ERJ TOP 10 Elastomers for SUSTAINABILITY

Entrant	Location	Project	Judges score
Hankook, Hyosung, SK Chemical	Seoul, South Korea	Chemically Recycled PET Tire	554
UPM Biochemicals	Leuna, Germany	Renewable functional fillers	540
Tosoh Europe	Amsterdam, Netherands	Chloroprene-CNF composites	523
Novoloop	Menlo Park, California	World's first chemically upcycled TPU	523
EcoCarbon Innovations Inc.	Toronto, Ontario	Producing pure recovered carbon filler	517
Arkema	Paris, France	CloudNeo recyclable, performance running show	510
Asahi Kasei Corp.	Düsseldorf, Germany	Hydrogenated SBR to reduce 6PPD usage	500
Cabot Corp.	Boston, Massachusetts	Evolve reinforcing carbons	495
Celanese	Irving, Texas	Bio-based copolyester TPE	490
Nynas AB	Gothenburg, Sweden	Bio-based processing oil	487

Innovation pipeline

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:

Hankook, Hyosung, SK Chemical
Project: Chemically Recycled PET Tire

Hankook Tire & Technology has launched commercial production of tires featuring recycled PET from discarded plastics materials – the project is a collaboration with SK Chemicals and Hyosung Advanced Materials.

As announced by the tire maker, the rPET technology is being employed in an 'electric vehicle-exclusive' iON-branded tire with rPET used in tire cords.

SK Chemicals employs a chemical recycling technology to break down discarded plastics and use them as raw materials for recycled polymers.

Hyosung Advanced Materials has developed the high-strength recycled PET-based tire cords for the iON tires, using the recycled polymers.

The new iON tire has a 45% sustainable material content and recently passed a reliability verification by "a European automotive manufacturer."

The tire has secured final approval for use and is being mounted as tires for new vehicles, according to Hankook.

Judging comments

"Ambitious and forward thinking and great to see some cross-sectoral activity (eg packaging into tires) with the rPET element to the fore. Hopefully the chemical recycling will deliver the right purity of material content. Hopefully also the project can sustain steady and guaranteed supplies of the PET waste stream - which can be limited and always commands a premium price for the highest bidder."

"Good work across the different areas, from chemicals recycling at industrials scale, fibre optimisation and development of a tire with 45% sustainable material-content. More information would be helpful. Described as a commercial first in South Korea and the tire has met stringent requirements for use on EU roads."

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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.

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UPM
Project: Renewable functional fillers

Since its last E4S submission, in October 2023, UPM reported signing first commercial RFF supply agreements for deliveries in 2025.

"Construction of Leuna biorefinery and RFF plant is progressing with full swing according to [the latest] schedule," the company stated in its latest update.

Meanwhile, commissioning the wood-handling area & debarking/chipping unit was completed this February and first deliveries of wood have recently been made to Leuna by rail.

A life cycle assessment of UPM BioMotion renewable functional fillers: RFF found a negative carbon footprint from cradle-to-gate.

UPM said it is also preparing to highlight new RFF application stories during the German Rubber Conference (DKT 2024) in Nuremberg, Germany.

Interestingly, also, Stellantis cited UPM's BioMotion RFF as a solution for the sustainability challenges facing automotive OEMs – at a recent global biopolymers forum in Amsterdam.

Judging comments

"While still awaiting – as ERJ went to press – start-up of its plant in Leuna, Germany, UPM has continued to supply updates showing significant progress being made in the background to the project, which has ranked highly in the E4S Top 10 since 2022."

"Attention being gained from leading automotive OEs and industrial rubber parts manufacturers, general market engagement and progress on the life cycle analysis front underscore how UPM intends to hit the ground running when full RFF production comes fully on-stream."

(See also previous E4S reports)

Tosoh Corp.
Project: New composites of chloroprene rubber and cellulose nanofibers

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 programme.

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."

Historically, however, integrating CNF with rubber materials has presented technical challenges in processes such as compounding and mixing.

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

Tosoh is exploring expanded applications for the SG Series and accelerating its development of manufacturing technologies for consistently high-quality mass production.

Judging comments

"Tosoh has somehow addressed the challenges of effectively mixing cellulose nanofibers into chloroprene rubber compounds. It would be nice to get more details."

"The project has nicely covered the commercialisation base through the involvement of transmission belts manufacturer Bando. Also helps to have the backing of Japan's NEDO."

"The CNF reference to steel strength calls to mind Henry Ford's use of industrial hemp in the early production of automobiles. One hundred years on we have yet to fully apply the lessons and realise the industrial potential of the plant kingdom."

Novoloop
Projects: World's first chemically upcycled TPU

The US venture capital-backed start-up is focused on chemically recycling polyethylene waste into performance materials, including thermoplastic polyurethanes (TPUs). Novoloop's patented ATOD (accelerated thermal oxidative decomposition) process has already found a number of promising applications including in On running shoes.

