

Bio-succinic acid:

A frontrunner for high-performance biobased polyurethanes and beyond

Biobased polyurethanes (PU) and packaging are increasingly being used for consumer goods and becoming more common in stores and supermarkets. Following this trend, the platform chemicals required to manufacture sustainable biomaterials are also becoming more readily available. Biosuccinium®, the renewable bio-succinic acid produced by Dutch biotech company Reverdia (Geleen), continues to demonstrate strong opportunities for polyurethanes and bioplastic products. These modern materials offer enhanced performance for footwear, the automotive industry and other market sectors.

VAUDE (Tettnang, Germany), a manufacturer of innovative outdoor products, is already benefiting from the winning footprint of bio-succinic acid. The company recently announced that it will reduce its dependency on oil by replacing conventional materials with those derived from Biosuccinium.

Sustainable footwear with benefits

As a near drop-in for adipic acid, bio-succinic acid can be used to produce biobased polyester polyols, which have been well received in the footwear industry. Vaude's new Skarvan range of trekking shoes will use Biosuccinium-based thermoplastic polyurethane (TPU) in its shoe toe caps and heel counters. It is the first time the brand will use a biobased TPU in its shoes and the range will be available to consumers in spring 2018.

This is a clear example of how biobased chemicals can help producers meet growing customer demands for more sustainable products. Vaude is committed to minimising the environmental footprint of its products while not compromising on high-end design and sturdy quality. The brand has previously demonstrated this by being the first outdoor company to be certified under the EU's Eco-management and Audit Scheme (EMAS).

Reverdia views the growing trend of biobased consumer goods as a positive sign of things to come. High-performance biobased footwear on store shelves is just one example. In 2017, it showcased a range of cutting-edge Biosuccinium-based polyurethanes at PSE Europe in Munich, Germany.

These PU prototypes could be used across markets. They have a significantly reduced environmental footprint due to the renewable raw materials used and the sustainable technology which produces the biobased chemicals. Biobased content reached 60 % in some samples. The biomaterials can be used for applications such as industrial components (cast PU), artificial leather (PU dispersion), footwear products including sole plates (TPU) for soccer boots and trainers for other field sports, as well as casual shoe soles (microcellular PU).

In China, Reverdia and Dezhou Xinhuarun Technology (Xinhuarun) have signed an agreement to jointly develop and promote microcellular PU foams. Xinhuarun's products are exported across Asia, America, Europe and the Middle East. The manufacturer will work exclusively with Reverdia, using Biosuccinium in its shoe soles and will expand the partnership towards development and commercialisation of other sustainable polymers with excellent functionality and best-in-class eco-footprint.

One step beyond!

It is not only footwear products which can benefit from switching to bio-succinic acid. Biosuccinium-based materials could also offer enhanced performance for the automotive and aircraft industries. Flexible PU foams with various densities have been synthesised by partially replacing traditional polyols with Biosuccinium-based polyols.

Recently in Italy, the Institute for Polymers, Composites and Biomaterials (Naples), the Institute for Macromolecular Studies (Milan) and Adler Plastic (Ottaviano) published studies showing bio-succinic acid-based flex foam with improved mechanical and acoustic performance. Amongst those benefits are a positive effect on the foams' compressive performance and their increased sound absorption level. With these benefits, the foams made with bio-succinic acid could be considered as potential substitutes to reduce vibrations and noise pollution and consequently increase comfort.



Bio-succinic acid-running shoes pair grey green



By:

Lawrence Theunissen
Global Director Application Development
Reverdia, Geleen, The Netherlands

Bio-succinic acid-Microcellular PU collage



An unrelated agreement between Reverdia and Covestro was announced in 2015 to jointly develop and promote TPU based on renewable raw materials. Covestro will use Biosuccinium in the production of its Desmopan®-brand TPU for a variety of applications beyond footwear, such as apparel and consumer electronics. Beyond biobased PU, bio-succinic acid is also enabling leading developments in plastic packaging and resins.

