Material Highlights at the K 2022

# Is Bio the New Standard?

The K 2022 offered an immense range of innovations and application examples for – and with more – sustainable materials. Interestingly hereby was that bio-based versions were extremely popular. Due to the sheer amount, the following overview of the presented sustainable highlights cannot be complete.


Shoes made from waste gas: genetically modified bacteria produce ethanol from waste gas, which is then used to create plastic, e.g. for the Cloudprime shoes from On. © Borealis

That sustainability would be a top subject at the K 2022 was clear even before the trade fair opened. This applied in particular for the presentations of plastics producers, compounders, and material distributors. Although it was ousted from top position by several machine manufacturers due to the current energy crisis, it was definitely a central theme for materials companies.

It was also interesting to note that this time, many plastics producers placed bio-based materials into the foreground. Partially, the reason for this is the lower availability of high-grade recyclates. For polyethylene (PE) and polypropylene (PP), it is still comparatively high. Nonetheless, many producers are not satisfied with the quality of the offered recyclates and the large quality variations. Moreover, packaging certification for direct food contact is still a high obstacle. Regarding technical plastics on the other hand, there is a lack of suitably prepared waste material. As many manufacturers told us, they have therefore changed to bio-based materials, where availability is better. Also, there are no quality problems with drop-in versions, and certification for food contact exists.

One example for this could be seen at the Akro-Plastic booth. The compounder supplied the biopolymer for a fan impeller developed jointly with Ziehl-Abegg (**Fig. 1**). Akro-Plastic explained that they decided to use a bio-based plastic instead of a material containing recyclate, because of better availability. Previously, the impeller fan was made of fossil-based PP-GF40. But now, for the new model, a bio-based PP with 40 % continuous fiber reinforcement is used. Called Akrolen Next PP-H LGF 40 2 CI, the material is based on waste cooking oil. Thanks to this change, the product's $CO_2$ footprint is reduced significantly. For the bio-based PP-LGF40, it is 0.5 kg $CO_2e$ ($CO_2$ equivalent) and thereby only one third of the fossil-based material's value.

Also Wacker uses bio-based raw materials for their silicones. At K 2022, the company showcased Elastosil eco, a silicone rubber made using plant-based methanol. The biomethanol is derived from plant residues that are neither suitable for food production nor as animal feed. Hereby, the organic content is apportioned to the products using the mass balance approach. Wacker says that the corresponding process has been certified by TÜV Nord according to the Redcert2 standard, and is audited regularly.

Because the biomethanol is identical to conventional methanol, the exhibited silicone rubbers exhibit the same properties as fossil-based versions. According to Wacker, a change to the bio-based version is possible without adapting the product or production method. The series encompasses eight silicone rubbers, six of which have different hardness degrees of the Elastosil LR 5040 liquid silicone rubber. Furthermore, in future Wacker will also offer rubber mixes of its Silmix series as biomethanol-based versions. At the exhibition, the company demonstrated the food-compatible compound Silmix eco R plus TS 40002 material in an Engel injection molder to produce a lemon squeezer (**Fig. 2**).

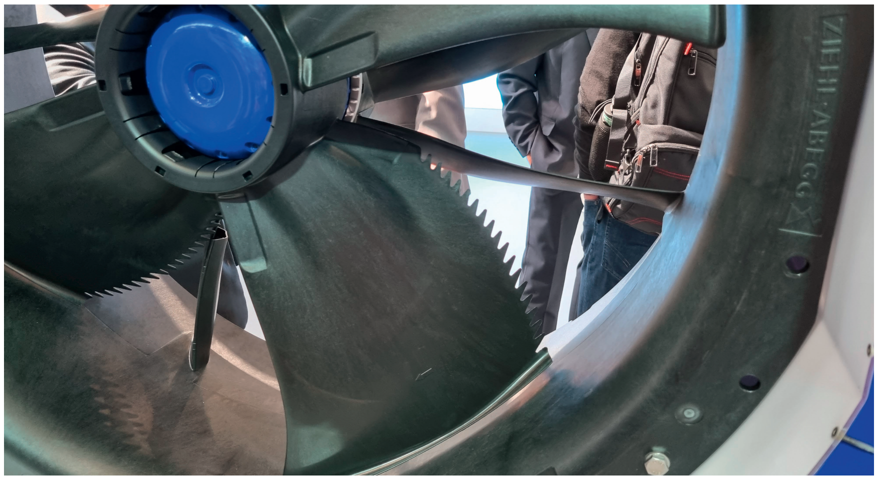

**Fig. 1.** Ziehl-Abegg's fan impeller consists of a bio-based and continuous glass fiber-reinforced PP from Akro-Plastic. © Hanser/F. Streifinger

