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Sirmax invests in Smart Mold

Italian compounder Sirmax has taken a 50% stake in Smart Mold, a sustainable plastics technology spin-off from the University of Padua.

Smart Mold operates in two key areas. Processing of recycled plastics, where it has a patented mould surface technology which allows filling at lower pressures. And polymer usage optimisation through detailed part and material design and simulation that allows development of material solutions containing recycled plastics.

"The technical knowledge acquired over the years, along with a desire to offer concrete solutions for sustainable plastic use, has led us to formulate a business proposal that contributes to reducing the impact of plastic," said



Sirmax has taken a 50% stake in university spin-off Smart Mold

Giovanni Lucchetta, Smart Mold Founder and Partner and Professor of Manufacturing Engineering at the University of Padua. "Thanks to our mould surface treatments, we can 'elevate' recycled plastic, while our engineering activity means we can significantly reduce the thickness and weight of many structural components, decreasing both plastic consumption and molding costs."

Sirmax has been collaborating with the Department of Industrial Engineering at the University of Padua for many years, taking part in research projects and donating scientific laboratory equipment.

"The synergy between Sirmax and Smart Mold will enable us to offer both new and existing clients something beyond simple compounds," said Sirmax President and CEO Massimo Pavin. "We will be able to offer stronger, more environmentally-conscious materials and replace high-impact materials with better-performing ones."

The investment in Smart Mold is part of a three-year €80m development plan at Sirmax that was initiated in 2019 and is largely focused on circular economy activities. This has seen it acquire plastics recycler SER and bioplastics producer Microtec, both based in Italy, as well as the inauguration of its second Polish plant at Kutno to produce high recycled content TPEs. The company also plans to open a second SER facility at Anderson in the US this year. > www.sirmax.com

DKSH works for Maag

Switzerland's Maag Group, which supplies pumping and filtration, pelletising, pulverising and recycling systems, has reached a distribution agreement for Indonesia with DKSH.

Maag and DKSH have worked together in the Japanese market since 1990. The new agreement covers marketing and sales, regulatory competence, distribution, logistics and after-sales service for customers in Indonesia.

> www.maag.com

PVC recycling 'on target'

VinylPlus, which manages the European PVC industry's voluntary commitment to sustainable development, has issued its 2020 progress report showing the industry recycled 771,313 tonnes of PVC in 2019, more than 96% of its 2020 target.

The association said the 2019 performance indicates that the industry is well on track to meet its challenging recycling target for 2025 of 900,000 tonnes.

The future for PVC recycling in Europe was clouded by the European Parliament's decision earlier this year to vote down a derogation from the



European PVC recycling will hit 900,000 tonnes in 2025

European Commission that would have allowed low level use of now-restricted "legacy" additives in recycled products.

A Vinylplus spokesperson told *Compounding World* it has provided feedback to the Commission on the consequences of that decision since the vote. "They are working on some amendments; for the time being VinylPlus does not know which ones." MAGE: SHUTTERSTOC

> www.vinylplus.eu

www.compoundingworld.com

Plastics recycling to hit 77m tonnes by 2030

Global plastics mechanical recycling volumes will grow to 77m tonnes by 2030 despite a short-term slowdown over the 2020-2022 period due to the ongoing impact of the coronavirus pandemic, according to new sector analysis from the consulting division of AMI (publisher of *Compounding World*).

The study – The Global Mechanical Recycling Industry - says plastics waste is at the forefront of regional and national policy debates and the global plastics recycling industry has never been more in the spotlight. It analyses the impact that China's restriction on waste imports since 2017 has had on the sector. At its peak the country imported 7m tonnes of plastics annually but now accepts just one fifth of that volume. While a number of south-east Asian countries stepped in to take some of this waste, the report says



that national governments across the region are now introducing their own waste import bans.

"It is clear that the reliance of countries on being able to export their waste, along with recyclers dependence on imports for feedstock, cannot be guaranteed," the report says. "The only truly sustainable solution is for domestic waste collection and recycling infrastructure to be adequate to deal with domestic demand, creating national self-sufficiency."

The **study** quantifies the global market for mechanical recycling, analyses the supply and demand balance, and evaluates current production by region. It also provides a detailed review of end-use applications for recyclate, with forecasts of potential future absorption.

> www.ami.international

Fire at RTP plant in Germany

A major fire broke out at the RTP Company technical compounding plant at Ladenburg in Germany on 19 May.

According to local media reports, extensive damage was caused and more than 150 firefighters were involved in bringing the blaze under control. No injuries were reported. RTP Company has declined to provide details of the damage to *Compounding World*.

RTP opened the Ladenburg plant in 2011. The 10,000m² operation produces a wide range of RTP products, including LFTs and conductive compounds. It is one of three RTP production units in Europe; the US company also has a 10,000m² facility at Beaune in France and an 8,000m² plant at Wroclaw in Poland (where it also makes LFTs).

> www.rtpcompany.com

Domo teams up with 3Dprint firm ZARE



Germany's Domo Chemicals has partnered with Italian 3D-printed parts service bureau ZARE to develop opportunities for its Sinterline Technyl family of 3Dprint powders.

ZARE specialises in precision mechanics and since 2009 has diversified into rapid prototyping service, with 25 industrial-grade machines that cover all additive manufacturing technologies.

Domo, which offers the Sinterline Technyl range of PA6 powders for selective laser sintering, said that as manufacturers move from prototyping to serial production they are demanding higher mechanical and thermal performance standards from suppliers. Working with ZARE will put it in a better position to offer support to customers, particularly in the automotive and consumer electronics industries, it said.

> www.domochemicals.com > www.zare.it

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PlasticsEurope's Baunemann dies

Dr Rüdiger Baunemann, General Manager of PlasticsEurope Germany, died "suddenly and unexpectedly" at the age of 58 in his home town of Leun in Germany on 17 April.

Baunemann joined PlasticsEurope Germany's predecessor, VKI, in 1989 and held the post of Managing Director and Head of the Plastics and Consumers Division from 2002 to 2010. He had been General Manager of PlasticsEurope Germany, as well as Regional Director for Central Europe and part of the PlasticsEurope leadership team in Brussels, since 2011.

"Under the leadership of Dr Baunemann, PlasticsEurope Germany has become a strong advocacy group for the plastics industry, which enjoys a high reputation with politicians and the public," said Dr Michael Zobel, Chairman of the association.

Dr Ingo Sartorius, currently Head of the People and Environment section at PlasticsEurope Germany, has taken over management on a provisional basis.

> www.plasticseurope.org



PlasticsEurope Germany's Dr Rüdiger Baunemann

Vestolit sale on hold

Orbia, formerly Mexichem, has put plans to sell its Vestolit PVC business (Polymer Solutions Business Group) on hold due to market disruptions caused by the coronavirus pandemic.

The company said the Vestolit business was fundamentally strong with a unique global footprint and strong cash generation. It said it was prepared to wait for the right environment to maximise shareholder value. > www.orbia.com

BASF licenses Red Avenue to produce PBAT in China

BASF has granted Chinabased Red Avenue New Materials Group a licence to produce compostable aliphatic-aromatic co-polyester (PBAT) to BASF quality standards.

Under the agreement, Red Avenue will build a 60,000 tonnes/yr plant in Shanghai that will use BASF's process technology. BASF will have access to raw material from the plant, which it will sell under its Ecoflex brand. Production is due to start in 2022.

BASF currently produces Ecoflex at its plant at Ludwigshafen in Germany. The certified-compostable polymer can be produced from bio-based sources but is currently made from fossil-based feedstock. Together with PLA and thermoplastic starch, Ecoflex forms the base for BASF's Ecovio blends.

The global market for certified compostable and bio-based plastics is expected to grow by around 15%/year, according to BASF, driven largely by new laws enforcing the use of compostable materials in packaging, agricultural mulch films and bag applications in certain countries.

■ In an unrelated move, BASF began piling work for the first plants in its 'smart verbund' project at Zhanjiang, Guangdong province, China, at the end of May. These will produce thermoplastic polyurethanes for various industries in southern China and throughout Asia. First production is expected to be on the market by the end of 2022.

> www.ecoflex.basf.com> www.basf.com

Suzhou Hechang lifts its LFT capacity



Chinese compounder Suzhou Hechang Polymeric Materials has upgraded the 64-strand LFT production line at its plant at Suzhou in Jiangsu province, lifting output by more than 40%.

The line was originally supplied by Germany's ProTec Polymer Processing in 2017. It has now been upgraded by ProTec to run at a line speed of 50 m/min, delivering outputs of up to 1.5 tonnes/hr depending on the specific recipe.

Protec has installed around 10 LFT lines in Asia, including four in China. Last year, Suzhou Sunway Polymer Co added a 64-strand Protec line to the 32-strand line from the German company it had been running since 2017.

> www.sp-protec.com

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Gabriel-Chemie adds PVs

Masterbatch supplier Gabriel-Chemie has completed a new photovoltaic installation at its site at Gumpoldskirchen in Austria in move that the company said shows "how to successfully combine plastics with sustainability, at the same time sending out a clear signal for climate and environmental protection".

The installation, which was part funded through the European Regional Development Fund, comprises 2,671 roofmounted photovoltaic panels covering an area of 4,487m² on its production and warehouse buildings. It will supply up to 903,500 kWh/yr of energy to the plant and the power grid. **> www.gabriel-chemie.com**

US machinery shipments down 20% in Q1 2020

US shipments of primary plastics processing machinery fell by 19.6% in Q1 of this year compared to Q4 of 2019, according to the latest report by the Plastics Industry Association's Committee on Equipment Statistics (CES). At \$254m, the result was also 6.9% lower than in Q1 2019.

Shipments of injection moulding equipment were 23.6% down on the previous quarter, following a large number of shutdowns driven by Covid-19 in March. Twin-screw extruders declined marginally by 0.8%. However, shipments of single-screw extruders rose by 15.5%.

US machine exports were 1.6% up at \$358.5m, while imports rose by 0.5% to \$746.3m, slightly narrowing



the trade deficit to \$387.8m. According to the CES's quarterly industry sentiment survey, 18.5% of respondents expect conditions to either improve or hold steady in Q2 and 22.6% expect this to hold for the next 12 months. Both figures are, however, massively down on expectations expressed in Q4 2019 before the pandemic struck. demic continues to disrupt the manufacturing and service sectors of the economy, both impacted by the plastics industry," said Plastics Chief Economist Perc Pineda. "However, the demand for plastics remains fundamentally healthy, particularly in the medical and consumer essentials spaces, and the economic slowdown is transitory."

