INNOVATIONS IN COLOUR MEASUREMENT

THE BATTLE TO KEEP BACTERIA IN CHECK

MELT FILTRATION ● IMPACT MODIFIERS
The drive to lighter parts, together with increasingly demanding performance specifications, is calling for polymer materials that display improved levels of toughness. Meanwhile, increasing demand for compounds containing recycled polyamides means taking steps to upgrade performance to near-virgin specification. Impact modifier technology can help in both scenarios; this article takes a look at some of the latest introductions.

Polyamides such as PA6 are the first choice for many demanding engineering parts for their inherent resistance to abrasion, heat, chemicals, and weathering, as well as their aging stability. However, some applications require more in terms of toughness and amine-terminated butadiene-acrylonitrile copolymers (ATBNs) can increase the impact strength of polyamide through co-polymerisation at concentrations of 10%-to-20%.

**CVC Thermoset Specialties**, part of Emerald Materials, markets ATBN polymers under the Hypro banner. These ATBNs are low-molecular-weight, liquid butadiene-acrylonitrile copolymers that contain secondary amines at the terminal positions of the polymer chains. Acrylonitrile content ranges from 0 to 26% and the nitrile content influences polymer compatibility, surface chemistry, and the ultimate polymer properties.

ATBN polymers can be incorporated into the synthesis of the polyamide through the reaction with caprolactam using various strategies, all resulting in phase-separated rubber domains with a typical size of around a micron in diameter. These rubbery inclusions can increase the impact strength of the polyamide by orders of magnitude over a wide temperature range, with little sacrifice in other properties such as modulus and glass transition temperature (see Figure 1).

Jeremy Pasatta, Technology Manager Specialty Polymers, at CVC Thermoset Specialties, says ATBN can also improve the wetting behaviour of glass fibres in polyamides, allowing an increase not only in the amount of glass fibre that can be incorporated but also the length of the glass fibres. ATBN also increases the adhesion between the glass fibres and the polyamide matrix. Because of these enhanced properties, the polyamide/ATBN – glass fibre composite has significantly increased tensile strength, tensile modulus, flexural strength, and flexural modulus, as well as improved heat distortion temperature (HDT).

Also working on ways to modify polyamides – but in this case mostly PA recyclates – is **Brüggemann Chemical**. It says its new Bruggollen TP-M1417 additive provides compounders and
processors with a way of precisely adjusting the relative viscosity of polyamides. “This newly developed modifier thus allows the upcycling of high-viscosity polyamide scrap to produce quality injection moulding grade material and offers compounders significant cost benefits over the use of virgin polymers,” the company says.

What can be achieved, Brüggemann says, is “a material that has the desired relative viscosity as well as mechanical properties that are on the same level as those of virgin polyamide injection moulding grades. With their high stiffness, tensile strength and impact strength, these upcycled materials are suitable for the same applications as virgin material of corresponding viscosity.” Typical mechanical improvements are shown in Figure 2.

Bruggolen TP-M1417 is supplied as dust-free granules that can be metered accurately. It is easy to process and compatible with the polyamide matrix, making it ideal for compounding applications, according to the supplier.

Another claimed benefit of the additive, which was introduced last year, is that it can be used to modify the relative viscosity of virgin polyamide. Brüggemann says polymer manufacturers can tailor relative viscosities during the compounding stage without having the burden of product change-over on a continuous polymerisation plant. This results in a significant gain in flexibility, the company claims, and can also considerably reduce the amount of off-spec material.

**Copolymer options**

Elastomer producer **Kraton Corporation** highlights the use of its Kraton block copolymers to modify polypropylene to provide an alternative to PVC in medical applications. The company says the medical industry has traditionally used plasticiised PVC in IV bags and tubing due to its flexibility, transparency and low cost. However, some phthalate plasticisers used in PVC can leach out in use, albeit in very low quantities.

There are also issues around recycling plasticiised PVC as, although diethylhexylphthalate (DEHP) is widely used to plasticiise PVC for medical applications, it is banned in many countries for use in other applications. “In recent years, there has been an increased demand for PVC-free solutions, such as Kraton’s hydrogenated styrenic block copolymers (HSBC),” says a Kraton representative.

