as PBT.

Among the more significant development trends, Clariant expects to see the introduction of new PA grades with better thermal stability and reduced water uptake, along with growth in partially bio-based polymer solutions. Other trends will include highly glass-filled and flame retarded compounds, greater use of recyclates, and increased use of halogen-free flame retarded polyamides in automotive applications for e-mobility.

Clariant says new PA additive solutions will continue to be in demand for stabilisation of highly glass-filled compounds, for both processing and long term use and in coloured, natural and black formulations. Flame retardance will also be a key area of development. In addition, recyclates that have endured extra heat histories and may contain contaminants will require unique material stabilisation and compatibilisation to make durable, aesthetically pleasing compounds. Recyclates are also often compounded with high amounts of fillers, for example minerals and glass fibres, which further increases the need for compatibilisation and performance improvements including flow and impact resistance.

PA stabilisation is now addressed by Clariant's Performance Additives business, while compatibili-

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sation is handled by Clariant's business line Advanced Surface Solutions, which offers functional maleated polymeric waxes that improve filler wetting. Clariant's third business line - Flame Retardants - tackles the interest concerning flame retarded polyamides in e-mobility, ageing and hydrolysis performance.

In the stabilisation area, Clariant's AddWorks TFB 117 has been developed to provide smooth processing, high light stability and good aesthetics for glass-filled polyamides. The additive was recently used in high processing temperature PA compounds, where it was found that the processing temperature could be reduced by 5°C compared to standard systems. This helps minimise thermo-oxidative degradation, the company says.

Clariant's Exolit OP 1400 flame retardant is claimed to meet the demanding requirements of e-mobility applications. A recent recycling study carried out at Fraunhofer LBF in Germany showed good results with Exolit OP 1400 used as a flame retardant in glass reinforced PA66.

The company says new grades that will allow improved glow wire performance are under development.

Clariant is also developing new additive products to improve recycling, including higher molecular weight MAH and similar grafted products that can enhance impact and tensile results of recyclates.

Stability improvements

Japan's **Adeka Corporation** has developed a range of light stabilisers to improve the long term weathering performance of PA. In particular, it says its ADK STAB LA-63P HALS (Hindered Amine Light Stabiliser) product has been found to be highly effective at improving weather resistance in accelerated testing of PA6. It is a methylated HALS grade with a high molecular of around 2000.

An evaluation of colour change (delta E) of PA6 sheet after weathering is shown in Figure 2, comparing the performance of ADK STAB LA-63P with a conventional NH-HALS and a competitor's high molecular weight NH-HALS at equivalent concentrations. The results show the Adeka grade was the most effective in suppressing discolouration. Furthermore, the company highlights an expected low volatility under polyamide processing conditions.

The company says only HALS was used as the light stabiliser in this study and it is recognised that, by formulating with a UV absorber (UVA), weather resistance can be further improved. It recommends its ADK STAB LA-31RG grade as a high heat-resistant UVA that offers low volatility at the processing temperatures of PA6.

Adeka offers additives to improve a wide variety of polymer attributes. One of its newest developments is a permanent antistatic agent series (ADK STAB AS-30X), which in preliminary testing in PA has shown promising results for improving surface resistivity. It will function with other engineering plastics as well as polyolefins.

Quarzwerke Group company **HPF Minerals** is continuing to develop high performance functional fillers for PA. "Polyamides are and will continue to be the most important of the engineering plastics, in particular within some key applications such as automotive including e-mobility and transportation. For this reason, there are and will be a lot of interesting developmental potential for polyamides in general," says Péter Sebö, Head of Marketing and Market Development.

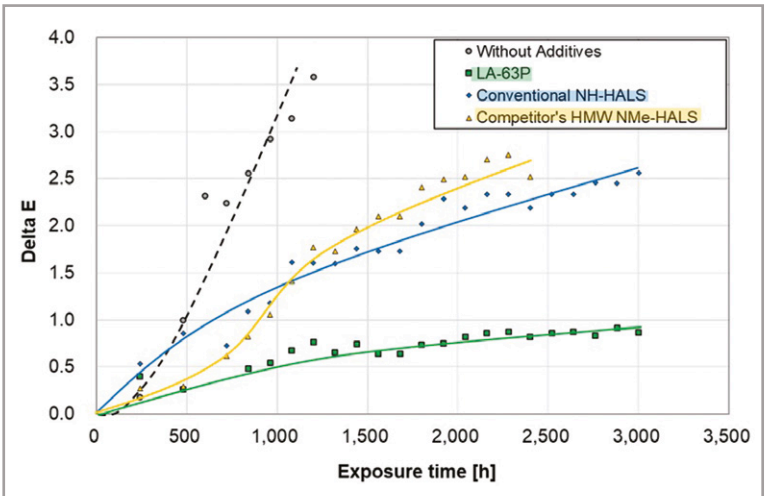

Figure 2: Evaluation of colour change (delta E) in PA6 sheet after weathering comparing Adeka's ADK STAB LA-63P with alternatives
Source: Adeka Chemical

Combination approach

"Replacement of PA66 by various PA6 compounds is still ongoing. Some interesting new developments have showed the possibilities of replacement of high-performance plastics, such as PPS, with some HT-PA grades. Furthermore, a combination of different properties will also start to play a more important role in the future, such as good flame resistance and thermal conductivity. These will probably require new additive solutions or combinations of additives and functional fillers," he says.