> www.plasticsindustry.org

"The coronavirus pan-

A rendering of the new Orion logistics centre in Germany

DRION ENGINEERED CARBONS

Orion investing in Cologne

Carbon black specialist Orion Engineered Carbons plans to "top out" its new logistics centre this month at its largest manufacturing plant in Cologne, Germany, which produces 160,000 tonnes/yr in over 100 differentiated grades.

The new centre is expected to be commissioned in December. When complete, the central warehouse will cover an area of 8,850 m².

> www.orioncarbons.com

Aimplas tackles odour with microbes

Spanish plastics industry centre Aimplas is trialling a technology that uses microorganisms to eliminate odours from plastics recycled from post-consumer dairy packaging.

The technology is part of the association's work in the Enzplast project, which aims to develop sustainable processes for production, recycling and composting of plastics. Results to date indicate that a reduction in odour intensity can be obtained.

The researchers have also found that treating polyurethane-type polymers with selected microorganisms can improve biodegradation by up to 70%. Other work has shown that incorporating polymer-supported enzymes in a molten polymer can improve biodegradation of various bioplastics under aerobic and anaerobic digestion conditions.

The Enzplast project is now in its second year and is supported by the European Regional Development Fund.

> www.aimplas.net

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LG and Cabot invest in CNTs

LG and Cabot are expanding their positions in carbon nanotubes (CNTs) with the former announcing new production capacity and the latter acquiring Chinese producer Shenzhen Sanshun Nano New Materials.

LG Chem is to invest KRW65bn (€121m) to expand carbon CNT capacity at its site at Yeosu in Korea from 500 tonnes/yr to 1,700 tonnes by Q1 2021. The move is largely driven by growth in demand for CNTs in electric vehicle batteries, which is projected to increase from 3,000 tonnes in 2019 to 13,000 tonnes in 2024. The company claims to be the world leader in this market.

LG Chem began development of its proprietary CNT technologies in 2011 and built a 20 tonne pilot production



CNT investment is being underpinned by growing EV battery demand

line in 2013. It currently holds more than 250 patents in CNT-related fields and claims the world's largest fluidised bed reactor for their production in various forms.

Meanwhile, Cabot Corporation

completed its \$115m acquisition of Shenzhen Sanshun Nano New Materials (SUSN) in April. The company, which makes carbon nanotubes (CNTs) and dispersions in China, recorded sales of \$28m in 2019 and will be integrated into Cabot's Performance Chemicals segment.

Cabot said that the move makes it the only carbon additive supplier with commercially proven carbon black, CNT,

carbon nanostructure and dispersion capabilities. It said the move "significantly strengthens" its position and formulation capabilities in the batteries market, particularly in China, which is the largest and fastest growing electric vehicle market in the world.

> www.lgchem.com> www.cabotcorp.com

Lactips wins €13m funding

Lactips, a French company that claims to have developed a fully biobased and biodegradable water-soluble polymer, has raised €13m in a new financing round.

The company will use the new funding to ramp up its product development and specifically "to accelerate the industrialisation of its plastic pellets and films to offer a wider selection of fully biodegradable and recyclable biosourced packaging". It also plans a new production plant on a 2,500m² site in the Gier Valley, south west of Lyon.

Collin launches P 2.0 series

Collin Lab & Pilot Solutions has launched its P 2.0 series compounder. The Lab Line ZK 25 P is claimed to offer 25% higher performance, with a speed of 1,200 rpm and a torque of 13 Nm/cm³ allowing processing of highly viscous or highly filled materials.

The series is available with processing lengths of 36 to 60D and can be configured with multiple side feeders with gravimetric or volumetric dosage. It can be provided with either mechanical or optional motor-driven height adjustment, allowing easy integration with other equipment, while the screw can be pulled out backwards without having to change the position of the



compounder, which the company says makes cleaning easier.

The machine can be equipped with the company's new CMI 17 controller, which offers a number of intelligent features including plug-and-play connectivity. "Exchangeable cylinder elements with coded plugs can be arranged in nearly any order, since the control recognises the respective function via the coding," said CEO Dr Friedrich Kastner.



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Chemical Recycling Europe calls for faster recognition

Chemical Recycling Europe (CRE), which claims to represent the chemical recycling sector, has published a position paper calling for "a faster recognition and legislation review" to unlock the technology's potential. The full paper is available on the CRE website.

CRE argues that for the EU to meet the EU recycling targets laid down in its Plastics Strategy and the transformational change required by the EU Green Deal "there is an urgent need to develop and implement new technologies for the recycling of polymeric waste, going beyond the limitations of traditional mechanical recycling."

The organisation says that chemical recycling complements mechanical recycling and will help meet targets by processing polymeric wastes that are currently difficult to recycle. Investment in it will also create new jobs, help to curb CO₂ emissions and increase recycling capacity, CRE claims.

The paper defines chemical recycling as any reprocessing technol-

Proponents see chemical recycling as essential to handle difficult



ogy that directly affects either the formulation of the polymeric waste or the polymer itself and converts it into chemical substances and/or products for the original purpose or others. These include depolymerisation, pyrolysis, hydrothermal cracking and gasification and dissolution, but not energy recovery.

CRE calls for EU member states to recognise that the Waste Framework Directive (WFD) regards chemical recycling as a form of recycling and to adjust targets accordingly. It also asked for an urgent review and harmonisation of regulation, and for Extended Producer Responsibility principles to apply to all recycling technologies.

The paper argues that EU recycling infrastructure should be developed along the lines of the Waste Hierarchy, which means preventing exports of plastic waste where possible and diverting recyclable plastics from energy recovery.

> www.chemicalrecyclingeurope.eu

Ascend partners with Resinex in Europe

Ascend Performance Materials has announced a distribution agreement with Resinex covering its Vydyne brand of PA66 across most

of Europe, as well as Turkey and South Africa.

"The wide reach of Resinex in the European thermoplastic market supports Ascend's growing European distribution model and better equips us to serve our customers efficiently," said Christelle Staller, Ascend's European Sales Director.

Resinex will distribute Ascend's PA66 grades across most of IMAGE: ASCEND PERFORMANCE MATERIALS Europe

Ascend is the world's largest fully-integrated producer of PA66 resins, which are mainly used in the automotive, electrical and electronics, and consumer and general industrial sectors.

> www.ascendmaterials.com

Mitsubishi Chemical acquires Gelest

Mitsubishi Chemical has agreed to acquire Gelest from New Mountain Capital, which had owned it since 2017. Completion is expected in 2020, pending regulatory review.

Gelest supplies silicones, organosilanes, metal-organics and speciality monomers for applications including medical devices, life sciences, microelectronics and personal care.

MCA president Steve Yurich said that Gelest "fits well within MCC's long-term strategy ... Furthermore, MCC's operating resources and customer network will enhance the ability to bring Gelest's technologies to market and accelerate the development of new customer solutions." > www.m-chemical.co.jp/en/

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Free registration opens for US plastics industry exhibitions

Free online **registration** is now open for four US-based exhibitions and conferences focused on plastics compounding, extrusion, recycling, and testing. Organised by *Compounding World* publisher AMI, the Compounding World Expo, Plastics Extrusion World Expo, Plastics Recycling World Expo, and Polymer Testing World Expo all take place at the Huntington Convention Center in Cleveland, Ohio, on 4-5 November 2020.

By registering in advance, visitors will receive free admission to all four exhibitions – featuring more than 250 leading suppliers – plus free entry to the five conference theatres hosting technical presentations, educational seminars and business debates. Attendees and exhibitors also have the option to buy tickets (just \$40 each) for a networking party at the Punch Bowl Social on the evening of 4 November.

"The event will provide visitors with a great opportunity to meet and compare suppliers from around the world, as well as giving them the chance to learn from business leaders and technical experts in the conference theatres," said Rita Andrews, Head of Exhibitions at AMI. "When we ran these expos in Cleveland last year,



4,375 visitors attended the first Cleveland plastics expo in 2019. The limited number of remaining booths are filling up fast. To find out more about exhibiting at any of the expos, visit https://www.ami.international/exhibitions.

we attracted 4,375 visitors, making them the biggest plastics industry gathering in the USA in 2019".

The four expos will occupy the largest halls at the state-of-the-art Huntington Convention Center in downtown Cleveland. They will feature a wide array of leading manufacturers of compounding, extrusion, recycling, and testing and analysis equipment, plus suppliers of a huge variety of polymers, additives and related services.

The exhibitor line-up already includes companies such as Amut, BYK, Cardinal Recycling, Clariant, Coperion, CPM Century Extrusion, Cumberland, Davis-Standard, Dover Chemical, Dynisco, Entek, Erema, Geon, Heritage Plastics, Intertek, Konica Minolta, KraussMaffei, Leistritz, Macro, Maguire, Matsui, Milliken, Netzsch, NGR, Nordson, Omya, PerkinElmer, PTi, Reifenhauser, Q-Lab, SI Group, Struktol, Thermo Fisher, Vecoplan, Windmoeller & Hoelscher, and hundreds more.

The five focused conference theatres will feature more than 120 expert speakers over the two days, including influential representatives from leading compounders, extruders, recyclers and testing organisations.

Book your free ticket for the expos and conferences, which is valid for both days of the event, **HERE** or visit: https://na.compoundingworldexpo.com

Total strikes partnership with PureCycle

Total and PP recycling specialist PureCycle Technologies have agreed a strategic partnership in plastic recycling that will see Total buy part of the output of PureCycle's planned facility in the US. The two companies will also consider developing a new plant together in Europe. PureCycle will begin construction of its first plant in Ohio this year. It will produce 48,000 tonnes/yr of PP using a patented recycling technology licensed from Procter & Gamble. The process technology is claimed to remove colours, odours and other contaminants from waste feedstock and transform it into virgin-like PP.

Total described the agreement as part of a much wider commitment to plastics recycling. It has set a target of producing 30% recycled polymers by 2030 and already has 15 grades of PP and PE that contain at least 50% recycled materials. It also owns French recycler Synova, which will be making 40,000 tonnes/yr of recycled PP compounds for the automotive sector by 2021.

- > www.total.com
- > www.purecycletech.com

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Suppliers of PVC stabilisers continue to work on improving the effectiveness and safety of their products. **Peter Mapleston** explores some of the latest developments

Stabiliser makers push the safer approach

Performance and safety appear to be the top priorities for PVC stabiliser development, with many PVC stabilisers working on increasingly complex systems that contain no substances of very high concern (SVHCs) while still providing superior performance. This is especially the case in Europe, according to the European Stabiliser Producers Association (**ESPA**, a Cefic sector group), whose nine members represent over 95% of the PVC stabiliser industry in the region. "ESPA members have committed to proactively use in their systems only molecules which, at the current knowledge, do not fall under future regulatory restrictions," says ESPA's Manager, Jordi Just.

