

ERJ
TOP 10

Elastomers for SUSTAINABILITY

Entrant	Location	Project	Judges score
UPM Biochemicals	Leuna, Germany	Renewable functional fillers	543
Evonik	Essen, Germany	Advanced rubber recycling formulation	520
Silox	Engis, Walonia, Belgium	New engineered generation of sustainable activators	518
Mitsubishi Chemicals Group	Tokyo	Synthetic leather from bio-based PU	511
Arkema (with On)	Paris	CloudNeo recyclable, performance running shoe	510
Hankook, Hyosung, SK Chemical	Seoul, South Korea	Chemically recycled PET tire	506
Asahi Kasei Corp.	Düsseldorf, Germany	Hydrogenated SBR to reduce 6PPD usage	500
Tosoh Europe	Amsterdam	Recycled styrene for tire SBR	490
Cabot Corp.	Boston, Massachusetts	Evolve reinforcing carbons	480
Huntsman	The Woodlands, Texas	Circular TPU elastomer footwear	470

Going commercial

The latest staging of *ERJ* programme to identify material science-based projects contributing most to raising the environmental profile of the elastomers/rubber industry.

E4S is an industry-first sustainability initiative, designed to highlight significant advances for end-user sectors including automotive, tires, automotive components, construction, consumer, industrial and medical.

The judging process has culminated in the new E4S Top 10 of materials-science-based developments, based on their potential to enhance the environmental profile of the elastomer/rubber industry:

UPM Renewable functional fillers

In its E4S 10 submission, UPM reported further progress with its Leuna Biorefinery project, including that “we estimate the technical start-up will be by the end of 2024.”

UPM also reported new LCA data: supporting its analysis that 1mt of RFF is equivalent to almost

-1,1 mt CO₂ footprint.

Meanwhile, the Finnish group stated that almost six supply agreements for 2025 volume have been finalised – with many other deals “under discussion and expected to close by end of November this year.”

UPM went on to highlight a previous announcement that Nokian Tyre has produced its first ever tire made with RFF, replacing 100% carbon black in sidewall application.

Also, a leading European OEM has approved RFF for four projects and is “ready to realise the volume as of 2025 for the new models with first commercial RFF supply agreements signed for deliveries in 2025.”

Judging comments

UPM has again supplied high-quality information with detailed updates to support its continued top-ranking in the E4S programme. The latest form shows further significant progress

ABOUT THE TOP 10 TABLE

The E4S rankings are compiled twice a year by an independent judging panel, which assesses projects for: Quality of the presentation; level of innovation; commercial potential; and contribution to sustainability. Along with ratings for overall strength & weakness, the system allows for a maximum score of 700 points. To keep the table ‘live’, project scores may be reduced by 10% unless regular updates are provided.

being made with the commercialisation of RFFs, while also signalling the imminent start-up of the Leuna biorefinery. The development work with automotive OEs and industrial rubber parts manufacturers supported by detailed life cycle analysis data offers a blueprint for the introduction of sustainable materials and related technologies within the tire & rubber manufacturing industry. (For further details see E4S 9 report)

➔ CONTINUED ON PAGE 46

→ CONTINUED FROM PAGE 45

Evonik Advanced rubber recycling formulation

Essen, Germany-based Evonik AG has developed a process that enables the use of up to four times more recycled rubber in new tires than is possible with existing methods.

The level of rubber recycle incorporated into tires has been very limited up to now as the polymer structure hampers interaction with other materials, according to Evonik.

In particular, it said, the sulphur bonds create a highly robust, three-dimensional network, which conventionally has an upper limit of about 5% when it comes to introducing ground tire rubber from end-of-life-tires into new tires.

Using a special formulation containing vinyl silanes, Evonik says it can now reverse the vulcanisation “more effectively than previously possible” – cleaving the sulphur bridges in the rubber, while leaving “as many of the long carbon chains as possible untouched.”

In trials, recycle levels in the rubber blend could be increased to up to 20%, said Evonik, which is now set to start next-stage testing and trials – towards seeing customers use the system in commercial-scale industrial production.

Judging comments

Impressive that the technology can deliver a four-fold increase in the effectiveness of conventional devulcanisation processes and raise the proportion of recycle in rubber blends up to 20%. As Evonik states: “Rubber is far too valuable a raw material to be used only once in tires.”

Legislation will always provide the circular economy ‘push’ but it’s very gratifying to see science and innovation providing the ‘pull through’ in terms of volume recycle.