Sebö sees the main technical areas of interest at present in additives for polyamides including thermal conductivity and electrical insulating compounds, as well as electrical conductivity (for ATEX and EMI shielding purposes). He says the need for good flame retardancy will also continue,

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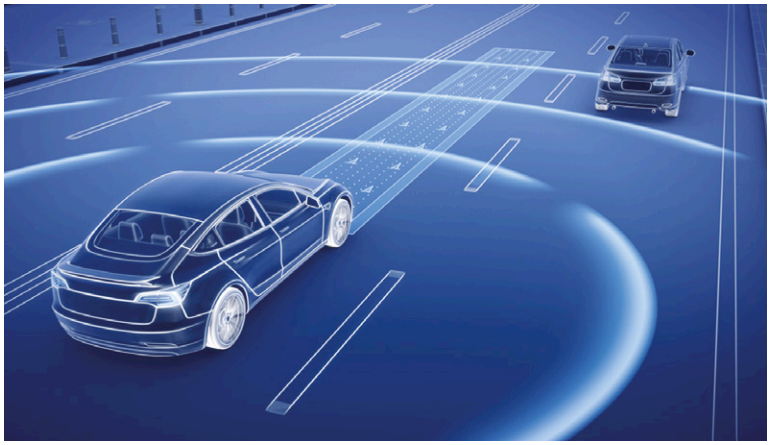

Above: Meeting performance demands of ever sophisticated driving aid technology will require combinations of specialty additives and functional fillers, according to HPF

as will lightweighting and good mechanical properties, and expects combinations of all these properties to be sought after.

"We have made a quite extensive investigation in terms of different high-performance fillers for high temperature polyamide grades, such as PA6/10, PA6T/6 and PA 9T, with the goal of modifying the properties," says Sebö. He says one of the company's key technologies in this area is the surface treatment of the minerals. A number of different temperature resistant surface treatments capable of meeting the higher processing and working temperatures for high temperature PA grades are currently under development, he says.

"We are also currently working on functional fillers for EMV/EMI (electromagnetic vulnerability/electromagnetic interference) applications and on the topic of combining CTI insulating characteristics with flame retardant and/or thermal conductivity properties," Sebö says. "As thermally conductive polymers find more application areas, we will also work closely with our customers and partners to optimise our Silatherm portfolio to achieve the requirements for e-mobility applications, in particular."

Enabling recycling

Sweden's **Nexam Chemical** also reports a positive development in polyamide markets and says it is receiving an increasing number of requests for additives to improve properties and processing. "We also see an increasing interest in the use of recycled polyamide, as well as other polymers in general," says Henrik Bernquist, Business Development Manager. "Generally during the recycling process, polymers lose a part of their performance due to degradation. The degradation decreases the molecular weight, and this has to be restored in order to reuse the polymer in more demanding applications. With our reactive recycling chemistry, we are able to offer products to ensure high quality products despite the use of recycled material."

Bernquist says rebuilding molecular weight in the extruder using its Nexamite masterbatch is of particular interest during recycling because it does not add cost in terms of equipment or extra processing steps. "We are also able to tailor our Nexamite range to fit specific customer requirements with respect to melt modification and chain extension and modification," he says.

Nexam Chemical has undertaken a number of tests to demonstrate the effectiveness of Nexamite, including an analysis of linear chain-extension in a long-chain PA intended for extrusion and monofilament processing. The improvement in melt strength due to chain extension is shown in Figure 3 while the impact on mechanical properties is demonstrated in Figure 4. ›

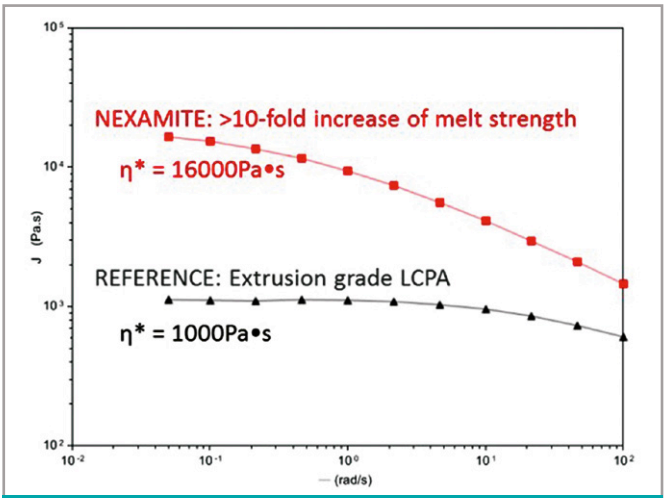

Figure 3: Analysis showing improvement of long chain PA melt strength due to linear chain extension using Nexam Chemical's Nexamite additive ***Source: Nexam Chemical***