This ambition is being supported by the Additive Sustainability Footprint (ASF) tool, which is a recent development from the VinylPlus Additives Committee and is a project led by ESPA President Ettore Nanni (who is also President of ESPA member Reagens). ASF is an industry-wide methodology based on the Sustainability Life Cycle Assessment approach developed by The Natural Step, an NGO advisor to VinylPlus. "Through a 10-step approach, this tool allows its users to assess and promote the sustainable production and use of PVC additives across entire product life cycles, including the role of additives in the performance of PVC products," says Just.

The stabiliser system is the key performance related additive in any PVC formulation, according to Guido Allieri, Business Manager at **Reagens**. He says that for the processing of flexible PVC, systems based on liquid mixed-metal soaps (LMMs) are the most commonly used form of stabiliser, but solid stabilisers are becoming more and more important because of increasingly demanding technical requirements and calls for reduction of emissions.

Reagens manufactures a full range of liquid stabilisers, including products with inherent self-lubrication properties as well as non-lubricating types, designed to fit different application technologies. Allieri says that as well as its convenMain image: PVC stabilisation system developments aim to provide better performance with an improved safety profile **Right: Markets** such as flooring are demanding an overall reduction in emissions

tional products, Reagens offers systems that meet with low odour/low phenol and low emission criteria. "In harmony with these concepts, all the products in Reagens' portfolio are characterised by the absence of chemicals that can be subjected to restriction by REACH regulations, like CMR category 1 and 2, PBT and ED and other undesirable chemicals," he says.

Explaining that REACH is driving the European chemical industry to develop safer solutions, Allieri highlights the SVHC list based on hazard classification. A supplier of any product on the list needs to communicate the presence of that product along the supply chain if it is used at levels above 0.1 wt.%. "This is triggering the development of new chemistries, and Reagens has developed a new generation of LMMs that are not only REACH-friendly today, but also REACH-friendly long term: the new liquid Reagens 600 & 900 Series that include products free from any S-VHC or potential S-VHC substances."

Allieri says Reagens has developed a process that enables it to manufacture organophosphate intermediates free from any phenol contamination. This makes it possible to formulate LMM stabilisers (barium/zinc or calcium/zinc) that are said to have zero phenol. "Reagens 600 & 900 Series stabilisers are giving a significant contribution to reduce emission problems from the final articles, particularly for indoor applications that have to meet more stringent regulatory and technical demands - flooring, wall covering, etc," he says.

In a number of applications, typically for indoor uses, technical requests are driving recipes towards a significant reduction in emissions from the final article, Allieri explains. "More and more, the answer to these requests is in the selection of a solid COS [Calcium Organic Stabiliser]," he says. "Reagens' Reapak range of solid COS stabilisers includes several grades in powder form, some of them available also in granules or in pastilles, to fulfil all technical requirements. The use of solid stabilisers is now increasingly possible also in plastisol operations, because of the appropriate composition and



the physical form of the powder - micronised - that allows an easy dispersion into the plastisols."

Enhancing value

At Galata Chemicals, Vice President Peter Frenkel says that, in an effort to enhance the cost-in-use value of its additive offerings, the company has developed, patented and commercialised a new range of high efficiency solid and liquid stabilisers. These are designed specifically to be used in compounds plasticised with its Drapex Alpha 200 and Drapex Alpha 215 bio-based plasticisers. He says efficiency of the new stabilisers exceeds the most demanding requirements.

Required loadings of solid Mark 3600, Mark 3601 and Mark 3602 – intended for use in general purpose, tarpaulin and cable PVC compounds respectively and all plasticised with Drapex Alpha 200 - were 60-80% lower than those needed for conventional Ca/Zn stabilisers in compounds plasticised with conventional plasticisers, he says. "These heat stabilisers imparted excellent transparency and extended long-term heat stability as well as improved overall dynamic heat stabilising performance of the plasticised compounds."

Similarly, stabiliser loadings could be reduced by 50-60% when using the new liquid Mark 3610 and Mark 3611 in combination with Drapex Alpha 200. Frenkel says the new stabilisers considerably

	Time (minutes)									
	0	10	20	30	40	50	60	70	80	90
CaZn Control/DOTP										
Mark 3600/Drapex Alpha 200										

SOURCE: GALATA CHEMICAL

Figure 1: Chip chart showing how a combination of Galata Chemicals' Mark 3600 solid stabiliser and Drapex Alpha 200 plasticiser imparts superior long-term heat stability to a PVC compound than a combination of a Ca/Zn stabiliser and DOTP at 200°C



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outperformed conventional liquid Ca/Zn and Ba/Zn stabiliser/plasticiser combinations in terms of both static and dynamic heat stability, while imparting comparable transparency.

"It is expected that incorporation of these high-efficiency stabilisers at reduced loadings into flexible PVC compounds will lead to improved plasticiser permanence as well as enhanced performance of final articles," Frenkel says. "In addition to the described performance attributes of the new liquid and solid high efficiency stabilisers, Drapex Alpha bio-based plasticisers also impart plasticisation efficiencies superior by 5-15% compared to conventional plasticisers such as DOTP and DINP."

Galata says that incorporation of these high efficiency stabiliser/plasticiser combinations into flexible PVC compounds can result in cost-in-use reductions. The company adds that the Mark 3600, Mark 3601, Mark 3602, and Mark 3610 products are all suitable for use in selected food contact applications in the US.

PMC Organometallix is developing what Clarke McGuire, Global Business Director Stabilisers, says is a next generation of organotin stabilisers that incorporate proprietary fatty acid ligands

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and that can be used by themselves or in conjunction with the standard 2-EHMA (ethylhexyl methacrylate) ligands. The fatty acid ligands are being utilised in octyl- and methyl-based stabilisers to overcome regulatory issues with dioctyltin EHMA (DOTE) stabilisers, he says.

REACH restriction

"DOTE has recently undergone further REACH restriction in its use and alternative stabiliser technologies have been developed. As well as providing potential alternatives to DOTE, these materials can also bring cost and performance improvements against traditional methyl-based EHMA stabilisers," he says.

The fatty acids are sourced from sustainable agricultural products and are produced by another company in the PMC Group, PMC Biogenix. Its activities are focused on speciality chemicals produced from renewable resources.

McGuire says a representative example in the new range of materials is Advastab OM-3126. The additive, which contains substantially less tin than traditional methyl-based EHMA stabilisers, has been shown to provide similar end-use perfor-

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IKA claims its patented S-granule technology enables broader formulation flexibility

mance in demanding applications such as exterior profiles and foam board. "Process improvements include lower torque as a result of the higher internal lubricity derived from the fatty acid components relative to the EHMA ligand," he says.

PMC Organometallix is also exploring tin stabilisers that are fully EHMA-free. An example is Thermolite OM-3130, which McGuire says has shown process and finished article improvements relative to the use of traditional octyl-based EHMA stabilisers in applications such as PVC film and sheet.

Established expertise

At **Valtris Specialty Chemicals**, Business Director Stabilisers Brenda Hollo points to an 80-year history of developing heat stabilisers for PVC applications, built up through its predecessors and acquisitions (notably Ferro, Lamberti and Akros).

Valtris offers state-of-the-art stabilisers free of TNPP (trisnonylphenol phosphite), such as Lankro-

mark LZC668 for flexible PVC food-contact applications. "Valtris continues to be the market leader in low-emission phenol-free liquid stabilisers for both ePVC and sPVC applications," claims Hollo. Recent introductions are more cost-effective but technically comparable to their predecessors (Lankromark LZC690 and Lankromark LZB1227) and are attractive in cost-sensitive market sectors where technical demands are increasing, she says.

The company has also recently developed several grades for the still fast-growing PVC floor covering market. Examples include Therm-Chek VT 348P, which is a heavy metal-free one-pack stabiliser for highly filled rigid LVT compounds. Hollo says it offers "excellent internal lubrication and provides long-term stability at an economical price point." Therm-Chek VT 117P is a non-toxic Ca/Zn stabiliser used in flexible/highly filled LVT layers, providing very good long-term stability and balanced rheology and lubrication. For carpet backing, Therm-Chek RC 995P (Ca/Zn) and Therm-Chek RC 996P (heavy metal-free) heat stabilisers have been developed to work synergistically with the Santicizer Platinum G-2000 bio-based plasticiser and offer what Hollo says is a sustainable, economical and high performing system.

In the area of traditional tin stabilisers for rigid PVC, recent Valtris product introductions have focused on technologies using renewable carbon sourced solvents. The product offering now features two weatherable stabiliser systems – Akcrostab T-5322 (22% butyl tin) and Akcrostab T-5335 (15%) – as well as Akcrostab T-5339 (9%) and Akcrostab T-5336 (6%) for non-weatherable and substrate applications. The new systems can

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be used to replace existing ones without any performance deterioration.

"Valtris has a wide range of additives for flexible PVC and as such is ideally positioned to provide complementary products to maximise the individual performance of each additive," Hollo says. She cites the example of its well-established heat stabiliser Lankromark LZB996, which is highly compatible with the company's Intercide and Micro-Chek biocides.

Building innovations

IKA Innovative Kunststoffaufbereitung offers high performance EuroStab calcium-based and GreenStab heavy metal-free heat stabilisers. Although primarily targeting building product applications such as window profile, foam profile and pipe, it also provides a full range of stabilisers for specialist and niche applications such as rigid sheet, high temperature cables and high Vicat injection moulding. In the building product sector, IKA sees an ongoing trend for stabilisers imparting exceptional earlier colour brightness, heat stability and surface finish and offers systems with or without calcium acetylacetonate co-stabiliser additive.

"Our stabilisers can be supplied in the full range of product forms from powder to low dusting compacted granule and melted tablet, ensuring that we have all bases covered," says Thomas Hillen, Managing Director and Head of Research at IKA. He says that IKA's novel melted tablet technology, marketed as S-granule, is produced via a patented production technology via extrusion and under-water granulation and is important in terms of effectiveness. "Manufactured by continuous process at temperatures that prevent secondary

High-efficiency lubricant options

Sasol is introducing two new Fischer-Tropsch lubricants, which it says are engineered for extrusion of PVC-U pipes, conduit, and profiles. Pat Haugen, Market Development Manager Americas at the company, says the Sasolwax P100 and P200 products will have PPI and NSF approvals, making them suitable for potable water, sanitary, and waste pipes.

The Sasolwax P100 and P200 additions are based on an existing Sasol lubricant, Sasolwax B52. This is described as highly external in function with some internal lubrication and metal release character. Haugen says it is 30 to 45% more efficient than 165F paraffin waxes. The new Fischer-Tropsch products are derived from the fully synthetic production of wax, which is said to provide low impurity levels, high crystallinity, n-alkane linearity, low viscosity, excellent thermal stability and lubricating properties.