As a major player in the field of rubber chemicals, Evonik is well equipped to deliver on the significant potential offered by this technology.

Silox New engineered generation of sustainable activators

In the E4S 10 entry for its ActiECO+ products, Silox said it developed a ‘flexible’ process technology for the precipitation of zinc-based solutions into zinc oxide (ZnO) – with

a ‘circular/green’ option in the new portfolio of activators.

Production involves precipitation of zinc-based ingredients into ZnO with precipitate dried or calcined to remove water and/or CO₂ yielding “a large variety of morphology.”

According to Silox, the vulcanisation efficiency of ZnO is improved by maximising contact between particles and the components of formulation: with high-surface-area, small particles “uniformly dispersed” throughout the rubber matrix.

The new product is said to ‘perform like an active ZnO, avoid the need for reformulation and offer benefits in terms of cost-control and ease of transportation & storage.’

Silox cited examples, including a 5 phr formulation for ‘white seal applications’, where the high-purity ZnO product is claimed to offer: ‘Improved blending and limitless shelf life – as well as having a low carbon footprint and being non-ecotoxic.’

Better dispersion is achieved ‘as the shape and morphology optimised for rubber mixing leading an improved ‘micro-structure’ of the compound,’ the company stated.

According to Silox, production is now up to 10ktpa within two years. Sales are “up to around 10 customers in the non-tire sector, with final approvals on-going with two tire manufacturers.”

Judging comments

The Silox technology appears based on innovative developments both in terms of process engineering and the optimisation of morphology of the rubber activators. The entry includes concise details about the ZnO technology, chemical composition and formulations, backed up with IP patent details.

Still early days, but this seems a solid advance offering significant sustainability benefits to the tire & rubber industry and is generating good commercial take-up.

Mitsubishi Chemical Group Synthetic leather from bio-based polyurethane

Tokyo-based Mitsubishi Chemical Group’s (MCG) plant-derived polyol BioPTMG has been adopted by Kahei Co. Ltd as a synthetic leather material.

In addition, items such as shoulder bags and tissue cases made with this bio-synthetic leather will be sold on the market via Triple A Co. Ltd, a planner and marketer of sustainable products.

Developed by Mitsubishi Chemical in 2021, BioPTMG is a plant-derived polyol said to impart flexibility, durability, and high resilience to polyurethane and polyester products.

A “unique” refining technology avoids colouring occurs during production, so that the materials can be used in a wide range of interior design, fashion, industrial and other applications.

Meanwhile, a biomass content of 92% or more reduces both the consumption of petroleum, and GHG emissions as the plant-based raw materials absorb CO₂ as they grow.

Judging comments

Very encouraging to see a project showing a full value-chain for a bio-based elastomer material; from plants in the ground to high-end products on sale at a commercial retailer.

Time and tide is everything when it comes to fashion. 2025 may be the year when sustainable synthetic materials finally turn the corner in terms of volume and profitability.

Arkema (with sportswear company ON) Recyclable, high-performance running shoe CloudNeo

Update: This May, On launched two new products from its circular Cyclon programme: the Cloudrise Cyclon for everyday running and the Cloudeasy Cyclon for training and all-day wear. Both products are available via On’s subscription service Cyclon. Once returned, On will take care of the recycling of the products. Customers can sign up for Cyclon for a monthly fee of around €25. The Cloudrise employs a 90% bio-based upper engineered from polyamide 11 derived from castor beans. The bottom unit is engineered from Pebax a 30% bio-based thermoplastic elastomer. For the Cloudeasy shoe, On partnered with Loop Industries, a producer of fibres based on chemically recycled PET.

Judges comments

While €400 a year likely busts the footwear budgets for the majority of consumers, it is encouraging to see

this recycling model – involving the impressive use of Arkema's bio-based elastomer materials – now fully up & running with Swiss maker On also offering new Cyclon products.
(For further details see E4S 9 report)

Hankook, Hyosung, SK Chemical Chemically Recycled PET Tire

Update: A video showcasing SK Chemicals' circular recycling technology has won a gold medal at the "2024 International Business Awards, a global competition that evaluates companies worldwide across a range of criteria, including promotional activities. SK topped the technology segment of the video category for its presentation titled 'SK chemicals Closed Loop Solution', which illustrates the process of transforming polymer waste into products identical to petroleum-based alternatives via collection, crushing, washing, depolymerisation, and polymerisation process.