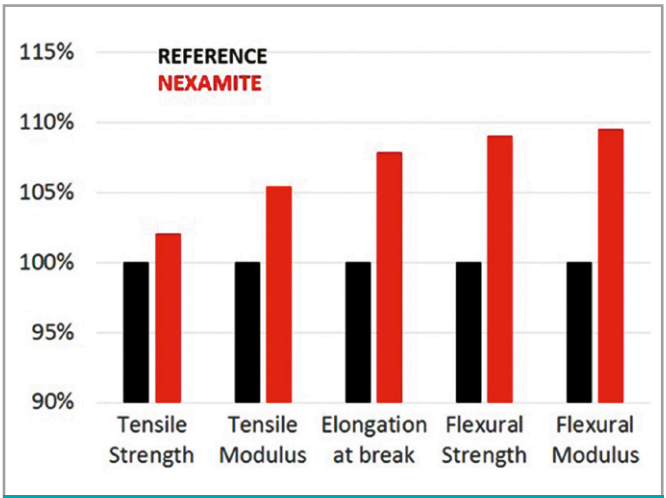

Figure 4: Mechanical property improvement of a long chain PA due to linear chain extension using Nexam Chemical's Nexamite additive ***Source: Nexam Chemical***

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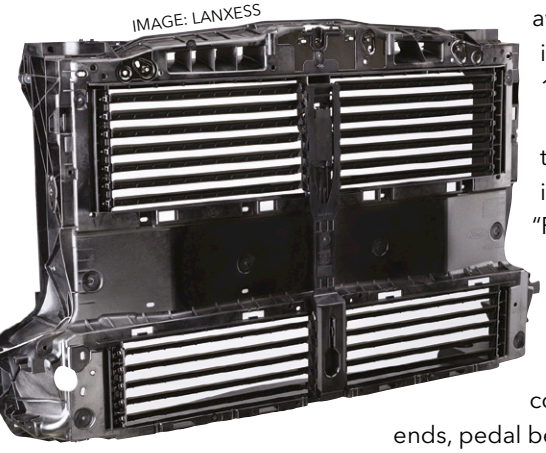
Compound development

Compounders and resin manufacturers are developing new PA compound formulations that meet higher performance, processing and sustainability requirement through the use of additives and innovative filler/reinforcement combinations. **Ascend Performance Materials** has launched several new grades of its HiDura long-chain PA 6/10 and 6/12 polymers, which are designed to provide good dimensional stability and long life along with enhanced resistance to chemicals, impact and abrasion. The new grades are said to be suitable for use in automotive fuel system and brake line applications, cable ties for solar power systems, battery seals and monofilaments for brush bristles.

The Durethan ECO PA product line from **Lanxess** uses reinforcing fibres produced from waste glass. Durethan ECOBKV30H2.0, ECOBKV35H2.0 and ECOBKV60XF are the most recent examples, using 30, 35 and 60% by weight recycled glass fibres respectively (the glass comes from waste left over from glass fibre production). Independent verification company Ecocycle has applied mass balance methods to the process and awarded an ecoloop certificate in accordance with ISO 14021:2016.

IMAGE: LANXESS



Above: Lanxess says structural automotive components, such as this front-end bolster for the latest Ford Kuga, could be produced in Durethan ECO PA compounds

Lanxess says the primary target for the new compounds is the automotive industry. "For instance, Durethan ECOBKV60XF offers exceptional strength and rigidity, which makes it suitable for manufacturing structural components such as front ends, pedal bearing brackets and A, B and C-pillars, as well as lightweight battery trays for electric vehicles," says Dr Guenter Margraf, Global Product Manager.

The company says its High Performance Materials unit will gradually increase the number of ECO product types certified in accordance with the mass balance method. It plans, for example, to launch a new PA6 with a glass fibre content of 30% and a reduced carbon footprint due to changes in its caprolactam production process.

Blending solutions

The High Performance Polymers division of Italy's **Radici Group** has introduced Radilon Mixloy, a new range of PA blends for automotive, consumer goods and E&E applications produced using compatibilisation technology. "At the moment, development is focused on certain types of alloys.