According to Dr Phil Richards, Sasol's Technical Leader North America, the Sasolwax P100 and P200 products have been created to meet the industry's need for a wider operating window (peak torque versus equilibrium torque versus nominal operating temperature). Haake torque



rheometry curves show the modifications to the products provide the same high efficiency as Sasolwax B52, but with a shift toward earlier shear heat generation. This results in a faster fusion time.

"Utilising highly efficient Fischer-Tropsch materials means less lubricant to interfere with fusion during extrusion, reduced die swell, and less die build-up" says Steve Torchia, Senior Manager Global Polymer Additives at the companmy. "We have observed higher melt viscosity and a stiffer melt exuding from the dies. This means less die swell and enhances the calibrator's role in controlling wall thickness."

In one series of tests, Fischer-Tropsch waxes were compared with 165F paraffin formulations in production of sanitary pipes, using flood feeding. With the new waxes, melt pressures were reduced by up to 20%, allowing for increasing screw speed for output rate increases from 5 to 15%. Average over-weight was less than 5% with the Sasolwax based formula, against slightly over 7% with the 165F paraffin. "For a plant producing 20,000t/yr of compound, that 2% saving in material is worth half a million dollars," says Torchia. > www.sasol.com



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Stephanie Hume, Senior Conference Coordinator **T** +1 610 478 0800 **E** stephanie.hume@ami.international Right: PVC pipe production is a key market for Chemson's stabilisers reactions between key stabiliser components, this allows a wide base of formulation flexibility to enhance stabiliser performance," he says.

Tackling dust

Peter Marschalek, Head of Global Marketing at **Chemson Polymer-Additive**, says the company continues to develop processes and products, particularly in the field of dust-free tablet systems. "These are tailored to all specific requirements of the processor/converter," he says. "The 1K tablet is enjoying increasing popularity, balancing strong stabilisers, sensitive co-stabilisers and lubricant packages, and combining them into a strong additive system. This product line is proven for demanding window formulations but also for reliable pipe applications, such as bi-oriented PVC pipes (OPVC)."

Chemson is also continuing to develop additive systems in powder form and as press granules, Marschalek says. Work has also resulted in a PVC filament for 3D printing, which he says makes use of the good processing properties as well as the durability of the polymer. The filament, first seen at the Formnext 2018 additive manufacturing show in Frankfurt, is available under the VBEE brand. "VBEE requires a different degree of attention to 3D printing details than most of the other AM/3DP polymer materials," Marschalek points out. "Chemson's advanced, benign stabilisation technology has provided remarkable and unprecedented thermostability for the 3D printing materials."

Below: Songwon's new partnership with Uniwel will lift capacity for tin-boosted stabilisers for PVC pipe fittings

investing around €30m in its production operations in Austria over the next two years.

Chemson is also planning to strengthen its

global presence in China and US with an annual

capacity expansion of 40,000 tonne, as well as

Strategic cooperation

Other key players with expansion in mind include **Songwon**, which entered into a strategic cooperation agreement with Chinese firm JiangSu Uniwel





Chemistry Co, effective as of July 2019, to meet the growing need for PVC stabilisers.

Uniwel was founded around the turn of the century and is now a leading supplier of PVC stabilisers in China. Songwon says the partnership will provide it with immediate access to state-ofthe-art production of liquid and solid mixed metal stabilisers and competitive Chinese raw materials. It says it will continue with its stabiliser production in South Korea. For customers, the cooperation brings an immediate capacity increase for its Songstab liquid and solid mixed metal stabilisers.

Songwon says it also plans to produce tin-boosted calcium/zinc stabilisers at Uniwel. "Specially designed for pipe fittings, these stabilisers have the combined advantages of a high Vicat softening temperature, a wide processing window and a solid physical form, attributes favoured by numerous pipe producers," the company says. "Since the products contain a unique tin stabiliser with a very high tin content, only a low amount of tin stabiliser is added in the one-pack, to achieve top performance. The main product, Songstab CZ-SF670, has been very well received in the market and is being used by a growing number of customers."

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Functional fillers offer the opportunity to enhance the mechanical performance of compounds while improving economics. **Peter Mapleston** reports

Filler developments target affordable functionality

Functional fillers can be used to enhance the intrinsic properties of plastics and even to impart entirely new effects. Taking that definition, it could be argued that any filler is functional, whether the function is to modify physical properties, or to adjust conductivity, density, or cost. However, for most the goal is mechanical gains and that will be the focus of this article, which will look at some of the latest development directions and achievements.

Independent plastic materials expert and **Phantom Plastics** founder and President Chris DeArmitt works with many world-leading materials companies on compound development. He highlights three main trends in the functional filler sector he has seen in recent months (some of them he says driven in part by his own work): advances in performance of established fillers; green and sustainable fillers; and new and niche fillers.

One performance improvement comes from a new continuous process for applying silane coatings onto additives of all kinds at a significantly lower cost than before. Historically, silane treatments have been applied using inefficient batch processes that did not scale well, DeArmitt says. He worked with **Arctic Minerals** (an affiliate of the US-based Kish Company in the US) to develop an alternative, which is claimed to be both more effective and more affordable. It is currently being used at scale at the Arctic plant at Jeffersonville in Indiana.

"A proprietary new QC method ensures that the silane is chemically bonded to the mineral, which was not previously possible. Commercial adoption has been extremely rapid - we're doing truckloads per week using it. Even companies prepared to invest in their own equipment to do treatment can't touch the price Arctic's process offers," DeArmitt says.

Sustainability figures strongly in developments at many filler companies. Along with the rest of the plastics industry, suppliers of industrial minerals are having to adapt to new societal demands for sustainable solutions, says Leonardo Cunha, Marketing Manager for the EMEA region at talc supplier **Imerys**. "In light of growing environmental awareness, more sustainable solutions are required and different paths are possible," he says. "We will continue to invest in technical solutions that provide Main image: Fillers enhance the mechanical properties of polymer compounds. New developments aim to satisfy ever more demanding performance and cost requirements



Above: Imerys is using talc to compatibilise PE and PP to simplify post-consumer recycling our customers - and the industry at large - with superior, sustainable performance at the right cost."

Anaïs Berjeaud, Development Manager Plastics & Rubber at the company, says that recycling plastics is one obvious way of going more sustainable. "The current challenge is to ensure that mechanical properties, which tend to deteriorate during the recycling process, are maintained or even enhanced to enable them to meet ever more stringent specifications and remain cost-effective," she says.

Talc compatibilisers

Talcs and carbonates can be added to recycled plastic compounds to restore mechanical performance, but a few years ago Imerys developed a mineral-based compatibiliser, ImerLink, to create effective links between the components of blends of polyethylene and polypropylene - which are normally mutually incompatible - through a reactive process. "This results in a fully compatibilised material having improved mechanical properties with an optimum stiffness/toughness balance," she says.

PE and PP are normally compatibilised using interfacial agents such as olefin block copolymers (OBCs), but Imerys says the resulting material still has two clearly visible phases and that this shows that the blend is not fully compatibilised. OBCs can also be quite expensive. ImerLink has been shown to be more effective because it not only changes the miscibility of the PE and PP phases but also creates a new network of bonds between the phases and the coated mineral.

At another talc supplier, **IMI Fabi**, Product and Application Development specialist Piergiovanni Ercoli Malacari says the company has achieved some significant developments in a variety of plastics applications. Special talc grades such as its highly engineered HVTextra and its HVTultraC ultrafine grades are intended to support automotive lightweighting applications. "In particular, solutions for downgauging are available where thinner parts are designed, as well as solutions engineered to reduce the specific gravity in the finished parts, allowing a reduced mineral loading rate, preserving the original mechanical performances," he says.

"Another important field where talc can be actively used in weight reduction is for foamed applications. Talc NSultraC works perfectly to nucleate bubbles in foamed moulded parts granting precise bubble size and distribution for superior mechanical properties, preserving aesthetic properties, and offering the opportunity to produce foamed parts also for visible components," says Malacari.

Due to talc's plate-like shape, highly micronised grades show a relatively high volume in loose powder form. Malacari says IMI Fabi has been working on compaction technologies to reduce the volume of such fluffy powders for easier and more efficient handling. He says the company has been able to engineer a special free-flowing and dust-free grade, HTP1s, which can be used for multiple purposes. These include use as a carrier for costly chemicals, such as stabilisers, in additive pre-mixes. The spherical agglomerate is said to preserve the mix flowability for a precise additive dosing. "Because of its high degree of fineness and its high purity, talc HTP1s is a perfect additive for several applications including crystal growth nucleation and polyethylene antiblocking," he says.

The same compaction technology is also used for NoBlock-S, a recently-developed additive employed in LLDPE films. Malacari says the grade offers high antiblocking efficiency at low loading for extremely high transparency, together with free flowing and dust free features.

Filling bioplastics

Any discussion of sustainability inevitably leads to biopolymers. Demand for bio-based and/or biodegradable plastics is rising but these materials provide a large variety of new challenges, with mechanical properties and thermal resistance often lower than standard thermoplastics and processing windows frequently narrower.

"Talc [hydrated magnesium silicate] is a natural mineral; it is inert, food contact approved and does not impede material recyclability, making it an ideal reinforcing agent for bioplastics," says Cyril Coppel, Marketing Manager - Plastics, EMEA, at **Imerys**. "Imerys talcs such as HAR (High Aspect Ratio) and

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Above: Talc is established as the workhorse filler for plastics Steamic provide improved processing and crystallisation speed along with increased stiffness and enhanced temperature resistance. Imerys also offers specific calcium carbonate grades for maximising processing, optical, and mechanical properties of bioplastics films, while reducing cost."

For both flexible and rigid compostable applications, talc plays a functional role and especially in PLA based applications, says **IMI Fabi**'s Malacari. He references a special talc grade, EcoFill, which he says meets the demanding requirements of food contact compostable applications, especially where relatively high temperature environments are in use. "High mineral purity and extremely enhanced lamellarity make EcoFill a new generation additive for such fast developing applications," he says.

Biopolymers are also in the spotlight at the HPF The Mineral Engineers division of **Quarzwerke**. Bio-based polymers such as PLA have the potential to be used in a broad range of applications, "but the required property profiles can often not be met by the biopolymers alone," says Péter Sebö, Head of Marketing & Market Development.

Sebö says studies at HPF show that different high-performance mineral fillers, including wollastonite, kaolin, and micas, open up various possibilities for property modification in PLA compounds. "The stiffness is significantly increased by using our needle-shaped fillers and the impact strength can be improved by using our blocky additives. In addition, these effects can be further enhanced by using suitable surface coatings," he says.