HSBCs are used extensively in medical devices for their processability, clarity, flexibility, resilience, strength and durability, according to Kraton. “The new Kraton MD1646 offers the benefits of HSBC and more. Its enhanced rubber segment (ERS) structure gives it a softer feature and excellent compatibility with PP,” the spokesperson says.

“When blended with polypropylene random copolymer (PPR), the low polystyrene content results in high elastic recovery, low hysteresis and good kink resistance. Thanks to its high melt flow, the polymer requires lower processing temperature and energy consumption, both for compounding and processing.”

Kraton MD1646 and RPR blends allow for sterilisation under ethylene oxide, gamma radiation and steam at 121°C.

Kraton MD1646 can also be used as an impact modifier to improve PPR toughness in non-medical applications. “Its compatibility with PPR and high rubber content enables higher efficiency than many other impact modifiers without losing transparency,” says Kraton. “The high efficiency also allows a minimum drop in stiffness.”

Alternatives to PVC have been on the agenda at recent medical tubing and fluid bag conferences.
organised by Compounding World publisher AMI. At the Medical Tubing 2018 event in Cologne in June this year, Kraton and rival SBC supplier Kuraray explained how their copolymers have been tailored for these extremely demanding applications. And at last year’s Medical Tubing event, LyondellBasell unveiled its Purell KT MR 07, which it says is the first polybutene-1 (PB-1)-based resin targeted at healthcare applications such as medical tubing and IV bags.

Plastomer potential
Purell KT MR 07 is a high molecular weight isotactic semi-crystalline polyolefin (a plastomer), produced using metallocene catalyst technology. It is highly compatible with polypropylene, making it easy to create blends, and is said to enhance not only flexibility, elasticity and softness, but also transparency and impact resistance, even at sub-zero temperatures.

Ankur Rastogi, who works in application development and technical service for PB-1 specialties, said Purell KT MR 07 also stands out with its low leachability and extractability, excellent resistance to kinking, sterilisability, and weldability. It can also be used to enhance impact resistance.

At AMI’s Plastics Recycling World Exhibition in Essen in June, Dow Packaging & Specialty Plastics showcased what it says is one of the broadest offerings for polymer recycling, as well as solutions for recyclable packaging. This offering now comprises portfolios of DuPont as well as Dow and includes Dow’s Engage, Intune, Infuse, and Retain brands as well as DuPont’s Elvaloy, Entria, Fusabond and Surlyn.

Recycling ideas
Dow says its portfolio for mechanical recycling comprises a range of modifiers and compatibilisers for improved mechanical performance when recycling post-industrial and post-consumer flexible packaging waste. “With the combined range we can help manage diverse streams for a huge variety of polymers, including polyethylene, polypropylene, thermoplastic polyesters, polyamide, and EVOH, and up-cycling opportunities for recyclers and brand owners,” says Dr Olaf Henschke, Product Technology Leader, Dow Packaging & Specialty Plastics.

“High performance impact modifiers from both companies have been successful across a broad thermoplastic compound range for many applications in transportation, infrastructure and consumer products. They are now finding new application spaces in recycling, with increasing demand for compounds from recycled polyolefins or polyesters with performance targets similar to virgin materials, again for many application fields,” he says.

Dow claims one of the broadest ranges of impact modifiers for recycled and virgin polymers. Products highlighted include: Engage and Versify polyolefin elastomers and plastomers for PP and Elvaloy 1224 and 1330 AC acrylate co- and terpolymers for ABS to improve flow, increase impact resistance and raise stress crack resistance; Elvaloy PTW ethylene terpolymer and Elvaloy AC acrylate copolymer combined for PET and PBT to provide a balanced performance of low temperature impact resistance and flow; and Fusabond functional polymers and Surlyn ionomers for polyamide impact performance.

The combination of metallocene base polymers and MAH functionality in Fusabond grades provides superior low temperature impact strength for polyamides, Dow says, while Surlyn ethylene copolymer ionomer resins combine low-temperature impact strength with enhanced surface quality. A recent addition to the Surlyn range is AD1032; this makes it possible to create almost transparent PA6-based compounds with processing performance and properties very similar to long-chain polyamides, the supplier says.

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