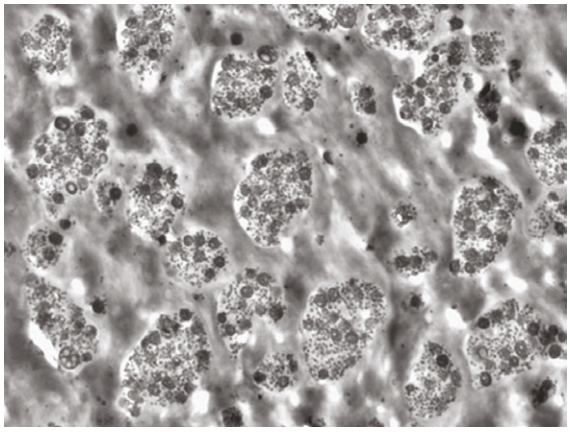


IMAGE: RADICI GROUP

Right: Radici Group's Radilon Mixloy compounds use PA blending technology to meet demanding performance requirements

But, in the future, we plan to add other products, with the goal of achieving properties that are simply not attainable with individual polymers," says Nicolangelo Peduto, Research and Development Manager.

"One of our objectives is to be able to meet the demand coming from market niches. Furthermore, thanks to our upstream vertically integrated polyamide production, we have at our disposal a number of different types of polymers that give us design freedom in formulating the new Radilon Mixloys," he says.

The base materials for the Radilon Mixloy product offering developed so far are PA6, PA66 and long-chain PAs, some of which are made from bio-sourced materials. The products offer high-performance, including good thermal resistance, mechanical resistance and surface appearance. They also offer low density, dimensional stability and ease of processing, together with low water absorption, improved tribological properties and low permeability.

The company sees many fields of application for the Radilon Mixloy products. In the automotive sector, they are suitable for interior parts, as well as for exterior body and engine compartment parts. Outside of automotive, the company sees the new blends finding applications in sporting goods, household appliances, and electronic equipment housings. They can also be used for FDM 3D printing due to their ease of processing, low water absorption and minimal shrinkage.

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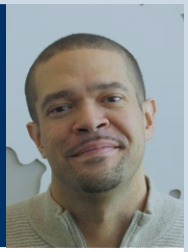

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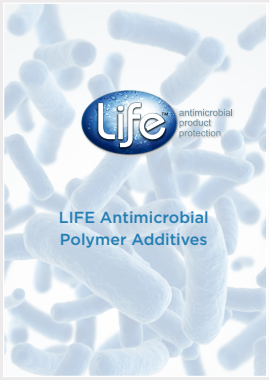

Life Material Technologies offers a full range of antimicrobial additives for protection of plastics from bacteria, fungi and algae, including silver inorganics, synthetic organics and natural botanics. Find out more in this four-page brochure.

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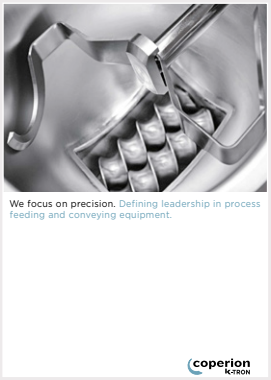

Coperion K-Tron provides a full portfolio of feeding and conveying equipment for compounders. This 16-page brochure details the full range, from volumetric and gravimetric feeders to blenders and metering units.

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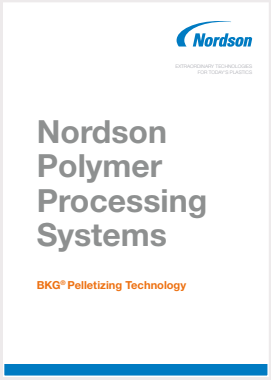

The BKG range of pelletisers from Nordson Polymer Processing Technology includes underwater, water-ring and strand systems suitable for almost any thermoplastic pelletising application. Find out more in this six-page brochure.

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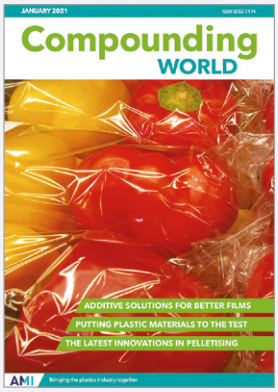

Compounding World January 2021
The first 2021 edition of Compounding World magazine looks at the latest additive developments for film production. It also explores the latest pelletising technologies and reviews new materials testing options.

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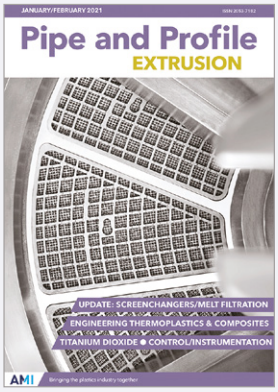

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The January/February 2021 edition of Film and Sheet Extrusion looks at how some polymer industry players have stepped up to take on the Covid pandemic. It also examines development in bioplastics, polyolefins and materials testing technology.

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