



ENABLING BIO-BASED PBS

INTRODUCTION

BIOSUCCINIUM[®], a 100% bio-based succinic acid, enables the production of a (partially) bio-based PBS (polybutylene succinate) with a substantially reduced carbon footprint. PBS is a biodegradable polymer that can be used as a single polymer or in compounds for both durable and biodegradable applications.

A UNIQUE RENEWABLE RAW MATERIAL

A 100% bio-based alternative to traditional chemicals

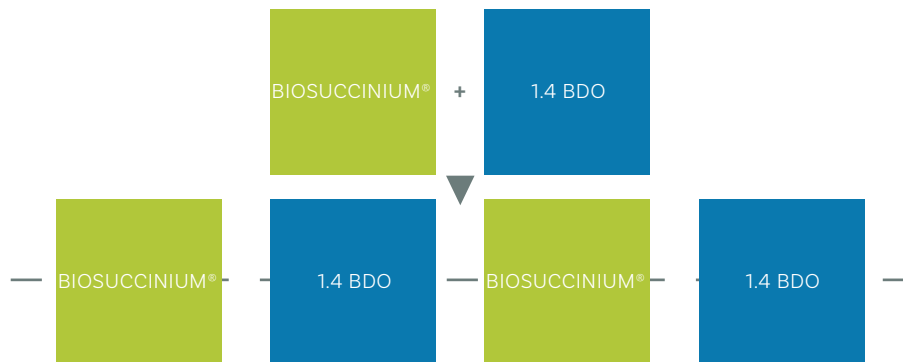
BIOSUCCINIUM[®] sustainable succinic acid is produced from renewable, plant-based resources which are converted via a unique low pH yeast process, a biotechnology process. BIOSUCCINIUM[®] offers an alternative to chemicals such as fossil-based succinic acid and adipic acid, which are commonly used for the production of aliphatic (biodegradable) polyesters.

BIOSUCCINIUM[®] IN PBS

Good flexibility, heat resistance, excellent processability and short cycles

The term “biopolymers” refers to polymers that are bio-based or biodegradable, or both. Most of the biodegradable biopolymers available today are aliphatic polyesters, manufactured from diacids and diols. PBS made with BIOSUCCINIUM[®] is biodegradable and (partly) bio-based. BIOSUCCINIUM[®] can be used in combination with 1,4-butanediol to produce PBS, poly-butylene-succinate (figure 1).

Figure 1: BIOSUCCINIUM[®] succinic acid enables the creation of a more sustainable, (partially) bio-based PBS



BIOSUCCINIUM[®] can also be combined with other monomers which allows for the production of a wide range of copolyester with diverse performance characteristics. For example, PBSA can be formed by combining BIOSUCCINIUM[®], adipic acid, and BDO, or PBST can be formed by combining BIOSUCCINIUM[®], terephthalic acid, and BDO.

Table 1 shows a comparison of PBS versus a selection of alternative bio-based and fossil-based polymers.

Table 1: Indicative performance comparison of a selection of biopolymers and fossil-based polymers

Property	Units	PBS	a-PLA	c-PLA	PBAT	PE-LD	PE-HD	PP	PS
Morphology semicrystalline - amorphous	-	SC	A	SC	A	SC	SC	SC	A
Melting temperature	[°C]	115	-58	>150	-115	110	130	165	-
Heat Deflection Temp-B	[°C]	85	55	<100	40	50	75	105	90
Tensile modulus	Mpa	550	3500	3500	80	200	1000	1500	3000
Tensile elongation at break	%	300	3	2	600	400	150	150	1.6
Processability	-	fast	fast	slow	fast	fast	fast	fast	fast

PBS-BASED COMPOUNDS

Ability to match application requirements

PBS can be used as a stand-alone polymer or in compounds to optimize physical properties for both biodegradable as well as durable applications. PBS is commonly used in compounds with PLA and/or starch, to improve flexibility, reduce brittleness, increase heat resistance and/or tune rate of biodegradation.

Figure 2 shows the position and possible role of BIOSUCCINIUM® and BIOSUCCINIUM® based polymers in the value chain.

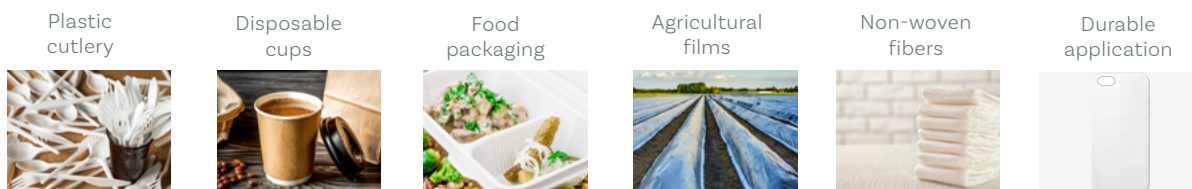
Figure 2: BIOSUCCINIUM® plays a key role in the value-chain



APPLICATION POTENTIAL

PBS allows for a wide range of applications (see figure 3).

Figure 3: PBS finds potential uses in a broad range of applications



HOW TO ORDER BIOSUCCINIUM®

Production

BIOSUCCINIUM® is available in commercial quantities from the first large scale commercial production plant, located in Cassano, Italy. Samples for evaluation are available, as well. The biotechnology process to produce BIOSUCCINIUM® was developed by Reverdia, a joint venture between DSM and Roquette. Since Reverdia's dissolution in April 2019, Roquette now manufactures and sells BIOSUCCINIUM® under licence from DSM. Please contact Roquette at www.roquette.com for more information.

USDA CERTIFICATION

Roquette has earned the U.S. Department of Agriculture (USDA) Certified Biobased Product label. The product, BIOSUCCINIUM® succinic acid, is now able to display a unique USDA label that highlights its percentage of biobased content. It shows that BIOSUCCINIUM® contains 100% USDA certified biobased content.



* Registered trademark(s) of Roquette Frères. The information contained in this document is to the best of our knowledge true and accurate but all instructions, recommendations or suggestions are made without any guarantee. Since the conditions of use are beyond our control, we disclaim any liability for loss and/or damage suffered from use of these data or suggestions. Furthermore, no liability is accepted if use of any product in accordance with these data or suggestions infringes any patent. No part of this document may be reproduced by any process without our prior written permission. For questions about a product's compliance with additional countries' standards not listed above, please contact your local Roquette representative.


ROQUETTE
Offering the best of nature™

www.roquette.com