Developments in sustainable packaging

Polybutylene succinate (PBS) is one of the newest biopolymers under development for numerous applications worldwide. Biosuccinium can be used to create PBS for plastics and packaging. Traditionally, PBS is based on petrochemical succinic acid and 1,4 butanediol (1,4 BDO). Petro-based PBS is already biodegradable. However, Biosuccinium can boost PBS's biobased content, making it even more sustainable.

PBS has a range of interesting properties including flexibility and heat resistance. The material can be used as a matrix polymer or as a modifier to be combined with another chemical such as polylactic acid (PLA). PBS offers opportunities for a wide range of applications like food packaging, coffee cups, paper lamination, agricultural mulch films, non woven, electrics and electronics, and automotive interiors.

In order to further broaden the application scope for PBS, Reverdia operates a joint development programme with Wageningen UR Food & Biobased Research on biobased PBS compounds for injection moulding. The research pays close attention to the longevity, appearance and processing

characteristics. Plastic product manufacturers will also play a key role in the testing process in order to validate these new compounds for reusable horticultural crates and rigid food packaging with hinges. The final biomaterials are predicted to demonstrate an improved carbon footprint in comparison to the polypropylene typically used for these applications.

Bio-succinic acid for resins

Paint and coating manufacturers can increase the biobased content of their resins by using Biosuccinium. Solvents and coalescing agents based on bio-succinic acid also allow for reduced levels of volatile organic compounds (VOCs) in their formulations, addressing continuously stricter government and industry regulations.

Investment in superior biobased resins is growing, as is the demand for more sustainable products across the value chain. Biosuccinium is a near drop-in for adipic and phthalic acids and has applications in a wide range of products. Product finishes, special purpose coatings and structural materials are just a few examples.

Alkyd paints which use bio-succinic acid are already on the market. Mader (Lille, France), the leading producer of paints and coatings, recently launched a range of biobased paints using Biosuccinium under the CAMI brand. The CADÉLI range includes two EU Ecolabel-certified products with extra functionalities: anti-microbial interior paint and depolluting (anti-formaldehyde) interior paint.

Both of the paints are 98 % biobased and use a combination of Biosuccinium and Roquette's POLYSORB isosorbide. The formulation allows for specific physical properties, such as hardness and scratch resistance. ❏

Bio-succinic acid-Reverdia & Wageningen UR have developed durable PBS based on Biosuccinium. Picture courtesy of RPC Promens



Going the distance

Whether for footwear, furnishings, packaging or paint, industry leadership is crucial for biobased plastic to compete with traditional petro-based products. New materials must be competitive and provide enhanced product specifications while also delivering sustainability advantages. Many modern materials derived from bio-succinic acid can outperform petro-based equivalents. With further incentives and industry buy-in, they can provide a significant impact.

This is why Reverdia works with brand owners and manufacturers towards truly sustainable products. It will keep building on its partnerships to co-develop innovative high-performance solutions throughout the value chain. Brand owners, original equipment manufacturers and chemical companies are becoming increasingly aware of Biosuccinium's potential to unlock and mainstream sustainable products. ■

 www.reverdia.com

Innovative biomaterials

Reverdia has been enabling innovative biobased materials since 2010. A joint venture between Royal DSM, the Dutch global Life Sciences and Materials Sciences company and Roquette Frères, the French global starch and starch-derivatives company, Reverdia was created to produce and commercialise bio-succinic acid, marketed under the brand name Biosuccinium.

Having opened the world's first dedicated, commercial-scale biorefinery for the production of renewable succinic acid in 2012, Reverdia supplies worldwide. Its production plant in Italy continues to use a patented fermentation technology with a best-in-class environmental footprint.

Biosuccinium is a biobased alternative to traditional diacids used in the production of plastics and other materials. Thanks to its biobased content and Reverdia's game-changing technology, bio-succinic acid has a carbon footprint which is half that of petro-based succinic acid and up to 90% lower than adipic acid.



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