The company's Trefil phlogopite mica can be used to improve thermal and mechanical properties in PLA compounds, says Sebö. What results is much reduced and more isotropic shrinkage, increased tensile strength and tensile modulus, and higher rigidity with no cost in toughness.

The appeal of mica

Phlogopite micas are also available from **Arctic Minerals** under the ThermaFlex tradename. DeArmitt says micas can provide a step up from talcs in several cases, not just for compounds based on biopolymers. For many years, talc has been a workhorse reinforcement, and much has been done to improve its aspect ratio to eke out the last drop of performance, he says. "As talc reaches its limits, people are looking more at ultra-pure, specially-milled mica, which can give even higher aspect ratio with a concomitant boost in strength and stiffness. For automotive customers, that means lightweight and better gas mileage."

Huber Engineered Materials is another company highlighting its broad portfolio of fillers, in this case ranging from alumina trihydrate (ATH) and magnesium hydroxide (MDH) to ground calcium carbonate. ATH and MDH are functional fillers that can reduce flame spread and smoke generation in a wide variety of plastic, rubber, adhesive and coating products. But, like other fillers, their presence alters the mechanical properties of the compound. To augment the degradation of properties such as elongation, tensile strength and flexibility, Huber produces a full line of surfacecoated ATH and MDH products (Table 1).

Huber says its newest surface treated halogenfree products are Magnifin H-5 TV and H-10 TV magnesium hydroxides. Compared to other MDH products, they offer higher elongation (Figure 1),

Table 1: Typical compound processing and performance gains resulting from various filler surface treatments

Surface Coating Type	Effect
Stearic acid	Faster incorporation, lubricity, reduced degradation, often used in PVC
Non-functional silane	Hydrophobicity, improved elongation, higher loadings at lower viscosity
Amino functional silane	Improved balance of tensile, elongation and flexibility in polyamide
Vinyl functional silane	Improved balance of tensile, elongation and flexibility in polyolefin and silicone
Epoxy functional silane	Improved cohesive strength in thermoset systems
Proprietary coatings	Improved mechanical properties after heat aging, improved fire retardance
Source: Huber	



Photo : the first reactor pot used in 1917 (exhibited in the headquarter showroom)



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Figure 1: Effect of addition of different grades of Magnifin MgOH on elongation, before and after ageing. Source: Huber



better melt flow, improved extrusion behaviour, reduced water uptake, improved LOI values, better wet electrical performance, and better aging performance at high temperatures.

Opportunity for CaCO₃

Calcium carbonate, widely used in rigid and flexible PVC compounds, imparts a good balance in impact strength, stiffness and brightness, Huber claims. Its Hubercarb W3N has an extremely low concentration of iron (40 ppm) and moisture (0.01%) along with a silica content below detectable levels. "The presence of iron chloride has been shown to promote the dehydrochlorination of PVC, even in small concentrations," the company says. "The use of Hubercarb W3N imparts much improved colour retention for rigid PVC pipes and exterior profiles." This effect is shown in Figure 2.

Consultant DeArmitt points out that use of calcium carbonate often makes sense in the less expensive polymers such as PE, PP and PVC where it can improve stiffness, retain strength, and improve impact resistance while lowering compound costs. He explains that while fillers in general tend to reduce impact resistance in impact resistant polymers, including PP block copolymers, they can actually improve the impact resistance of more brittle polymers such as PP homopolymer.

"It is observed that 10-20 weight % of fine calcium carbonate treated with stearic acid helps impact resistance by causing the polymer to cavitate in many locations upon impact," he says. "This spreads the impact energy over a greater volume of polymer. As the particles debond, encouraged by reduced adhesion caused by the

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Figure 3: Calcium carbonate coated with stearic acid can increase impact resistance of a polymer through the process of filler debonding



Source: Chris DeArmitt/ Kirk-Othmer Encyclopedia of Chemical Technology

Brittle 20 kJ/m² - Untreated 2 Micron CaCO₃

stearic acid coating, a foam is created." This is shown in the micrograph images in Figure 3.

IMAGES: CHRIS DEARMITT/ KIRK-OTHMER ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY

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Thoughts on wear and nanocomposites

Phantom Plastics founder Chris DeArmitt, who features in this article, recently contributed a chapter on fillers and filled plastics to the latest edition of the Kirk-Othmer Encyclopedia of Chemical Technology (which is **published** by Wiley). These selected excerpts present his thinking on equipment wear and nanocomposite potential.

Where is the wear coming from?

"In the plastics industry, people observe wear of their equipment and attribute that wear to the filler. Even soft minerals such as talc and calcium carbonate are blamed for wear. This is intuitively nonsense because talc is so soft that it is scratched by a fingernail. So, what is the explanation? Studies have proven that almost all wear observed is due to traces of hard impurities, usually quartz, in the mineral. Larger amounts of quartz and larger quartz particles cause excessive wear that can be avoided by using purer grades of filler."

And what about nano-composites?

"A lot of hype has sprung up around the topic of nanofillers. This is surprising for a couple of reasons. Firstly, because nanofillers are not new. Nano-silica and carbon black have been in our tyres for decades, colloid scientists have understood the nano/surface realm for over half a century.

"The small particle size actually turns out to be the least important factor. Small size can lead to some useful properties such as transparent composites but, usually, the size is a problem because small particles give rise to huge viscosity and severe difficulties with dispersion. The high surface area, often in the hundreds of m²/g, means huge contact area with the surrounding polymer. This leads to higher strength but also requires very large amounts of surface treatment to cover the surface.

"Platy nanoclays have very high aspect ratio making for excellent reinforcement. However, they can only be used at low loadings and do not perform better than standard reinforcements. The extreme level of interest in [these] nano-composites is therefore unwarranted."

A new sustainable calcium carbonate has been launched by Arctic Minerals under the AquaFlex tradename. "Unlike standard calcium carbonate, which is mined from ancient deposits, AquaFlex is newly deposited and very pure. Because it is deposited at a vastly greater rate than it is mined, the calcium carbonate is fully renewable," DeArmitt says. "Many companies have set targets for renewable content without any clear plan on how to reach those targets. For them, AquaFlex is a dream come true. Everyone is comfortable with calcium carbonate filler used at 20-40 wt% in polyolefins, so it is a drop-in solution."

Targeting barrier

Joe Lichtenhan, Vice President of Business Development at Hybrid Plastics, highlights an interesting effect it has seen when its polyhedral oligomeric silsesquioxane (POSS) is loaded at ppm levels into PE, which could lead to the possibility of singlelayer PE barrier films. "We get improved mechanicals and oxygen permeation barrier," he says.

Lichtenhan and Dr Angel Romo-Uribe, who works in the R&D department at Johnson & Johnson (J&J) in Jacksonville, Florida, US, shared some details with Compounding World of a joint project that has demonstrated that just 80 to 400ppm of POSS nanochemical melt blended with PE can form nanostructured films with a more than 100% increase in tensile modulus. "Strikingly, at these concentration levels there is no penalty on the extensibility of the films, as usually seen in reinforced (nano) composites. Furthermore, other important mechanical properties like toughness, yield stress, tear and puncture resistance were also enhanced at this rather low POSS content," they say. See Figure 4 for effect on modulus.

The investigation determined that the dispersion of POSS into the polyethylene matrix at nearly

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Above: Hybrid Plastics has found partper-million additions of POSS can improve mechanicals and reduce OTR of PE packaging films single nanocage unit is the key to the mechanical reinforcement. Transmission electron microscopy is said to have showed that the POSS size was smaller than the empty space in the macromolecular web and so POSS intercalated the macromolecular web and mechanically reinforced without acting as a stress concentrator.

"Furthermore, the entanglement intercalation and consequent reduction of empty space in the macromolecular web induced reduction of oxygen transmission (OTR) through the films. That is, POSS acted as a nano-plug filling the empty space (free volume) that macromolecules cannot fill," they say. This OTR reduction is shown in Figure 5.

Hybrid and J&J believe that the dispersion of POSS nanocages at the near single cage unit level lies at the heart of polymer nanocomposite performance, and large concentrations > 3 wt%) are unnecessary. In fact, they point out that at high concentrations the POSS cages can aggregate and even produce gelation, which may degrade the desired rheological and thermo-mechanical effects.

"Dispersion at near unit-level takes advantage of the high surface area and volume of POSS," they say. "Under this condition, only small nanoparticle content is required to enhance mechanical and transport properties of polymers."

Processing is not challenging. Romo-Uribe says the efficient dispersion of POSS into PE was achieved using conventional twin-screw extrusion machinery and films were produced on a standard blown film line. He adds that the very low amount of POSS needed to significantly enhance the mechanical and transport properties of the PE keeps cost down and makes POSS a highly competitive additive. The compound is also recyclable.

The reduction of oxygen transport opens opportunities for a single-layer packaging material, Romo-Uribe believes. "These findings offer a new paradigm in polymer nanocomposites formulation and establish the need to match nanoscopic particle size to polymer network dimensions in order to achieve optimal design of engineering property enhancements," he says. "Furthermore, the implications of this study are broader as nanosize and dispersion are the key factors for mechanical reinforcement. Therefore, the same principles of properties enhancement apply to POSS mixed with diverse polymer hosts as long as the nanoparticle is dispersed to a size capable to intercalate the macromolecular web."

Hybrid Plastics says it is now working with a number of partners to explore application of the concept. "Packaging is one natural market but the field is wide open to novel applications," says Romo-Uribe.

Hybrid and J&J say that work so far has developed and proved a concept, the dispersion of POSS at nearly single unit in a polymeric matrix. "Essentially, we have demonstrated that using large amounts of nanoparticles to reinforce polymers is a myth," they say. "This work is at fundamental level





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Above: Kraiburg TPE is using 3M's Glass Bubbles as an alternative to foaming in a new family of low density TPEs

and we chose to publish this novel strategy in the open literature as a benefit to the polymer/ materials community."

Foam alternatives

Development activity extends beyond mineralbased fillers. New uses continue to be found for hollow glass beads (also known as microspheres) produced by companies such as 3M, Nouryon (previously part of AkzoNobel), and Kish Company's Sphere One. Glass is not considered a mineral, by the way, because of its non-crystalline structure.

Last year, **Kraiburg TPE** introduced a series of weight-saving thermoplastic elastomers (TPEs) that use **3M**'s Glass Bubbles to reduce material density instead of physical or chemical blowing. The company is now offering three new product lines for automotive vehicle construction, power tools and various other application areas with densities between 0.7 and 0.9 g/cm³.