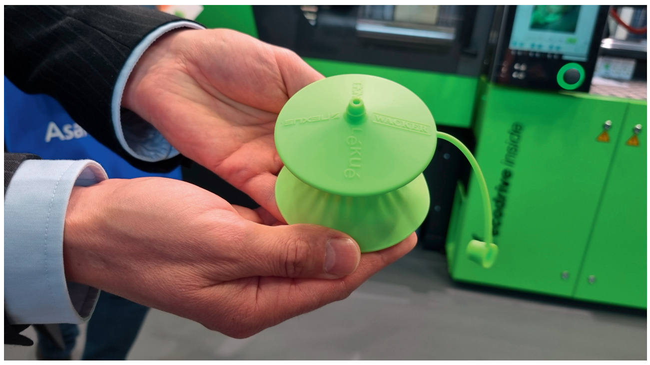

**Fig. 2.** Green squeezer, machine, and silicones: biomethanol is the raw material for the silicone rubber used to produce lemon squeezers on an Engel injection molder. © Hanser/F. Streifinger

## *Combining PLA and Flax*

Also Lanxess is working intensively to make its Tepex brand of fiber compound materials more sustainable. At the exhibition, the company showcased a fiber-reinforced PA6 that uses bio-based cyclohexane for its production. According to Lanxess, it consists of 80 % sustainable raw materials.

An entirely bio-based new version is the Tepex dynalite Scopeblue 813 that was introduced to the market shortly before the K show. It features a matrix of polylactide (PLA; polylactic acid) that is reinforced with flax fibers. The plastics manufacturer opted for this combination, because PLA is readily available, plus the fact that flax and the polymer have similar melt temperatures, whereby they can be processed together very well. Apart from other applications, the material is used for sports shoes, which are subjected to high loads, such as football shoes. Hereby, it is an alternative for other fiber-reinforced plastics. At the exhibition, Lanxess showed a sports shoe inner sole made of the new material (**Fig. 3**).

Other companies also exhibited sustainable materials for shoes. For example, DuPont presented a thermoplastic copolyester elastomer (TPC) with a biomass content of up to 72 %. According to the company, the organic content is obtained from plant residues and organic wastes. In this way, the raw materials do not compete with foodstuffs production. Named Hytrel Eco B, the material is certified according the ISCC mass balance approach. It is supposed to have the same properties as fossil-based versions. What is more, 100 % of the electric power DuPont uses for its production comes from renewable sources. The material can be used for shoe soles as well as shoe uppers. At the exhibition, the plastics producer showed a sample whose foamed sole as well as the fibers for the shoe upper are made of the TPC (**Fig. 4**).

Use of alternative raw materials for shoe materials was also presented by Borealis. One of the highlights at the Austrian plastics producer's booth was the Cloudprime sneaker of the Swiss brand On (**Title figure**). Its midsole consists of an EVA foam (ethylene vinyl acetate copolymer) from Borealis. Main point of interest: the polymer's raw material is produced from the carbon monoxide (CO) emissions of industrial sources such as steelworks or refuse incineration. »

## Info

In the first part, we reported about exciting automotive highlights at the K 2022. It appeared in ***Kunststoffe international*** 9/22 (pages 34 to 37). Additional news of material novelties at the trade fair is also available under ***en.kunststoffe.de/k-fair***

### Digital Version

A PDF file of the article can be found at ***www.kunststoffe-international.com/archive***

### German Version

Read the German version of the article in our magazine ***Kunststoffe*** or at ***www.kunststoffe.de***

**Fig. 3.** As an alternative for conventional fiber-reinforced materials (right) for shoe soles, Lanxess has developed a completely bio-based Tepex (left). Consisting of PLA, it is reinforced with flax fibers. © Hanser/F. Streifinger

Also involved are the two companies Lanzatech and Technip Energies.

Lanzatech is responsible for collecting the CO, and subsequently processes it into ethanol. This is done using a fermenting process with genetically modified bacteria. The ethanol obtained in this way is subsequently dehydrated to ethylene by Technip Energies, and then processed into EVA by Borealis. In future, the material will be used not only for the midsole, but also for other shoe parts. For the Cloudprime sneaker, also other materials made of alternative raw materials are used. For example, the polyester of the shoe upper is based on raw materials made of carbon emissions, and the outsole is made of a thermoplastic polyurethane (TPU) produced from chemically recycled post-consumer wastes.


**Fig. 4.** Up to 72 % biomass content in the TPC developed by DuPont, e.g. for making shoes. What is more, it is produced with 100 % green power. © Hanser/F. Streifinger

## *Bio-Based Additive Reduces $CO_2$ Footprint*

Also the additives producers are increasingly opting for bio-based versions of their products. For example, Eckart GmbH showcased effect pigments with bio-based carrier material at the trade fair. Named Mastersafe BCR, the products are currently available in eight color tones. The pigment preparations are supplied in pellet form, whereby the pigment content is 80 %, and that of the carrier material is 20 %. The carrier is 100 % bio-based. As a result, the product's $CO_2$ footprint is reduced by a total of 50 %, claims the company. Dietmar Mäder, Global Head of Plastics at Eckart, says that this has enabled them to achieve the lowest $CO_2$ footprint of all comparable products available on the market – for a price that is only slightly higher.