In April, Novoloop announced the startup of a pilot plant in Surat, India, under a collaboration with chemicals maker Aether Industries. The US company said it is now moving from batch reactions to an integrated and automated plant that validates its process technology. The recycling technology is said to offer a carbon footprint reduction of up to 91% when compared to the conventional process of producing adipic acid feedstock.

Novoloop said plans to expand the pilot capacity to the full 70 metric tons per year demonstration plant scale are already underway.

Judging comments

"The pilot plant start-up looks like a significant step forward for the ATOD (accelerated thermal oxidative decomposition) technology, designed to upcycle plastics packaging waste into high-value products such as elastomeric TPUs for footwear and sports goods."

"Successful chemical recycling has to be the bedrock of future large scale and sustainable solutions. The proven technology shown here - and the creation of real value (TPUs) from the bottom of the barrel (mixed PE waste) is to be applauded."

(See also previous E4S reports)

EcoCarbon Innovations Inc.
Project: Environmentally friendly plants to produce and sell sustainable pure recovered carbon

The target of this project is to build environmentally friendly, waste tire processing plants in Europe and the Americas that produce sustainable 'pure' recovered carbon (80-100% carbon) fillers as an alternative to virgin carbon. The facilities are to be based on proprietary upgrade processes, particularly for reducing ash-content.

In terms of commercial pro-

gress, ECI said its patented continuous flow pyrolysis technology is currently being used in an 80 tons/day demo plant in Malaysia and by several licensed operators in Asia, currently producing sustainable recovered carbon (approx. 80% carbon / 20% ash) and hydrocarbons.

Judging comments

"Significant progress on the process engineering side points to the emergence of a significant new player in the sustainable carbon filler arena. Could offer a potentially significant contribution to improving the sustainability of the tire and rubber industries."

"Encouraging to see fresh innovation and impetus in pyrolysis technology and investment - something other parts of the polymer world could and should take inspiration and intent from."

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

Produced from Arkema's bio-based polyamide polymers Cloudneo sports footwear meets ON's performance requirements – light weight, comfort and energy-return – as well as compatibility of components during end-of-life recycling.

Based on a series of sustainable material-science developments– Arkema's bio-based polymers are derived from renewable castor beans – Swiss-based ON has employed these materials to develop the textile, foam, and other components of the Cloudneo.

The collaborative project also features an innovative approach to recycling, reaching right down to consumers: the footwear is "leased" rather than sold to the end-user, via a monthly subscription service.

(See previous E4S report)

Asahi Kasei Europe
Project: 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.

(See previous E4S reports)

Cabot Corp.
Project: Evolve reinforcing carbons

In its E4S update, Cabot said it is advancing additional reinforcing carbon technologies recovered from end-of-life tires – recovered carbon, pyrolysis oils. These are to be applied 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.

New products are in the pipeline, while Cabot has also "demonstrated" progress with rCB loadings of up to 25% and achieved good results in N330 applications.

Also, prototypes with "high levels of recovered carbon loading in pre-mixed elastomer composites used in passenger car sidewall tire applications, achieved 2X improvements in fatigue life at 88% recovered carbon loadings."

Judging comments

"Always good to see a mix & match sustainability strategy at work – including both bio and recyclate. It allows for creativity and wiggle room and shows intent to get the customer over the line with whatever combinations will suit their applications and marketplace."

(See also previous E4S reports)

Celanese
Project: Thermoplastic elastomer from bio-circular feedstock

For E4S VII, Celanese entered a bio-based version of its Hytrel TPC copolyester thermoplastic elastomer grades that can save up to 20% in carbon footprint.

In its latest update, Celanese reported the commercialisation of two new Hytrel TPC ECO-B grades for cosmetic applications with 35% and 60% bio-circular content, certified by ISCC+. The grades, it stated, can be used as a direct drop-in without the need to re-qualify. A "large share of the wide Hytrel TPC portfolio now offers an ECO-B alternative with bio-circular content, for use in industrial, consumer and automotive applications."

Judging comments

"Based on this update, Celanese seems to be making good progress with these bio-elastomers on both the technical and commercial side."

(See previous E4S reports)

Nynas
Project: Bio-based processing oil

Nynas reported confirmation of performance in all properties, including 'taxi fleet wear test', in the first test project with PCR winter tires and a second tire test project for a PCR summer tire showing "promising results" vs. TDAE (wet, RRC, handling). Other tests in applications with natural rubber and carbon black "confirm good performance vs. most used mineral oils in tire industry… not only in PCR tread applications but also in internal compounds and for instance, in truck or agriculture tread applications."

Judging comments:

(See previous E4S reports)

E4S JUDGING

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

Jirí 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 Wilma Dierkes, associate professor at the University of Twente Faculty of Engineering Technology, who has contributed to pioneering developments in areas such as reinforcing-filler systems and the recycling and re-utilisation of tire & rubber materials.

Dr Anureet Kaur MRSC, postdoctoral research assistant, soft matter group, School of Engineering and Materials Science, 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.