"3M Glass Bubbles have been tried and tested as weight-saving fillers in various 'hard' thermoplastics, but our new lightweight technology is using them in TPEs for the first time," says Martina Hetterich, Project Manager Advance Development at Kraiburg TPE.

One of the reasons for taking the microsphere route was the need to achieve high quality surfaces.

Kraiburg TPE says expandable materials typically require strict process control procedures to achieve an even surface quality without surface waviness. It says its new compounds can be used for production of thin-walled mouldings with high quality surfaces that can withstand high mechanical loads. Compression-set values are described as excellent.

3M Glass Bubbles are made of chemically stable borosilicate glass. Kraiburg TPE says they disperse evenly in the TPE matrix and help improve dimensional stability. Production waste can be recycled directly.

Thermolast K LW/UV (lightweight + UV resistance) grades are specifically formulated for exterior vehicle components; Thermolast K LW/CS/UV (with increased compression set) grades adhere to polypropylene, making them particularly suitable for various sealing applications; Thermolast K LW/ PA (lightweight + adhesion to polyamides), which are rated HB under UL94, are suitable for power tools, among other things.

Meanwhile, **Lehmann&Voss** recently introduced a new ultrafine version of its Tri-Sphere silicatebased multicellular hollow microspheres. The 45XS Ultra product can be used as functional fillers in plastic compounds for injection moulding or extrusion processing. The company says they can be used to reduce density as well as to modify acoustic and thermal insulation.

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Whether to improve clarity or to enhance physical properties, application of clarifier and nucleator additives continues to grow. **Mark Holmes** learns more

Making a clear difference

Clarifiers and nucleating agents improve the performance of plastics and can considerably expand their range of applications. Advanced nucleators can enhance stiffness, providing scope for weight savings and improving physical properties. This can, for example, allow PP to be substituted for heavier and more expensive materials such as PS or PET. Meanwhile, clarifiers, as the name suggests, allow polymers such as PP to be used in applications requiring high clarity in place of amorphous polymers such as PS, PC, PET and PVC, and in some cases glass. This article takes a look at some of the latest developments.

Nucleating agents are widely used in PP to improve both physical and optical properties. "The improved stiffness and strength of nucleated PP and the faster achievable cycle times in moulding and extrusion lead to down-weighting and cost savings. Nucleated PP also exhibits higher heat deflection temperatures allowing it to be used in more demanding, high temperature applications," says Dr Philip Jacoby, independent consultant and President of **Jacoby Polymer Consulting**.

"In recent years, nucleating agents have been introduced that achieve higher clarity, higher

stiffness, and a reduction in warpage and shrinkage. Another growing trend has involved the use of special nucleating agents that can induce the formation of a different crystal phase of PP, known as the beta crystal phase. These beta nucleants have been used to further improve certain physical properties and have also led to unique products such as microporous films used in the manufacture of protective clothing and lithium ion batteries," he says.

Nucleators are most commonly employed to increase the stiffness and tensile strength in moulded parts, with cost reduction a key goal. "High modulus or stiffness is especially important in automotive applications, where PP is the most widely used plastic. Higher modulus allows the part to be down-weighted by reducing the wall thickness while still retaining high rigidity. This allows the part weight to be reduced, and lower weight leads to higher automotive fuel efficiency," Jacoby says. "In addition, the main factors driving new technical developments include the desire to downgauge and reduce cost, substitute PP for more expensive polymers, and reduce the environ-> mental impact of the PP part."

Main image: Clarifiers such as Milliken's Millad NX 8000 can enhance the clarity of PP while reducing process energy requirements and speeding cycle times MAGE: MILLIKEN

ADDITIVES | CLARIFIERS AND NUCLEATORS

Right: Beta nucleation technology is used to make micro-porous films for Li-Ion battery separator films



Relative advantage

Jacoby points out, however, that new products must offer some advantage relative to existing products and that is usually measured in terms of higher performance and/or lower cost. At present, most commercially available nucleants and clarifiers increase stiffness but not impact strength, while beta nucleating agents increase impact strength but can result in lower stiffness. He says that, in terms of future development, nucleating agents that simultaneously improve stiffness and impact strength would be highly desirable. As well as improved stiffness and strength, other important factors include clarity, faster cycle rates, lighter weight parts and lower cost.

Jacoby has worked extensively on development and commercialisation of beta nucleating agents for PP. While working for Amoco he developed and patented a product and process using beta nucleated PP to produce breathable polypropylene films for protective clothing and roofing membranes. Today, such technology is used in battery separators in lithium ion batteries. He also patented a process using beta nucleation to reduce the weight and cost of thermoformed PP food packaging. While working with **Mayzo**, he developed beta nucleant masterbatches for use in markets including thermoforming, breathable films, geotextiles and injection moulded products.

His research has found beta nucleation particularly useful for improving the properties of PP in moulded applications

that require high impact strength without a significant sacrifice of stiffness. "Beta nucleation also dramatically broadens the processing window for producing thermoformed containers and improves material distribution, leading to higher rigidity, higher top-load crush strength, and the ability to down-weight by up to 20%," he says. "For example, when thermoforming occurs at low temperatures, cups take on a white appearance that dramatically lowers the amount of white pigment that is required. Beta nucleation also facilitates the production of low density oriented microporous films without the need for a cavitating filler to obtain the void cavities."

Beta nucleation can be used in a variety of applications to improve properties such as impact strength, drawability, thermoformability, and creep rupture performance in pressure pipes, for example. The drawing characteristics of the beta crystal phase results in more uniform wall thickness distribution in thermoformed PP and biaxially oriented geogrids, allowing for improved downweighting and cost savings.

Terminology: Nucleator or clarifier?

Nucleators and clarifiers both do broadly the same thing in that they encourage crystallisation of the polymer. This can result in significant improvement in physical properties such as strength and stiffness, heat deflection temperature (HDT), and dimensional stability. It can also shorten cycle times and allow processing at lower temperatures, which can lift output and save energy. And, depending on the size of the crystallites formed, enhance clarity.

Nucleators for PP can be divided into two main types - insoluble and soluble. Insoluble types include talcs, metal oxides and sodium benzoate. They are relatively low cost and function by providing sites in the polymer that initiate crystallisation during cooling, so particle size and dispersion is important for effective functioning.

Soluble nucleators, such as sorbitols and nonitols, work by crystallising faster than the polymer during the cooling phase to form a multitude of initiation points.

Clarifiers are best seen as nucleators optimised to improve clarity by forming crystallites smaller than the wavelength of light, resulting in reduced light scattering. A number of sorbitols have been used as clarifiers, including DBS (dibenzylidene sorbitol), MDBS (methyldibenzylidene sorbitol) and DMBDS (dimethyldibenzylidene sorbitol).

DMBDS in particular provides good clarity, thermal stability and favourable organoleptics. It was established in the market by Milliken under the Millad 3988 name but is now available from other suppliers. Milliken's NX 8000 product line has now taken over as its premium clarifier. Last year, the company announced a 50% capacity expansion for the product, a move brought forward by two years due to "unprecedented global demand". Cables

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Key considerations

In terms of nucleator development for PP, Jacoby highlights some important considerations that must be taken into account by developers and potential users:

How difficult will it be to obtain FDA or EU regulatory approval for food contact application and will there be limitations on use;

> How readily will the nucleant disperse in PP and will the dispersion be stable or prone to re-agglomeration;
> Will the nucleant display synergistic or antagonistic interactions with other additives, such as acid scavengers,

> > stabilisers and fillers; Will there be organoleptic issues - taste and odour - associated with its use;

 Will the nucleant lead
 to uneven shrinkage and warpage in injection moulded parts;

And finally, and more of interest to nucleant developers, how will the product be positioned relative to existing

products in terms of performance, cost and ease-of-use. And will it be sold to PP resin producers, to compounders for incorporation into their PP grades, or a a masterbatch for use by converters?

Integral to polyolefin

Clarifiers and nucleators are now an integral element in polyolefin grades developed for various fabrication processes and end use applications, according to **Milliken**. "Over the past few years we have seen robust growth in clarifier and nucleator use and we expect to have similar growth in the future as demand for storage containers, houseware parts, packaging material, automotive and industrial components keeps rising," says Allen Jacoby, Senior Vice President Plastics Additives, at the company. While he sees the current global coronavirus pandemic leading to some dramatic short term impacts in areas such as automotive, the company's longer term view is that demand will grow.

Right: Underthe-hood automotive PP parts such as fluid tanks are a target market for Milliken's Hyperform HPN 715 nucleator

IMAGE: MILLIKEN

Above: PP

containers nucleated with

Milliken's

Hyperform

HPN 715 are

suitable for

microwave use

"Consumer buying behaviour is changing rapidly. Today, the consumer wants to see, touch, feel and experience a product before making a purchasing decision. Consumers are asking for more robust products which are long lasting as well as sustainable. With changing consumer buying behaviour, demand for clear as well as sturdier packaging is increasing. These market demands are being fulfilled by clarifiers like Millad NX 8000 and nucleators like Hyperform," he says. "On the other hand, an increase in polypropylene production capacity is driving resin producers to create speciality grades with Milliken's clarification and nucleation technology. A classic example is thin wall injection moulded containers nucleated with Hyperform, which provides the required attributes for a packaging material used for home delivered food in Asia."

In assessing what drives new developments in clarifiers and nucleators, Bhavesh Gandhi, Global Product Line Manager Hyperform, says that the end use application determines the development of resins that meet consumer demand for safety, clarity, integrity and sustainability of the products they buy. Global sustainability initiatives are driving developments in both clarifier and nucleator technologies, particularly those that enable recyclability.

There is also an ever-increasing demand for better optical, thermal and physical property improvement in the polyolefin sector. Like Jacoby earlier in this article, Gandhi also highlights a demand to improve the rigidity of PP while maintaining impact properties. With regard to clarifiers, he says enhancing the sustainability and processability of clarified PP while continuing the push for greater clarity are driving new generation technologies.

Among the latest product developments from Milliken is Hyperform HPN 715, which addresses the demand for a high stiffness additive for PP. The company says HPN 715 has enabled development of resin grades that can be used to replace PS in packaging applications.

Developed for injection moulded PP, Milliken says the Hyperform HPN 715 nucleating agent can provide stiffness up to 10% higher than PP using other nucleators and up to 30% higher than non-nucleated PP (it is suitable for use with PP

IMAGE: MILLIKEN

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Above: Nucleated PP has been used to replace ABS in some applicance applications homopolymers, impact copolymer and high crystalline PP materials). In addition, due to its high effectiveness at low loadings, it is said to avoid negative effects on impact performance. An optimised stiffness/impact balance enables thinner wall designs and reduces the need for fillers, promoting weight-out, design flexibility and cost reduction.