The product's ecological balance has been certified by the TÜV Süd testing institute. Also the biomass content is monitored regularly and independently, adds Mäder. The products are intended to be used primarily for packaging. They are compatible with PE, LDPE and HDPE, as well as PP, polystyrene (PS), acrylonitrile butadiene styrene (ABS), and polyamide (PA), and according to Eckart they are also suitable for food packaging. For production, the company exclusively uses renewable energies. For this, Eckart installed their own power generation capacities during the past years. A trend that can be observed for many plastics producers. Some of them install their own systems for green power; others invest in corresponding projects with large power utilities, or enter long-term supply contracts for green power.

Bio-based additives were also shown by Wacker at their booth. Their Vinnex eco series consists of additives based on polyvinyl acetate, with which the polymer properties and the compatibility between different bioplastics can be improved. They were developed specifically for bio-degradable polyesters and starches, whereby their organic content is also determined using the mass balance approach. They exhibit the same properties as their fossil-based counterparts, but have a smaller $CO_2$ footprint.

With their Vinnex series, Wacker also offers additive masterbatches, which are claimed to ensure clearly better handling than resins based purely on vinyl acetate. The batches are blends of PLA and polyvinyl acetate, and are offered as granulates. Contrary to non-compounded polyvinyl acetates, they do not have to be cooled during transport or storage at high ambient temperatures. Nor do they agglutinate with temperatures up to 30 °C, according to Wacker. The additives producer offers several versions for different application areas. One version, for example, enables melt strength to be increased for film extrusion. This reduces the necking tendency frequently encountered with bio-degradable polyesters, and boosts extrusion speed. For injection molding applications, Wacker has also developed a version that permits melt viscosity to be reduced.

## Improved Demolding of Parts

Better injection molding results are also claimed to be achievable with another bio-based additive, which was introduced at the trade fair. Clariant's bio-based wax Licocare RBW 560 TP Vita is a combined lubricating and nucleating media. The company says that the wax features very good thermal stability and low volatility, thereby being able to withstand higher processing temperatures. Moreover, it is supposed to remain effective also with low dosage. According to Clariant, it simplifies the demoldability of injection molded parts, whereby fewer parts remain stuck in the mold. This reduces machine downtimes, and the risk of short shots and rejects is also reduced. In addition, improved demoldability results in higher surface quality of the parts.

The additive is said to be particularly suitable for use in polyesters. It is derived from crude rice bran wax, a by-product from the production of rice bran oil. Consequently, it does not compete with food production. Clariant says that organic content is at least 98 %, and FDA food contact approval has been applied for.

## Additives Improve Recyclate Quality

Also showcased at the trade fair were additives for quality improvement of recyclates. As already mentioned, their quality is frequently criticized as being too low. During their use, and also during the recycling operation itself, plastics are subjected to environmental influences that damage the polymer chains and structure. Moreover, the function of some additives is impaired. Poorer mechanical and processing properties of the recyclates are the result. This can be remedied e.g. by means of further special additives. Brüggemann presented three such products at the K (**Fig. 5**). They are stabilizers for polyolefins, with which their properties are significantly improved, also without the addition of virgin material.

Named Brüggolen R, two of the types are intended for PP recyclates, and one for PE recyclates. One of the two PP types was developed specifically for recycled battery cases, and therefore contains a higher amount of acid scavenger. The PE type is intended particularly for recycled LLDPE (linear low density PE) used in film extrusion. It is supposed to significantly reduce the number of defects in films, and increase their strength. According to Brüggemann, tests showed that an additive content of 0.3 % increases tensile strength by about 25 %, and elongation at break by about 10 %. This is achieved because the stabilizer repairs existing defects in the molecular chains. As a result, the recyclate's mechanical strength is close to that of virgin polymer, says Brüggemann.

Also intended for the recycling of PE is a silicone additive masterbatch presented by Wacker. Genioplast PE50S08 is a processing aid for compounding PE, which improves the polymer melt's flowability, and the distribution of fillers in corresponding types. According to the company, this leads to higher throughput and a lower energy demand of the extruder. PE recycling is improved by the additive, as it ensures uniform mixing of different polymer types. Moreover, it is also claimed to improve the subsequent processing into a compound as well as product surface quality. Wacker markets the masterbatch with LDPE as carrier material. Silicone content is 50 %.

In recent times, the industry has also increased its efforts in chemical recycling. At present, the existing capacities are still low, but they are growing continuously. In the recycling methods used, the plastic wastes are broken down into oligomers, monomers or chemical raw materials. For example, pyrolysis oil is produced, which can then be reprocessed in steam crackers. However, the pyrolysis oil obtained from waste material can be contaminated with e.g. chlorine or oxygen products. These differ, depending on the source of the waste material.

For purification of the pyrolysis oil from mixed plastic waste, Clariant has developed special catalysts and adsorption media. They can be used by recyclers during the chemical process, or by chemical companies, e.g. before the pyrolysis oil is fed into the steam cracker. The result is a product that is compatible for ethylene plants. ■

*Florian Streifinger, editor*


**Fig. 5.** Normally, recyclates must be re-stabilized with additives during the recycling process. Three newly introduced additive types enable the quality of PE and PP to be increased significantly.

© Hanser/F. Streifinger