As previously reported, Hyosung Advanced Materials has employed SK's technology in the development of high-strength recycled PET-based tire cords for use in Hankook's ION tires – a product with 45% sustainable material content.

Judging comments

High-quality presentations and promotional activities have a crucial role to play in the introduction of any sustainable-materials technology – within the rubber & tire industry and the global commercial and consumer sectors more generally. So, well done here to SK for increasing awareness of the complex chemicals recycling value-chain to a high-profile international audience.

(For further details see E4S 9 report)

Asahi Kasei Europe New selectively hydrogenated SBR for reduced 6PPD usage

Asahi Kasei previously reported on the enhanced ozone resistance of its selectively hydrogenated styrene-butadiene rubber and its ability to allow reduced usage of 6PPD in the rubber compounds.

In its latest update, Asahi explains how further studies have shown that the HSBR makes it possible, to not only reduce usage of the antioxidant/antiozonant, but

also to improve mechanical properties, including fatigue resistance.
(For further details see E4S 9 report)

Tosoh Corp. New composites of chloroprene rubber and cellulose nanofibres

Tosoh Corp. has started to manufacture and sell a newly developed grade of the company's Skyprene chloroprene rubber. The SG Series features a composite of chloroprene rubber and cellulose nanofibres.

To commercialise the SG Series, Tosoh collaborated with Bando Chemical Industries to incorporate the composite in transmission belts that Bando produces and has begun selling.

The collaboration was in conjunction with the Japanese government's New Energy and Industrial Technology Development Organization (NEDO)'s subsidy program.

An alternative to fossil-derived reinforcing fillers, such as carbon black, CNF is "a biomass-derived, high-performance material that is one-fifth the weight of yet more than five times stronger than steel."

Tosoh said its proprietary technology makes possible the uniform and fine dispersal of CNF in chloroprene rubber.

(For further details see E4S 9 report)

Cabot Corp. Evolve reinforcing carbons

In last E4S update, Cabot said it is also developing additional reinforcing carbon technologies recovered from end-of-life tires – recovered carbon, pyrolysis oils. These are to be produced at industrial scale, for use in tires and other industrial applications.

Cabot is collaborating with IFF Health and Biosciences to commercialise sustainable rubber reinforcing additives based on IFF's polysaccharide, created by enzymatic polymerisation of sustainable European sugar beets.

(For further details see E4S 9 report)

Huntsman Circular TPU elastomer for footwear

Huntsman has developed a range of thermoplastic polyurethane (TPU) materials for the production of footwear with enhanced grip,

durability and 'circularity'.

Tailored for use in soling of running, hiking and safety shoes, the new Avalon Gecko TPU series includes an extrudable grade for creating "super thin" outsoles and a product that can be foamed to produce a very low density material with "unique" touch and feel.

Huntsman said it was inspired by the "extraordinary grip of geckos" in developing the TPUs, which are said to offer comparable slip performance to rubber in both wet and dry conditions.

All TPU grades offer adhesive-free bonding when paired with other TPU midsole materials and, due to their compatibility, can be mechanically recycled with minimal impact on material performance.

In-house testing of the regranulated TPU showed no signs of degradation in performance, reported Huntsman, while noting that "the ability to perform mechanical recycling is dependent on end-of-life take-back programs and a recycling ecosystem being in place."

Judging comments

Seems to be on the cusp of commercial introduction, with Huntsman indicating that there has been significant customer-facing involvement behind this innovation.

Impressed that tests on outsoles produced using regranulated TPU showed no signs of degradation in performance, as well as by Huntsman's awareness of the need for end-of-life take-back programmes and a 'recycling ecosystem' within the market introduction programme...

This neat, high-grip TPU innovation could really gain commercial 'traction'. Of course, it would be nice to learn more about the materials science involved...

E4S JUDGING

The expert panel, which was coordinated by ERJ editor Patrick Raleigh, comprised:

Jiri Brejcha, head of Brejcha Rubber Consulting, and former materials development specialist at Trelleborg Wheel Systems, and before that Mitas, Prague, Czech Republic.

Prof James Busfield, professor of materials & national teaching fellow director of industrial engagement & head of the soft matter group, Queen Mary University of London.

Dr Thomas Griggs, PDRA sustainable rubber projects, Queen Mary University of London.

Adrian Lunney, experienced media professional for the UK and international polymer sectors, covering industries including medical, automotive and packaging as well as machinery, materials and processing technologies.