The new nucleating technology is also claimed to provide higher heat deflection temperatures (HDTs) compared to other advanced nucleators, allowing PP to be used in microwaveable containers, under-the-hood vehicle components, and household appliance parts. HPN 715 was recently used for an inter-material replacement project in the appliance sector, according to Milliken, where it allowed a PP to provide the required HDT and rigidity to replace ABS.

Another recent addition to Milliken's Hyperform product line is HPN 900ei, which targets demand for balanced physical properties and improved aesthetics in thin wall packaging for delivered food.

Targeting migration

Millad NX 8000 ECO is the latest version of the Millad NX 8000 clarifier line up. It is said to offer a number of additional advantages, including a more consistent "fresh" appearance regardless of the light source or the presence of ultraviolet light. It also offers a reduced specific migration limit (SML)

Right:wUL-validatednMillad NXfc8000 ECOsaprovidesccenhancedotransparencyinand increasedaenergy savingsthfor the USongthcontainerb

without need for addition of new ingredients to the formulation, and is said to lower overall concern over extraction of optical brighteners into packaged products, as well as the yellowness that can be induced by the ageing of optical brighteners. Other



benefits include minimal disruption of optical sorting devices used in medical, recycling and other markets.

> Zach Adams, Global Product Line Manager for Millad, says the NX 8000 ECO clarifying additive not only produces the fully transparent NX UltraClear PP – which yields durable end products with good, glass-like clarity – but addresses the growing trend for greater sustainability among brand owners, converters and consumers. NX 8000 ECO

is claimed to enable faster production rates, average energy savings of 10% for the production of clarified PP parts (certified by Underwriters Laboratories), tuneable clarity to meet specific market needs, and a reduced risk of defects such as white specs, streaks and voids. Milliken says the NX 8000 ECO additive was used in the development of the USong storage container, where it provided enhanced transparency and a process energy savings.

The Millad NX 8000 product range recently became the first PP clarifying agents to receive Critical Guidance Recognition from the US Association of Plastic Recyclers, validating that the additive is compatible with plastic packaging recycling. The company says that it is currently looking at increasing its focus on additives to enhance recyclability and reusability, as well as enabling the use of biopolymers.

Pandemic effects

Demand for PP clarifiers has been lifted by the coronavirus pandemic, according to **NJC Europe**, which reports high demand for products such as its Geniset DXR (3, 4-dimethyl benzylidene sorbitol or DMDBS), particularly for food packaging but also for medical applications.

"Currently, the main factor driving demand is the Covid-19 situation, with an increased requirement for plastic wrapping and packaging as well as for a wide range of medical applications from non-woven face masks to disposable syringes. We believe

> that the global market will increase its reliance on products for these applications for the foreseeable future," says Dr Estibaliz Santamaria, Technical Manager at the company.

"Other major trends in clarifiers include



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environmentally friendly solutions, such as energy saving, as well as meeting the needs of the circular economy with all its ramifications across the polyolefins industry," Santamaria says. "In addition, the incompatibility of nonitol-based

Right: A PA66 cylinder injection moulded using Clariant's Licocare RBW 360 Vita nucleator clarifiers is a well-known industry problem. This incompatibility with other clarifiers causes downtime issues due to the thorough cleaning measures needed between production runs. A dedicated silo storage system is required, as well as careful separation of regrind, which adds to the problems not only for the PP manufacturer but also for the downstream user."

To meet the energy saving and environmental requirements of the

polyolefins industry, New Japan Chemical and NJC Europe have developed a new range of clarifiers that perform at lower temperatures, and which are fully compatible with existing clarifiers. This solves contamination problems for PP manufacturers, masterbatch makers and converters. The RiKAFAST EDX and RiKAFAST EDXP clarifiers have been developed in close collaboration with the company's partners in the PP industry, where there is an ongoing shift towards higher

MFR grades. This calls for clarifiers to perform at lower processing tem-

peratures than standard grades, the company says. The new technology enables the clarifier and resin to form a solution at relatively low temperatures to yield good haze values and improved aesthetics, both in homopolymer and random copolymer polypropylene.

Future clarifier developments at NJC Europe will involve improvement in aesthetics and performance for high-end applications. The

company is also working closely with automotive industry suppliers to develop a new product that will meet the sector's high specifications and cost requirements.

"In a post Covid-19 market with a global recession likely, the polypropylene industry will be

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looking for clarifiers with a price-performance benefit," says Santamaria. "Since any downtime is costly, the obvious choice will be a compatible clarifier that eliminates any possibility of disruption of the supply chain due to cross-contamination. Clarifiers that can be processed at low temperatures would offer an additional advantage in this price conscious situation, providing much needed energy savings."

Nucleator growth

The market for nucleators continues to grow, particularly for electronic and automotive components, according to **Clariant**. "The trend towards smaller, lighter parts continues due to the increase in personal communication devices and electric or hybrid power," says Frank Neuber, Regional Technical Manager NORAM. "This has necessitated the need for more parts made with limited machine time, which is where nucleators help by reducing cycle times. Nucleators also reduce shrink and warp, which means less moulded-in stress and an increased number of better fitting parts, when precision is critical during rapid assembly."

Sustainability remains a major influence for nucleator development, both with respect to material and the manufacturers' ecological footprint, with the goal being reduced energy consumption and more recyclable parts with less scrap. "Sustainable solutions and biodegradability are becoming increasingly important when formulating for recyclability and end-of-life," Neuber says.

"OEM's and manufacturers have difficulties claiming complete compliance when their products use additives that do not meet these criteria. The development of clarifiers or nucleators meeting these criteria is needed to complete the circularity of sustainable cradle-to-grave supply and production. In addition, products which may end up in landfill - whether single use or a durable good - will eventually need a compostable, biodegradable or recyclable designation, and preferably originate from sustainable sources. Developments are underway to make energy reducing, polymer nucleators from such sources," he says.

PA nucleation

One example is a new, sustainable, polyamide nucleator, which helps to reduce cycle times when moulding un-filled polyamide parts. "Licocare RBW 360 Vita is made of raw materials extracted from non-food-competing, rice bran hulls," Neuber says. "Its structure is analogous to the well-known Licomont CaV 102, which has been used for years to reduce injection moulding cycle times in



Vita can provide a significant increase in impact strength in PA66 Source: Clariant

under-the-hood structural mounts and clips. This material may now be made with non-food-competing raw material sources, though."

As with Licomont CaV 102, cycle time reductions of more than 20% are claimed for some parts made using the Licocare RBW 360 additive compared to parts produced in the same polymer with no nucleator additive. RBW 360 also lubricates the polymer flow path, allowing easier filling of complex geometries, and improves impact performance (Figure 1). Clariant's own laboratory data shows that the performance of Licocare RBW 360 matches that of Licomont CaV 102; Neuber says proprietary qualifications are currently underway at strategic partners.

Clariant says future development of its renewable nucleators will focus on polyesters, such as PBT, used for electrical connectors. The company says it already has a fossil fuel-based product for PBT nucleation in this application – Licomont NaV 101.

The company says its existing manufacturing capabilities for the NaV 101 grade will be used to produce a rice bran-based solution that performs as well as, or better than, the conventional product. The new products will speed up production and improve the dimensional consistency of injection moulded electrical connectors used in e-vehicles and hybrids.

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Wood and other natural fibre plastic composites are benefiting from interest in a more circular economy and the growing recycling agenda. **Mark Holmes** reports

"Natural" appeal lifts WPCs

Wood-plastic composites (WPCs) have been providing a direct replacement for timber in outdoor living and industrial spaces for some time and continue to grow in popularity. Current composite decking and cladding products now offer the aesthetics of natural materials, while providing significantly enhanced weathering and performance. However, the use of wood or natural-fibre composites is extending beyond construction to many other application areas where there is a desire to use materials with a "natural" content. That especially applies to products based on recycled materials.

The current market for WPCs, or to use the more general term natural fibre composites (NFCs), shows considerable potential with most studies predicting a CAGR of more than 10% for the next few years, according to the Austrian research institute **Wood KPlus**. "The main reasons for the increase include greater awareness of these materials and the use of more recycled materials, as well as numerous bio-economic strategies all around the world," says Dr Andreas Haider, Area Manager Bio-Based Composites and Processes.

"The main drivers for new developments in processing machinery include the critical process parameters needed for good material performance and high extrusion output - principally screw design - which has to be optimised for many formulations as well as for effective degassing of materials," he says. "Regarding materials, the main driver is efficiency. Increasingly more recycled materials are being used to meet the needs of the circular economy, such as durability and re-use. Coextrusion is one solution to use more recycled material, for example as a core material, but that cannot yet be readily found on the market. Matrix polymers are principally standard polymers, such as PE, PP and PVC, for traditional WPC. For NFC the use of biopolymers - industrial and home compostable - is growing."

Haider says that where WPC and NFC production quality is high, so is product quality. "We did a comprehensive benchmarking of commercial WPC available in the European market, which showed a broad range of material performance. This showed that the main issue for WPC is still production quality and resistance to water uptake. The situation for NFCs, which are processed by various polymer production processes such as injection moulding, thermoforming and 3D-FLM printing [Fused Layer Modelling], is different. With these processes, density for lightweight applications can be addressed through chemical and physical foaming, as well as improved resource efficiency > through the application of 3D-FLM printing."

Main image: Wood-plastic composite decking producers are benefiting from demand for durable products with a "natural" content, according to Austrian institute Wood KPlus Nevertheless, the weaknesses of WPC and NFC remain impact strength and water uptake, particularly for outdoor applications. "We try to overcome these by using different types of fibres or even employing hybrid formulations with more than one type of fibre in the compounds," says Haider. "Other hot topics are the circular economy, where there are issues of recycling and/or reuse of these materials as they contain more components. Increasingly, the need for home compostability is being

requested for many applications. This can be addressed by using degradable biopolymers and bio-based additives. However, it must be considered that such materials should also run several cycles before they are composted, because significant amounts of energy is needed to produce them. Finally, for injection moulding and 3D-FLM printing, simulation of material processing behaviour as well as performance is of great interest at present, but has not yet been solved."

Wood KPlus says it has developed formulations for physical and chemical foaming to produce extruded profiles and pellets for injection moulding. Some success has also been achieved in the simulation of processing steps in collaboration with partners, but without suitable correction factors this is not yet considered to be sufficient.

Packing performance

Germany's **Fraunhofer WKI** (Institute for Wood Research) recently developed a crate for transport and storage of vegetables comprised of up to 25% wood fibres. Researchers claim the new crates are more sustainable, lighter and sturdier without increasing production costs. In the future, they intend to transfer the expertise in materials research and injection moulding technology to other products.

The project aimed to create a replacement for conventional crates, which are made from PP, that made use of the highest-possible proportion of renewable raw materials. Both wood and cellulose fibres fulfilled this criterion, were regionally readily available and are relatively inexpensive. In addition, the use of wood fibres makes the crate lighter. "If we consider the entire life cycle of the vegetable crate, the majority of the emissions are not created during the production of the material or through disposal, but during the use phase due to repeated transport. The transportation of lighter vegetable crates would therefore be an advantage, as less carbon dioxide would be produced," says Christoph Habermann at Fraunhofer WKI.

During the development of the material, Habermann and his team not only took into account environmental aspects but also improved a number of application properties, such as stacking capability and resilience. "We are experts in materials research and innovative injection moulding processes, both of which are hugely influential factors," says project member Carsten Asshoff. "With the aid of computer simulations, for example for strength simulation, we are able to optimise the production time and the product quality. The vegetable crates are a good example. Through the wood fibres, the strength and rigidity of the crates is increased. As a result, the wall thicknesses could be reduced and the internal volume increased. Users could benefit from lower transport costs."

The researchers examined the entire life cycle of the crates. "We can only achieve real sustainability within the packaging industry if we also take further use and recycling into account when addressing the material composition," says Habermann. "Wood fibres are better suited for this than, for example, glass fibres, which are to some extent also combined with polypropylene. Vegetable crates made from wood-fibre-reinforced plastic can be melted down to make new transport containers."

The advantages of the new materials are not limited to vegetable crates; many other versatile possible applications are foreseen. "Our tests have been very successful and the acquired knowledge can, theoretically, be applied to all types of reusable containers and transport crates as well as all kinds of injection moulded parts," Asshof says. "Furthermore, it would also be conceivable to use the materials for disposable products, such as shampoo bottles. In the future, customers could then buy their organic shampoo in organic packaging."

Additive options

Additives to improve the performance and processing of wood-plastic composites have been essential to their continued development and more widespread use. Among the companies that are active in this area is **Struktol**, which has expanded its line of lubricants, as well as introducing a new coupling agent and additive to fortify capstock compounds for the wood-plastic composite market.

The new Struktol TPW 813 coupling agent is said to offer superior properties to traditional products. In addition to providing good flexural properties, it is said to be especially effective in reducing water absorption, resulting in a much more durable product that can withstand many more wetting and freeze-thaw cycles. TPW 813 can be used with any

Above: Fraunhofer WKI developed these injection moulded vegetable crates that contain up to 25% wood fibres

IMAGE: FRAUNHOFER WKI

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Tracking trends in WPC decking

The desire for outdoor living spaces has never been higher and the appeal of the great outdoors seems to grow ever stronger, with homeowners investing more time and money into their outdoor spaces, according to US-based **Trex Company**. It has identified several trends that are currently influencing outdoor living in the North American market, including: Mixed materials – juxtaposing WPC with traditional materials such as concrete, wicker, aluminium, copper and stone creates more visual interest.
Industrial inspiration – WPCs support the accelerating shift towards sleek contemporary designs involving large expanses of glass, smooth surfaces, and clean lines.
Outdoor dining – the desire to eat and cook outdoors is driving new opportunities for WPCs to create all-year-round entertainment spaces.
Personal privacy – WPCs allow simple creation of all-weather curtains to maximise privacy. Garden storage – raised or elevated WPC decking can provide a bonus space for storage of garden equipment.

Latest addition to the Trex line is Trex Cladding, which is claimed to provide a maintenance-free, fade and stain resistant alternative to hardwood planking. The system uses the company's square edge Transcend deck boards to create an open-joint façade. Transcend boards are made from 95% recycled plastic and reclaimed wood scrap. > www.trex.com

type of lubricant and works especially well with Struktol TPW 617, the company's next generation high efficiency lubricant/processing aid.

Struktol has also developed a full product line for WPC decking materials. This includes Struktol TPW 420, a full capstock compound that offers durability combined with good scratch resistance, adhesion to substrate, processability and a low gloss surface. Struktol TPW 230 is a masterbatch version of TPW 420 designed to be let down with PE resin. Struktol is further developing its capstock line with new compounds that have a 'soft feel' surface. These soft touch compounds offer superior anti-slip properties with greatly increased coefficient of friction, the company says. The focus for the compounds will be on handrails, poolside decking, stairs, ramps and other applications where a soft surface with improved grip and feel is required. They can all be supplied with or without a stabilisation package.

Below: Budit 620 from Budenheim is a halogen-free flame retardant specifically designed for natural fibre plastics

Struktol TPW 720 is an additive for capstocks that allows for further modification of the capstock properties, such as gloss and scratch resistance, based on the customer's specific requirements. **Dow** has developed Amplify Si Silicone En-



hanced Polymer Systems (SEPS), a silicone-polyethylene hybrid technology that improves product performance. Designed for wood-plastic composite decking, it is one of the first in a series of products Dow expects to launch under its new SEPS platform and is said to address the need for innovative and sustainable alternatives in the wood-plastic composites industry.

"Dow's Amplify Si PE 1000 enables manufacturers to utilise more economical options, such as a variety of recycled plastic and higher levels of fillers, in their wood composite manufacturing processes," says Mauro Gregorio, Business President, Dow Consumer Solutions. "By incorporating this product into wood-plastic composite boards, manufacturers can more easily bring new life to recycled plastic, a tremendous contribution to sustainability and product reuse. Amplify Si PE 1000 also reduces energy costs and carbon footprint associated with this manufacturing process."

According to Dow, Amplify Si PE 1000 allows higher throughput, lower melt temperature and less thermal degradation. Manufacturers can also expect to see higher production rates, lower rejection rates and overall improvement in the tensile and flex strength of their wood-plastic composite boards, the company says. Beyond decking, Amplify Si SEPS can be used with similar results in applications such as docks, railing, wall cladding, siding, fencing, window profiles, automotive and many other applications.

"This new family of products...drives sustainability and innovation across many industries, provides a unique value proposition to our customers, and helps to facilitate the transition to a circular economy," says Gregorio.

In addition to their mechanical properties and durability, WPCs frequently require effective fire

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Above: Scona modifiers from BYK strengthen the physical bonding of wood fibres in thermoplastics protection for use indoors and in public buildings. **Budenheim** has developed a new environmentally-friendly flame-retardant for wood-plastic composites – Budit 620. It is described as a halogenfree flame retardant system specifically designed for natural fibre-reinforced plastics and is said to meet high requirements in terms of fire behaviour.

BYK has developed its Scona modifiers for wood plastic composites to strengthen the physical bonding of the wood fibres in the thermoplastic matrix. It is said to make it possible to achieve higher loading levels while maintaining good mechanical properties and resistance to impact required for applications including decking and outdoor panels.

Americhem recently collaborated with a producer of wood-plastic composite fencing that was struggling to get good weathering performance in dark colour spaces due to degradation that led to excessive colour fade of the product. Americhem says that it changed the customer's formulation from a blend to 100% Americhem eCap technology that was colour matched to what they were currently selling. It used nGrain simulated woodgrain and eCap high-performance pre-colour capstock compounds, which are available in cedar, green, black, brown and redwood finishes. Americhem says the switch has allowed the fencing producer to increase sales, integrate better weathering, and add more colours to its product line.

Right: NeoTimber Advanced composite decking is a performance optimised capped hollow core product

Product innovations

Producers of WPC products are also introducing their own innovations. US-based **MoistureShield** introduced its DiamondDefense all-polymer cap for its Vision line last year. The company says Diamond-Defense resists damage from scratches, stains and fading, resulting in the look of interior hardwoods with the strength that is needed in outdoor environments. The Vision line features a variegated appearance with a diverse pallet of colour options including Smokey Grey, Spanish Leather, Sandstone, Cathedral Stone and Mochaccino. Some are now also available with the option of CoolDeck technology, which minimises heat absorption by up to 35% compared to traditional capped composite boards for a more comfortable deck.

UK producer **NeoTimber** has added a capped hollow deck board to its line. The company's Advanced range is described as a second-generation (capped) composite decking based on its Essential hollow product that wraps a composite core in an highly-durable four-sided polymer capping. The four-sided capping provides allround protection and weather resistance, but also means the board is reversible, with an authentic embossed woodgrain on one side and grooved channels on the other.

The Advanced board is said to differ from others on the market is in its use of hollow-tube design and less extreme core reduction - 40% compared to up to 80% from other manufacturers. "We've had great success with our hollow range, the Essential, and we were keen to replicate this design philosophy with our capped decking range," says Toby Allen, NeoTimber Marketing Director. "We believe that by only removing a small proportion of the material within the board, and doing so in circular increments, the board remains considerably stronger than others on the market. This is the perfect compromise: supplying an affordable option that remains strong enough to cope with the everyday strains of home life."

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4-5 November	Compounding World Expo USA, Cleveland, USA www	w.compoundingworldexpo.com/na/		
10-13 November	Plastimagen, Mexico City	www.plastimagen.com.mx		
10-13 November	Formnext, Frankfurt, Germany https://form	nnext.mesago.com/frankfurt/en.html		
1-5 December	Equiplast, Barcelona, Spain NEW DATE	www.equiplast.com		
5-8 December	Plast Eurasia, Istanbul, Turkey	www.plasteurasia.com/en		
9-12 January	Arabplast 2021, Dubai, UAE	www.arabplast.info		

2021

2020

9-12 January 25 Feb-3 March Inter 13-16 April 4-7 May 17-21 May

Arabplast 2021, Dubai, UAE Interpack, Dusseldorf, Germany **NEW DATE** Chinaplas 2021, Shenzhen, China Plast 2021, Milan, Italy NPE 2021 www.arabplast.info www.interpack.com www.chinaplasonline.com www.plastonline.org/en www.npe.org

AMI CONFERENCES

14-16 September	Polymer Sourcing & Distribution, Hamburg, Germany
16-17 September	Polymers in Flooring North America, Atlanta, GA, USA
16-17 September	Plastics Recycling Technology Europe, Vienna, Austria
30 Sept-1 October	Performance Polyamides Europe, Dusseldorf, Germany
12-14 October	Polyolefin Additives Europe, Cologne, Germany
20-21 October	Oil & Gas Non-Metallics Europe, London, UK
27-28 October	Plastic Pipes in Infrastructure Europe, Hamburg, Germany
2-4 November	Plastics Regulations Europe, Cologne, Germany

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







7 - 8 October, 2020 ESSEN, GERMANY



4 - 5 November, 2020 CLEVELAND, OHIO

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